House of Energy

International Forum Frankfurt

TOWARDS A SECURE ENERGY SUPPLY IN A NET ZERO EMISSION SOCIETY

January 23-25, 2023 | Clubhaus Germania | Frankfurt am Main

With the support of

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HESSEN Hessisches Ministerium für Wirtschaft, Energie, Verkehr und Wohnen

Proceedings of the 1st International Forum

TOWARDS A SECURE AND RESILIENT ENERGY SUPPLY IN A NET-ZERO-EMISSION SOCIETY

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Funding for the Forum was provided by the United States European Command, Stuttgart, Germany and House of Energy, Kassel, Germany.

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Executive Summary

This International Forum, *Towards a Secure and Resilient Energy Supply in a Net Zero-Emission Society*, was convened In Frankfurt, Germany on January 23-25, 2023. The Forum was organized by the U.S. Army Engineer Research and Development Center, Champaign, IL, USA, and the House of Energy e.V. Kassel, Germany, and was hosted by House of Energy e.V. This International Forum brought together more than 120 experts from Austria, Denmark, Italy, the Netherlands, the United Kingdom, and the United States of America to initiate conversations among key stakeholders regarding ways to establish a secure energy supply in Europe, to limit climate change, and to provide a basis that supports a net zero emission society.

This Forum was designed for personnel in state and local governments and defense agencies that are responsible for shaping energy policy, fostering cross-sector strategies, and forming future building codes, legal frameworks, taxes, and rebates; for engineers and scientists dealing with advanced energy technologies and systems; and for energy planners tasked with developing resilient, environmentally friendly, cost-effective energy solutions applicable at the municipal level, at local military, commercial, and residential community levels. Participants included representatives from energy utility companies that provide energy to regions, cities, and local communities; energy performance contractors; architects; and equipment manufacturers, who shared their unique insights. A key feature of the forum was the transdisciplinary exchange between experts with military and civil background on the sustainable, secure and resilient energy supply of buildings.

Over the 3 days of the Forum, participants shared information and discussed strategies, technologies, business and legal approaches to address current energy-related challenges in Europe, with an emphasis on Germany. The discussions were structured around six sessions:

Session 1: **Strategies toward Net Zero Emission Future and Energy Security** – Gaps to be bridged and challenges to be overcome (from the perspective of industry, civilian, and military sectors).

Session 2: **Building- and Community-Level Solutions** – Codes, standards, and technologies for newly built and existing buildings.

Session 3: **Sustainable Communities and Regions** – Case studies

Session 4: **Current and Future Utility-Level Solutions** – Challenges, tasks, options, and strategies.

Session 5: **Implementation Strategies** – Business models, legal constraints, data security, planning, guiding, and monitoring energy transformation.

Session 6: **Guidelines and Tools for Energy Master Planning toward a Resilient and Net Zero Energy Supply**.

Introduction

Industrialization starting at the end of the 19th century increased the overall welfare of human beings and contributed to economic growth, political stability, and overall development and security of other sectors such as agriculture and manufacturing. The World Health Organization (WHO) has shown that access to clean, sustainable, and affordable energy plays a crucial role in advancing health.[1] Energy is also critical for achieving nearly all other global goals that include eradication of poverty, opportunities for quality education, access to clean water, job security, economic growth, and combat of climate change.

Most of the development took place in the "Western Hemisphere" and was based on the large-scale use of fossil fuels. Today there is a sufficient amount of energy coming from different sources (fossil and renewable energy [RE] sources), but a secure energy supply from multiple sources has been disrupted for Europe and potentially might be the case for Asia in the future. In the short term, it affects the well-being of the population, and the economy of counties with industry and transportation heavily dependent on readily available and cheap energy. It also affects the geopolitical situation and political choices of the countries affected.

The increase of carbon dioxide concentration in the atmosphere causes global climate changes. According to the analysis of the World Resources Institute about 75% of global greenhouse gas emissions are linked to energy, while the remaining 25% is connected to nutrition for a growing global population.[2]

Energy-Related Challenges in Europe

Through the Forum presentations and discussions, participants identified the following current major energy-related challenges:

- Energy Supply Security
- Energy System Resilience
- Climate change mitigation
- Operating/energy cost control.

Energy Supply Security

The International Energy Agency (IEA) defines energy security as the reliable availability of energy resources at an affordable price. To achieve energy security, a country must have access to a reliable and diverse mix of energy sources, including fossil fuels, nuclear power, and renewable energy.

Countries may be divided into three groups: producers/exporters, who wish to ensure reliable demand for their commodities (e.g., Organization of Petroleum Exporting Countries [OPEC] countries, Norway, USA); consumers, whose goal commonly is to diversify energy supply to maximize their security; and transit states (e.g., Ukraine and Turkey) that are the essential bridges that connect producers/exporters with their markets (Luft and Korin, 2009). A consideration of the goals of the various countries and stakeholders highlights two important concepts for energy security: security of supply (for the consumers), and security of demand (for the exporters). For energy-exporting countries, the security of demand is equally as important as the security of supply (Johansson 2013).

Diversification of energy sources is essential to energy security and allows operation without disruption of supply and shields consumers from exorbitant price rises. Nations that can supply all their energy needs and still maintain surplus energy resources, e.g., Norway, Russia, and Canada, are energy secure.

In 2000, the European Commission referred to energy supply security as "*the uninterrupted physical availability of energy products on the market, at a price that is affordable for all (private and*

[1] https://www.who.int/health-topics/energy-and-health#tab=tab_1
[2] https://www.wri.org/data/world-greenhouse-gas-emissions-2018

industrial) consumers, while respecting environmental concerns and looking towards sustainable development" (EC 2000). This extends the IEA definition to include environmental and sustainability issues.

In the 21st century, energy security is driven by the rising demand in Asia, disruptions of gas supplies in Europe, and the pressure to decarbonize energy systems (Yergin 2006, Hancock and Vivoda 2014). Moreover, in today's energy mix, Europe is increasingly dependent on gas imports, primarily from Russia and Norway. Beginning in 2005, the Russian Federation cut down the supply of gas to Ukraine on several occasions, on the premise that they were not ready to accept newly established prices. As a result, the supply of gas to western European countries was also shortened. The Russian-Ukrainian crises showed that the main supplier of natural gas to the European Union (EU) was not only unreliable but was also capable of using energy resources as a geopolitical weapon.

In addition to the diversification of energy sources, an important element of energy security is the reliability of energy distribution.

Energy Distribution Chain Vulnerabilities

Security and government officials around the globe are concerned about the vulnerabilities of critical infrastructure, which includes energy distribution. There are three classes of threats to critical infrastructures (Tal 2018):

1. **Natural** – Earthquakes, tsunamis, land shifting, volcanic eruptions, extreme weather (hurricanes, floods, droughts), and fires.
2. **Human-Caused** – Cyber-attacks, terrorism, explosions, and bombing.
3. **Accidental or Technical** – Infrastructure and hazardous material failures and accidents, power-grid failures, safety-systems failures, and a host of other disasters of omission and/or commission.

On March 5,2019 there was no blackout, and it's not even clear that it was a specifically targeted attack, but hackers did use firewall vulnerabilities to cause periodic "blind spots" for grid operators in the western US for about 10 hours. It is the first known time a cyberattack had caused that kind of disruption. The incident was originally referenced in a Department of Energy report in April 2019, but only in vague terms. A new North American Electric Reliability Corporation document described it in more detail, including the type of vulnerabilities that let hackers compromise the web portals in question.

On February 19, 2020, a cyberattack on a U.S. natural gas compression facility highlighted longstanding concerns that some pipeline operators are not deploying best practices to foil hackers. The attackers gained access to information technology systems, infecting them with ransomware that subsequently infected operational technology systems, including those that control industrial systems in factories, plants, and infrastructure.[3]

On May 7, 2021, Colonial Pipeline, an American oil pipeline system that originates in Houston, Texas, and carries gasoline and jet fuel to the Northeastern United States, suffered a ransomware cyberattack that impacted computerized equipment that manage the pipeline.

On September 26, 2022, a series of clandestine bombings and subsequent underwater gas leaks occurred on the Nord Stream 1 and Nord Stream 2 natural gas pipelines. Both pipelines were built to transport natural gas from Russia to Germany through the Baltic Sea, and are owned in great part by the Russian majority state-owned gas company, Gazprom. The true identities and the motives of those responsible for the sabotage remains an issue of debate.

In 2022, there were 163 direct physical attacks on the U.S. electric grid, according to data from the Department of Energy, a 77% increase from 2021.[4]

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[3] https://www.helpnetsecurity.com/2020/02/19/gas-pipeline-ransomware/
[4] https://democrats-homeland.house.gov/imo/media/doc/letter_to_dhs_electrical_facility_attacks.pdf

Fixing natural gas supply chain issues by replacing natural gas with liquefied natural gas (LNG) is limited by the available capacity to transport LNG around the world due to a lack of shipping capacity, terminals, and connecting pipelines. Achieving energy security is a complex challenge that requires a coordinated effort by government, industry, and consumers. This nexus of rising energy prices, increased demand for energy, and disruption of existing supply chains, highlights the critical need to define energy security and clearly delineate ways to achieve it. NATO countries' military installations have unique requirements for energy security and must quickly adapt to changing requirements resulting from the military aggression of the Russian Federation.

Energy Systems Resilience

Energy resilience is defined as the ability to prepare for and recover from energy disruptions that impact mission assurance (DoD 2020). The resilience of the energy system impacts the primary functions of military installations, hospitals, and education campuses during disruptions. Throughout the history of energy systems, major disruptions of energy supply (both electrical and thermal) have degraded critical capabilities and caused significant social and economic impacts on private and public communities. Therefore, resilience must be an integral goal of the community-wide energy master planning process, and the application of energy resilience principles is important during the design of new energy systems and upgrades to existing systems. Best practices for resilient electric and thermal energy systems favor the use of installed and operating energy sources over emergency generation for short durations; promote the use of multiple, diverse sources of energy; and favor local energy resources that originate within the community/country.

Energy Cost Control

In 2021 the unreliable gas supply from Russia spurred a 600% increase in European gas prices. The price of wholesale gas has caused several smaller energy providers in the UK and Italian markets to collapse and has halted production in some industries.

Climate Change Mitigation

Rising temperatures, changing precipitation patterns, and more frequent, extreme, and unpredictable weather conditions caused by climate change are worsening existing security risks and creating new challenges for the United States and its allies and partners (O'Neill 2022). The European Union and the United States are striving to limit climate change by establishing ambitious policies at home and by closely cooperating with international partners to cut greenhouse gas emissions by at least 55% by 2030 to become climate-neutral by 2050.

Interrelations between Challenges, Scale, Priorities, and Scope

Climate change mitigation and challenges to energy systems' resilience are related and global, while the issues of energy supply security and control of operating costs are regional. The Russian/Ukraine war has dramatically changed the local marketplace in both the West and the East with differing implications for both markets. In the West, gas prices are anticipated to remain high until at least 2026 (Mackenzie 2022) due to the change of energy suppliers, bottlenecks, and the additional costs of LNG transportation, while in the East, those that are willing to procure energy from Russia are obtaining gas and oil at lower than what would have been normally prevailing rates. From a climate change perspective, global emission increases due to more coal use in the West as well as the war are impacting climate change across the whole globe.

Each of these individual challenges can be addressed separately or in a holistically structured way. For example, while readily available coal may provide a cheap solution to address energy supply security and reduce high energy costs, expanding coal usage will not support a roadmap to society's decarbonization and will not support energy system resilience. LNG can provide an alternative to piped natural gas but will require significant investments into LNG transportation and conversion, which will divert significant funds from investment in renewable energy.

From a practical point of view, each challenge will be characterized by its own urgency, timeframe, and scope of loads/buildings under consideration. Energy supply security and cost control can be considered as short-term objectives that shape the geopolitical mix, that impact national economies, and that affect the well-being of the population. Energy system resilience may be seen as a mid-term (2-5 year) objective, and planning for climate change mitigation must start immediately and be implemented throughout the longer term to meet established goals by 2045-2050.

When considering the mission-critical buildings and types of systems that must be addressed to meet energy system resilience requirements, one must assume that the event causing loss of power or thermal energy to the building is due to a natural or a man-made act for a relatively short period of time (between few second to few days), and that there will be the emergency capability to support critical missions during this period of time.

By contrast, energy supply security, caused by periods of power and thermal interruption due to geopolitical or other reasons, can last much longer (months to years); and such interruptions demand an approach to provide power and heating/cooling to all or a part of the installation, which may be greater than the subset of mission-critical facilities needed to sustain operations.

The long-term objective to mitigate climate change is to reduce energy loads and decarbonize the remaining energy supply options for the entire building stock, transportation and process loads.

To achieve all four objectives (supply, resilience, security, and climate change mitigation) in a cost-effective and timely manner requires a holistic approach. The core and common element in achieving all four energy-related framing goals is energy efficiency, which reduces the amount of fuel required, the size and cost of systems, needed to meet the remaining loads, the amount of emissions generated, and operating costs. Energy security for DoD installations, in the European/Asian regions, can be achieved by replacing Russia-originated fuels with alternative fuels and/or renewable energy sources, eventually transitioning to 100% energy from renewable energy sources. Most of the measures supporting energy supply security will enhance energy system resilience and will provide a smooth transition to a net zero emissions society.

Energy Planning To Address Near-Term and Long-Term Energy Challenges

Benchmarking – Load vs. Supply

The starting point for any energy program is an accurate benchmark of the facility or site from a load perspective. Traditionally, benchmarking has focused on energy supply rather than load. Accurate benchmarking of the various loads requires significant effort in sorting through a myriad of data, but it is only benchmarking of the load that allows for accurate forecasting of proposed building-level energy conservation, storage, or fuel-switching technologies. Utility-level solutions can only be considered after building-level solutions have been assessed. It should be noted that building-level solutions also need to recognize local utility infrastructure delivery and capacity capabilities.

Reducing energy load and/or demand for existing facilities historically has been the focus of many energy service agreements, which have concentrated on standard conservation measures such as upgrades to lighting, appliances, and heating, ventilating, and air-conditioning (HVAC) equipment. In the current energy climate, reducing energy demand requires that one go beyond traditional equipment efficiency improvements by reducing facility loads through envelope upgrades, optimized equipment operating strategies, repairs/upgrades to energy distribution systems, and the use of load shifting through energy storage or fuel switching. Resource security is more influenced by reducing load use than by implementing advanced supply measures. From this perspective, efficiency measures at a facility when considering energy generation efficiencies and distribution system losses, can have a 3 to 1 payoff in supply security – saving a million kWh/Btus at the load can save 3 million kWh/Btus of fuel use and storage.

There is a need to revisit the building and energy systems standards and codes and methods of life cycle cost (LCC) analysis, which are based only on reducing energy and maintenance costs. In a holistic approach, energy system resilience and the last phases required for addressing climate change mitigation (energy storage, green fuels, etc.) will be considered when investing in energy systems efficiency and waste utilization. The scope of energy projects (individual buildings vs. building clusters, vs. cities, vs. the whole nation, vs. the continent) must be optimized so that electrification of energy systems in some regions does not place a burden on the entities (regions, states, countries) where this power is generated.

Site Energy vs. Source Energy Considerations

A move away from the traditional site energy-based analysis, toward an accounting for source energy resource utilization and related emissions of all energy streams, is critical to efforts to achieve energy security, clean air and decarbonization. This will more properly identify the need for, and the benefits of, new technologies and efficiency improvement approaches.

Recognition of actual energy requirements, utilization, and availability at the source for end-users inside the fence is vital to ensuring mission capability and to informing energy managers on how best to ensure energy security. This also allows planners to technically and cost-effectively combine the best available technologies in electric and thermal microgrids to provide facility energy and mission-critical support. In many regions, decarbonization efforts have resulted in a mandate to reduce fossil fuels in power generation, while also electrifying end uses such as space heating. While these goals appear to lead to a reduction in emissions from both the grid and buildings, the results have in fact been somewhat different. In New England where natural gas is being discouraged as a power generation resource, the New England Independent System Operator (ISO) has shown that as additional resources are needed, they have actually become more reliant on oil and even some coal to maintain system stability (Figure 1). While renewable energy generation is growing, it is not always incorporated as a dependable capacity resource, such that the ISO may be forced to dispatch high emissions units when renewable generation is lower than projected. Supply constraints in Europe have produced similar outcomes as supplies of Russian natural gas dwindle, there has been a return to coal mining in Germany. While some may see these increases in high-emission fossil fuel use as anomalous ‘blips’, note that the United States has not yet begun its planned electrification of heat on a wide scale, which is likely to significantly increase U.S. wintertime grid demand at a time when Solar PV output is at 50% of nominal summer output in cold weather climate zones.

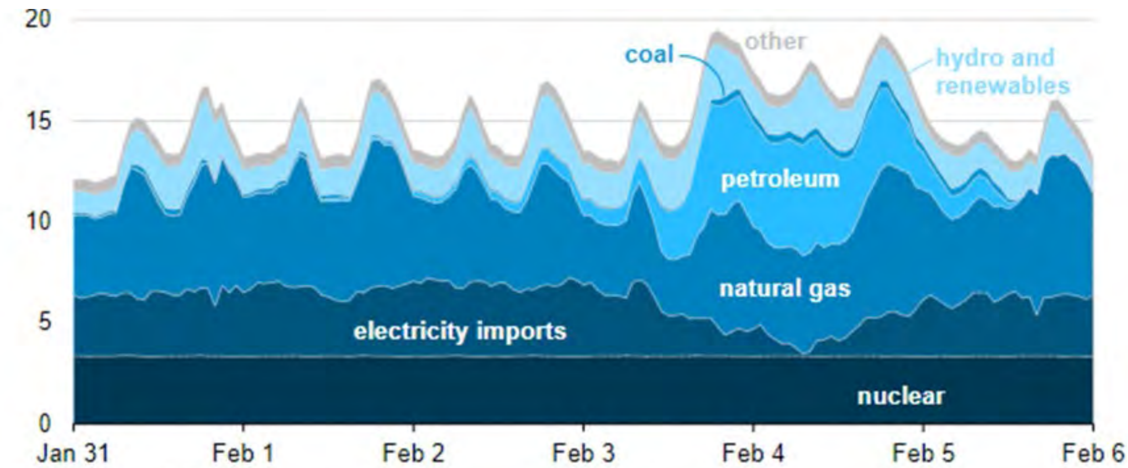
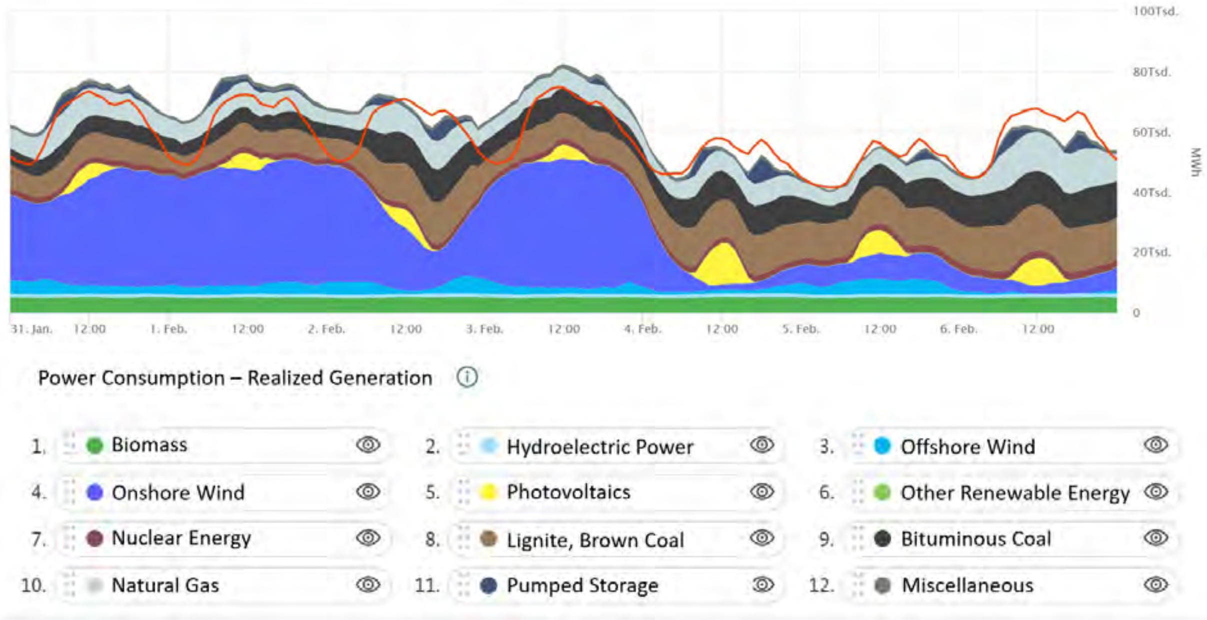


Figure 1. New England ISO Electricity Supply by Source Energy Jan 31 – Feb 6, 2023 (US EIA).

Figure 2 shows a chart of electricity supply in Germany over the same time.



Source: https://www.smard.de/

Figure 2. German Electricity Supply by Source Energy Jan 31 – Feb 6, 2023 (SMARD).

Technology Solutions To Be Considered

The first category of technical solutions includes those that focus on energy efficiency improvements during new construction, major and minor building renovation, and energy waste repurposing. These contribute to achieving the four energy goals stated above. Projects in this category implemented in Europe have to comply with the host nation minimum requirements. For example, in Germany mandatory requirements are specified in GEG (Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden – Law on saving energy and using renewable energies for heating and cooling in buildings, http://www.gesetze-im-internet.de/geg/). Appendix …. Presents the flowchart summarizing the GEG. Additionally, a few states have adopted laws mandating renewable energy as part of building construction and renovation projects.

For U.S. military installations projects executed in Europe shall consider the most stringent between the host nation requirements and 10 CFR Part 433 Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings. ebaudeenergiegesetz (GEG – German building energy law that includes requirements for reducing energy consumption and increasing renewable energy).

To effectively decarbonize the power grid without undue risk to the mission, an integrated approach to energy demand reduction, supply security, and supply decarbonization must be devised and implemented to include integrated technology solutions. These systems are expected to include grid electricity and outside-the-fence fuel supplies where cost-effective, and to complement decarbonizations efforts by using applicable on-site energy resources, including:

1. Photovoltaics
2. Solar thermal
3. On-site wind
4. Battery Energy Storage Systems
5. Thermal Energy Storage (diurnal and seasonal)
6. Combined Heat and Power (CHP) (natural gas, biofuel, biomass, H_2, jet fuel, blends)
7. Geothermal
8. Geoexchange

9. Heat Pumps.

Increased reliance on on-site (inside the fence) energy supply (electricity and thermal energy to serve optimized loads) for long durations (minimum 7 to 14 days) is necessary to ensure mission readiness as the electric grid shifts to more intermittent sources of supply and as fossil fuels are phased out in favor of more limited supplies of biofuels and other energy sources.

While recent European energy strategies have included optimal cost-effective zoning of district heating (DH) and gas grids (1979-2020) and the replacement of fuel oil with natural gas, the 2021-2030 strategy is to replace oil/gas boilers with district heating systems (DH) or heat pumps. According to these strategies, the optimal energy generation and storage options for many new solutions benefiting from economy of scale and includes:

- Use of CHP potential- no power-only generating plants, use of biomass and synthetic natural gas CHP for base load, use of natural gas at low fuel prices, transition to hydrogen-based fuels when they become available, use of CHP as a clean dispatchable resource to support intermittent renewable energy supplies.
- Full use of waste-to-energy potential.
- Use of seasonal gas storage.
- Use of electric boilers in DH when there is surplus wind energy (to balance the power grid) or to supply local electrolyzers to make, use and store hydrogen as a fuel source.
- Use of large heat pumps in low temperature DH, cascade heat pumps to achieve higher temperatures where cost effective.
- Use of low temperature heat sources from data centers, district cooling, deep geothermal, and wastewater.
- Use of large heat storage tanks and pits for leveling daily, weekly, and even seasonal fluctuations.
- Use of large, chilled water tanks for optimizing the use of electricity for cooling and as back-up for critical cooling loads.
- Use of ground source heating and cooling.

Thereby many of these existing District Heating and Cooling (DH&C) systems in cities or campuses combining large heat pumps, electric boilers, CHP and storages demonstrate that they respond on electricity prices as if there was installed a huge electric battery – referred to as a virtual battery. These DH&C offer resilient, low carbon and clean thermal energy.

Further development for 2030 includes the following generation, storage, and infrastructure:

- Wind and solar energy will be the primary renewable energy source, followed by waste, biogas, and biomass.
- Distribution of 70% of the market to DH, 30% to building-level heat pumps.
- Use of district cooling (DC) in campuses and business districts.
- Use of gas (upgraded biogas, synthetic gas) for industry, CHP peak capacity and DH peak boilers (but no individual gas boilers for heating).Use of seasonal thermal storage for DH.
- Use of thermal storage tanks for DC.
- CO_2 capture from waste and biomass CHP plants and use of surplus heat for DH. Electrolysis for generation of H_2 from wind and use of surplus heat for DH and for up-regulation (by disrupting a constant demand with short notice).

European energy plans for 2030 include sector integration of:

- Biomass and waste CHP to be used for baseload of power and heat, and electric boilers in case surplus electricity generated from wind energy.

- Large heat pumps for combined heating and cooling harvest of surplus heat from industry and ambient heat.
- Large electric boilers that harvest surplus wind energy and deliver voltage and/or frequency regulation to the market and to local power grids so there is no curtailment of wind and solar power generation. With storage, this allows for excess renewable generation to be used to curtail demand when the grid is constrained.
- Sustainable forestry that delivers timber to buildings and waste wood from forestry and industry for use in DH.
- Timber, which replaces concrete, steel, and plastic in buildings.
- The sustainable agriculture and food industry, which delivers wet biomass for biogas production.

European energy strategies in a wider scale beyond 2030 include:

- CO_2 capture from waste incinerators, biomass boilers, and biogas; and surplus heat delivered to the DH.
- CO_2 infrastructure grid will distribute CO_2 from plants to fuel factories, for food processing and on-shore and off-shore storage facilities.
- Electrolysis plants will produce H_2 and surplus heat for DH (providing additional power when there is a shortage in power generated from renewable energy sources and that results in high power price).
- H_2 infrastructure will distribute H_2 from electrolysis plants to large consumers (but not to small boilers).
- Fuel factories will combine H_2 and CO_2 to generate renewable fuels (P2X) and deliver surplus heat for DH.
- Some European countries and the United States are considering using small modular nuclear reactors (SNRs). First US SMR is to be online in 2029 at 462 MW of capacity.

Transitional and Future Fuels

All energy generation technologies show an interaction with and have an impact on the environment. Green energies can be considered as domestic energy sources and thus also have a national strategic dimension.

However, a choice of transitional fuels (e.g., LNG, LPG, diesel) needed for energy security supply today must be selected so that their use today shall be guided by a common infrastructure that supports short-, mid-, and long-term goals.

Thermal and power storage is a critical tool in the overarching architecture, in that it allows the use of intermittingly generated energy, energy available during certain periods of time (e.g., wind, solar), or energy waste streams from industrial processes, when needed.

Digitization (the use of “smart” digital technologies) helps reduce energy demand by identifying opportunities for increases in efficiency and by helping to stabilize the energy system in a specific time and place.

The energy supply system of the future will be multi-focused with a heavy emphasis on electricity for light transportation and commercial buildings. However, it will not be an electricity-only system. Energy-dense transportation systems such as airplanes, trucks, buses, and trains may rely on hydrogen or renewable fuels to meet their requirements. Military installations, industry, and urban areas will likely use district heating and cooling systems with long-term thermal energy storage for areas with a high demand density. Efficient electrically-driven heat pumps and water source heat pumps for standalone and networked buildings will be used. It will be essential to have clean dispatchable power in the future for electric grid stabilization, security of supply resilience and economics. Today, renewably fueled CHP appear to be the best suited solution available to produce low/no carbon dispatchable power. Digitalization becomes an indispensable element; however, cyber vulnerabilities will have to be addressed with all these systems.

Implementation Strategies

We must recognize the physical and fiscal limitations involved in transitioning to a renewables-based energy economy. Our existing energy infrastructure has evolved over 100+ years and investments in a new infrastructure will take time. Recognizing these limitations, we should jointly develop and proceed with realistic approaches to an energy transition. In partnership with the private sector, governments should set the direction and develop transition plans to enable a common approach with shared responsibilities.

New energy supply, distribution, and storage systems, and new energy-related requirements for buildings and processes call for new methods of funding and implementation of energy-related projects, new business models, and taking full advantage of existing but underutilized existing financing mechanism (e.g., energy saving performance contracts), better coordination of the execution of these projects, and collaboration between end-users and utility companies in financing, construction, operation of systems and in energy procurement. Interpretation of current laws and improving contracting mechanisms is an urgent topic that must be addressed. Legal frameworks, energy regulations, and market models must be reviewed in light of required/proposed changes.

Forum session 6 discussed Energy Master Planning to achieve community, national, or international energy goals. The scope of the Energy Master Plan (EMP) can be broad; it may include new construction, demolition, and consolidation projects; energy supply; and energy distribution and energy storage components, including creative methods to build innovative site-to-grid arrangements that may provide grid stability or site resilience. An EMP is not limited to energy-related projects; it may include a spectrum of non-energy-related projects, including new building construction and demolition; utility modernization projects; non-energy-related measures to improve energy supply security and to enhance the resilience of energy systems such as the elevation of energy equipment, construction of flood walls, and burying of cables. In most cases, an EMP covers multiple interrelated projects where the outcome of one project or a group of projects influences one or more other projects. For example, building efficiency improvements impact the size of required energy generation capacity; thermal energy supply to a new building requires installation of a pipe connection to an existing district system; and connection of additional buildings to a hot water district system allows for an increase of CHP base load. Low temperature heating systems in buildings allow using low temperature DH which opens for more efficient distribution and use of low temperature heat sources. Therefore, the selection of alternatives for an EMP must be based on the cost-effectiveness of the entire EMP instead of individual projects that comprise the EMP. It is possible that some individual projects will not be cost-effective when considered separately.

In general, many public and government agencies and communities usually provide insufficient funding and staff capacities to carry out complex EMPs over time. The use of energy performance contracts or a combination of the appropriated fund with third-party financing is well-established in the United States but is less known in Europe, especially in the public sector, where it could support the implementation of EMPs.

The local community owned DH and power grids (consumer cooperatives or municipal owned public utilities) in Denmark are examples of the drivers for the collaboration among key stakeholders which support the development of cost-effective solutions that are financed 100% by low-cost credits. So, the energy sector in Denmark can be developed to the benefit of the society and the consumers without help from energy services companies (ESCOs) or similar third-party financing.

Likewise experience from many countries, including the USA (e.g. Stanford University and Princeton University) demonstrates that campuses that have one owner are able to plan and implement efficient resilient solutions for DH&C.

Different types of energy saving performance contracts that allow the government agency/service branch to implement projects with or without up-front funding were discussed during the forum. Under energy saving performance contracts, a private sector ESCO provides turnkey services for project design, equipment procurement and installation, financing, and measurement and verification; the ESCO guarantees the savings; and the ESCO is repaid through the resulting energy cost savings over the life of the contract, which can be up to 25 years. By U.S. law, the annual energy and operational cost savings must exceed the annual repayment costs. Energy performance contacts can be used to install a wide variety of improvements, including building envelope improvements (insulation, air sealing, windows); lighting; heating and cooling equipment and controls; retro-commissioning; water efficiency; solar photovoltaics (PV) and thermal (hot water); CHP; battery storage; microgrid controls; and other resilience measures. Available DOE energy performance contracting methods are ESPC, ENABLE, and Utility Energy Service Contract (UESC). ENABLE, with an expedited 6-12 month period for the project award, is considered particularly relevant to the near-term needs in Europe as a consequence of the war in Ukraine and the requirement to reduce the use of Russian gas (by contrast, ESPC projects were described by several presenters as requiring 24-30 months). A UESC would also be of value, as it entails contracting with the serving utility rather than ESCOs. Although there are no "guaranteed" energy savings, a UESC can have the same measurement and verification (M&V) requirements as other contracting methods; currently, the utility is contracted under a General Services Administration (GSA) area-wide contract that does not include Europe. (Note that it is possible to contract with any serving utility even outside of a GSA contract, but GSA is easier.)

Energy performance contracts can leverage other funding sources including available government funding such as the DoD's Energy Resilience and Conservation Investment Program (ERCIP), utility rebates and incentives, grants including DOE's Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) grant ($13 million available through February 28, 2023, $250 million in upcoming Bilateral Infrastructure Law funding). The grants can be used to provide up-front funding to buy down the amount that needs to be financed and/or to add efficiency and resilience measures that wouldn't otherwise achieve the necessary positive cash flow. AFFECT grants can be used to implement Deep Energy Retrofits that reduce energy costs by 40%. The previous AFFECT restriction on Outside Continental United States (OCONUS) sites was removed, and OCONUS projects are now being encouraged.

Power purchase agreements (PPAs) provide a Design-Build-Operate-Maintain arrangement with the contractor, under which energy generating equipment (e.g., PV or CHP), chilled water, or steam is installed, owned, and maintained by the private sector partner (ESCO or utility), which sells the electricity produced at a defined cost per kWh. DOE offers an Energy Sales Agreement (ESA), under which the PPA is included in an energy performance contract, which allows the private sector partner to take advantage of available tax credits, thereby lowering the cost of the delivered electricity to the government.

Another business model discussed was Enhanced Use Leasing, under which land is leased by the land owner; lease payment is often made "in kind." A central plant and/or microgrid is built – typically power– which is sold to the local utility or the landowner or both.

For projects using any of these business models to go forward, projects in Europe must comply with NATO SOFA, including ABG 1975 in Germany, which requires meeting German laws and regulations in a variety of specific requirements. Project sites and ESCOs must be familiar with the host country's legal requirements. Examples include the nationality of contractors who may perform construction, repair, maintenance, security, and other services. Additional considerations include zoning, safety, building codes, construction and environmental laws, energy and renewable energy supply, and sales of excess energy to the grid, taxes, and related permitting requirements concerning HVAC, controls, building envelope, water heating, and other codes and standards. In Germany, German law generally applies, e.g., construction, environment, RE, CHP, grid connection, etc. Permits must be obtained by German officials on behalf of United States; exemptions apply for direct construction up to $1.2

million. For these considerations, there is a need to identify what level of approval or consultation is needed with host country authorities.

A potential constraint in Germany is that energy generated on site (e.g., renewable energy) that is not used on site must be sold to the market with associated taxes e.g., VAT and business taxes. An exception applies if the renewable energy implementation is done by the local utility. This constraint would also apply to ESCO ESAs, which would need to meet German and U.S. contracting requirements, and would require advance consultation with German authorities.

Legal Challenges and Procedural Obstacles

Current approaches to investment in energy systems and implementation procedures in Germany and other EU host nations are based on a historical approach to meeting energy demands with fossil fuels. If the U.S. Forces (USF) want to quickly transition away from fossil fuels and especially fossil fuels derived from Russia, we must apply new concepts and solutions.

Military installations have unique requirements but could also help energy transformation in the neighboring communities; they often represent sizable areas without civilian residential structures. Their potential for installing renewable energy sources should not be left unused.

The time it takes to design, permit, and construct projects, however, is too long to meet today's challenges. An expedited realization of modern energy projects using energy supply contractors requires amendment of the existing rules and procedures and faces legal challenges.

Significant challenges are for example:

1. Any construction on accommodation made available to the USF's use "shall be carried out by the (competent) German authorities in accordance with German legal provisions and administrative regulations in force, and in accordance with special administrative agreements" (see Art. 49, SA). This means, normally the ABG 1975 administrative agreement applies to all construction on USF installations.
    - Under ABG 1975 construction projects over $1.2M are normally done by the German authorities indirectly.
    - Larger modernization projects on existing structures will also likely qualify as construction. The "Kenntnisgabeverfahren" (notification procedure) for privileged defense projects applies (rather than the regular construction permit requirement). The notification procedure is governed in the respective State building regulations and is based on §37, par. 2 of the German Federal Building Code ("Baugesetzbuch"; BauGB), which substitutes the construction permit requirement under State building regulations with a mere approval decision by the higher federal construction authority for projects serving national defense. Additionally, it waives the requirement of obtaining consent from the local community administration.
    - Any construction on consigned land must be approved by BImA, the German federal real estate agency, which owns or leases all land consigned to the USF. Construction by third parties on federal land consigned to the USF outside the ABG1975 and the regulations applicable to federal construction, is currently not envisioned in the existing framework.
    - German authorities will have to agree to allow ESCOs to do construction under direct contracts with the USF on consigned land. When such agreements regarding direct projects are obtained, they will be subject to regular permitting requirements.
2. Energy produced on USF accommodation currently cannot be marketed off-post.
    - Large-scale production of renewable energy by the USF using facilities installed after 2016 with a capacity of more than 100mW currently requires a direct marketing of energy that cannot be consumed 100% or stored. This causes unacceptable taxation. It is currently not possible to feed energy into the public grid at one location and take it out of the grid at another location via an offset-type arrangement.

- BImA (Bundesanstalt für Immobilienaufgaben – The Institute for Federal Real Estate), the German federal agency that consigns land to the USF, currently does not allow excess energy produced on federal real estate by commercial contractors be sold to the public; this means that private companies are only allowed to operate energy facilities on USF installations if they are exclusively supplying to the USF.

The USF and host nation (HN) partners in the federal real estate administration, the construction administration, and the Ministry of Defence (MoD) need to discuss these challenges and find new solutions to enable the USF to make use of the full potential of modern energy contracting. Such solutions should provide for construction by private contractors on consigned land outside the ABG 1975, and should provide the ability to market energy produced on USF installations to the general public without tax implications for the USF.

HQ USAREUR-AF OJA (Headquarters U.S. Army, Europe, and Africa Office of the Staff Judge Advocate) is supporting the U.S. Army Corps of Engineers Europe District (CENAU) and IMCOM-E (Installation Management Command – Europe) with their efforts to implement new energy supply strategies. This office has reached out to various HN stakeholders to initiate a discussion of the above legal and procedural challenges. HN representatives have shown openness to discuss new solutions.

Conclusions and Recommendations

- The current major energy-related challenges in Europe include energy supply security, energy system resilience, climate change mitigation, and operating/energy cost control. From the practical point of view, there is a different urgency, timeframe, and scope of loads/buildings that must be considered in addressing each challenge.
- Addressing all four objectives in a cost-effective and timely manner requires a holistic approach. Enabling this holistic approach will entail determining the regional, host country and European Union's direction with regard to energy sources and supported infrastructure. This direction will allow us to focus our efforts and move forward in an efficient and sustainable manner.
- The core and common element in achieving all four energy-related framing goals is energy efficiency, which affects the amount of fuel required, the size and cost of systems, the amount of emission generated, and operating costs. New European nation-specific energy efficiency standards shall be used for new construction and major renovation projects. Training/information sessions for engineers and energy managers responsible for these projects shall be provided with an emphasis on new requirements.
- Building weatherization and retro-commissioning programs need to be established to address the scope and implementation strategies.
- Energy security for DoD installations can be achieved through diversification of energy sources and the replacement of Russia-originated fuels with alternative fuels and/or renewable energy sources with the following transition to 100% energy from renewable energy sources. Though the use of energy from renewable energy sources is preferable, the use of readily available fuels that can be procured using existing logistics (e.g., JP5, JP8, LPG, LNG) and stored at or near the installations can be considered for the near future.
- On-site thermal and electric energy generation using energy from renewable energy sources or transition fuels stored locally can increase energy security and energy systems resilience by providing an infrastructure that will be required to use "green" fuels.
- Most of the measures supporting energy supply security must enhance decarbonization and energy systems' resilience, and will provide a transition to a Net Zero emissions society.
- Energy master planning (EMP) for building communities is essential to identity and implement the most cost-effective solutions meeting the four goals, in particular for development of cost-effective zoning of DH&C grids.

- Energy Saving Performance Contracts are available now to allow for design, financing, and installation of a broad range energy efficiency and renewable energy measures with no up-front funding required. They can be used to implement quick payback measures such as lighting, building envelope (insulation, weatherization, air sealing, windows), retro-commissioning, and water/wastewater efficiency and can be bundled with longer payback measures such as high efficiency HVAC (including heat pumps) and controls, solar thermal and PV, CHP, district heating improvements, and resilience measures including battery storage and microgrid controls.
- Combined funding using appropriated funds and third-party financing can be used for achieving Deep Energy Retrofits with major renovation projects that reduce energy and operating costs by 40% or more.

Different available decarbonization strategies must be selected based on the specifics of each individual community/military installation, including existing and potential microgrids (thermal and electric), local utilities' strategies, legal constraints, etc.

The energy system of the future must take the local and regional situation into consideration. There is no "one system fits all" solution. The same technical component may yield differing performance depending on the place where it is installed. Therefore, the available portfolio of technical solutions must be adapted to specific regions. As a result, specific circumstances in one region combined with available technologies will establish the parameters for the regional system. International cooperation and exchange of experience will support the transformation of individual existing energy systems.

At the same time, it is important to recognize that the local, regional, and international energy infrastructure that supports the local systems must be planned, coordinated, and supported at all levels of government, and that investment must be made with a common end goal.

Additional working meetings are required to further discuss real and perceived legal limitations, to initiate collaboration between local utility companies, and to establish the use of energy performance contracting mechanisms for developing and implementing more comprehensive and advanced energy projects.

The formation of a joint technical and political group to address military requirements in NATO partner countries is needed.

Further Collaboration

This forum served as a kick-off of a continuous mutual consultation process. The participants exchanged their contact information, which will foster a bilateral exchange of ideas. It has been suggested to create an informal core team to support information gathering and to provide a basis for further discussions in the areas of policies, strategies, and technologies, and to seek a better understanding of advanced business approaches, legal constraints, and their mitigation.

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Appendixes

Appendix A. List of Acronyms and Abbreviations

Abbreviation	Term
AHU	Air-Handling Unit
BMS	Building Management System
CHP	Combined heat and power
DH	District Heating
EMP	Energy Master Plan
ESA	Energy Sales Agreement
ESCO	Energy Services Company
PPA	Power Purchase Agreement
CENAU	U.S. Army Corps of Engineers Europe District
DH&C	District Heating and Cooling
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
ERCIP	Energy Resilience and Conservation Investment Program
GSA	General Services Administration
HN	Host Nation
HVAC	Heating, Ventilating, and Air-Conditioning
IEA	International Energy Agency
LCC	Life Cycle Cost
LNG	Liquefied Natural Gas
M&V	Measurement and Verification
MoD	UK Ministry of Defence
OCONUS	Outside Continental United States
OPEC	Organization of Petroleum Exporting Countries
PV	PhotoVoltaic
RE	Renewable Energy
SNR	Small Modular Nuclear Reactor
UESC	Utility Energy Service Contract
USF	U.S. Forces
WHO	World Health Organization

Appendix B. Gebäudeenergiegesetz (GEG) Flowchart (updated December 2022)

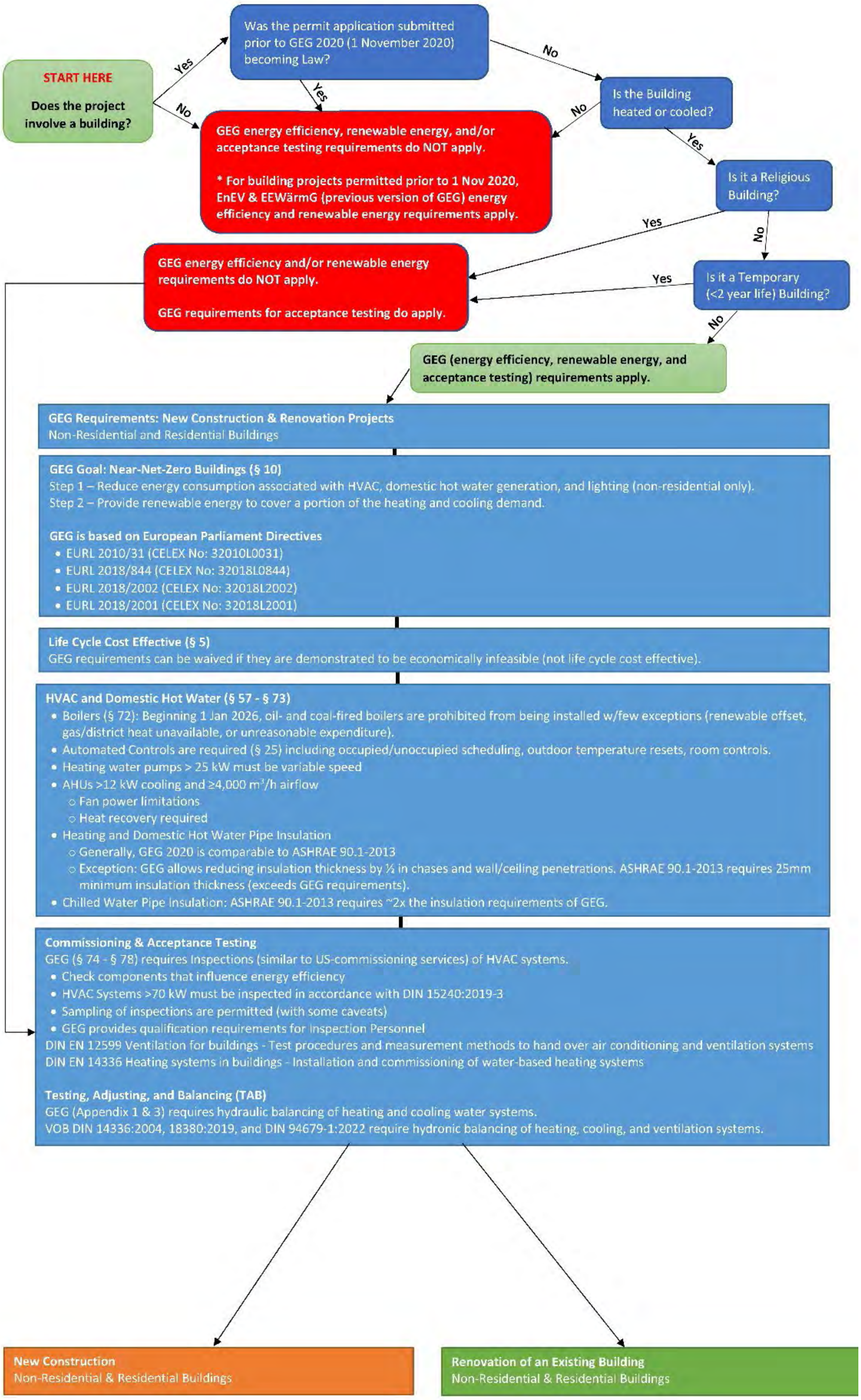

Figure B-1. GEG Flowchart, page 1.

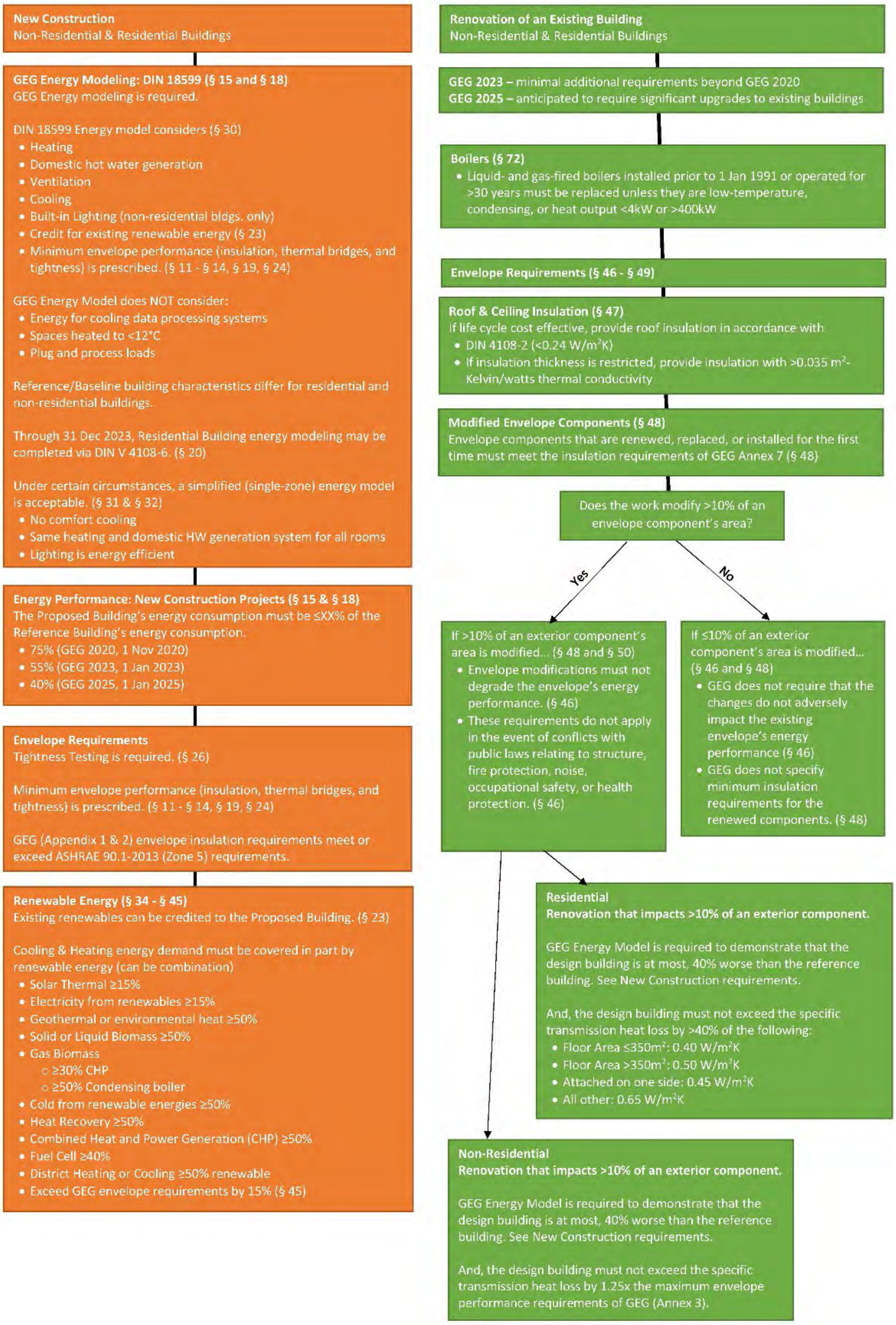

Figure B-1. GEG Flowchart, page 2.

GEG 2020 does NOT apply to (§ 2 scope)

1. Buildings that are NOT heated or cooled
2. Buildings mainly used for rearing or keeping animals
3. Buildings that are kept open over a large area and for a long time
4. Underground structures
5. Greenhouses and culture rooms for growing, propagating, and selling plants
6. Oktoberfest Tents (buildings design to be repeatedly erected and dismantled)

7. Temporary buildings with a planned useful life of up to 2 years
8. Buildings dedicated to worship or other religious purposes
9. Residential buildings that
    - are intended for a useful life of less than 4 months annually or
    - are intended for a limited annual useful life and whose expected energy consumption for the limited annual useful life is less than 25% of the expected energy consumption for year-round use
10. other craft, agricultural, commercial, industrial or company buildings used for public purposes which, according to their intended purpose
    - be heated to a target room temperature of less than 12 degrees Celsius or
    - heated for less than 4 months per year and cooled for less than 2 months per year.

GEG 2020 Economic Feasibility (§ 5 Economic Efficiency)

1. GEG Requirements must be Life Cycle Cost Effective.
    a. GEG requirements/obligations must be feasible according to the state of the art and economically justifiable for buildings of the same type and use and for plants or facilities.
    b. Requirements are considered economically justifiable if, in general, the required expenditures can be generated within the usual useful life through the resulting savings.
2. For existing buildings, systems and facilities, the expected useful life must be taken into account.

GEG 2020 Responsibility (§ 8 scope)

Building owner (unless another person is expressly designated) and persons who work on behalf of the owner/builder in the construction or modification of the building are responsible for compliance with the provisions of this Act.

GEG 2020 New Construction, Non-Residential Building Requirements (Section 2 & 3)

§ 10 Principal and zero-energy buildings

The building is to be constructed in such a way that:

1. The total energy requirement for HVAC, domestic hot water generation, and built-in lighting (non-residential bldgs. only), does not exceed the respective maximum value (§ 15 or § 18)
2. Energy losses during heating and cooling can be avoided through structural thermal insulation (Section 16 or Section 19), and
3. the heating and cooling energy demand is covered at least in part by the use of renewable energies in accordance with Sections 34 to 45.
    a. Note – This does NOT apply to a building that serves the national defense, insofar as its fulfillment is contrary to the nature and the main purpose of the national defense.

§ 11 Minimum Thermal Protection: Meet the minimum thermal insulation requirements of DIN 4108-2: 2013-02 and DIN 4108-3: 2018-10

§ 12 Thermal Bridges: Design and construction to minimize thermal bridges

§ 13 Tightness: Design and construction to minimize leaks

§ 14 Summer Thermal Protection

1. Coordinate with public laws regarding daylighting
2. Meet the summer thermal insulation requirements of DIN 4108-2: 2013-02 Section 8
3. Meet the solar energy transfer requirements of DIN 4108-2: 2013-02 Section 8.3.3 for transparent building components
4. A simulation calculation (DIN 4108-2: 2013-02 Section 8.4) can demonstrate compliance.
    a. If cooling is provided, architectural shading features to reduce heat load should be provided if LCCA-effective.

§ 18 Total Energy Requirement

1. Annual primary energy requirement for the design building must be 0.75 (GEG 2023 revised from 0.75 to 0.55) of the reference building (same floor area, geometry, orientation, and occupancy). Annual primary energy requirement for non-residential buildings considers the following:
    a. Heating
    b. Domestic hot water generation
    c. Ventilation
    d. Cooling
    e. Built-in Lighting
2. Annual primary energy is calculated in accordance with Appendix 2 numbers 1.13 – 9
3. Calculate the annual primary energy requirement in accordance with GEG Sections 21 to 24, Section 25 Sections 1, 2 and 4 to 8, Sections 26 and 27, Section 30 and Sections 32 and 33

§ 19 Thermal Insulation

1. Established minimum envelope performance.

§ 21 Calculation of annual primary energy requirement (NON-residential building)

1. Calculation in accordance with DIN V 18599: 2018-09.

§ 22 Primary Energy Factor

1. the district heating utility has determined and published for the heat transfer medium in the heating network to which the building is connected.
    a. Includes guidance for liquid or gaseous biomass
2. District Heat systems with CHP and Natural Gas
3. In derogation from Appendix 4 number 15 for the heat generated in a highly efficient CHP system (section 2 number 8a) the non-renewable portion the value 0.6 can be used if the CHP system permanently supplies the building
4. 0.3 is the minimum allowed Primary Energy Factor

§ 23 Crediting of Electricity from renewable energies

1. The building can receive credit for existing renewable energy electricity-generating sources located in the vicinity of the building and primarily used in the building and only the excess amount of electricity is fed into the public grid.
2. ~~The building can receive credit for existing battery storage systems storing electricity generated by renewable sources.~~ Deleted in GEG 2023.

§ 24 Influence of thermal bridges: Thermal bridges are considered in the calculation of primary energy demand

§ 25 Primary energy demand calculation assumptions

1. Building Automation System (BAS): The design building's BAS is Class C (DIN V 18599 -11: 2018-09) but can be Class A or B if constructed with one of these systems.
2. Default shading factor is 0.9 if structural conditions are not yet detailed.
3. Climate data
    a. Design building: DIN V 18599-10: 2018-09 Tables 5 to 9
    b. Reference building: DIN V 18599-10: 2018-09 Table 5
4. Provides guidance for heating in rooms exceeding 4m ceiling height
5. Construction index: Use 0.9 as a basis for the design and reference buildings, unless the construction is exactly in accordance with DIN V 18599-4 : 2018-09 section 5.5.2 is determined.
6. Maintenance factor: In the zones of use 14, 15 and 22 according to DIN V 18599-10: 2018-design and the reference buildings 09 Table 5 should be set at 0.6 and otherwise at 0.8.
7. Lighting energy consumption
    a. Design Building can use the actual illuminance, but <1,500 lux for zones of use 6 and <1,000 lux for zones of use 7

   b. Reference building, using the table method to be calculated according to DIN V 18599-4: 2018-09.

§ 26 Testing the tightness of a building

1. Tightness check/test in accordance with DIN EN ISO 9972: 2018-12 Annex NA
2. Tightness is considered in the primary energy demand calculation
3. Test procedure identifies the maximum allowable airflow to maintain a minimum pressure (50 Pa) in the building. Maximum allowable airflow varies depending:
   a. If the ventilation system is installed
   b. Volume of the building
   c. Envelope area
4. Sampling is permitted in some cases (repetitive rooms with doors to the exterior).

§ 27 Common heating system for several buildings

1. Building's primary energy demand calculation should consider heat loss of new heating system site piping.

§ 30 Annual Primary Energy Calculations must consider the following

1. HVAC zones
2. Spaces heated to ≥12C and an average duration >4 Months per year.
3. Cooling energy for systems active >2 months/year and >2 hours per day.
4. Steam supply if active >2 months/year and >2 hours/day.
5. Domestic hot water if the average daily consumption ≥0.2 kWh/person/day or ≥0.2 kWh/employee/day.
6. Lighting if >75 lux is required in a building or a building zone and an average usage period of >2 months/year and >2 hours/day
7. Back-up systems: heating, ventilation, or cooling system(s), hot water system or lighting.

§ 32 Simplified calculation for non-residential buildings

1. A one-zone model can be used if (all of the below are true):
   a. The sum of the net floor area from the typical main use and the traffic areas of the building is > 2/3 of the building's total net floor area
   b. The heating and hot water preparation are carried out in the same way for all rooms
   c. The building is not cooled
   d. ≤10% of the net floor area of the building is illuminated by incandescent lamps, halogen lamps or the type of lighting "indirect" according to DIN V 18599: 2018-09
   e. Outside of the main use, no ventilation and air-conditioning system are with specific fan power limitations exceeding the values in Appendix 2, numbers 6.1 and 6.2.
2. The simplified calculation method can be used for
   a. Office building, sales facility, a commercial enterprise, or a restaurant,
   b. Building for wholesaling and retailing with a max net floor area of 1,000 m^2 if, in addition to the main use, only office, storage, sanitary or traffic areas are available,
   c. A commercial enterprise with a max net floor area of 1,000 m^2 if, in addition to the main use, only office, storage, sanitary or traffic areas are available,
   d. A school, gym, kindergarten and daycare center or similar facility,
   e. An accommodation facility without a swimming pool, sauna or wellness area, or
   f. A library.
3. The hot water energy requirements in Appendix 6. Section 30 (5) shall apply.
4. The simplified procedure can be for a sales facility, commercial enterprise or restaurant in an office bldg. is cooled and the net floor area of the cooled rooms is ≤450 m^2.
5. The energy requirement for cooling data processing systems is not considered as energy input.
6. The maximum and reference values of the annual primary energy requirement are to be increased by 50 kWh/m^2 year per m^2 of cooled net floor space of the sales facility, commercial enterprise or restaurant.

7. The lighting annual primary energy requirement may be calculated in a simplified manner for the area of main use with the least amount of daylight.
8. The annual primary energy requirement of the reference building determined in the simplified procedure according to § 18 Paragraph 1 with Annex 2 is to be reduced by 10%. This is the maximum value of the annual primary energy requirement of the building to be constructed.
9. Section 20 (3) shall apply accordingly.

§ 33 Other calculation methods

1. If structural or system-related components are used in a building for whose energetic assessment neither recognizes the technology or reliable empirical values published in accordance with section 50 (4) sentence 2 are available, the energetic properties of these components may be estimated according to §§ 20 to 30 dynamic thermal simulation calculations or other components are to be used that have similar energetic properties.

GEG 2020 New Construction, Residential Building Requirements (Section 1 & 3)

§ 10 Principal and zero-energy buildings: See non-residential above.

§ 11 Minimum Thermal Protection: See non-residential above.

§ 12 Thermal Bridges: See non-residential above.

§ 13 Tightness: See non-residential above.

§ 14 Summer Thermal Protection: See non-residential above.

§ 15 Total Energy Requirement

1. Annual primary energy requirement for the design building must be 0.75 of the reference building. Annual primary energy requirement for residential buildings considers the following:
    a. Heating
    b. Domestic hot water generation
    c. Ventilation
    d. Cooling
2. Calculate the annual primary energy requirement in accordance with GEG Section 20, Sections 22 to 24, Section 25 Sections 1 to 3 and 10, Sections 26 to 29, Section 31 and § 33

§ 16 Structural thermal insulation: Design building's insulation must minimally meet the reference building requirements (section 15).

§ 20 Calculation of annual primary energy requirement (residential building)

1. Calculation in accordance with DIN V 18599: 2018-09.
2. Prior to December 31, 2023, the annual primary energy calculation can be completed in accordance with DIN V 4108-6: 2003-06 with caveats.
3. In deviation from DIN V 18599-1: 2018-09, when calculating the final energy requirement, Residential building primary energy factors do not need to consider:
    a. solar radiation energy and environmental heat generated in the immediate spatial context of the building.
    b. Electrical user applications (receptacles and process loads)

§ 22 Primary Energy Factor: See Non-Residential Notes Above

§ 23 Crediting of Electricity from renewable energies: See Non-Residential Notes Above

1. Residential buildings can receive credit for existing battery storage systems storing electricity generated by renewable sources.

§ 24 Influence of thermal bridges: See Non-Residential Notes Above

§ 25 Primary energy demand calculation assumptions 1-3, 10

1. See Non-Residential Notes above relating to the building management system (BMS), shading factor, and volume calculations.

§ 26 Testing the tightness of a building: See Non-Residential Notes Above

§ 27 Common heating system for several buildings: See Non-Residential Notes Above

§ 28 Credit for mechanically operated ventilation systems

1. Allows residential primary energy demand calculation to receive credit for heat recovery in mechanical ventilation only under some circumstances.
    a. Tightness confirms to § 13 and § 26.
    b. Ventilation system allows individual apartments to control the airflow volume (required if more than two apartments)
    c. HVAC controls must first use the ventilation heat recovery (over heating system)

§ 29 Rowhouses – Calculation of the annual primary energy requirement and the transmission heat loss

1. When surrounding spaces are heated to at least 19C, do not need to be taken into account in heat transfer calculations.
2. When surrounding spaces are heated to 12-19C, calculate heat transfer according to DIN V 18599-2: 2018-09 or by December 31 2023 also according to DIN V 4108-6: 2003-06, changed by DIN V 4108-6 correction 1: 2004-03
3. When surrounding spaces are NOT heated, these spaces should be weighted with a temperature factor of 0.5 in heat transfer calculations

§ 31 Simplified calculation procedure for a residential building

1. A new residential building meets the requirements of section 10 (2) in conjunction with Sections 15 to 17 and Sections 34 to 45, if it meets the requirements of Annex 5 number 1 and its design meets one of the Appendix 5 number 2 and 3 options.
2. Appendix 5: Can use simplified procedure if the following are met:
    a. Building is residential
    b. No comfort cooling
    c. Design accounts for thermal bridges
    d. Tightness testing is required
    e. Room with the highest summer heat gain has window area <35% of the envelope
    f. External sun shading is provided
    g. $115m^2$ < Buildings Floor area < 2,300 m^2
    h. 2.5m < Mean ceiling height < 3m
    i. Building must be <6 heated floors
    j. Façade must be < 35% fenestration
    k. North facing % fenestration cannot be larger than other mean % fenestration of the other orientations
    l. Total area of exterior doors < 2.7%
3. GEG 2023 includes more flexibility on the allowable systems options.

§ 33 Other calculation methods: See Non-Residential Notes Above

GEG 2020 Renewable Energy for New Construction (Section 4)

§ 34 Use of renewable energy to cover heating and cooling needs

1. Renewable energy measures can be combined (must total to 100% compliance)

§ 35 Solar Thermal Systems

1. GEG Renewable Energy requirement is satisfied if solar thermal systems provide ≥15% of the total heating and cooling energy required.
    a. Residential: This requirement is met if a residential building with ≤2 apartments, solar thermal systems with an area of at least 0.04 m^2 aperture area per m^2 of usable roof area are installed and operated, and
    b. Residential: In residential buildings with >2 apartments, solar thermal systems with an area of at least $0.03m^2$ aperture area per m^2 of usable roof area are installed and operated.

2. Solar thermal system with liquid (glycol) heat transfer medium, the collectors or system must be certified with the European “Solar Keymark” mark, as long as and to the extent that a CE mark is used in accordance with 2009/125/EC of the European Parliament and of the Council of October 21, 2009 to create a framework for the definition of requirements for the environmentally compatible design of energy-related products (OJ L 285 of October 31, 2009, p. 10), most recently by the Directive 2012/27/EU (OJ L 315 of 14.11.2012,

§ 36 Electricity from renewable energy

1. GEG Renewable Energy requirement is satisfied if electricity generated by renewable energy is ≥15% of the heating and cooling energy required.
2. Residential: GEG Renewable Energy requirement is met if electricity from solar radiation energy is satisfied if the system for generating electricity from solar radiation energy is installed and operated with a nominal output in kW ≥0.03 times the usable building area divided by the number of heated or cooled floors according to DIN V 18599-1: 2018-09.

§ 37 Geothermal Energy or Environmental Heat

1. GEG Renewable Energy requirement is satisfied if heat pumps (drive by electricity or fossil fuels) use the following to provide 50% of the heating and cooling energy required.
   a. geothermal energy
   b. environmental heat or
   c. waste heat from wastewater

§ 38 Solid Biomass

1. GEG Renewable Energy requirement is satisfied if solid biomass provides 50% of the heating and cooling energy required.
   a. Solid Biomass must be used in a Biomass boiler or automatically charged biomass furnace with water as a heat transfer medium

§ 39 Liquid Biomass

1. GEG Renewable Energy requirement is satisfied if liquid biomass provides 50% of the heating and cooling energy required.
2. Liquid biomass must be used in a CHP system or condensing boiler

§ 40 Gaseous Biomass

1. Gaseous biomass must be used in a highly efficient CHP plant or condensing boiler
   a. GEG Renewable Energy requirement is satisfied if gas biomass provides ≥30% in a CHP Plant
   b. GEG Renewable Energy requirement is satisfied if gas biomass provides ≥50% in a Condensing Boiler

§ 41 Cold from Renewable Energies

1. GEG Renewable Energy requirement is satisfied if cooling from renewable energy provides 50% of the heating and cooling energy required.
   a. Ground source heat pumps (ground or surface water)
   b. Thermal cold generation with heat from renewable energies

§ 42 Use of waste heat

1. GEG Renewable Energy requirement is satisfied if waste heat (directly or heat pumps) provides 50% of the heating and cooling energy required.

§ 43 Use of combined heat and power generation

1. GEG Renewable Energy requirement is satisfied if:
   a. A highly efficient CHP provides 50% of the heating and cooling energy required.
   b. Or heat from a fuel cell heating system provides 40% of the heating and cooling energy required.

§ 44 District heating or district cooling

1. GEG Renewable Energy requirement is satisfied through purchased district heating or cooling.
2. Accounts for the amount of district heating or cooling from renewable energies.

3. The district heating or cooling must come from:
    a. a substantial proportion of renewable energies,
    b. at least 50% from systems for the use of waste heat,
    c. at least 50% from CHP systems, or
    d. at least 50% through a combination of the above.

§ 45 Measures to save energy

1. GEG Renewable Energy requirement is satisfied **by increasing envelope performance by 15% beyond the prescriptive minimum.**

GEG 2020 Renovation Requirements (Part 3 – Existing Building)

§ 46 Maintain Envelope

1. Do not make degrade the envelope's energy performance.
    a. This requirement does not apply to changes to external components if the area of the changed components is ≤10% of the total area of the respective component group according to Annex 7.
2. This requirement is superseded if there is a conflict with other public laws on stability, fire protection, noise protection, occupational safety, or health protection.

§ 47 Retrofitting an existing building

1. Non-residential and residential buildings heated >4 months/year to ≥19C must ensure that the top floor ceilings meet minimum thermal insulation (DIN 4108-2: 2013-02, heat transfer coefficient <0.24 watts/ m^2 Kelvin) or roof (DIN 4108-2: 2013-02).
2. If the insulation thickness is limited due to technical reasons,
    a. provide the highest possible insulation thickness and maintain a thermal conductivity of 0.035 watts per meter Kelvin.
    b. If insulation is in-between rafters (blown into cavities) or made from renewable raw materials, a rated value of the thermal conductivity of 0.045 watts per meter and Kelvin is acceptable.
3. Ceiling and Roof insulation requirements do not apply if not Life Cycle Cost Effective.

§ 48 Modifications to existing building

1. External components renewed, replaced or installed for the first time at heated or cooled rooms must comply with the heat transfer coefficients of Annex 7.
    a. Requirement does NOT apply to changes affecting ≤10% of the total area of the respective envelope component group.

§ 49 Heat Transfer Coefficient Calculations

1. The heat transfer coefficient of a component according to § 48 is calculated taking into account the new and existing component layers. The following procedures are to be used for the calculation:
    a. DIN V 18599-2: 2018-09 Section 6.1.4.3 for the calculation of the components bordering the ground,
    b. DIN 4108-4: 2017-03 in conjunction with DIN EN ISO 6946: 2008-04 for the calculation of opaque components and
    c. DIN 4108-4: 2017-03 for the calculation of transparent components and curtain walls.
    d. Appendix C of DIN EN ISO 6946: 2008-04 in conjunction with DIN 4108-4: 2017-03 for sloping roofs

§ 50 Energy Assessment of an existing building

1. The requirements of Section 48 are satisfied if the
    a. Renovated Residential building as a whole
        i. The design building's annual primary energy requirement (HVAC and domestic hot water generation value) < 40% more than the annual primary energy requirement of the reference building (same geometry, building area and orientation)

        ii. The design building does not exceed the maximum value of the specific transmission heat loss by >40% according to paragraph 2
    b. Renovated Non-Residential building as a whole
        i. The design building's annual primary energy requirement (HVAC, domestic hot water generation and built-in lighting) <40% more than the value of the reference building's annual primary energy requirement
        ii. The design building is ≤1.25 times the maximum values of the average heat transfer coefficient of the heat-transferring surface area according to Annex 3, rounded to one decimal place
2. Section 18 (1) sentence 2 shall apply accordingly. The maximum value according to paragraph 1 sentence 1 number 1 letter b is
    a. 0.40 watts/m^2-Kelvin: free-standing residential building with floor are ≤350m^2
    b. 0.50 watts/m^2-Kelvin: free-standing residential building with floor area of >350m^2
    c. 0.45 watts/m^2-Kelvin: residential building attached to one side
    d. 0.65 watts/m^2-Kelvin: all other residential buildings
3. Simplified measurements can be used to estimate existing building characteristics.

§ 51 Existing Building – Addition/Expansion

1. When expanding or upgrading a building to include heated or cooled rooms
    a. Residential buildings: the specific transmission heat loss related to the heat-transferring perimeter area of the external components of the newly added heated or cooled rooms does not exceed 1.2 times the corresponding value of the reference building according to Annex 1
    b. Non-residential buildings: the mean heat transfer coefficients of the heat-transferring surface area of the external components of the newly added heated or cooled rooms do not exceed 1.25 times the maximum values given in Appendix 3.
2. If the additional contiguous usable area is larger than 50 square meters, the requirements for summer heat protection according to § 14 must also be observed.

GEG: HVAC and Domestic Hot Water Generation (Part 4)

~~Section 1 Maintaining the performance of existing systems~~

~~§ 57 HVAC and/or Domestic Hot Water System Modifications~~

1. ~~HVAC and/or Domestic Hot Water Systems may not be changed in such a way that the energetic quality of the building is impaired.~~
2. ~~This requirement is superseded if there is a conflict with other public laws on stability, fire protection, noise protection, occupational safety or health protection.~~

~~§ 58 Readiness for Operation~~

1. ~~Devices that reduce energy consumption in systems and devices for HVAC and domestic hot water supply must be kept ready for operation by the operator and used as intended.~~
2. ~~The operator can also fulfill this obligation by taking other technical or structural measures that compensate for the influence of a device that reduces energy consumption on the annual primary energy requirement.~~

~~§ 58 Proper Operation~~

1. ~~A system and facility for HVAC or domestic hot water supply must be properly operated by the operator.~~

~~§ 60 Maintenance~~

1. ~~Components that have a significant influence on the efficiency of HVAC or domestic hot water supply must be regularly serviced and maintained.~~
2. ~~Specialist knowledge is required for servicing and maintenance.~~

Section 2 Installation and Replacement, Subsection 1 Distribution Equipment and Hot Water Systems

§ 61 Reduction and shutdown of the heat supply & activation and deactivation of electrical drives

1. Automated Controls are required. If central heating is installed in a building, the building owner must ensure that the central heating is equipped with central, automatically operating devices for reducing and switching off the heat supply and for switching electrical drives on and off. The regulation of the heat supply as well as the electric drives within the meaning of sentence 1 is dependent on
    a. the outside temperature or another suitable reference variable and
    b. time schedule
2. If central heating is installed in a residential building >5 apartments, which supplies each individual apartment with heat for heating and hot water from the central system by means of a heat exchanger using the continuous flow principle, each individual apartment can be equipped with the facilities according to paragraph 1 to be equipped.

§ 62 Water heating that is connected to a local or district heating supply without a heat exchanger

1. In the case of water heating that is connected to a local or district heating supply without a heat exchanger, the obligation according to § 61 with regard to reducing and switching off the heat supply can also be fulfilled without a corresponding device in the house and customer system by adjusting the flow temperature of the local or District heating network is regulated as a function of the outside temperature and the time by a corresponding device in the central generation plant.

§ 63 Room Temperature Control

1. Automatic room temperature controls are required for heating hot water systems.
2. Group regulations are permitted for groups of rooms of the same type and use
3. Automatic room temperature controls are NOT required at
    a. Underfloor heating systems with <6m^2 floor space
    b. Single solid- or liquid-fuel heater
4. Renovation projects must comply with the above requirements (except for underfloor heating systems installed before 1 Feb 2002).

§ 64 Circulation Pumps

1. Heating pumps >25 kW must be equipped with a minimum of 3-stages to vary operation (electrical power consumption) based on demand (exception – variable speed is not required if conflict with the boiler's requirements.)
2. Domestic Hot Water pumps must automatically switch on/off (coordinate with drinking water ordinance).

Section 2 Installation and Replacement, Subsection 2 Air-Conditioning

§ 65 Limitation of Electric Power

1. Fan Power output limit is set by DIN EN 16798-3: 2017-11 Category 4
    a. Air-Conditioning systems >12 kW cooling and airflow ≥4,000m^3/h
2. Exception: Fan Power limit requirements may be exceeded for gas and particulate filters and heat recovery components (class H2)
    a. DIN EN 16798: 2017-11 section 9.5.2.2
    b. DIN EN 13053: 2012-02.

§ 66 Humidification and Dehumidification

1. Automatic controls are required for systems that are intended to change humidity. Controls must minimally include
    a. Humidity setpoint
    b. Discharge air humidity (measured)

§ 67 Regulation of volume flows

1. Air-Handling Units (AHUs) with >12 kW cooling, airflow ≥4,000m^3/h, and meet the below must include air volume controls (thermal and material loads or time)
    a. Non-residential: >9m^3/h/m^3 net floor area
    b. Residential: >9m^3/h/m^3 building floor area

2. Exception if the supply air volume is required for occupational health and safety or if changes in load cannot be measured or measured over time.

§ 68 Heat Recovery

1. Heat recovery devices are required at AHUs with >12 kW cooling, airflow ≥4,000m^3/h
    a. Exceptions heat cannot be used or supply and exhaust systems are far apart from one another

Section 2 Installation and Replacement, Subsection 3 Thermal Insulation of Pipes and Fittings

§ 69 Pipe Insulation – Heating and Domestic Hot Water

1. Comply with GEG Appendix 8
2. GEG Appendix 8
    a. Heat distribution and hot water pipes as well as fittings must be insulated as follows:
        i. Diameter <22 millimeters, 0.035 w/m-Kelvin, minimum thickness is 20 millimeters.
        ii. Diameter 22-35 millimeters, 0.035 w/m-Kelvin, minimum thickness is 30 millimeters.
        iii. Diameter 35-100 millimeters, 0.035 w/m-Kelvin, minimum thickness is the same as the inside diameter.
        iv. Diameter >100 millimeters, 0.035 w/m-Kelvin, minimum thickness is 100 millimeters.
        v. For pipes and fittings that penetrate walls or ceilings, the thickness of the insulation may be half the value identified above (maintaining thermal conductivity 0.035 w/m-Kelvin) at the penetration.
        vi. For pipes and fittings located in chases located between heated rooms, the thickness of the insulation may be half the value identified above (maintaining thermal conductivity 0.035 w/m-Kelvin) in the pipe chase.
        vii. For pipes and fittings located in the floor structure, the minimum thickness of the insulation may be 6 millimeters (maintaining thermal conductivity 0.035 w/m-Kelvin).
        viii. For pipes and fittings exposed to outside air, the minimum thickness of the insulation is double the thickness identified above (maintaining thermal conductivity 0.035 w/m-Kelvin).
    b. Heating hot water pipe does not require insulation if all the following are true:
        i. Pipe is located in a heated room or components between heated rooms
        ii. Heat output can be influenced by exposed shutoff valves
    c. Branch domestic hot water pipes do not require insulation if all the following are true:
        i. Pipe is located in a heated room
        ii. Pipe contains <3L water
        iii. Pipe is not in the circulation circuit
        iv. Pipe is not heat traced
    d. Must adjust thickness requirements if the thermal conductivity differs from 0.035 w/m-Kelvin

ASHRAE 90.1-2013 Table 6.8.3-1, Pipe Insulation – Heating Hot Water and Domestic Hot Water.

Temperature Range (°C)	Insulation Conductivity		Insulation Thickness based on Nominal Pipe Size (mm)				
	Conductivity (W/(m-°C)	Mean Rating Temperature (°C)	<25	25-40 (note below)	40-100	100-200	200
>177	0.046-0.049	121	115 (90)	125 (100)	125	125	125
122-177	0.042-0.046	93	80 (55)	100 (75)	115	115	115
94-121	0.039-0.043	66	65 (40)	65 (40)	80	80	80
61-93	0.036-0.042	52	40 (25)	40 (25)	50	50	50
IECC > 41°C	1.89	-	-	-	-	-	-
GEG-2020	0.035	-	20	30	Pipe Diameter	100	100
41-60	0.032-0.040	38	25 (25)	25 (25)	40	40	40

1. ASHRAE 90.1-2013 table note c: Insulation thickness on piping smaller than 40mm diameter and located in partitions in conditioned spaces can be reduced by 25mm but cannot less than 25mm thickness. These values are shown in the (brackets) above.
2. ASHRAE 90.1-2013 table noted: For direct-buried heating and hot water system piping the insulation thickness can be reduced 40mm, but not less than 25mm minimum thickness.
3. ASHRAE 90.1 values are based on steel pipe.

§ 70 Pipe Insulation – Chilled Water and Domestic Cold Water

1. Comply with GEG Appendix 8
2. GEG Appendix 8
    a. The minimum insulation is 6 millimeters with thermal conductivity of 0.035 w/m-Kelvin
    b. Must adjust thickness requirements if the thermal conductivity differs from 0.035 w/m-Kelvin

ASHRAE 90.1-2013 Table 6.8.3-2, Pipe Insulation – Chilled Water.

Temperature Range (°C)	Insulation Conductivity		Insulation Thickness based on Nominal Pipe Size (mm)				
	Conductivity (W/(m-°C)	Mean Rating Temperature (°C)	<25	25-40	40-100	100-200	200
4-16	0.030-0.039	24	15	15	25	25	25
GEG-2020	0.035	—	6	6	6	6	6
IECC 2018 <13°C	1.89	—	—	—	—	—	—
<4	0.029-0.037	10	15	25	25	25	40

1. ASHRAE 90.1-2013 table note c: For direct-buried chilled water piping insulation is not required.
2. ASHRAE 90.1 values are based on steel pipe.

Section 2 Installation and Replacement, Subsection 4 Retrofitting Heating Systems, Operation Ban for Boilers

Requirements applicable to DPW – developing/executing projects to upgrade existing systems. Not typical concern for MILCON.

§ 71 Insulation of heating distribution and hot water pipes

§ 72 Prohibition of operating oil heating boilers

1. Prohibits operation of liquid or gas-fired boilers that meet the following:
    a. Were installed prior to 1 January 1991
    b. Were installed after 1 January 1991 and operated for >30 years
    c. Requirement does not apply to:
        i. low temperature boilers
        ii. condensing boilers
        iii. heating systems with nominal output <4kW or >400kW
2. Beginning 1 January 2026, oil- and coal-fired boilers are prohibited from being installed or put into operation with few exceptions (renewable offset, gas/district heat not available at the site, unreasonable expenditure).

§ 73 Exception

Section 3 Energy Inspection of Air-Conditioning Systems

§ 74 Operator Obligation

1. Similar to US-style commissioning?
2. HVAC system > 12 kW require inspections by a qualified person (§ 77)

a. Not required for non-residential buildings with BAS systems that includes the following:
   i. Continuous monitoring
   ii. Energy efficiency benchmarking/notify maintenance personnel if benchmark not met
   iii. Connected to existing building control system(s)
b. Not required for residential buildings
   i. Connected to a continuous electronic monitoring function that monitors energy efficiency and notifies maintenance personnel if energy efficiency has deteriorated
   ii. Effective control function

3. Sampling permitted if >10 HVAC systems that are
   a. Of the same type and output
   b. >12 kW (up to 70 kW)
   c. In non-residential buildings

§ 75 Implementation and scope of the Inspection

1. Check components that influence the efficiency of the system
2. Check components that influence the capacity of the cooling system
3. Check setpoints (airflow volume, temperature, humidity)
4. Check time schedule and tolerances
5. Determine the efficiency of essential components
6. HVAC systems >70kW must be inspected in accordance with DIN 15240:2019-03
7. Sampling inspections is permitted.

§ 76 Time of Inspection

1. At initial installation
2. Minimally every 10 years
3. Following replacement of essential components (i.e., heat exchangers, fans, refrigeration machines, etc.)
4. The cooling system's dimensioning/capacity check does not have to be repeated following the initial inspection if there have been no changes impacting the cooling demand.

§ 77 Qualifications – Inspection Staff

1. Inspection Staff must be a "competent person" (meet one of the following)
   a. University degree in appropriate profession (mechanical or electrical engineering, technical building equipment, etc.) and has a minimum of 1-year professional experience in planning, construction, operation or testing of HVAC systems
   b. Trade register for plant engineering trade
   c. Master's Degree for an unrestricted craft
   d. State-approved or certified technician with focus on HVAC
2. Equivalent training can be acquired in another EU member state

§ 78 Inspection Report & Registration Numbers

1. The Inspector must prepare and sign an Inspection Report.
2. Inspection Report includes
   a. Inspection results
   b. Recommendations for management of energy-related system
   c. Maintenance and replacement schedule/recommendations

Part 5 – Energy Certificates

§ 79 Principles of Energy Certificates

1. Provides information about the energetic properties of a building
2. Rules do not apply for a small building.

§ 80 Issue and Use of Energy Certificates

1. Owner collects the energy certificate at the completion of the building.

2. Energy certificate can be requested by the authorities.
3. If renovations meeting **§** 48, a new energy certificate is required
4. Energy certificate is required at time of sale of a building

§ 81 Energy Requirement Certificates

1. Energy certificate is based on calculations **§15/16 or §18/19.**

§ 82 Energy Consumption Certificates

1. Certificate can be based on actual consumption data

§ 83 Determination and provision of data

§ 84 Recommendations for improving energy efficiency

§ 85 Information in the Energy Certificate

§ 86 Energy Efficiency Class of a residential building

§ 87 Mandatory information in a real estate advertisement

§ 88 Authorization to issue Energy Certificates

Part 6 Financial Support for the Use of Renewable Energies F or the Generation of Heating or Cooling and for Energy Efficiency Measures

§ 89 – § 91

GEG 2023 revised the regulation funding measures.

Part 7 Implementation

§ 92 Declaration of Performance

1. New Construction and/or Renovation Projects: Owner must demonstrate that GEG was complied with.

§ 93 Mandatory Information in the declaration of performance

§ 94 Authorization to issue ordinances

1. State governments verify compliance with GEG.

§ 95 Official Powers

§ 96 Private Evidence

1. Contractors provide evidence that their work complies with GEG.

§ 97 Duties of the authorized district chimney sweep

§ 98 Registration Number

1. Persons who issue inspection reports or energy certificates must have a registration number (provided by German Government).

§ 99 Spot Checks of energy Certificates and Inspection Reports on Air-Conditioning Systems

Part 8 Special Buildings

§ 104 Small Buildings and Buildings made up of room units

1. If maximum envelope insulation requirements are met, GEG requirements are satisfied for the following:
    a. Small Building
    b. Building intended for useful life ≤5 years with room cells ≤50m^2

§ 105 Monuments and Historic Preservation

§ 106 Mixed-use buildings (Residential + Non-Residential)

Annex 1 Residential Reference Building Requirements

Annex 2 Non-Residential Reference Building Requirements

Component/System	GEG 2020 Non-Residential (Appendix 2) Room Temp ≥19°C	GEG 2020 Non-Residential (Appendix 2) Room Temp 12 – 19°C	GEG 2020 Residential (Appendix 1)	ASHRAE 90.1-2013 (Climate Zone 5)	IECC 2018 Residential (Zone 5, 3500 HDD)
External Wall	U = 0.28 W/ (m^2 K)	U = 0.35 W/ (m^2 K)	U = 0.35 W/ (m^2 K)	U = 0.513 W/(m^2 K) (Mass)	U = 0.334 W/(m^2 K) (Mass)

Component/System	GEG 2020 Non-Residential (Appendix 2) Room Temp ≥19°C	Room Temp 12 – 19°C	GEG 2020 Residential (Appendix 1)	ASHRAE 90.1-2013 (Climate Zone 5)	IECC 2018 Residential (Zone 5, 3500 HDD)
Curtain Wall	U = 1.4 W/ (m² K) G=0.48 glazing transmittance	U = 1.9 W/ (m² K) G = 0.60	—	U = 2.84 W/(m² K) (Fixed, Metal Frame) SHGC = 0.40	
Floor Slab	U = 0.35 W/ (m² K)		U = 0.35 W/ (m² K)	U = 0.321 W/(m² K) (Mass) F = 1.191 (heated slab on grade)	U = 0.3 W/(m² K)
Roof	U = 0.20 W/ (m² K)	U = 0.35 W/ (m² K)	U = 0.20 W/ (m² K)	U = 0.184 W/(m² K) (Insulation entirely above deck) U = 0.210 W/(m² K) (Metal Bldg) U = 0.119 W/(m² K) (Attic and Other)	U = 0.116 W/(m² K)
Roof (Glass)	U = 0.27 W/ (m² K) G = 0.63		-	U = 2.84 W/(m² K) SHGC = 0.40	
Light Strips	U = 0.24 W/ (m² K) G = 0.55		-		
Skylights	U = 2.7 W/ (m² K) G = 0.64		U = 2.7 W/ (m² K) G = 0.64 (DIN 18599)	U = 2.84 W/(m² K) SHGC = 0.40	U = 3.1 W/(m² K) SHGC = NR
Windows, French Door	U = 1.3 W/ (m² K) G = 0.60	U = 1.9 W/ (m² K) G = 0.60	U = 1.3 W/ (m² K) G = 0.60 (18599) glazing transmittance	Window, Operable, Metal Frame U = 2.84 W/(m² K) (Operable, Metal Frame) Entrance Door, Metal Frame U = 4.37 W/(m² K) (Attic and Other) SHGC = 0.40	U = 1.7 W/(m² K) SHGC = NR
Roof Windows	U = 1.4 W/ (m² K) G = 0.60	U = 1.9 W/ (m² K) G = 0.60	-	U = 2.84 W/(m² K) SHGC = 0.40	
Exterior Doors	U = 1.8 W/ (m² K)	U = 2.9 W/ (m² K)	U = 1.8 W/ (m² K)	U = 2.839 W/(m² K) (Opaque Doors)	
Thermal Bridging Surcharge	ΔU = 0.05 W/ (m² K)	ΔU = 0.1 W/ (m² K)	ΔU = 0.05 W/ (m² K)		
Building Tightness (rated value n^{50})	Category per DIN V18599-2: 2018-09	Category I	Leak test (DIN V 4108-6: 2003-06) Category I (DIN V18599-2: 2018-09)		
Daylight Supply w/glare protection	DIN 18599-4:2018-09	• No sun or glare protection available: 0.70 • Anti-glare protection available: 0.15	-		
Sun Protection Device	Same as the design building with prescribed performance		No sun protection device		
Lighting	• Direct/indirect w/electronic ballast and fluorescent lamps • Occupancy and Manual controls (specific zones) • Daylighting Control w/Manual (specific zones)		—		
Heating System (rooms ≤ 4m ceiling height)	• Condensing boilers >0.15 L/kW • DOAS & Radiators: Water Temperature: 55/45°C • AHUs: Water Temperature: 70/55°C, Room Temp Control • Testing, Adjusting and Balancing (TAB) Required		• Condensing boilers • Water Temperature: 55/45°C • Radiators		Provides performance requirements for Gas Furnaces and water heaters Water Temperature: 55/45°C
Heating System (rooms > 4m ceiling height)	• Decentralized heating system (DIN 18599) • Not Condensing 25-50 kW/device • Natural Gas • Centrifugal Fan • Room Temp Control • TAB Required				
Water Heating System (Centralized)	• Solar Thermal • Distribution with circulation		• Central hot water generation • Solar Thermal • Distribution with circulation		
Water Heating System (Decentralized)	• Electric instantaneous heaters • Distribution with circulation				

Component/System	GEG 2020 Non-Residential (Appendix 2) Room Temp ≥19°C	Room Temp 12 – 19°C	GEG 2020 Residential (Appendix 1)	ASHRAE 90.1-2013 (Climate Zone 5)	IECC 2018 Residential (Zone 5, 3500 HDD)
Cooling	• Chillers: R134a, multi-stage scroll compressors • Water Temperature: 6/12°C • 30% safety factor (water flow) • Fan Coil Units • Seasonal, night and weekend controls • Primary energy requirement for zones 1-3, 8, 10, 16, 18-20, and 31 can only be credited to 50% • TAB Required		No cooling		Provides SEER/EER requirements for AC, Heat Pumps • Central AC: SEER 16, EER 13 • Packaged AC SEER 16, EER 12 • Heat Pumps
Ventilation	• Exhaust specific fan power (SFP): 1.0 kW/(m³/s) • Supply air volume control • Supply specific fan power (SFP): 1.5 kW/(m³/s) • Heat Recovery via plate heat exchanger • Cooling designed for 6/12°C • Humidification only if in proposed/design building		Central Exhaust		
Building automation	Class C (DIN V 18599-1: 2018-09)		Class C (DIN V 18599-1: 2018-09)		

Annex 3 – Non-Residential Renovation Envelope Requirements

Components	Maximum values of heat transfer coefficient Room Temp ≥19°C	Room Temp 12 – 19°C	ASHRAE 90.1-2013 (Climate Zone 5)
Opaque exterior components	U = 0.28 W/ (m² K)	U = 0.50 W/ (m² K)	U = 0.513 W/(m² K) (Wall – Mass) U = 0.119 W/(m² K) (Roof attic and other)
Fenestration	U = 1.5 W/ (m² K)	U = 2.8 W/ (m² K)	U = 2.84 W/(m² K) (Operable, Metal Frame)
Curtain wall	U = 1.5 W/ (m² K)	U = 3.0 W/ (m² K)	U = 2.84 W/(m² K) (Window Fixed, Metal Frame)
Glass roof, light strips	U = 2.5 W/ (m² K)	U = 3.1 W/ (m² K)	U = 2.84 W/(m² K)

Annex 4 – Primary Energy Factors

Category	Energy Source	Primary energy factor (non-renewable part)
Fossil Fuels	Heating Oil	1.1
	Natural Gas	1.1
	Liquid Gas	1.1
	Hard Coal	1.1
	Brown Coal	1.2
Biogenic Fuels	Biogas	1.1
	Bio oil	1.1
	Wood	0.2
Electricity	Network related	1.8
	Large Heat Pumps (GEG 2023 added)	1.2
	Generated close to the building (from PV or Wind)	0.0
	Displacement mix for CHP	2.8
Warmth, Cold	Geothermal energy, solar thermal energy, ambient heat	0.0
	Earth cold, ambient cold	0.0
	Waste heat	0.0
	Heat from CHP (integrated into the building or close to the building)	according to procedure B according to DIN V 18599-9: 2018-09 section 5.2.5 or DIN V 18599-9: 2018-09 section 5.3.5.1
Municipal waste		0.0
Böblingen District Heat	16 February 2022	0.70
Clay Kaserne District Heat	03 June 2022	0.15
Ramstein Air Base	15 February 2022	0.36

Annex 5 – Simplified Procedure for Residential Buildings

See § 31 above.

Annex 6 – Usage Profile for Simplified Building Energy Calculations

Annex 7 – Renovation Projects: Maximum values of heat transfer coefficients

Component/System	GEG 2020 Non-Residential (Appendix 7) Residential & Non-Residential Room Temp ≥19°C	Non-Residential Room Temp 12 – 19°C	ASHRAE 90.1-2013 (Climate Zone 5)

External Wall • Replacement • First time installation • Attaching cladding • Renewal of external plaster	U = 0.24 W/ (m² K)	U = 0.35 W/ (m² K)	U = 0.513 W/(m² K) (Mass)
Curtain Wall • Entire component replacement or initial installation	U = 1.5 W/ (m² K)	U = 1.9 W/ (m² K)	U = 2.84 W/(m² K) (Fixed, Metal Frame) SHGC = 0.40
Floor Slab	U = 0.50 W/ (m² K)	No Requirement	U = 0.321 W/(m² K) (Mass) F = 1.191 (heated slab on grade)
Roof Areas • Replacement or initial installation • Replacement of roof covering • Application or renewal of cladding or insulation	U = 0.24 W/ (m² K)	U = 0.35 W/ (m² K)	U = 0.184 W/(m² K) (Insulation entirely above deck) U = 0.210 W/(m² K) (Metal Bldg) U = 0.119 W/(m² K) (Attic and Other)
Roof Areas • Replacement of watertight seal	U = 0.20 W/ (m² K)	U = 0.35 W/ (m² K)	
Roof (Glass) • Entire component replacement or initial installation • Glazing replacement	U = 2.0 W/ (m² K)	U = 2.7 W/ (m² K)	U = 2.84 W/(m² K) SHGC = 0.40
Skylights • Entire component replacement or initial installation	U = 1.4 W/ (m² K)	U = 1.9 W/ (m² K)	U = 2.84 W/(m² K) SHGC = 0.40
Windows, French Door • Entire component replacement or initial installation	U = 1.3 W/ (m² K)	U = 1.9 W/ (m² K)	Window, Operable, Metal Frame U = 2.84 W/(m² K) (Operable, Metal Frame) Entrance Door, Metal Frame U = 4.37 W/(m² K) (Attic and Other) SHGC = 0.40
Windows, French Door • Replacement of glazing	U = 1.1 W/ (m² K)	No requirement	
French Door (sliding, folding, or lifting) • Entire component replacement or initial installation	U = 1.6 W/ (m² K)	U = 1.9 W/ (m² K)	
Windows, French Door w/special glazing • Entire component replacement or initial installation • Installation of front or inner windows	U = 2.0 W/ (m² K)	U = 2.8 W/ (m² K)	
Windows, French Doors, and Skylights w/special glazing • Replace special glazing	U = 1.6 W/ (m² K)	No requirement	

RESOURCES

1. GEG Flowchart
    a. O:\EC-E\PS_EngTechLibrary\LEED_and_Sustainability\Host Nation Requirements\Germany
2. Gebäudeenergiegesetz, GEG 2020
    a. O:\EC-E\PS_EngTechLibrary\LEED_and_Sustainability\Host Nation Requirements\Germany
3. Gebäudeenergiegesetz, GEG 2023
    a. O:\EC-E\PS_EngTechLibrary\LEED_and_Sustainability\Host Nation Requirements\Germany
    b. https://www.forum-verlag.com/blog-bi/geg-2023
4. Testing, Adjusting and Balancing (TAB) requirements
    a. https://www.hydraulischer-abgleich.de/allgemeines/service/normen-und-regeln/
    b. https://www.hydraulischer-abgleich.de/wissensbox/din-94679-zum-hydraulischen-abgleich/
5. ASHRAE 90.1-2013
    a. O:\EC-E\PS_EngTechLibrary\LEED_and_Sustainability\ASHRAE 90_1

Appendix C. List of Participants

International Forum

House of Energy

23.01.2023 - 25.01.2023
Clubhaus Germania, Frankfurt

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Ext.Ass Professor, R&D projects responsible, EMD International A/S

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Chris Battisti
Mechanical Research Engineer, US Army Corps of Engineers (USACE ERDC-CERL)

Mr. Chris Battisti primary research focus is on HVAC controls, facility related control system integration and interoperability, and retro-commissioning. This includes research projects, specification and criteria development, and installation support. Prior to joining CERL, Mr. Battisti was a mechanical engineer at for Ft. Leavenworth Directorate of Public Works. Before starting in the government, Mr. Battisti spent six years as a mechanical engineer focusing on the design and construction of power plants.

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Prof. Dr.-Ing Peter Birkner is an honorary professor at the University of Wuppertal. He teaches at the Chair of Electrical Energy Supply Systems and deals with the technical options for effective and efficient implementation of the energy transition in Germany. He gives lectures and talks on an international level.
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He is the spokesman for the State Commission for Environment and Energy of the German Council of Economic Advisors in Hesse. He is also a member of the German committee of CIRED and is involved in the advisory boards of young but also renowned international companies. Finally, he participates as an expert in the awarding of various prizes - including the Hessian State Prize for Energy. He is a member of the advisory boards of various periodicals and the Energy Academy.
Prof. Birkner holds a degree and doctorate in electrical engineering and has almost 30 years of experience in leading positions in regional and municipal energy supply companies in Germany and the EU. In addition, he headed the committee for grids at Eurelectric for many years and was a member of the board of the Energy Technology Society ETG in the VDE.

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Thomas Blumenthal is the founder, CEO and Senior Security Architect of QGroup GmbH. He is an acknowleged IT security expert and expert in the field of military multi-level security. Very early, he focused on military security and developed new approaches and procedures, which he also applied to civilian agencies, organizations and companies.
Thomas Blumenthal recognized, that conventional approaches to developing IT security systems takes too long. Nowadays, he advises governmental agencies and international companies on all aspects of cybersecurity. He is also head of QGroup's rapid IR team.

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Edward "Ted" Borer is the Energy Plant Director for Princeton University and is actively involved in campus energy and carbon emissions reduction efforts and strategic planning. He has 38 years of experience in the power industry, starting in the nuclear industry in the early 1980s. He is a registered professional engineer and holds bachelor's and master's degrees in mechanical engineering as well as the CEM, CEP, and LEED-AP certifications. He has leadership roles in the International District Energy Association and New Jersey Higher Education Partnership for Sustainability. He has provided briefings for members of the US Senate and FERC commissioners.

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Prof. Christian Held
Lawyer and Partner at Becker Büttner Held

Christian Held deals with strategic, energy law and corporate law consulting. He also serves as Chairman of AEEC, Vice President of GEODE, Vice Chairman of IKEM, Chairman of the Supervisory Board of BBH AG, Chairman of the Supervisory Board of BBH Consulting AG, Arbitrator at EACS, Chairman of the Board of the European Cartel Damage Alliance e. V., Lecturer at the Technical University of Bingen for energy law, energy environmental law and energy policy, Managing Partner of the Disibodenberg Winery.

Andrew Knox
Director, Installation Energy

Andrew Knox is Director, Installation Energy, in the Office of the Deputy Assistant Secretary of Defense for Environment & Energy Resilience. In this role, he manages resilience, clean energy, and efficiency programs and initiatives relating to installation energy. Formerly, he was Advisor to the DOD Chief Sustainability Officer, where he led initiatives to design and deploy a Carbon Pollution-free Electricity (CFE) pilot and streamline the Department's collection, analysis and reporting of sustainability data. He holds degrees from Rice and Harvard Universities and is a Certified Energy Manager (CEM) and a Chartered Financial Analyst (CFA) charterholder. Mr. Knox has managed the Navy's Smart Cities and Smart Grid programs, as well as renewable energy programs.

Rüdiger Lohse
Managing Director, DENEFF EDL_HUB

Rüdiger Lohse 58 is MD of the Energy Service Hub (EDL_HUB) the leading ESCO policy and innovation network in Germany. He began his business career in 1990 by optimizing the first German large scale heat pump, after which he co founded the energy agency of the Federal State of Baden Württemberg in 1994. In 2009 he earned the European Energy Service Award for outstanding market and business model development in Germany. As a leading project facilitation entity Rüdiger and his small team initiated ESCo projects in the public and housing sector with investments of more than 300 M€. He co-coordinated IEA Annex 61 and the first ESPC business model for holistic building renovation. In 2019 he founded the Energy Service Hub (EDL_HUB) under the roof of the German Initiative for Energy Efficiency. The EDL_HUB represents major ESCO more than 72% of the annual ESCO market turnover. Major activities include hork on policy advisory, networking, and highly innovative projects aimed at the design of ESCo powered one-stop shops.

Werner R. Lutsch
Managing Director / CEO, AGFW

Werner is the Managing Director and Chief Executive Officer of AGFW, the German Energy Efficiency Association for District Heating, Cooling and CHP in Frankfurt, Germany, where he has served since 2003. AGFW represents over 600 district energy suppliers and industrial operators in Europe and has over 95% of the heat load connected to German district heating systems – the largest in Western Europe. Werner has over 35 years experience in energy and process management mainly in the optimization of power plants and DH. He has been a Consultant and Senior VP/Executive of a subsidiary of the FICHTNER Group, Germany, General Manager with VA TECH, Austria and Managing Director/CEO at Communa Systems, Germany. Werner has a M.Sc. in Production Engineering from the University of

Applied Science, Technology and Economics Rosenheim, Germany and a General Manager Degree from the HM Institute, Austria. He is the author of numerous technical papers and articles on energy and environmental topics and frequent speaker at national and international conferences.

Clara Lutz
Project Advisor for the CEO , Stadtwerke Heidelberg Energie GmbH

Project Advisor for the CEO of Stadtwerke Heidelberg Energie GmbH since 2021. Master of Arts in Management with focus on ecological economics.

Douglas Mackenzie
Director of Federal Energy Security, Black & Veatch

Mr. Doug Mackenzie, Director of Federal Energy Security, currently leads Black & Veatch's Federal Energy program, where he helps clients navigate the energy transition by providing solutions that best serve their mission needs. In the past decade, he has led the development of more than $700M in distributed energy infrastructure projects, with a focus on microgrids, sustainability and energy resilience. The infrastructure projects in his global portfolio utilize industry's most innovative technologies to increase deployment of renewable energy, provide energy autonomy, and ensure power availability, reliability, and stability. He is a leader in project execution of resilient, sustainable and secure power and energy infrastructure projects for Federal clients, including microgrids, energy storage, solar PV, renewable energy, power system upgrades, and more. He holds a Master of Science in Economics from Johns Hopkins University and a Bachelor of Science in Electrical Engineering from the University of Denver.

Dr. Andreas Meissauer, PhD
Head of Division: Energy Policy, Renewable Energies, Energy Technologies, Hessian Ministry of Economics, Energy, Transport and Housing

Dr. Andreas Meissauer is Head of Department Energy Policy, Renewable Energies, Energy Technologies at the Hessian Ministry of Economy, Energy, Transport and Housing. Since 1992, he has been with the state service and had various positions in the Hessian environmental administration. From 2002 - 2007 he was in the service of the EU Commission (secondment to the Ministries of Environment in Poland and Bulgaria, task: implementation of EU environmental law). From 2008 - 2014 he worked for the Ministry of the Environment of Hesse. Since 2010, he has served as the Head of the "Basic Energy Policy Issues" unit, and acting Head of the Energy unit. From 2014 to present, Dr. Meisauer is Head of the "Energy Policy, Renewable Energies, Energy Technologies" unit.

Dr. Klaus Menge
CEO, Franger Systems, BV

Dr. Klaus Menge is CEO of FRENGER SYSTEMEN BV, leads the R&D-department of FRENGER SYSTEMEN BV where highly energy-efficient heating systems for high bay applications like hangars, sports halls, or warehouses and future-oriented heating, cooling, and sound-absorbing solutions for offices are being developed. Furthermore, he is responsible for the international and national sales departments. His specific expertise is energy efficiency in industrial and commercial buildings and he has deep knowledge in radiant heating and cooling technology. After studying general mechanical engineering at the TU Darmstadt with a PhD at the University of Stuttgart, he held various professional positions in Great Britain and Switzerland. Since 2014 he is the chairman of the national technical committee of the Federal Association for technical building equipment in Germany and since more than 10 years he is President of the EMCP (European manufacturers of ceiling panels).

Dr. Andrew Nelson
CEO of FRENGER SYSTEMEN BV

Dr. Andrew Nelson is director of the U.S. Army Engineer Research and Development Center's (ERDC) Construction Engineering Research Laboratory in Champaign, Illinois. As the CERL director, he is responsible for the activities of a highly interdisciplinary team of approximately 300 federal and contracted staff conducting research in materials and structures, energy, training lands and heritage, emergency and operational support, warfighter engineering and installation readiness. Dr. Nelson has served in numerous roles throughout ERDC including as the CERL technical director for Infrastructure Science and Engineering, director of the ERDC International Research Office, which is based in London, and chief of the CERL Energy Branch. He began his career as a research physicist at CERL, with a diverse research portfolio including energy efficient mitigation of biological particulate contamination in indoor air, quantification and atmospheric impacts of the biogeochemical nitrogen cycle, and water purification/treatment for contingency operations. He holds a B.A. in Physics from Illinois Wesleyan University and M.S. and Ph.D. degrees in Environmental Engineering from the University of Illinois at Urbana-Champaign.

David Petermann
Head of Research and Development, e-netz Südhessen AG

He has been head of the Research and Development department at e-netz Südhessen AG since January 1st, 2022. In addition to his vocational training as an energy electronics technician in industrial engineering and a degree in electrical engineering, his education includes a Master in General Management. In addition to the application, coordination and technical and commercial handling of infrastructure-related research projects, primarily in the field of network infrastructure, both at EU, federal and state level, the development of innovative ideas and technical solution models within the framework of research projects is part of his area of responsibility. The observation of energy industry trends and the derivation of future requirements, primarily in the area of network infrastructure, play a key role here.

Wiliam Pfleger

Microgrid Project Development Manager, US East

Bill Pfleger is part of the Schneider Electric North American Microgrid Competency Center where he currently serves as the team's Project Development and Engineering Manager, North America – East, focused on microgrids and distributed energy resource projects spanning from the customer side of the meter to the utility control center. He also assists in general business development and marketing activities, product research and development, and mentors the Competency Center's Microgrid Solution Architects, a team he previously managed. Prior to his current role with Schneider Electric, Bill worked as a Microgrid Solutions Architect and a Business Development and Marketing Specialist. Bill holds Masters Degrees in Renewable Energy Engineering, Building Science and Efficiency, and General Experimental Psychology as well as a bachelor's degree in Psychology from Appalachian State University. Prior to joining Schneider Electric's microgrid team, Bill held employment a professor at Appalachian State University teaching renewable energy engineering and worked as a design engineer, project manager, project estimator, and manager of the Drafting and Design team for Mid-South Engineering, a company focused on the wood products manufacturing and cogeneration/combined heat and power fields.

A. Kirk Philipps

Director, Air Force Office of Energy Assurance (OEA)

Kirk A. Phillips is the Director, Air Force Office of Energy Assurance (OEA). OEA serves as the integrator of energy and water resilience efforts by ensuring projects align with installation needs and with the three goals of the Department of the Air Force (DAF) Installation Energy Strategic Plan – identify enabling system vulnerabilities, improve resilience planning, and ensure resilience results. Prior to his current position, Kirk was the Health Safety and Environmental Practice Leader and Vice President at LJB Inc. and worked as a thought leader with the American Industrial Hygiene Association on Total Exposure Health. In 2018, he retired as the BSC Associate Chief for Bioenvironmental Engineering in the Office of the Air Force Surgeon General. As a Colonel in the Air Force, Kirk was the Director of Policy and Programs for the Deputy Assistant Secretary of the Air Force for Environment, Safety and Occupational Health.

Christine Ploschke

Acting Deputy Assistant Secretary of the Army for Energy and Sustainability (ADASA(E&S))

Ms. Christine Ploschke is currently the Acting Deputy Assistant Secretary of the Army for Energy and Sustainability (ADASA(E&S)), where she leads the program development and oversight of energy and water security, resilience, and conservation; sustainability; and operational energy. When not the Acting DASA, she serves within the DASA(E&S) Office as the Water Resilience Program Manager. From 2016 through July 2020, she was the Sustainability Branch Chief for the Office of the Chief of the Army Reserve, leading the Army Reserve's Installation Energy, Water, Sustainability, and Environmental Programs. She began her federal career as the Environmental Branch Chief of the Army Reserve 99th Regional Support Command in 2010. A native of Queens, New York, Ms. Ploschke graduated magna cum laude from St. John's University in 2006, where she earned a Bachelor of Science degree in Environmental Science (Ecology). She became a Certified Energy Manager through the Association of Energy Engineers in 2015.

Felix Rosenberger
Senior Host Nation Attorney, U.S. Army in Europe and Africa

University of Mannheim, Abat Oliba Barcelona, University of Heidelberg, First State Examination in Baden-Wuerttemberg in 2003, Second State Examination in Baden-Wuerttemberg in2005, Paralegal Specialist, U.S. Army Claims Service Europe (2006-2008), Chief, Affirmative Claims, U.S. Army Claims Service Europe (2008-2013), Senior Host Nation Attorney, International Law Division, Office of the Judge Advocate USAREUR-AF (2013 – current)

Prof. Dr. Ing Stephan Reimelt
Senior Advisor, Bloomenergy

Dr. Reimelt served for six years as an executive board member at Lurgi (one of Germany's largest engineering companies), as an executive board member at MAN ferrostaal, and then as CEO and President of General Electric in Germany and Europe. He is currently a Professor at the Technical University in Berlin.

Georg Reithe
Segment Manager, Engie Impact GmbH

Mr Reithe is Segment Manager of the energy planning and economics team at Engie Impact GmbH. He has 15 years of relevant professional experience. He holds an M.A. and a B.Sc. in Energy economics. In 2008, he joined Lahmeyer International's department of energy economics and planning (later Tractebel Engineering/ Engie Impact). He covers the domains of economic and financial modelling, load forecasting and expansion planning combining thermal, hydropower, renewable energy and storage solutions. As a project manager, he led national energy planning studies in countries such as Vietnam, Indonesia, Myanmar, Egypt and Saudi Arabia, as well as industry planning studies in Germany and the MENA region.

Dr. Stephan Richter
Board of Directors / CEO, GEF Ingenieur AG

Dr. Stephan Richter completed his undergraduate studies in physics and geography in 2000 at the University in Münster. He then moved to the Max-Planck-Institute for Plasma Physics in Munich where he undertook his PhD in the field of energy system analysis. A significant output of his doctoral work was an energy system optimization tool-box that facilitates the optimization of entire urban energy systems. He received his doctorate in physics in spring 2004, following which he was appointed at GEF Ingenieur AG as scientist and project manager. After managing two major federal funded R&D projects in 2006 involving the future of the district heating systems in Munich and the Ruhr area, he was made head of GEF's R&D activities, and was subsequently appointed to the company's management board. From 2014 until 2021 he was managing director for the engineering cooperation planning of Germany's largest district heating system interconnection. In 2016 he was appointed CEO of GEF, where he oversees the pipeline engineering and consulting branches. In addition, he is regularly invited to deliver lectures at several universities and keynote addresses at industry conferences. In 2020, Stephan was part of the team that propounded the Bundesförderung Effiziente Wärmenetz (BEW), implemented in September 2022, as the most important set of subsidies in Germany to accelerate the transformation of the district heating sector towards climate neutrality. With over 20 years of experience, Stephan manages multiple important projects including the hard coal phase-out in the Hamburg DH system published in 2022.

Terry Scharp
Energy consultant, PE, CMVPOak Ridge National Laboratory, USA

Terry Sharp is a buildings energy consultant. Formerly with Oak Ridge National Laboratory in the U.S., he has over 30 years of experience in improving the strategic energy management of buildings, building energy analytics, and in developing related decision-making tools. He is currently developing greenhouse gas use targets for U.S. buildings for ASHRAE Standard 100 and supports U.S. Navy strategic energy management efforts.Terry pioneered the development of building energy performance analytical engines and performance rating tools for EPA's Energy Star program, and for the States of California and New York. Terry is a professional engineer with M.S. and B.S. degrees in mechanical engineering.

Norman Thatcher Scharpf
Consul General, US Consulate General Frankfurt

Norman Thatcher Scharpf has been Consul General at the U.S. Consulate General Frankfurt since August 6, 2021. From August 2018 to December 2020, he served as Deputy Director of the Office of the U.S. Secretary of State, headed its Secretariat, and was responsible for organizing the Secretary's foreign travel.

Dr. Matt Swanson
Senior Researcher, ERDC-CERL

Dr. Swanson is a Senior Researcher within the Energy Branch of ERDC-CERL. He has been a part of more than 100 energy sustainability and resilience plans for military installations and helped to develop several tools to assist with this process. His current work focuses on automating portions of the planning process through the use of existing installation data and data sources.

Bill Taylor
Director, Center of Excellence, Energy Systems Group (ESG)

Bill is the Director of the Energy Systems Group (ESG) Center of Excellence (ECOE). In this role he leads of team of subject matter experts in the development and implementation of technologically advanced energy-based water and wastewater solutions for the Federal Government, Municipalities, Universities, Schools , and Hospitals. Bill and his team also evaluate the latest technology from other industries and determine their viability and usage in the energy markets. Bill has over 40 years of engineering experience in a range of industries, but always with a focus around energy-based solutions. Before joining Energy Systems Group, Bill worked for an ESCO as the Engineering Operations Leader for Energy Solutions. The energy solutions provided included renewable power generation, smart grid and micro-grid development, and critical infrastructure updates. Bill is the author/co-author of over two dozen technical papers and holds 5 US Patents. Bill holds a Bachelor's of Science degree in Mechanical Engineering from the University of Utah and a Master's of Science Degree in Mechanical Engineering from the University of Washington. Bill is a licensed Professional Engineer (PE) and a Certified Energy Manager (CEM).

Steven Tratt
National Sales Manager

Steve has over 30 years of experience in the building envelope air barrier industry as well as the insulation and thermal barrier industry, including expertise in air leakage testing and weatherization materials. He has worked extensively in the custom design of building science solutions for the education, healthcare, commercial, "multi-family", and government markets. He was on the taskforce that wrote the US Army Corps of Engineers Air Leakage Test Protocol for Building Envelopes. He has trained building envelope retrofit contractors in Canada, USA, Ireland, England, and Australia and has made numerous presentations to a wide variety of trade associations. Currently he has been involved in organizing and presenting air barrier seminars for architects, engineers, building owners and facility managers throughout Canada and the United States.

Jay Tulley
USACE, Construction Engineering Research Laboratory (CERL)

Since 2020, Jay Tulley has worked at the US Army Corps of Engineers Construction Engineering Research Laboratory (CERL) as a Research Engineer focused on retro-commissioning and energy portfolio planning and analysis. Prior to working at CERL Jay worked at the US Army Garrison Presidio of Monterey for 10 years as the energy manager; in commercial management doing hospital, retail, and industrial projects; and in the US Navy's Civil Engineer Corps doing engineering/facilities management and construction management in the US and Italy. Jay lives in Pacific Grove, California with his wife and two children.

Prof. Dr. Hannes Utikal
Head of the Center for Industry and Sustainability, Infraserv Höchst & Provadis Hochschule

Professor for Strategic Management and Sustainability; Head of the Center for Industry and sustainability at the Industriepark Höchst (a "think and do" tank for a sustainable industry); Head of the Process4Sustainability: Cluster for climate neutral process industries in Hessen; Editor in Chief of the Journal of Business Chemistry (businesschemistry.org); Studied business administration in Germany, France and USA; PhD University of Cologne, Germany

Andy Walker
Senior Research Fellow, National Renewable Energy Laboratory

Dr. Walker serves as Senior Research Fellow in the Energy System Integration directorate at NREL, where he advises the directorate on research priorities and helps staff deliver impact and quality of research products. He also teaches energy-related courses at universities in Colorado.

Paul Westerman, MSc. MBA
Global Supply Director LPG & Renewables, DCC plc

Paul joined DCC plc 3 years ago to develop and implement a global supply strategy for LPG and renewable liquid gases. DCC is a leading international sales, marketing and support services group with a clear focus on sustainable growth. DCC is an ambitious and entrepreneurial business, headquartered in Dublin (IRL) and listed on the London Stock Exchange, operating in 21 countries, supplying products and services used by millions of people every day. Prior to joining DCC, Paul spent 25 years working for bp in a variety of roles spanning refining, sales, logistics, supply & trading in LPG, Aviation and road fuels. He holds an MSc in Chemical Engineering from Delft University and an MBA from Rotterdam School of Management. He is fluent in Dutch, English and German, has conversational French and a little Spanish.

Keith Yamanaka
Energy Branch Chief, US Army Garrison Hawaii

Keith Yamanaka CEM, REP, Energy Branch Chief, US Army Garrison Hawaii. Keith leads a team that buys, sells, conserves and generates energy for 22 Army installations in Hawaii. He currently also serves on the Hawaiian Electric Company (HECO) Integrated Grid Planning Council, HECO Resiliency Working Group, HECO Microgrid Tariff Group and the Department of Defense/HECO Executive Committee. Throughout his 38 year DOD career, he has been increasing efficiencies and resilience of mechanical and electrical systems for nuclear submarines, hospitals and military installations. Takeaway: Partnering with the utility company can increase energy resilience and security for both the military and utility.

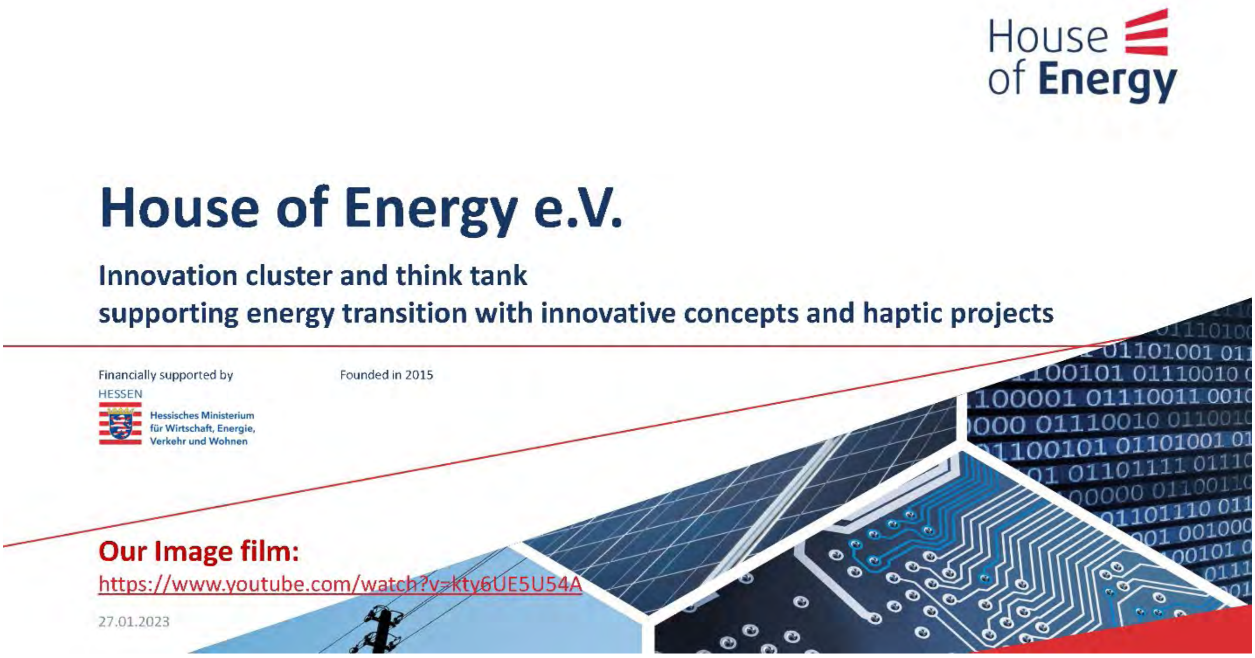
Dr. Alexander M. Zhivov

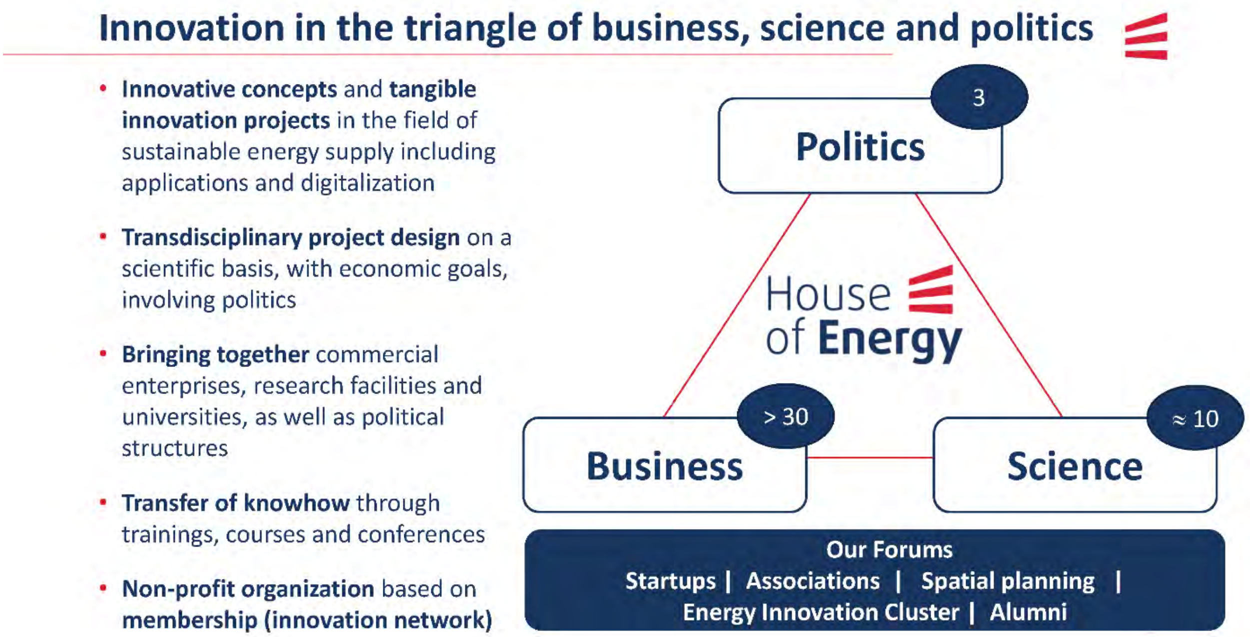
Senior Research Engineer, Engineer Research and Development Center, Construction Engineering Research Laboratory

Dr. Alexander M. Zhivov is a senior research engineer at the Engineer Research and Development Center Construction Engineering Research Laboratory in Champaign, Illinois. He holds a Ph.D. degree in mechanical engineering and an MBA degree. His area of expertise includes Army-wide facilities energy strategic planning leading to the implementation of new HVAC systems, distributed generation technologies, renewable energy, heating plant modernizations, building commissioning processes, and modeling and analysis tools for installation operations. He develops the framework and concepts of a secure, reliable, and efficient Army installation energy strategy and supporting implementation programs. Dr. Zhivov served as an Operating Agent for the International Energy Agency ECB Program Annex 46 "Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings "EnERGo," Annex 61 "Business and Technical Concepts for Deep Energy Retrofit of Public Buildings," and Annex 73 "Towards Net Zero Energy Public Resilient Communities." Dr. Zhivov is a Fellow and Life Member of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers. He has authored more than 250 books and technical papers and has been a contributor to National and International Ventilation Guides, and Energy Standards.

Appendix E. Presentations

Day 1, Introduction (Peter Birkner,)





Our holistic mindset in terms of energy transition

- Embedded in UN-Sustainable Development Goals (SDGs)
- System understanding generates clarity about the requirements
- Technology creates options for implementation
- Everything starts from the materials → Circular economy is important (decarbonization needs dematerialization)
- The legal framework influences feasibility and economic viability
- Financing must be secured
- Acceptance determines implementation (participation, integration, cooperation, actor diversity, social balance)
- Knowledge and skills are to be developed and shared, Experiences have to be communicated

27.01.2023 3

Projekt examples – Public private partnerships

- Smart Grid LAB Hessen
- Storage of Energy & Power Systems in North West Europe
- E-Mobility Lab Hessen
- Smart charging of e-vehicles in parking garages
- Optimized energy systems for non-residential buildings
- Critical infrastructure in technical change
- Smart phone app for regional climate protection
- Carbon capture in industrial sites

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag

EUROPEAN UNION
Investing in Your Future
European Regional Development Fund

HESSEN
Ministry for Economic Affairs, Energy, Transport and Housing
State of Hessen

Interreg North-West Europe
STEPS

4

Day 1, Keynote Speaker (Dr. Andreas Meissauer),
"Energy policy: Principles and strategies in Hesse and Germany"

Dr. Andreas Meissauer
Head of Division: Energy Policy, Renewable Energy, Energy Technology
Ministry for Economic Affairs, Energy, Transport and Housing - State of Hessen

We are currently undergoing disruptive processes of a global dimension that we considered unthinkable just a short time ago and from which our world has already now emerged changed.

Already the effects of the coronavirus pandemic have made us drastically aware of the vulnerability of our economic and social system.

Then, in the middle of a phase when the end of the pandemic and with it the recovery of the economy and a return to social normality seemed in sight, devastating and felonious war was machinated from the Russian government against Ukraine, a sovereign neighbouring state.

In the course of this, the Ukrainian infrastructure for electricity and heat - from large power plants to wind farms or even individual wind turbines to the transmission and distribution grids - has become the target of military action to an unprecedented extent. This far-reaching destruction and the accompanying arbitrary shortage of fossil fuels completely calls the services of general interest into question - not only in this winter, but also in the medium to long-term perspective.

Even if the acts of war do not directly affect us, we are experiencing the fatal effects on the European and global economic system.

This includes, for example, a rapid rise in prices in almost all sectors of the economy and above all in the energy sector, although there is no real shortage of oil and gas from a global perspective.

This is driving global inflation with the very real risk of recession and widening the gap between rich and poor.

Even though the German federal government and the other European governments have taken suitable measures to avoid a shortage of gas, at least for this winter, there is urgent need for creating sustainable long-term solutions.

In addition, it should now have become drastically clear to the last person: We must end our dependence on fossil fuels as quickly as possible.

Moreover, it is beyond all question that we must not lose sight of the ongoing climate change - despite all the burdens we are currently bearing because of war and pandemic.

In order to be able to achieve the necessary limitation of global warming, the decarbonization of the energy sector, which recently caused more than 30 percent of all greenhouse gas emissions in Germany, is essential.

In the long term, however, the energy transition also serves to reduce existing dependencies on unstable supply chains.

It is therefore one of the central political projects of the federal government and has been one of the main priorities of the Hessian state government for many years.

In our energy policy, we consistently focus on expanding renewable energies and increasing energy efficiency in the consumption sectors of heat, electricity and transport.

First, the federal government sets the legal framework for energy and climate policy.

Before this background, it has consequently geared the entire German climate and energy policy towards achieving internationally binding targets since the beginning of last year.

The first thing to be mentioned in this context is the comprehensive amendment to the federal law on renewable energy, EEG.

This law for the first time enshrines the principle that the expansion of renewable energies is in the overriding public interest.

Furthermore, it stipulates the target of an 80 percent share of renewable energies in power generation in 2030 and the extensive climate neutrality of the energy sector in 2035.

Further components of the Easter package are:

- A solar acceleration package that aims to use all suitable roof space for solar energy in the future;
- A wind-on-shore law for the short-term development of area potential for wind energy;
- The reduction in electricity prices by abolishing the EEG surcharge;

- The increase in the new building standard on January 1, 2023 to the previous Efficiency House 55 standard, which reduces energy consumption;
- The revision of the national hydrogen strategy with the aim of doubling the production of green hydrogen compared to previous plans through new funding programs.

All of these measures mean nothing less than a departure from the previous "business as usual" and point the way to a climate-neutral energy future and are therefore welcomed and supported by the Hessian state government.

Overall, we have made considerable progress with the energy turnaround in Hesse in recent years, and we are generating electricity in an increasingly sustainable, environmentally and climate-friendly manner.

Wind, sun and other renewable energy sources now account for more than half of Hessian power generation, even if the expansion of wind energy has not yet regained the dynamics of previous years.

Hesse takes into account nature and species protection when expanding renewable energies.

With our innovative concepts, we are a big step ahead of other federal states.

However, the necessary expansion of renewables requires that the necessary areas are available.

In this context, we have simplified and standardized the enforcement of the law with the administrative regulations for the provision of suitable land.

As early as 2012, the Hessian energy summit recommended securing around 2 percent of the area of the state of Hesse for wind power.

In view of the current nationwide area target of 2.2 percent for wind energy, this finding is downright visionary. Up to now, we can consider a share of 1.89 percent of the state area as priority wind areas.

These are just a few examples of the successful course of the energy transition in Hesse to date. We continue to develop our energy policy on this solid basis.

The Energy Future Act of November 2012 plays a key role.

We revised this State Act by the end of last year and - in the light of the new and extraordinarily ambitious goals at federal level - it is providing new impetus for energy efficiency and the expansion of renewable energies.

First, the competent authorities for the approval of wind turbines and other facilities must take into account the principle that the necessary installations are in the overriding public interest and serve public safety.

For the first time, with the new HEG, we have legally anchored the goal of making one percent of the country's area available for photovoltaics.

In addition, the act considers the roof areas.

However, we assume that at most half of this area, around 10,500 hectares, is available on roofs and other sealed surfaces.

The remaining part is therefore going to be provided by outdoor areas, in particular conversion areas and areas used for agriculture.

By simultaneously reducing the area used for bioenergy, we ensure that there will be no competition with regional food cultivation.

By focusing on agri-PV, we aim at achieving the PV expansion targets in the most space-saving way possible.

Furthermore, the act invents a photovoltaic obligation for state-owned new and existing buildings as well as for large car parks.

Overall, we see Hessen on a trend-setting path with regard to the environmentally compatible energy transition.

With regard to energy efficiency, we will provide higher subsidies for building measures in the future that go beyond the minimum legal requirements.

This measure particularly rewards highly efficient energy standards that reduce the building's energy requirements.

Furthermore, we substantially increase the energy requirements for state-owned buildings.

Finally, we establish a heat-planning obligation for municipalities with more than 20,000 inhabitants, covering 50% of the Hessian population.

This allows municipalities to develop their heat supply strategically and in the long term in the direction of energy efficiency, climate neutrality and security of supply.

All these examples show that we in Hesse have already anticipated much of what is currently under discussion on federal level within the scope of the possibilities of an individual federal state and have established ways of implementation.

We will continue to follow this path consistently and accept the challenges.

This includes, on the one hand, that the materials required for the expansion of renewable energies and the various measures in the field of energy efficiency are available in sufficient quantities and at affordable prices.

Furthermore, we must motivate the young people in our country in particular to pursue appropriate career paths in the skilled trades.

Because it is particularly important to close the fatal shortage of skilled workers in the production of the components and parts required for the energy transition, in plant construction and in building renovation.

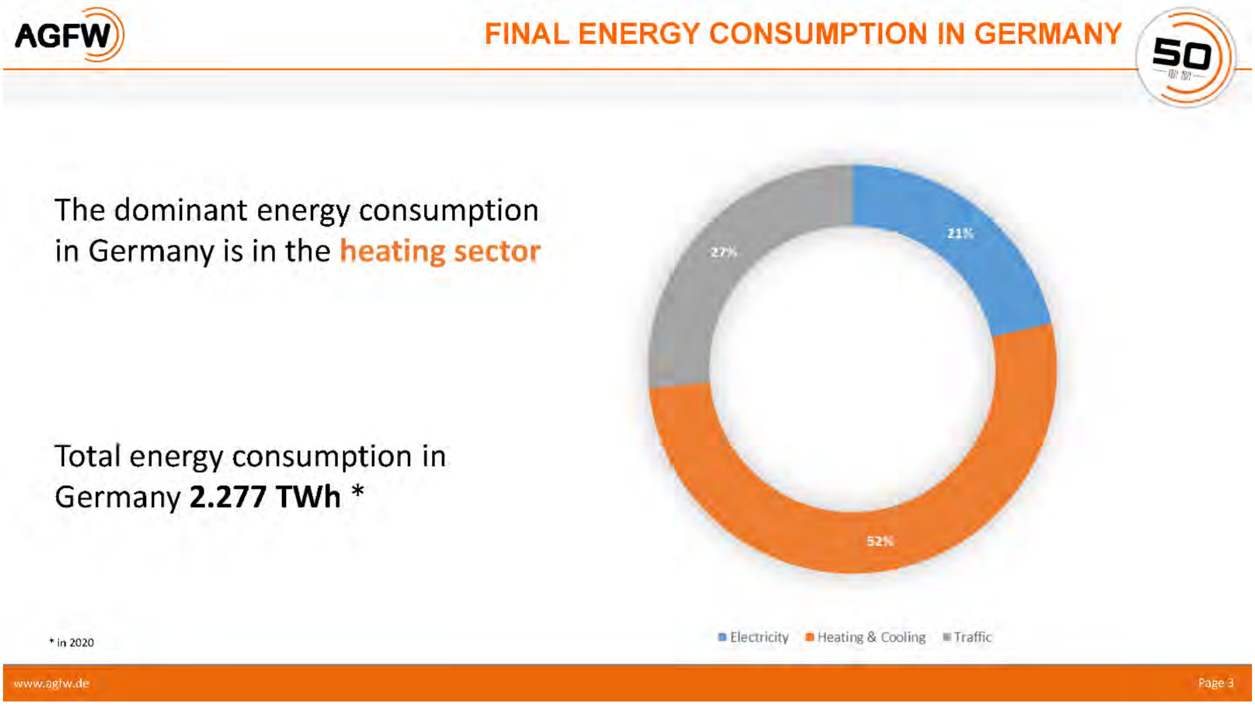
To this end, we work intensively with all relevant actors.

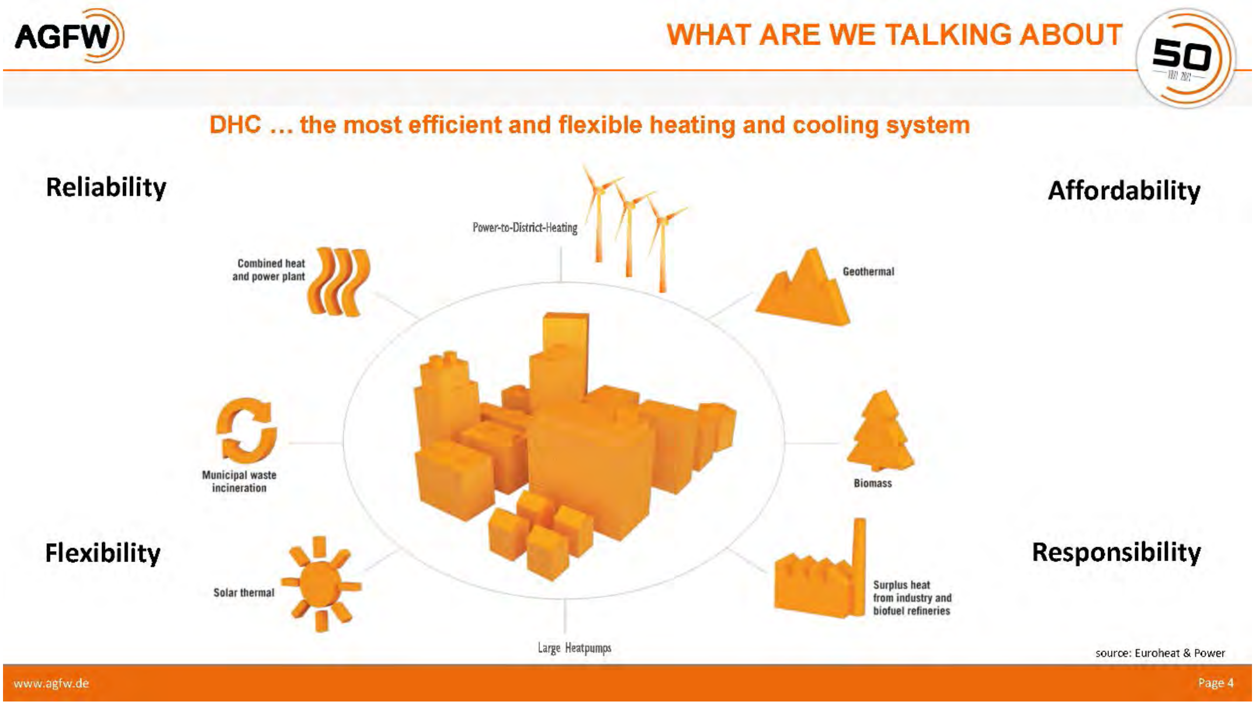
We have set up a large number of programs and measures for education and qualification in the energy sector.

In addition, of course, we will continue to be actively involved at federal level in the forthcoming design processes for implementing the energy transition.

An ecologically, economically and socially compatible energy supply is and remains the benchmark for energy policy in Hesse

Day 1, "District Heating Germany" (Werner Lutsch)


AGFW
FINAL ENERGY CONSUMPTION IN GERMANY
The dominant energy consumption in Germany is in the heating sector
Total energy consumption in Germany 2.277 TWh *
21%
27%
52%
* in 2020
Electricity
Heating & Cooling
Traffic
www.agfw.de
Page 3


AGFW
WHAT ARE WE TALKING ABOUT
DHC … the most efficient and flexible heating and cooling system
Reliability
Affordability
Flexibility
Responsibility
Power-to-District-Heating
Combined heat and power plant
Geothermal
Municipal waste incineration
Biomass
Solar thermal
Surplus heat from industry and biofuel refineries
Large Heatpumps
source: Euroheat & Power
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TARGET AND TARGET IMAGE OF THE HEAT TRANSITION

The ideal picture of a succeeded heat transition

© iStock.com/Sven Loeffler

… the reality in big cities …

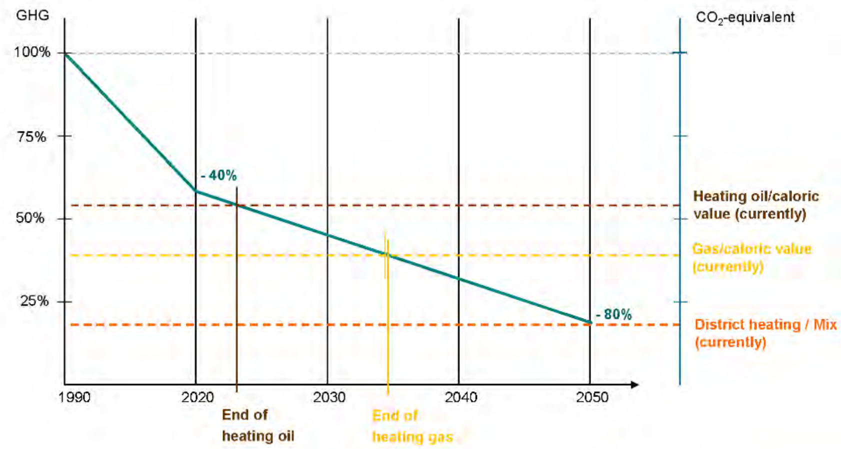
© iStock.com/Lichtwolke

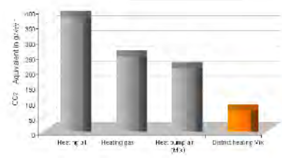
… and in small cities/rural areas

© iStock.com/DragonFly

… this means, that instruments and laws have to be more oriented on local circumstances

DISTRICT HEATING AS PART OF THE CO_2 EMISSIONS REDUCTION





The reduction of GHG-emissions, The concept of German government, "Energieszenarien für ein Energiekonzept der Bundesregierung" Project 12/10

source: UBA/ifeu/WWF

AGFW

FACTS AND FIGURES – DISTRICT ENERGY IN GERMANY

- The district heating production per year in Germany is approximately **58.779 GWh** and we have a growing DH grid length of **31.252 km**
- **13%** CHP share in the public electricity production (17% in total)
- The district heating customers are: **46%** private homes, **36%** public buildings, commercial and trade sector and **18%** industry
- Closed to **86%** of District Heating is generated in high efficient cogeneration (CHP) plants - partly with renewables and waste incineration already

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FACTS AND FIGURES – GETTING GREEN

- The conversion of the municipal heat supply is one of the central infrastructure and climate protection tasks of the next 30 years.
- **By 2050, the energy supply in Germany should be climate-neutral.**
- This goal can only be achieved if the heat supply in cities and communities is significantly decarbonized through the use of renewable energies and highly efficient solutions for combined heat and power are promoted.
- **Green district heating** accompanies the path to reducing CO_2 emissions towards a climate-neutral heat supply and the associated integration of renewable energies. It is therefore an essential component of the heat transition.

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GETTING GREEN – CREATING REGIONAL NETWORKS

AGFW

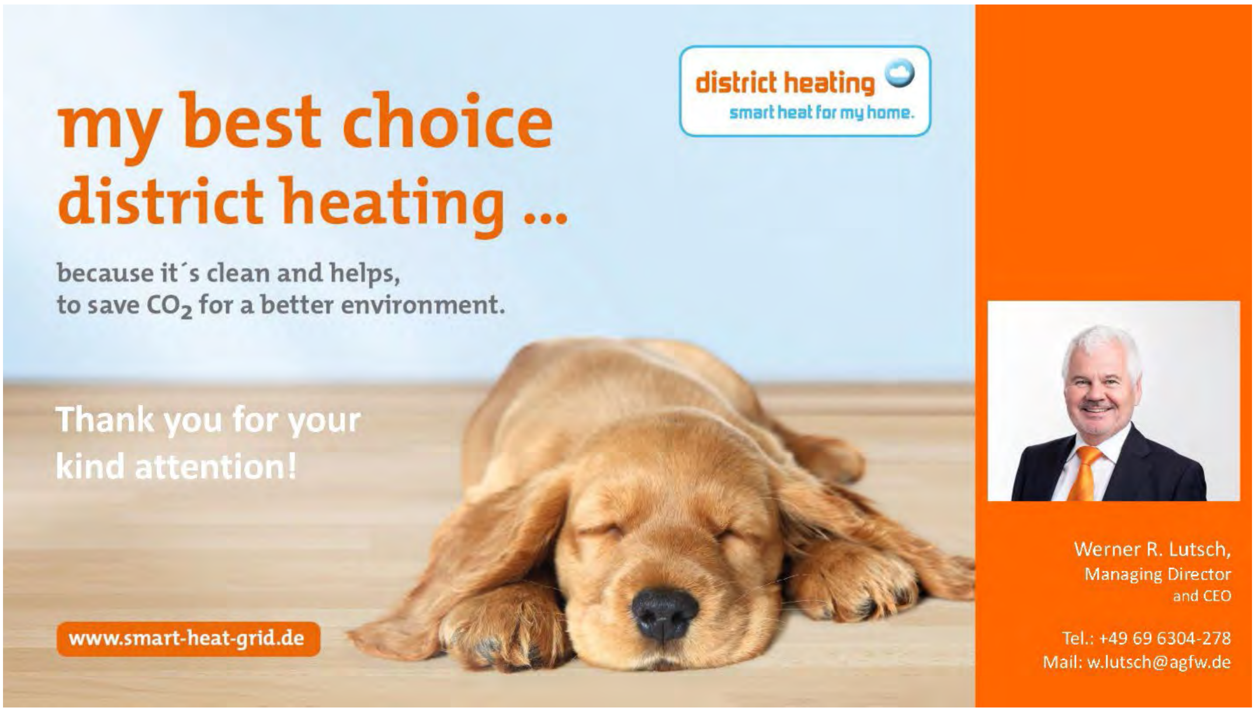
A STRATEGY FOR THE DHC SECTOR

FACTS ABOUT DHC

- **75 %** of the global pollutants are **emitted in cities** (predominantly major cities and metropolitan areas)*
- Cities which have developed **DH in favor of individual heating** (oil, natural gas, coal) were able to significantly **lower their air pollutants** (CO_2, CO, SO_2, NO_x, particulate matter)*
- The DHC sector in Germany has always been advocating an **efficient, environmentally friendly and secure heating supply** at fair market conditions
- Around **56 % of the space heat** in German residential and administrative buildings is **suitable for district heating** supply**

> Investments in these future-proof technologies have to be realized today in order to be effective in the following 60 years and provide security of supply for our citizens

* source: IEA – International Energy Agency ** source: BEI - Bremer Energie-Institut in order of the German Ministry of Industry and Energy



Day 1, "Legal Framework" (Christian Held)

bbh

The Impact of Legal Framework in the Process of Energy System Transformation with a focus on hydrogen networks

23.01.2023

23.01.2023· 02377-06 / 8021154

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About the BBH group

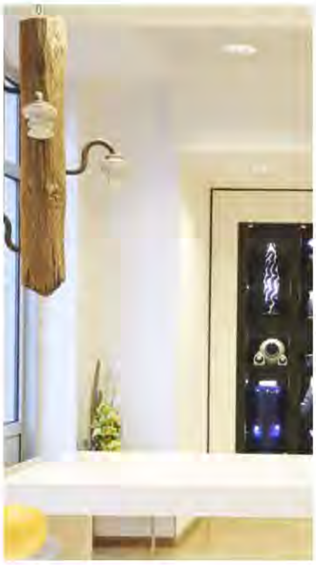
The BBH group consists of the law firm Becker Büttner Held (BBH), the audit firm BBH AG Wirtschaftsprüfungsgesellschaft, the business consulting firm BBH Consulting (BBHC), the project developer for urban neighbourhoods BBH Immobilien and BBH Solutions.

What makes the BBH group special is our interdisciplinary advisory approach: lawyers, public auditors and tax advisors work hand in hand with engineers, business experts and IT professionals.

Together, we develop solutions tailored to suit your business needs in every situation.

- approx. 600 staff
- more than 4,000 clients

About us



Becker Büttner Held has been operating since 1991. At BBH, lawyers, auditors and tax advisors work hand in hand with the engineers, consultants and other experts of our BBH Consulting AG. We provide advice to more than 4,000 clients and are the leading law firm for the energy and infrastructure industry.

BBH is known as "the" law firm of public utilities. But we are far more than that – in Germany and also in Europe. The decentralised utilities, the industry, transport companies, investors, political bodies such as the European Commission, the Federal Government, the Federal States and public corporations appreciate BBH's work.

- Accredited professionals: ca. 250; in Berlin, Munich, Cologne, Hamburg, Stuttgart, Erfurt & Brussels
- Registered representative of special interests – lobbying register at the German Bundestag – R000790

Prof. Christian Held

Professor Christian Held advises first and foremost on strategy, energy and company law issues.

- Born in Meisenheim am Glan in 1961
- Since 1992 lawyer at BBH Berlin
- Since 1993 partner
- Chairman of AEEC, deputy chairman of GEODE, deputy chairman of IKEM, chairman of the supervisory board of BBH AG Wirtschaftsprüfungsgesellschaft, chairman of the supervisory board of BBH Consulting AG, arbitrator for the EACS, first chairman of the management board of European Cartel Damage Alliance e. V. (ECDA)
- Lecturer on energy law, environmental energy law and energy policy at the University of Applied Sciences Bingen
- Managing partner of the winery Disibodenberg

Rechtsanwalt / Lawyer · Partner
10179 Berlin · Magazinstr. 15-16 · phone +49 (0)30 611 28 40-48 · christian.held@bbh-online.de

International climate protection efforts

- **Paris Agreement 2015 (COP 21)**
  - Limitation of global warming to **2° C** by 2050, preferably **1.5° C**
  - Reduction of Greenhouse Gas (GHG) emissions to **80-95%** by **2050** compared to 1990
- **Green Deal** – EU Commission, proclaimed 11th December 2019
  - Comprehensive transformation and growth strategy
  - Goal: Europe should become the first climate-neutral continent
- **Adoption of the (first) European climate law on 21st April 2021**
  - Translation of COP 15 into directly applicable European law
  - Increase of the GHG reduction target for 2030 from 40% to at least 55%
  - Reduction of EU GHG emissions to net zero by 2050
- **Fit for 55:** Package of political initiatives to implement the new climate targets
  - Draft "gas package" submitted on 15th December 2021

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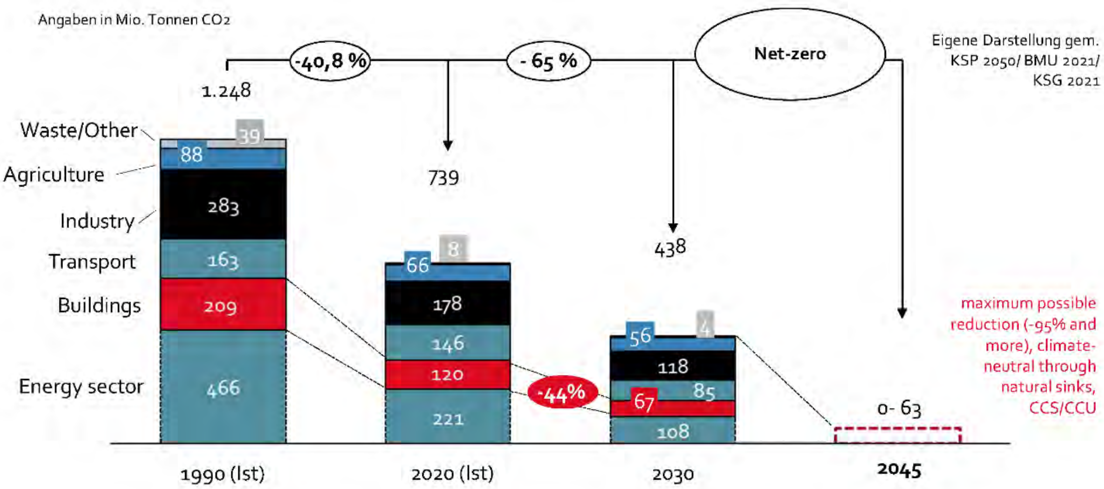
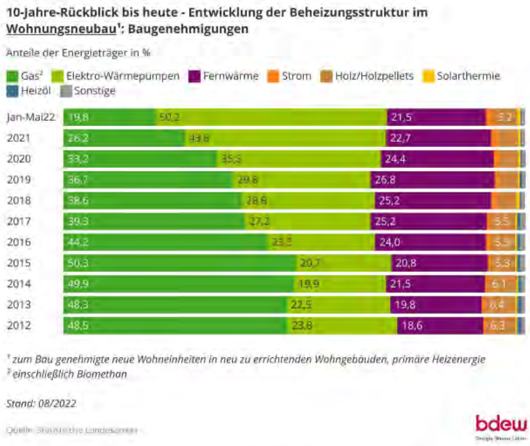
National climate protection regulations

- **Federal Climate Protection Act**, entry into force on 18th December 2019
  - Legal standardization of the CO2 reduction by 55% by 2030
  - Annual emissions budgets for individual sectors
  - Mechanism for annual budget review and determination of special measures in case of non-compliance
- Decision of the Federal Constitutional Court of March 24th, 2021 - "Climate protection"
  - Intertemporal safeguarding of freedom and the "fundamental right to the future"
- Tightening of the climate protection goals - change of the Federal Climate Protection Act on 31st August 2021
  - THG-reduction: 65% by 2030, 88% by 2040 and net-zero GHG emissions by 2045
- New federal government wants to present comprehensive immediate climate protection program in 2023, sectoral emergency program for buildings already presented in 2022 (2021: Transgression of THG-reduction target in buildings sector by two million tons of CO_2eq)

Germany – emission reduction targets according to the Federal Climate Protection Act 2021



Heating Structure in Germany – Old and new buildings



- The share of natural gas for heating in existing buildings has been at a high level (about 50%) for years
- Declining share of natural gas in new buildings since 2015, here increasing importance of the heat pump
- Still: in the first half of 2022, more than 50% of the installed heat generators were based on natural gas

Natural gas as "bridging technology"?

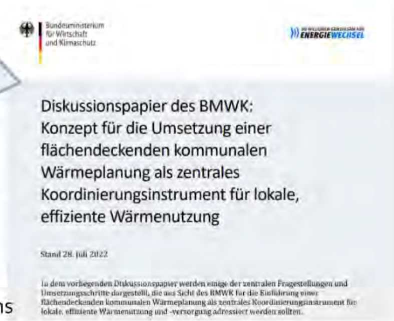
- After coal (and nuclear) phase-out, natural gas (and mineral oils) are the last pillars of the **"fossil" energy industry**
- **Coalition Agreement 2021:** Natural gas "essential" for a transitional period
  - In the short and medium term (until 2030) even increased gas demand in power generation and heating market (due to the substitution of oil heating) likely
- **Fundamental reassessment of the energy policy agenda as a result of the Ukraine war:** The importance of **natural gas** as a "bridging technology" within the framework of German climate policy is being reconsidered or the **"bridge" should/will be shortened → Energy sovereignty as a new narrative of the energy/heating transition**
  - Acceleration of renewable energy expansion + greater electrification of sectors (sector coupling)
  - But: Expansion of H2-ready gas power plants to ensure security of supply in a climate-neutral energy system
- In the heating market, the **intended phase-out of natural gas by 2045** is now being **clearly communicated** and **measures are on the way**

The pressure on natural gas in the heating market is increasing

- BMWK intends to reduce natural gas consumption in both decentralized and centralized heat supply; by 2030, 50% of the heat shall be generated climate-neutral
- **Decentralized heat supply:**
  - From January 1st, 2024, every newly installed heating system should be operated with 65% renewable energy (amendment of Buildings Energy Act pending, concept paper published on July 14th, 2022)
  - No funding for natural gas heating systems as part of the federal funding for efficient buildings (BEG) since August 15, 2022
  - Heat pumps (next to green district heating) benefit and are significantly promoted as a politically desired technology option
    - regulatory (relief in electricity prices, etc.) + financial (heat pump bonus in the BEG)
- **District heating:**
  - Emergency measures passed 2022 aim (in the short term) to reduce natural gas consumption in CHP systems, ban on the use of natural gas in CHP systems possible by ordinance (not yet activated)
  - Start of federal funding for efficient heating networks in September 2022
    - Promotion of the construction of new heating networks with a high proportion of renewable energies and the decarbonisation of existing networks
- Of course, new price signals in the market are also supporting the search for alternatives to fossil fuels

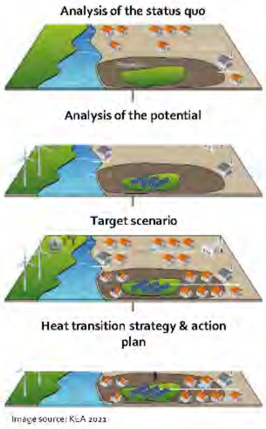
Accelerating the transformation through the Act on Municipal Heat Planning

"The ***central goal*** *of municipal heat planning is to* ***increase planning security for all*** *[...] investments that directly or indirectly affect the heat supply [...]. The heat planning should* ***give the actors binding orientation as to which part of the municipal area should primarily be used for which type of heat supply*** *[...]."*


Diskussionspapier des BMWK:
Konzept für die Umsetzung einer flächendeckenden kommunalen Wärmeplanung als zentrales Koordinierungsinstrument für lokale, effiziente Wärmenutzung

- Discussion paper BMWK from 28.07.2022:
  - Non-binding draft on the current status of the planning and considerations of the BMWK / presentation of open questions
- Draft Act is to be (possibly) presented in the second quarter 2023
- The municipalities (as addressees) should issue binding heating plans no later than 3 years after the law comes into force
- As foreseen by BMWK: Municipal heating plans are to be linked to implementation instruments of the heat transition and their findings are to be taken into account in a binding manner
  - Among other, legal and regulatory requirements, named as examples: Obligation to connect to the grid according to §§ 17 and 18 EnWG, allocation of rights of use/concessions

Content and subject of a municipal heat plan



Analysis of the status quo

- Assessment of heat demand/energy and greenhouse gas balance as well as building and supply infrastructure

Analysis of the potential

- Potential survey on efficiency development in buildings and survey of locally available renewable energies as well as waste heat sources

Target scenario

- Scenario for future coverage of heat demand by renewables/waste heat + planned supply structure
- Climate-neutral scenario for 2050 with intermediate targets e.g. 2030, 2035, 2040

Heat transition strategy & action plan

- Definition of a transformation plan with action strategies and concrete measures

Hydrogen as an alternative in the heating market?

- **National hydrogen strategy, 6th October 2020**
  - Use initially where (a) economic viability can be realized in a timely manner or (b) there are no alternatives for decarbonization
  - especially steel and chemical industry as well as heavy goods and air traffic
- **Coalition Agreement 2021**: No exclusion, but priority use in areas where direct electrification is not possible
- According to the, **BMWK concept paper on the 65% RE target for heating systems** the use of hydrogen and green gases in decentralized heating systems is not ruled out; but special hurdles!
- **Amendment of Energy Industry Act (June 2021)** includes regulations for hydrogen networks
  - Starting network for hydrogen outside and separate from the existing gas network regulation
  - **Gas Package of the EU (draft December 15, 2021) goes even further!**
- **Consequence: Beginning of the end of the gas distribution networks? No transformation possible?**

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EU Gas Package Draft

- In the light of the **Fit for 55** package:

  On 15.12 2021 draft EU gas package to adapt the **regulatory framework for gas networks** published by EU-Com:

  - According to the definitions, gas includes both **natural gas and hydrogen**
  - Nevertheless, **separate regulation** of natural gas and hydrogen networks

- **Further process steps to the gas package:**
  - **European Parliament**
    - 09. February 2023: ITRE Committee vote
    - Plenary vote in EP expected in Q1 2023
  - **European Council**
    - General approach of the Council expected in Q1 2023
  - Start of **trilogue** expected in **Q2 or Q3 2023**
  - **End of the process probably in Q3 2023**

Unbundling of H2 networks: Very extensive unbundling requirements

- **Extensive unbundling requirements** for H2 grid operations and competitive activities
- Requirements for **vertical unbundling**:
  - Art. 62 Gas Directive: **Ownership unbundling** as a principle, i.e. unbundling of competitive areas hydrogen and natural gas (**Implementation period**: 1 year from entry into force of the Gas Directive)
  - Member states can introduce exemptions as the **ISO model** („Independent Hydrogen Network Operator") or until 31.12.2030 as **ITO model** („Integrated Hydrogen Network Operator")
- Requirements for **horizontal unbundling**:
  - If the hydrogen network operator is part of an undertaking active in *transmission or distribution* of **natural gas or electricity**, then unbundling at least with regard to **legal form** and **organization** is required
  - According to the draft gas package, establishment of a separate company for hydrogen is necessary
- **Unbundling of accounts** requirements also apply

Implications for vertically integrated undertakings and DSOs (1)

- **No reference** to unbundling requirements for **DSOs**
  - **No differentiation** between **DSOs and TSOs** regarding H2
  - No **„De-Minimis" rules** or other exemptions for local hydrogen networks
  - Strict TSO unbundling requirements therefore applies to "small" hydrogen network operators within a local vertically integrated undertaking
- **For DSOs particularly problematic: DSOs probably** not conceivable as ITO/ISO for the hydrogen grids
  - Ownership in H2 society
  - No simultaneous control/substantial minority rights H2 network operation and competitive areas
  - Minimum staffing and operational structure

Implications for vertically integrated undertakings and DSOs (2)

- Draft of the EU-COM leads to the fact that **the joint network operation** of natural gas and H2 networks is not possible for **vertically integrated undertakings (VIU)**

  Due to ownership unbundling, VIU are forced to sell the H2 assets they previously financed
- **Legal unbundling** prevents development of H2 infrastructure from natural gas networks (both DSOs and VIU affected)
- **Probable consequence:** Sale of H2 assets to **a state-owned** H2 grid operator

  Germany: Introduction of a state-owned H2 grid operator **under discussion**
- **In addition:** no concrete rules for **the decommissioning of natural gas networks** and **decommissioning provisions**

Gas Directive: Draft report EU Parliament

- The amendments to the EU gas directive proposed by **rapporteur Jens Geier** (S & D, Germany) are spreading **optimism**
- Jens Geier recognizes the important role of DSOs regarding the market ramp-up of the hydrogen economy
- Proposed amendments to problematic unbundling requirements at DSO level
  - In Art. 2 proposal of a definition of "hydrogen distribution"
  - Amendment of Art. 42 → For natural gas and hydrogen, the **same** unbundling rules shall apply at the DSO level
  - Unbundling provisions of Art. 62 (e.g., "ownership unbundling") shall **only apply to TSOs**
  - **Horizontal unbundling** of Art. 63 for H2 network operators has been **deleted** in the report of Jens Geier

Conclusions (1)

- Due to the political climate goals (climate neutrality), a GHG reduction of 100% (compared to 1990) in the energy sector (including heat generation) is required by 2045
- In the long term, this will/must greatly reduce **natural** gas consumption; as a result of the Ukraine war, this need takes on a new dimension and urgency (energy sovereignty)
- The **legal framework** and its design is **the decisive basis** for the progress of the heat transition and the shape of the future heat supply
- A **transformation of the gas distribution networks to hydrogen networks** for the decentralized supply of heat is currently completely open...
  - If the idea of the EU Commission (ownership unbundling) prevails, this will be impossible, and the gas distribution grids would inevitably be shut down and dismantled (in considerable parts).
  - If the position of the rapporteur Jens Geyer prevails, **there is a real chance of building a decentralized hydrogen infrastructure**
    - although the distribution grids will then probably be configured smaller than today's gas distribution grids

Conclusions (2)

- The planned Act on Municipal Heat Planning is a **key instrument** for accelerating the heat transition in Germany
- Important: **Municipal heat planning should be**
- A) **open in terms of heat sources**
  - Individual definition of the locally/regionally most sensible, economical and efficient solution (possibly combination)
  - Hydrogen as an option must not be ruled out or hindered by legal pre-determinations (gas package)
- B) **and also binding**
  - This is the only way to create investment security for everyone involved

Thank you very much
for your attention.

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Backup.

Fundamental reassessment of the energy policy agenda!

- The war in Ukraine has given the issue of **energy sovereignty** a **key role** on the energy policy agenda
  - **Diversification of fossil fuel sources + reduction of consumption** as an urgent field of action
- **Consequences**:
  - The **important role of natural gas** in the German energy market and climate policy is being reconsidered
    - Implications in particular for power/heat generation, building sector and distribution networks
  - **However, climate protection should not be left behind: Acceleration of the expansion of renewable energies** + stronger electrification of the sectors (sector coupling)
- **Energy sovereignty as a new (further) narrative of the energy and heat transition**

Privileging of renewable and low-CO2 gases in the natural gas network

- TSOs and DSOs obligation to
  - **priority feed-in** to the natural gas network
  - Ensuring **firm capacity** for production facilities connected to the gas network; and
  - Joint development of procedures, regulations and investments to enable **reverse from the distribution to the transmission network**
- DSOs obliged to provide **transparent, efficient, non-discriminatory connection procedures** for new production facilities
  - Connection procedure requires approval by Regulatory authority
  - Connection refusal in case of economically justifiable and technically feasible connection requests **is not permitted**

Requirements for green hydrogen

- This question is not yet answered in a **consistent manner**: catalogs of criteria are currently being developed
- **In the future**, the requirements for all utilization paths for green hydrogen should be as standardized as possible
- Certification requirements currently result from:
  - Renewable Energies Directive II (RED II)
    - **But:** Certification Requirements currently only relevant for accountability to the RE target in the **transport sector** (Art. 25 RED II)
    - **Differentiation via Delegated Act (currently only in draft version):** *„setting out appropriate rules for the production of renewable hydrogen from electricity"*
  - **In Germany**: After adoption of the delegated act, regulation on "requirements for green hydrogen" will probably be introduced according to § 93 EEG 2023

Delegated Act: Hot spots in the requirements for green hydrogen

- The following requirements are currently under discussion
  - Electricity for fuel production must be **generated from renewable energies**
  - **Additionality:** RE plant must start operation after or at the same time as the e-fuels plant
  - **Simultaneity:** electricity generation unit should correlate in time with fuel production in terms of its electricity production and the amount of electricity used
  - **Geographical correlation:** Electricity production unit with which the producer has a contract for the purchase of electricity shall be geographically correlated with fuel production
- **Note:** Requirements *should not be too restrictive* to speed up the H2 market ramp-up

Derivation

- **H2 market ramp-up faces big challenges**
- The essential course could be set by
  - Adjustment of the EU gas package through **less stringent unbundling requirements**
  - Guarantee of origin for green hydrogen with **less stringent requirements** and **a broader scope of application** (e.g. in relation to energy supply)
  - A **binding integral** Municipal Heating Plan including a *transformation strategy*

European Hydrogen Backbone Initiative: European Hydrogen Backbone vision

Source: Map of Initiative European Hydrogen Backbone

- **European Hydrogen Backbone Initiative** initiative of 31 gas companies (incl. OGE and ONTRAS)
- Conceptual design of a **European hydrogen network**
  - 19 EU member states plus Switzerland and UK interconnected
  - In response to EU Commission's REPowerEU plan, H2 network size **significantly expanded again**
    - by **2030**: 11,600 km to 27,000 km
    - by **2040**: 39.700 km to 53.000 km

Hydrogen Network 2050 of the TSOs

Quelle: Map of Visionary Hydrogen Network of FNB Gas e. V.

- **Further development** of the Visionary Hydrogen Network published in 2020
- Target state of the hydrogen network in 2050
  - H2 network size: 13,300 km
  - based on 11,000 km of converted natural gas pipelines
- Majority of future consumption focal points (industry, mobility, heat as well as underground storage) **connected via the hydrogen network** with supply focuses

Day 1, "Financing the Future Renewables Based Energy System" (Olaf Beyme)

Olaf BEYME, Head of Renewables & Power, ING
January 23, 2023

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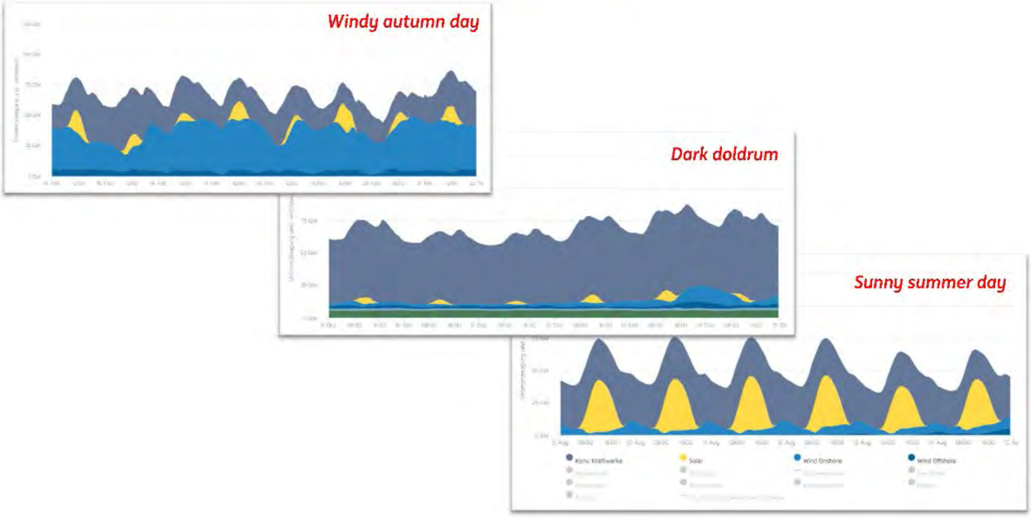
Turning the Energy System upside down in less than 3 decades...

...a Herculean Task and Open Heart Surgery at the same time

2

"Renewables based" – what does that mean? Power production profiles in Germany



3

Every Stakeholder in the German economy **needs to take action**

4

Every Stakeholder in the German economy needs to take action

Thermal insulation

New Wind and PV

Production process redesign

Grid growth and upgrade

Carbon Capture

Heat pumps

EV Charging Infrastructure

Hydrogen

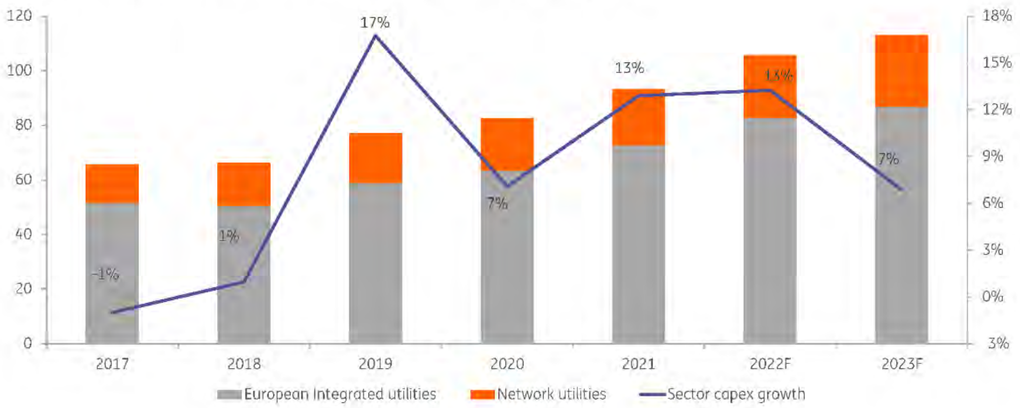
Power-to-X

The Transition will require Tremendous Amounts of CAPEX....

5

Real life Example: Utilities CAPEX Development

Capital expenditure programmes – 2017-2023F (€bn) and YoY change (%)

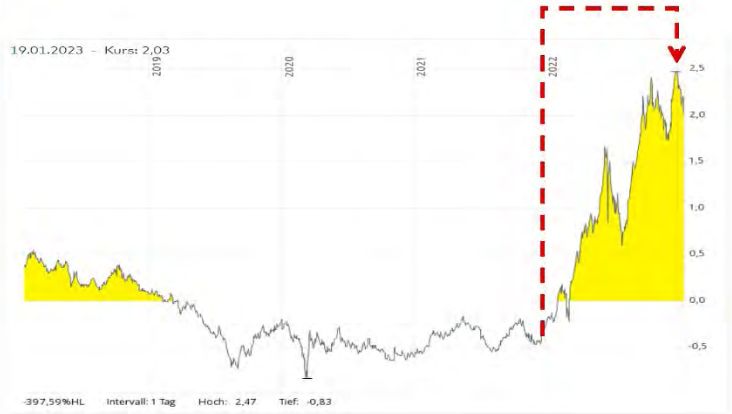


Source: Company data, ING

6

The transition is facing headwinds…

Interest rates



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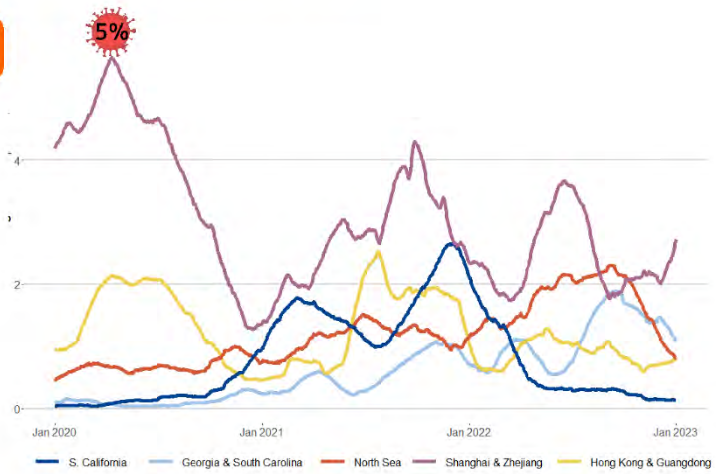
The transition is facing headwinds…

Supply chains



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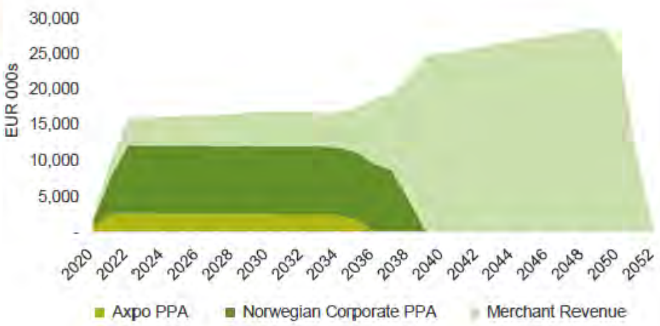
The transition is facing headwinds…

Inflation

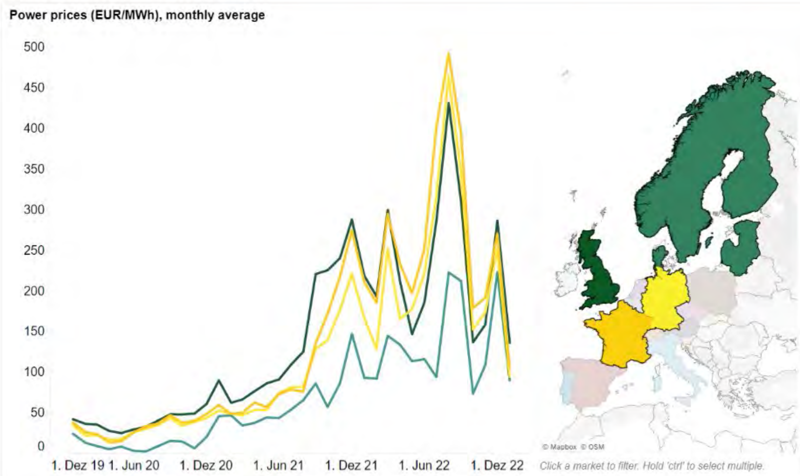
9

The transition is facing headwinds…

Offtaker & Merchant risk



...but increased power prices do also offer new opportunities



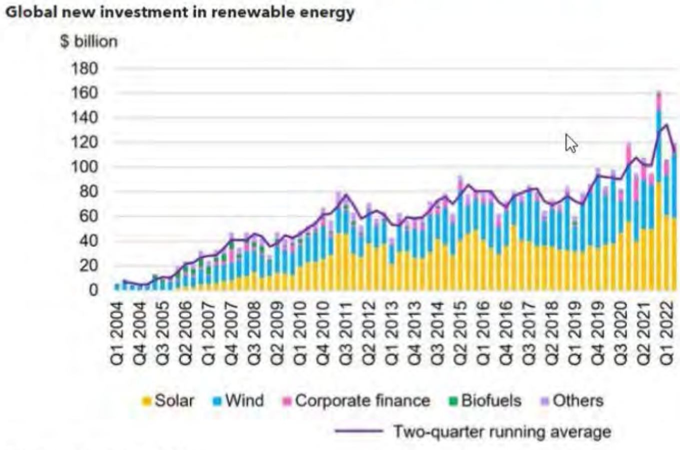
11

Finance industry is ready to support its clients, despite all odds

Retail Financing	Corporate & Project Financing
Bank's operations & Credit Policy	Sustainability Advisory

12

Challenge accepted – the Money keeps flowing



Source: BloombergNEF

13

Hornsea 2
Offshore Windfarm

The largest Wind Farm in the World
Project Financing of EUR > 1.3bn

Ørsted AXA Investment Managers CA ASSURANCES

Summary

- The **challenges** are enormous, but so are the **opportunities**
- For some years, **regulatory** and governmental financial **support** will still be required
- The financing industry can play a key role as a **facilator of change**
- We have already come a long way – **there are enough reasons to be optimistic**

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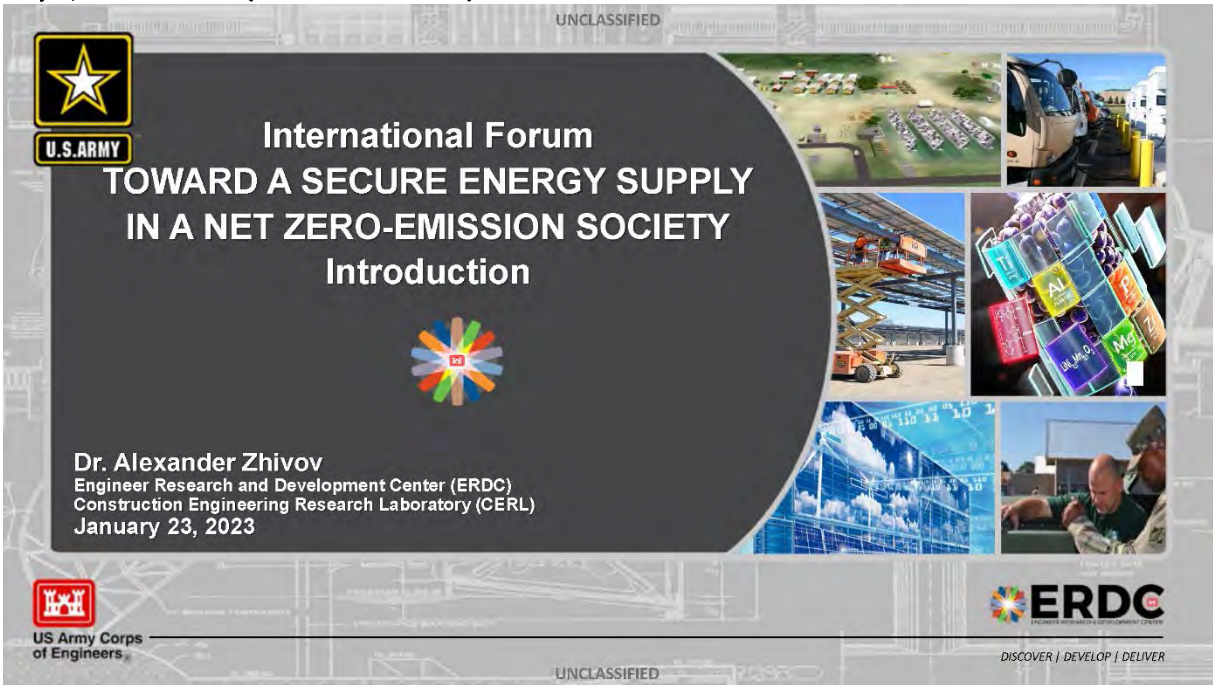
Day 2, Introduction (Alexander Zhivov)



1/27/2023

1/27/2023

Forum Objectives

- Present and discuss different international strategies for Climate Change Mitigation
- Define energy supply security and its metrics and establish a better understanding of the differences between energy supply security and energy systems resilience.
- Discuss major energy-related objectives in Europe, what they have in common and what is different, and how to achieve some of them without jeopardizing other
- Present and discuss currently available building-level technologies contributing to energy supply security
- Present and discuss utility-level solutions contributing to energy supply security
- Present and discuss business models supporting the implementation of energy supply security strategies
- Discuss legal constraints and collaboration strategies between installations and utility companies that will allow compliance with existing limitations
- Introduce examples of best practices from DoD services, academia and industry supporting presented concepts

US Army Corps of Engineers • Engineer Research and Development Center

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1/27/2023

Forum Audience

115 energy experts from Austria, Belgium, Denmark, Germany, Italy, the Netherlands, the UK, and the USA representing

- Decision-makers
- End users, representing Defense, universities, municipalities, and other major government and private sectors communities
- Engineers and scientists dealing with new technologies
- Energy planners developing resilient and environmentally friendly, least-cost solutions on the municipal level
- Representatives of regional and municipal energy utilities
- Energy performance contractors
- Industry representatives, including energy systems engineers, architects, equipment manufacturers

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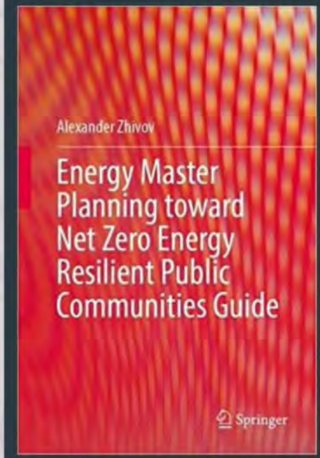
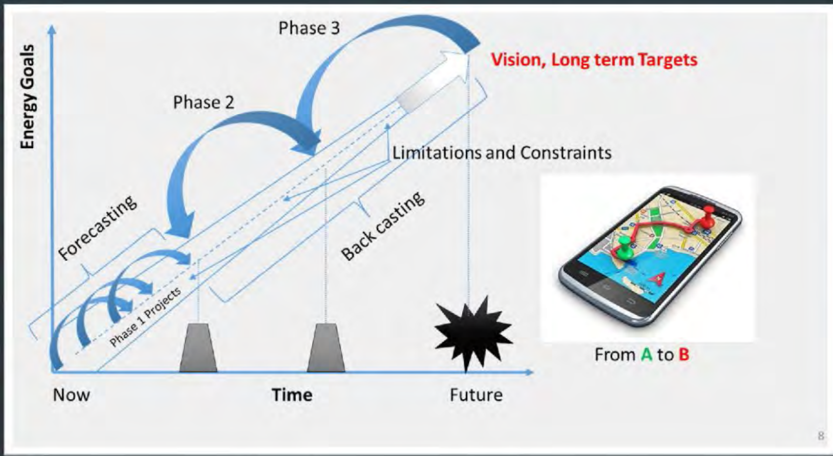
Energy Master Planning = Establishing a Roadmap





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What are the Major Challenges and the Energy–related Framing Goals in Europe?

1. Energy Supply Security – short-term, regional
2. Energy System Resilience - short and mid-term, global
3. Climate change mitigation – midterm and long-term, global
4. Operating/energy cost control – short to long-term, regional

Are they competing or complementing??

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Energy Systems Resilience

Energy resilience/resiliency refers to the ability of energy-related systems of a building or community of buildings to predict and prepare for, withstand, recover rapidly from, and adapt to major or unanticipated disruptions.

The scope includes energy systems within the community's fence

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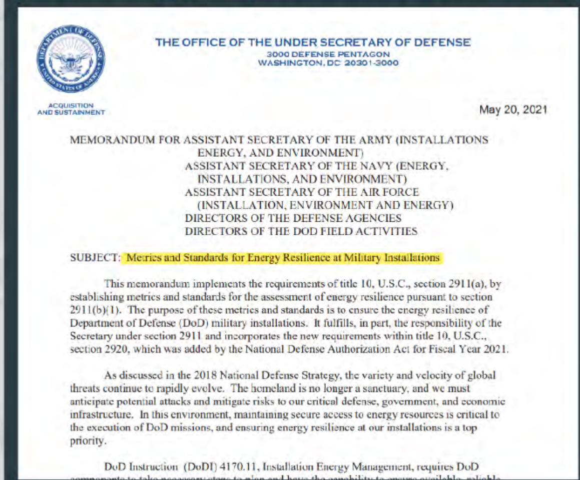
Energy Systems Resilience



THE OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION AND SUSTAINMENT

May 20, 2021

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS ENERGY, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY (ENERGY, INSTALLATIONS, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATION, ENVIRONMENT AND ENERGY)
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: Metrics and Standards for Energy Resilience at Military Installations

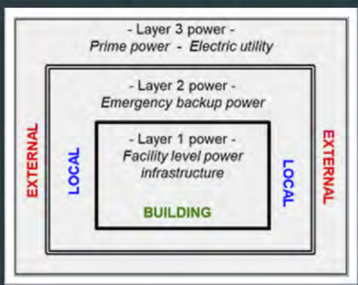
This memorandum implements the requirements of title 10, U.S.C., section 2911(a), by establishing metrics and standards for the assessment of energy resilience pursuant to section 2911(b)(1). The purpose of these metrics and standards is to ensure the energy resilience of Department of Defense (DoD) military installations. It fulfills, in part, the responsibility of the Secretary under section 2911 and incorporates the new requirements within title 10, U.S.C., section 2920, which was added by the National Defense Authorization Act for Fiscal Year 2021.

As discussed in the 2018 National Defense Strategy, the variety and velocity of global threats continue to rapidly evolve. The homeland is no longer a sanctuary, and we must anticipate potential attacks and mitigate risks to our critical defense, government, and economic infrastructure. In this environment, maintaining secure access to energy resources is critical to the execution of DoD missions, and ensuring energy resilience at our installations is a top priority.

DoD Instruction (DoDI) 4170.11, Installation Energy Management, requires DoD

Metrics

1. Energy System Robustness
2. Energy System Recovery time
3. Energy Availability
4. Energy Quality



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Energy Availability & Max Single Event Downtime

Evaluate ➡ Criticality + Remoteness + Redundancy

\- Then determine -

⬇

Resilience Phase
= Availability + Recovery

Resilience Metric	Facility Level	Resilience Sub-Metric	Category	Degraded State Availability	Acceptable Average Weekly Downtime (Minutes)	Maximum Single Event Downtime (Minutes)
Low	Primary	Low	LP/1	0.92	806.4	2,419
		Moderate	LP/1+	0.95	504	1,500
	Secondary	Low	LS/0	0.9	1008	3,024
		Moderate	LS/0+	0.92	806.4	2,419
Moderate	Primary	Low	MP/2	0.99	100.8	302
		Moderate	MP/2+	0.995	50.4	150
	Secondary	Low	MS/1	0.95	504	1,500
		Moderate	MS/1+	0.99	100.8	302
Significant	Primary	Moderate	SP/3	0.999	10.08	30
		Significant	SP/3+	0.9995	5.04	15
	Secondary	Moderate	MS/2	0.95	504	1,500
		Significant	MS/2+	0.99	100.8	302
High	Primary	Significant	HP/4	0.9999	1.008	3
		High	HP/4+	0.99999	0.1008	0.3
	Secondary	Significant	HS/3	0.9995	5.04	15
		High	HS/3+	0.9999	1.008	3

9

1/27/2023

Climate Change Mitigation

In 2018, the Intergovernmental Panel on Climate Change (IPCC) published the Special Report on Global Warming of 1.5°C. The report details the impacts of a 1.5°C temperature rise and proposes mitigation strategies to remain below the 1.5°C target. It will require lowering global carbon dioxide (CO_2) emissions in 2030 by 45% compared to 2010 and will require net zero emissions around 2050.

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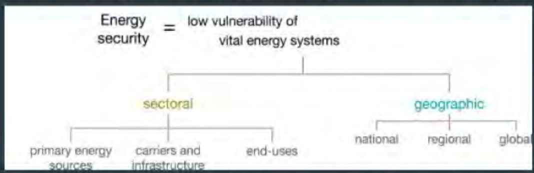
Energy Security Concepts

Energy security means different things in different situations and to different people. There are natural explanations for this variation. First, energy systems vary from one place to another which gives rise to different energy security problems. Secondly, the energy security term is sometimes extended to other energy policy issues ranging from energy poverty to climate change.



Hughes'(2012) 'generic framework for the description and analysis of energy security contains three indicators: availability, affordability, and acceptability. Sovacool (2011) proposed 20 dimensions of energy security including availability and affordability.

Affordability for whom?	Energy prices should be...
Households and private consumers	Low compared to household income[a,b,c]
Industry and businesses	Low compared to competitors' prices[c]
Nations	Low enough to ensure the energy import bill is small compared to export earnings[c]
Energy companies and investors	High enough to ensure sufficient profitability for energy companies and investors[d]

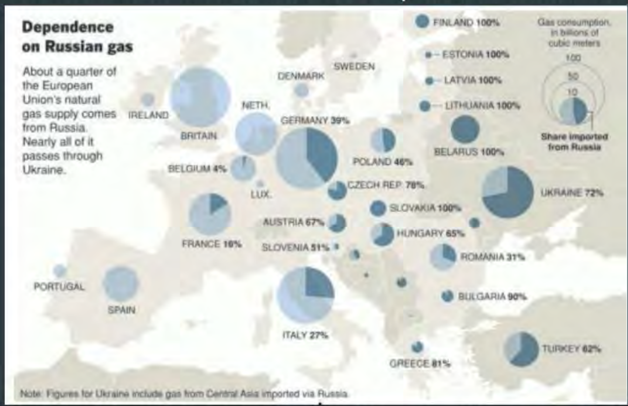
[a] Kruyt et al. (2009) says that affordability translates to low energy prices but does not specify the consumer group (households or industry).
[b] Sharifuddin (2013) defines affordability relative to government accounts, private consumers and industries.
[c] Hughes (2012) defines affordability relative to consumer income.
[d] APERC (2007) refers to investment cost affordability.

Energy Supply Security Categories

- Long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs.
- Short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance:
    - natural disasters,
    - geopolitical conflicts, and
    - emerging threats related to cyber attacks

European dependence on Russian gas

Currently, Europe depends on Russia for roughly 40 percent of its natural gas needs, and European leaders have vowed to reduce their dependence by two-thirds before the end of 2022 and eliminate dependence on Russian gas well before 2030.



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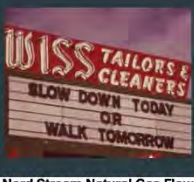
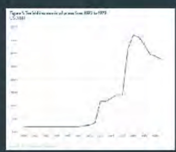
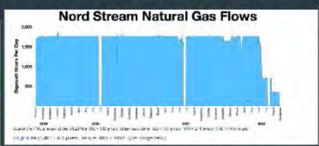
Energy Security Vs Resilience of Energy Systems

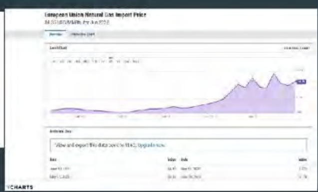
IEA defines energy security as the uninterrupted availability of energy sources at an affordable price.



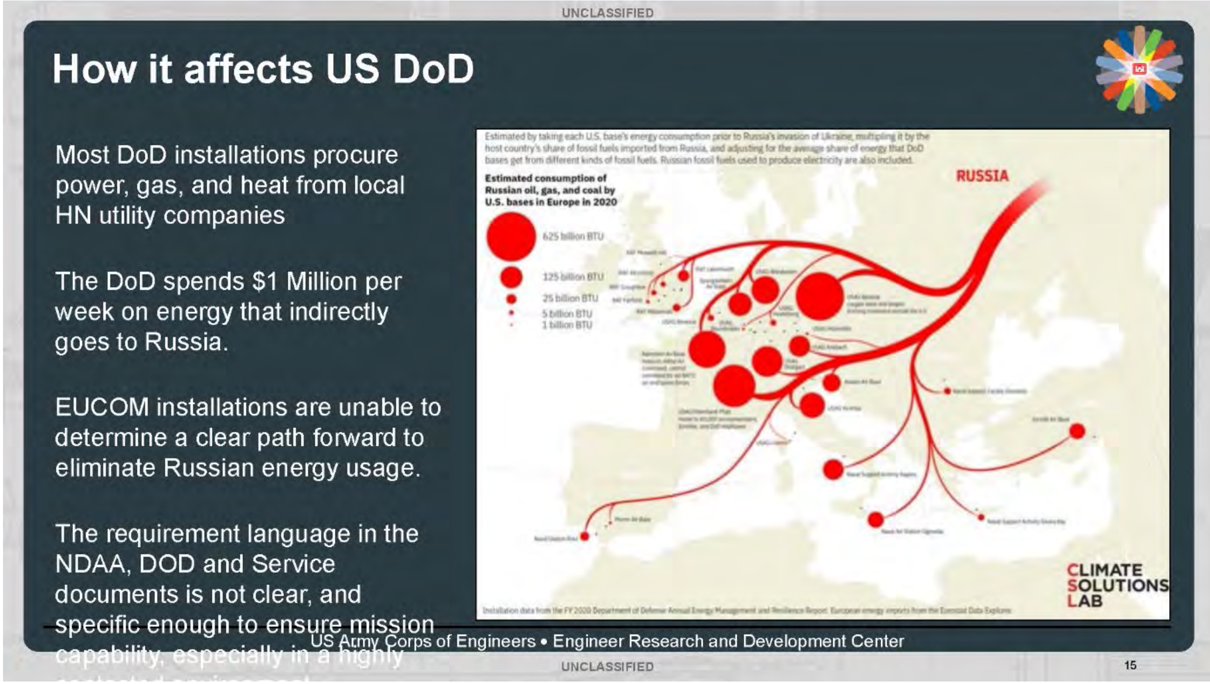


1973 Oil Crisis





Collins Ayoo, Department of Economics, Carleton University, Ottawa, Ontario, Canada
"Energy security is a goal that many countries are pursuing to ensure that their economies function without interruption and that their people have access to adequate, reliable and affordable supplies of modern and clean energy"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How it affects US DoD
Most DoD installations procure power, gas, and heat from local HN utility companies
The DoD spends $1 Million per week on energy that indirectly goes to Russia.
EUCOM installations are unable to determine a clear path forward to eliminate Russian energy usage.
The requirement language in the NDAA, DOD and Service documents is not clear, and specific enough to ensure mission capability, especially in a highly contested environment
Estimated consumption of Russian oil, gas, and coal by U.S. bases in Europe in 2020
625 billion BTU
125 billion BTU
25 billion BTU
5 billion BTU
1 billion BTU
RUSSIA
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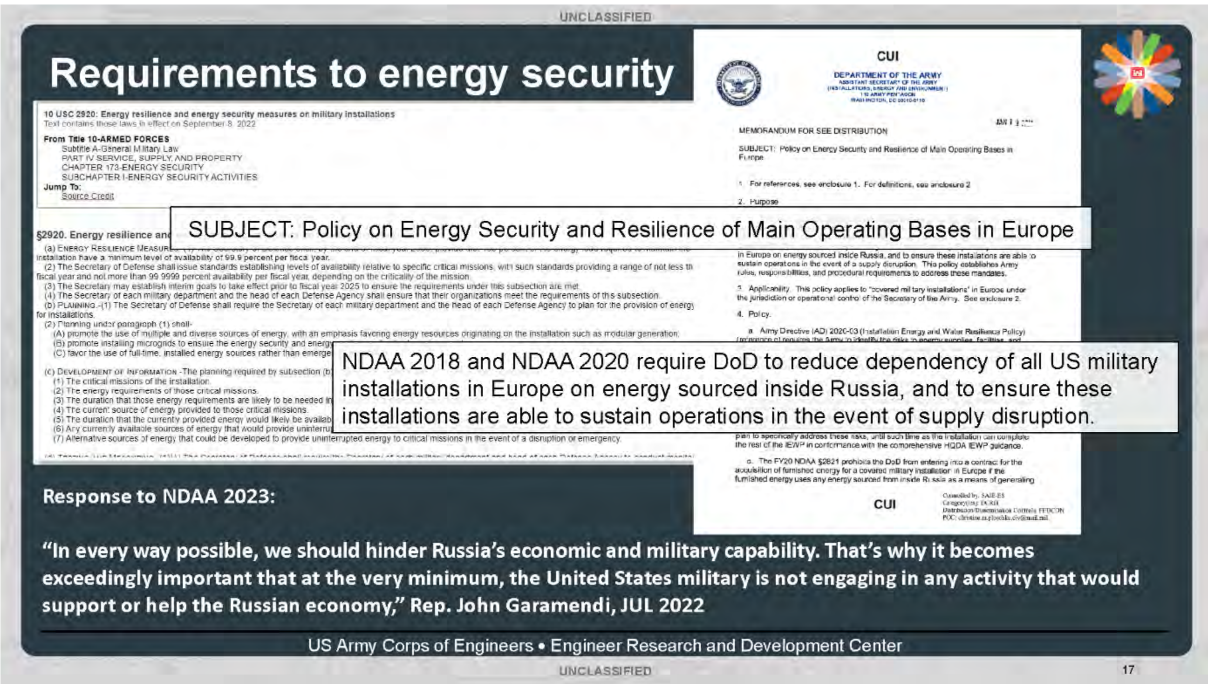
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Requirements to energy security
10 USC 2920: Energy resilience and energy security measures on military installations
From Title 10-ARMED FORCES
CUI
DEPARTMENT OF THE ARMY
MEMORANDUM FOR SEE DISTRIBUTION
SUBJECT: Policy on Energy Security and Resilience of Main Operating Bases in Europe
§2920. Energy resilience and
NDAA 2018 and NDAA 2020 require DoD to reduce dependency of all US military installations in Europe on energy sourced inside Russia, and to ensure these installations are able to sustain operations in the event of supply disruption.
Response to NDAA 2023:
"In every way possible, we should hinder Russia's economic and military capability. That's why it becomes exceedingly important that at the very minimum, the United States military is not engaging in any activity that would support or help the Russian economy," Rep. John Garamendi, JUL 2022
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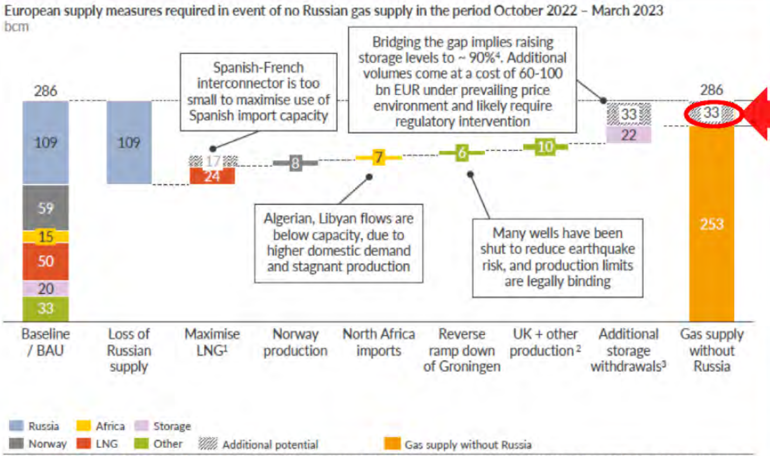
A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas by about 30% (IEA 2022 Report)

1. No new gas supply contracts with Russia
2. Replace Russian supplies with gas from alternative sources
3. Introduce minimum gas storage obligations to enhance market resilience
4. Accelerate the deployment of new wind and solar projects
5. Maximize generation from existing dispatchable low-emissions sources: bioenergy and nuclear
6. Enact short-term measures to shelter vulnerable electricity consumers from high prices
7. Speed up the replacement of gas boilers with heat pumps
8. Accelerate energy efficiency improvements in buildings and industry
9. Encourage a temporary thermostat adjustment by consumers
10. Step up efforts to diversify and decarbonize sources of power system flexibility

European energy situation

European supply measures required in event of no Russian gas supply in the period October 2022 – March 2023



1) Includes maximum increase in pipeline flow from Spain to France 2) Includes Romania and Poland 3) Assumes withdrawals in winter 2022-23 are in line with the lowest since 2015 (winter 2018-19) 4) Initial 22bcm fills storage facilities to 60% at start winter 2022-23, additional 33bcm fills storage to 90%, assumes stocks would end winter at 20%

Source: Aurora Energy Research

12% gap in projected supply for winter 2022-2023

How to close the gap?

- Reduce inefficiencies and repurpose wastes
- Reduce distribution and conversion losses (e.g., use CHP, waste heat from chillers)
- Replace Russia-originated fuels with alternative fuels and/or renewable energy sources
- **The core and common element in achieving all four energy-related framing goals is energy efficiency, which affects the amount of fuel required, the size and cost of systems, the amount of emission generated, and operating costs.**
- **Most of the measures supporting Energy Supply Security will enhance energy systems resilience and will provide a transition to a Net Zero emissions society.**

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Short-term Opportunities

Building weatherization (will reduce heat consumption by about 10 % with a payback of 1 to 1.5 years)

Retro-commissioning:

Multi-apartment building/barracks:

Basic - about 28% savings with a payback period of 1.5 years

High-performance strategies - 40% savings, the payback period of about 4.5 years

Office buildings:

Basic - about 20% savings with a payback period of 1 year

High-performance strategies - 41% savings, the payback period of about 4 yrs.'

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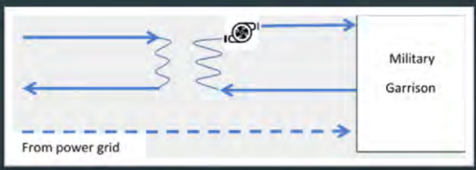
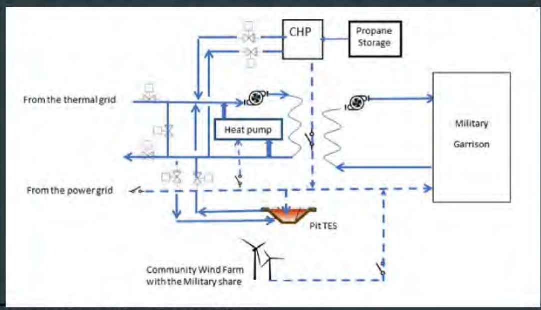
Some Mid-term Opportunities in Collaboration with Local Utility Companies

- On-site combined heat and power using alternative fuels
- PV with bi-directional use of generated power
- Seasonal storage

BAU



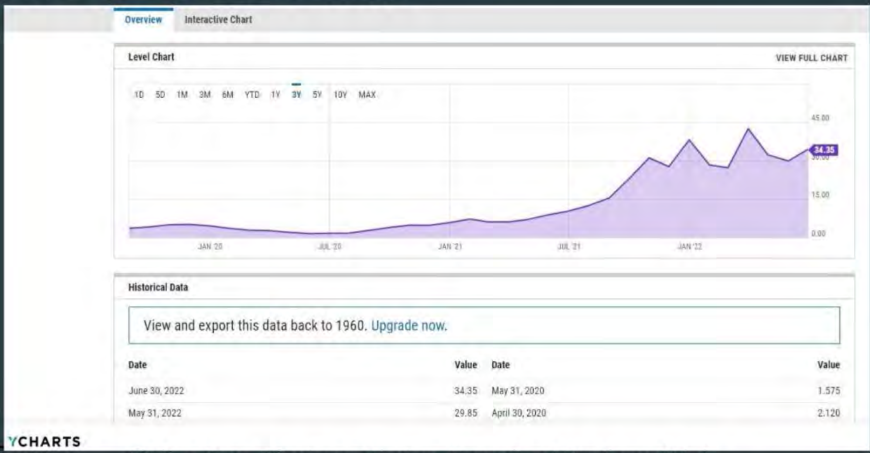
One of Possible Alternative



One of the Options Based on Current Strategies

- Install one or several CHPs with the generation of power and heat required for mission-critical facilities AND to offset Russia-originated fuels components in the generation of power and thermal energy supplied to the installation
- Connect CHPs to the microgrid along with existing emergency generators and a PV farm
- Connect CHPs to nearby clusters of buildings with heating and/or cooling needs (using adsorption chillers)
- Contract a local utility company to operate CHPs and a PV farm for bi-directional use of energy

Economics - Natural Gas Price is Historically High that Offers Incentives to ESPC Companies and Utilities to Collaborate!!!!



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Alternative Fuels

- JP5 – jet fuel used by the Navy
- JP8 - jet fuel used by the Air Force
- Propane-air mix - used by the Army
- Biogas
- Biomass used by all services
- Green hydrogen – future fuel
- Ammonia

The first three fuels can be used as transitional fuels in dual fuel energy conversion equipment

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Comparison of NG and LPG
(Provided by Paul Westerman, DDC)

Note: while trade flow diagrams on previous slides are outdated, the key take-aways still stand:

- Europe is short NatGas, which –until recently- was imported predominantly from Russia
  - While there is enough spot LNG available, Europe lacks the import infra to replace more than 50% of its needs
  - Floating storage and alternative fuels (coal, nuclear) should make up the deficit
- Europe is also short LPG, but–increasingly- this is imported from the USA (Russian exports to Europe strongly reduced back in 2020 as it commissioned a large scale Petchem facility in Tobolsk)

	C3* ($/mt)	NG** (€/MWh)	**C3 eq. ($/mt)*****	diff ($/mt)***
Oct-22	649.81	212.60	**2820.44**	2170.63
Nov-22	653.78	215.00	**2852.28**	2198.50
Dec-22	654.04	215.36	**2857.05**	2203.01
Jan-23	649.49	213.78	**2836.02**	2186.53
Feb-23	641.16	211.60	**2807.17**	2166.01
Mar-23	616.91	206.80	**2743.49**	2126.58
Apr-23	593.64	195.80	**2597.56**	2003.92
May-23	579.38	190.85	**2531.89**	1952.51
Jun-23	572.61	185.80	**2464.90**	1892.29

- On an energy equivalent basis the NatGas price is 4 x (!) that of Propane.
- Differentials, again on an energy equivalent basis, are around US$2000/metric ton

Sources:
** https://www.cmegroup.com/markets/energy/petrochemicals/european-propane-cif-ara-argus-swap.html*
*** https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures/data?marketId=5419234*
**** https://www.google.com/finance/quote/EUR-USD*
***** https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html*
*Energy contents (Lower Heating Value) *****
C3 12.88 kWh/kg
NatGas 13.1 kWh/kg

DCC

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Approach: Technologies

- **New construction and major renovation**: high-performance building envelope, passive design, use of low hot temperature water for heating and high-temperature water for cooling
- **Minor renovation**: building weatherization, retro-commissioning
- **Utilize energy waste**: CHP, waste heat from refrigeration, heat recovery from exhaust air
- **Create daily thermal storage**: chilled water and hot water tanks
- **Create seasonal thermal storage**: connections to the district heating and cooling systems
- **Heat pumps** for heating and cooling.
- **Install on-site renewable energy**: solar PV
- **Install batteries**

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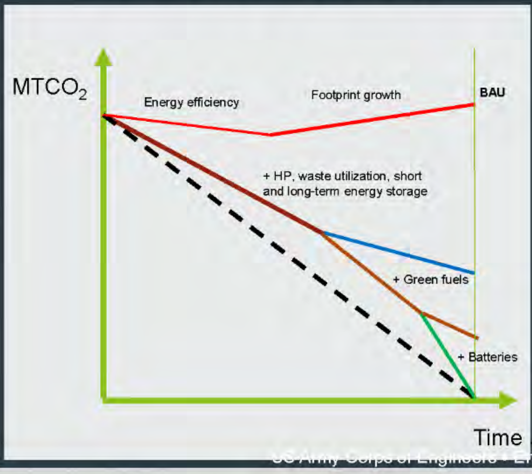
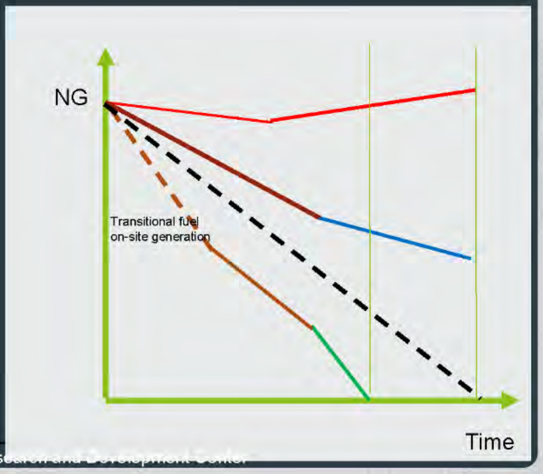
Key Message: Secure energy supply is a backbone of a net zero-emission society

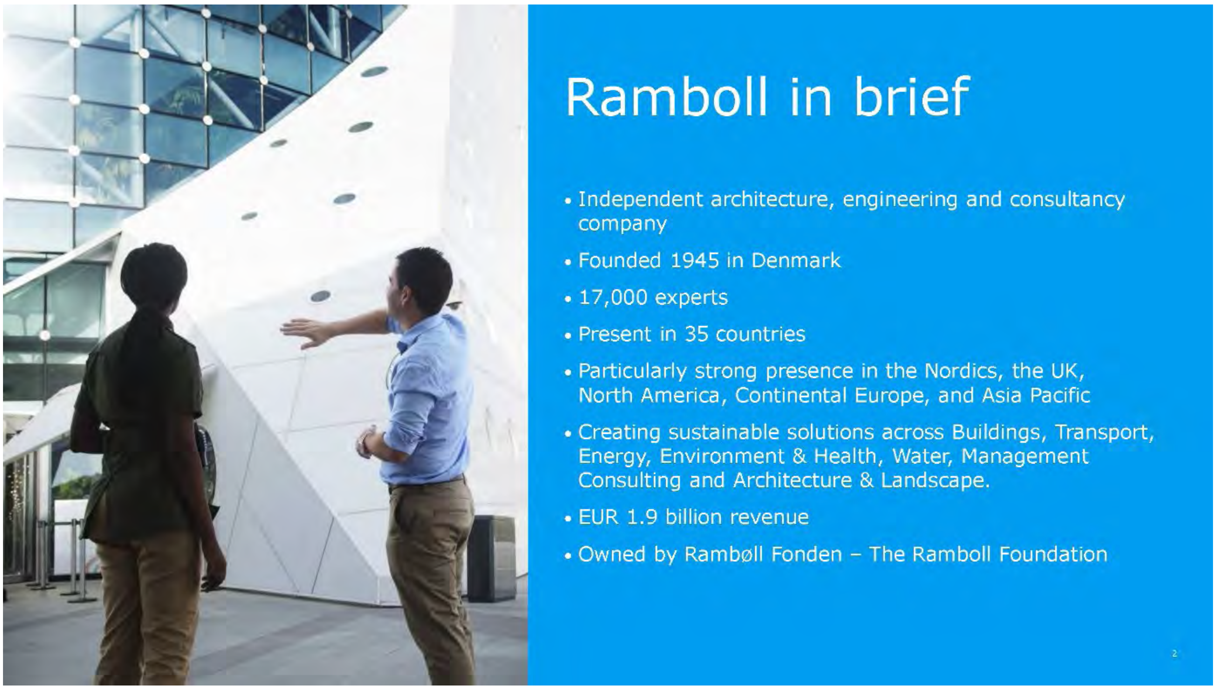




Relentless Collaboration leads to Energy Security Solutions

QUESTIONS?

Day 2, “EnergySecurity + Cost Effectiveness” (Ander Dyrelund)



Geographical footprint, Ramboll offices

Australia	3	Japan	1
Austria	1	Malaysia	3
Belgium	3	Mexico	2
Brazil	6	Netherlands	1
Canada	2	Norway	17
China	3	Poland	1
Cyprus	1	Qatar	1
Denmark	14	Romania	1
Faroe Islands	1	Saudi Arabia	1
Finland	23	Singapore	2
France	4	South Africa	1
Germany	16	Spain	2
Gibraltar	1	Sweden	30
Greenland	3	Switzerland	1
Hong Kong	2	UAE	2
India	11	UK	17
Ireland	1	US	64
Italy	2		

Global Markets

Buildings

We work closely with investors, contractors, developers, tenants to provide buildings that are distinctive, sustainable and designed to meet user needs.

Transport

Our transport specialist work together with national and transport authorities and cities to develop holistic mobility solutions.

Architecture & Landscape

Our team of architects, engineers, designers, and specialists remain at the forefront of new technologies to produce world-class design, creating places that progress society at large.

Water

Ramboll's global water team creates value for clients and societies by converting challenges related to water, climate and sustainability into opportunities.

Environment & Health

One of the world's leading environmental and health consultancies, we are trusted by clients to manage their most challenging environmental, health and social issues.

Energy

Our energy experts take a holistic approach to supporting the energy sector as portfolios and strategies change through the green transition.

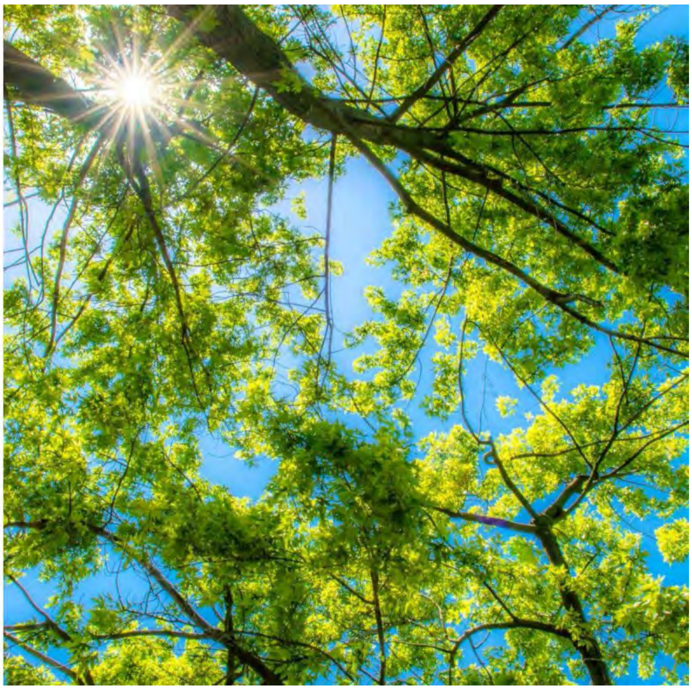
Management Consulting

We assist our clients on their most challenging tasks of today and help them be fit for the future.

Ramboll Energy
Fields of expertise

- Wind & solar
- Green hydrogen and Power-to-X
- Carbon capture, utilisation & storage
- Energy infrastructure
- District energy
- Bioenergy
- Waste-to-energy
- Energy-intensive industries

Ramboll



Energy Security and Cost Effectiveness – A Cornerstone of 50 years of Danish Energy Policy

Ramboll 6

Presentation and back ground

- The role of Ramboll in the Danish energy transition and in Greater Copenhagen selected references:
  - Planning of most of the heat supply for district heating utilities and municipalities
  - Planning, design and supervision of district heating projects for utilities
  - Design of the three waste incinerators for the waste management companies
  - Design of the two large CHP plants and heat storge tanks for the power utilities
  - Planning and design of Taarnby district cooling system

- Anders Dyrelund
  - Energy planning since 1979:
    - 1975-1981 Engineer and energy planner in Ramboll
    - 1981-1986 Civil servant and energy planner in the Energy Agency
    - 1986- Energy planner and senior market manager in Ramboll
  - First heat plan in Denmark for the city of Aarhus 1980
  - Heat planning mainly in Greater Copenhagen since 1979
  - Transfer of Danish experience to 25 countries since 1990
  - Urgent planning of district heating to replace fossil fuels boilers 2021-

Ramboll

Content

Energy policy
The holistic energy system and sector couplings
Important sector couplings
Danish show cases in EU and IEA reports

Ramboll 8

Energy Policy and objectives at all levels

- The world: UN SDG
  - Affordable, clean, low carbon energy
- EU
  - Main objectives of the EU directives
  - Cost effective, low carbon, resilient energy
- Denmark
  - Main objective of The Heat Supply Act
  - Cost effective, and resilient energy, taking into account cost of environment at the national level
- Cities
  - The aim og any city council representing the citizens
  - Cost effective, affordable, clean and resilient energy for the citizens taking into account tax incentives

Rambøll 9

Important EU Directives promote sector integration Special opportunities in cities and campuses

- Strategic environmental assessment Directive
  - **Co-operation** cross sectors
  - Plans, Policies and Programs in one sector have to be send for hearing in other sectors
- Energy Performance of Buildings Directive
  - Good indoor climate
  - **Cost effectiveness**
  - Local conditions
  - **Low carbon (nearly zero), taking into account**
    - RES via District heating and cooling, DH&C
    - CHP via District heating and cooling, DH&C
    - Heat pumps
    - Local RES

Rambøll 10

EU Directives promote sector integration in cities

- Renewable Energy Directive (RES)
  - **Urban planning** of heating and cooling infrastructure
  - Nearly Zero buildings taking into account RES via DH&C

- Energy Efficiency Directive approved 25.10.2012
  - New power plants to be **CHP located near heat markets**
  - **Urban planning** of heating and cooling infrastructure
  - Nearly Zero buildings taking into account CHP via DH&C

Oil crisis in 1973 kick-started Danish energy policy based on cost-effectiveness, environment and resiliency

- Electricity supply act from 1976
  - All new power capacity since 1976 has been CHP (Combined Heat and Power)
  - EU regulation from 1977 encouraged member states to consider CHP

- Heat supply act from 1979
  - Main objective to replace oil and save energy in a **cost-effective way for the society taking into account costs of CO2** and harmful emissions
  - Municipalities have since 1990 had been the local Energy Planning Authority
  - Secondary Act for approval of investment projects bases on socio-economic analysis

- **This holistic approach has opened for cost effective sector couplings, but**
  - Building Code is however in contradiction with EU directives and Heat Supply Act
  - Tax incentives important tax on fossil fuels in 1986, but could be better today

- **Large majority in the parliament agree on the long-term energy policy**
  - No fossil fuels to heat and power in 2030 –
  - CO2 neutral in 2050, in the most cost-effective way for the society

Content

Energy policy

The holistic energy system and sector couplings

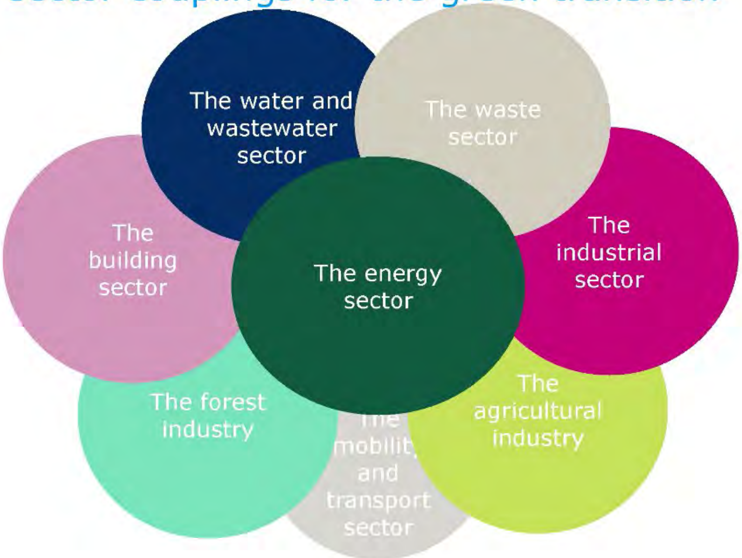
Important sector couplings

Danish show cases in EU and IEA reports

Ramboll

13

The holistic approach in the energy sector is the key cost effective sector couplings for the green transition



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The integrated energy system is the key to identify energy couplings

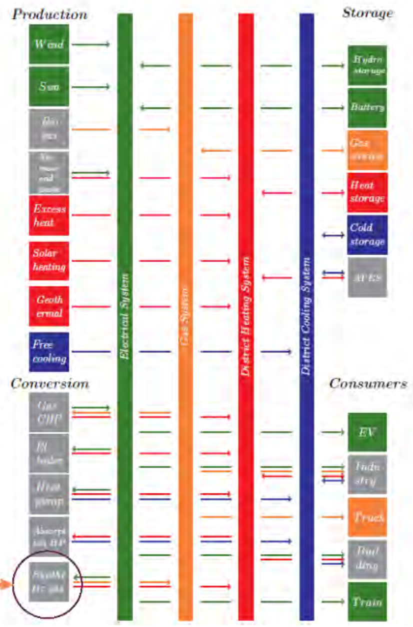
The energy infrastructure

- Power grid to integrate all Renewable source
- District heating grid city-wide, heat storage for CHP and RES
- District cooling grid in clusters, chilled water storage
- Gas grid with biomethane, storage and CHP back-up for power

Some important sector couplings:

- District heating with CHP, large heat pumps, electric boilers respond on electricity prices (the virtual battery)
- Buildings connect to DH&C, timber replaces concrete, steel and plastic
- Sustainable forestry and farming absorb CO2 stored in biomass
- CO2 is captured from waste and biomass, waste heat is utilized
- H2 from electrolysis, waste heat is utilized
- E-fuels from CO2 and H2 for transport and back-up for wind

P2X the missing link



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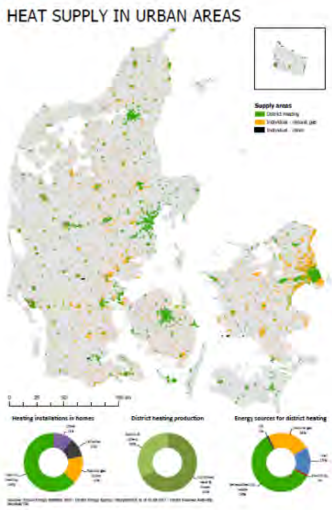
43 years of energy policy and energy planning based on cost effectiveness has given Denmark a leading role

- Optimal cost effective zoning of DH and gas grids
  - 1979-2020 preference to gas to replace oil
  - 2021-2030 oil/gas boilers to be replaced by DH or heat pumps
  - DH supplies 65 % of all homes, 99% in Copenhagen

- Optimal production
  - CHP potential utilized, no power only plants, biomass CHP is base load, but stop at low prices, gas CHP is back-up capacity
  - Waste-to-energy potential fully utilized
  - Electric boilers in DH (booming) use surplus wind energy and balance the power grid (down regulation)
  - Large heat pumps to low temperature DH (booming) use low temperature heat sources from data centers, district cooling, deep geothermal, wastewater
  - Large heat pumps can interrupt as long as needed or as long as electricity prices are too large to be competitive



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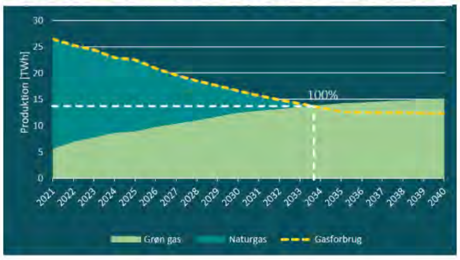
Plans for 2030 – generation storage and infrastructure Further development

- Wind energy will be the primary renewable energy source, followed by waste, biogas and biomass
- 70% of the market to district heating (DH), 30% to building level heat pumps
- District cooling (DC) in campuses and business districts
- Gas (upgraded biogas) to industry, CHP peak capacity and DH peak boilers, (no individual gas boilers for heating)
- Seasonal gas storages,
- Thermal storage tanks and pits for DH
- Thermal storage tanks for DC



Plans for 2030 – the sector integration In progress

- Biomass and waste CHP is baseload for power and heat, but turbine by-pass in case of surplus of wind (electric boiler)
- Large heat pumps for combined heating and cooling harvest surplus heat from industry and ambient heat
- Large heat pumps interrupt in case of large electricity prices and shortage of wind
- Large electric boilers harvest surplus wind energy and deliver down-regulation to the market and to local power grids (no curtailment of wind and solar)
- The sustainable forestry delivers timber to buildings and waste wood from forest and industry to DH
- Timber replaces concrete, steel and plastic in buildings
- The sustainable agriculture and food industry delivers wet biomass til biogas production

Plan for 2030 – P2X
The first plants in operation

- CO_2 will be captured from waste incinerators, biomass boilers and biogas and surplus heat delivered to the DH
- CO_2 infrastructure grid (Scenarie 3) will distribute CO_2 from plants to on-shore and off-shore storage facillities, and to fuel factories
- Electrolysis plants will produce H_2 and surplus heat for DH and deliver efficient up-regulation to the power system (a large constant load can be disrupted with short notice)
- H_2 infrastructure will distribute H_2 from electrolysis plants to large consumers (not to small boilers)
- Fuel factories will combine H_2 and CO_2 to generate renewable fuels (P2X) and deliver surplus heat for DH

Thank you for your attention

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See slides below for further details

Content

Energy policy

The holistic energy system and sector couplings

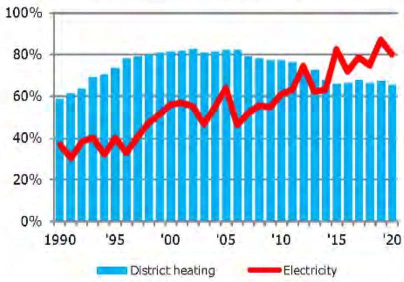
Important sector couplings in more detail

Danish show cases in EU and IEA reports

The role of Combined heat and power (CHP)

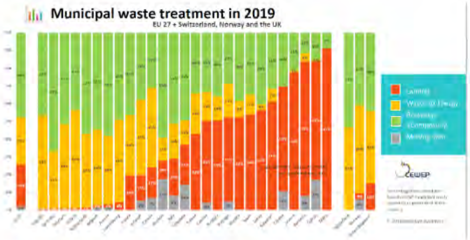
- The first important sector coupling in Denmark
- Avedøre CHP plant in Greater Copenhagen from 1990

- Thermal power generation is declining due to more wind, however
  - 80% of the thermal power generation is in combined production with heat
  - 60% of the district heating is in combined production with power
  - Electricity in combined production replaces power condensing plants in Northern Europe
  - Steam turbines are by-passed in case of low electricity prices



The new role of the waste sector and the agricultural industry

- Still huge potential for recycling energy in municipal waste in the EU
- Energy from waste which can not be recycled is used 100% efficient in DH in Denmark
- Denmark can help other countries to reduce landfilling
- Surplus straw from agriculture is a resource for district heating
- Wet biomass from the agricultural industry is resource for biogas
- **CO2** from upgraded biogas, straw and waste incineration will be a resource for e-fuels in P2X



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The new role of the forest industry in P2X, CCU, CCS

- Sustainable forests produce timber and absorb CO2
- Waste wood from the forest (tinnings) and from the timber industry is used efficiently without pollution in DH
- Timber, in particular cross laminated timber, is utilized in a booming low carbon building industry, replacing cement, steel and plastic
- The embodied cross laminated timber can, if the buildings are demolished after 100 years be reused for other secondary products or paper 2-3 times
- Finally end of lifetime, all the biomass will be used efficiently without pollution in wood chip boilers or waste incinerators and the concentrated **CO2** will be captured to be stored or reused for e-fuels in **P2X**

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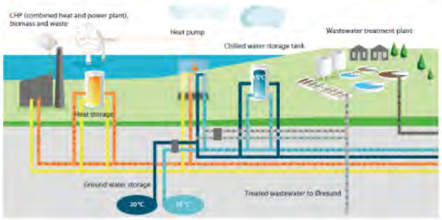
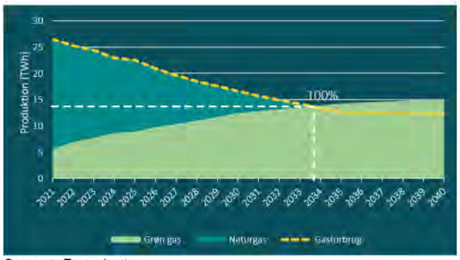
The new role of the water and wastewater sector

- Large heat pumps for combined district heating and district cooling utilize surplus heat from cooling processes in the industries and in the buildings (not domestic), which need active cooling for thermal comfort
- Ground water combined with heat pumps for seasonal storage of cold energy and ambient heat
- Wastewater is becoming a heat source for heat pumps
- All kinds of water is becoming
  - a heat source for heat pumps in the district heating
  - a cooling source in district cooling



The new role of the gas sector

- The "Green gas" produced in Denmark will meet the Danish gas demand in 2030-2034
- The gas infrastructure distribute and store large capacity in salt caverns and in aquifer storage:
  - Biomethane (from upgraded biogas) and
  - Electrogas from P2X
  - Fossil gas from the market
- Gas is too expensive to be the primary heat source, but
  - Gas in DH peak boilers and CHP plants will be important back-up for the fluctuating wind energy
  - Oil from P2X in DH peak boilers and CHP plants will be important back-up for gas in case of new energy crisis.



Source: Energinet

The role of the buildings

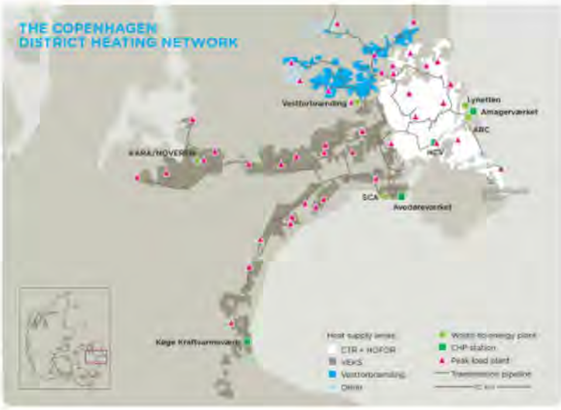
- Growing cities is an opportunity to plan and implement smart, clean sustainable solutions, in particular within energy
- DH&C utilizing surplus heat and efficient ambient energy is in general the most cost effective solution for the society, the city and the consumers, taking into account cost of CO2
- Connecting to the planned urban infrastructure for DH&C is an opportunity for building owners to gain maximal sustainability score both on the economic, environmental and social criteria

- Carlsberg city is a good commercial case
  - All buildings, 600.000 m2, will be connected to the DH
  - All buildings with active cooling demand, 350.000 m2, will be connected to the DC in accordance with commercial contracts
  - Carlsberg City prefers off shore wind farms and green roof tops

- Nordhavn is also a good show case, but difficulties, as the building code promotes building level solutions

Sustainable energy in buildings in Greater Copenhagen The historical development, in brief

- 1980
  - Steam based DH in the city centre
  - Growing hot water DH from coal CHP and waste
  - Heavy oil for DH and light oil in most buildings
- 1980-1990
  - Central heat supply planning of DH and gas grids
  - Agreement to establish 2 CHP and the DH system
  - Gas to small buildings and northern suburbs
  - 1990-2005
    - Consolidation and preference to gas
  - 2005-2020
    - Close steam, biomass, large building from gas to DH
  - 2021-
  - Replace all gas boilers with DH and heat pumps
  - Electric boilers and heat pumps in the DH



Content

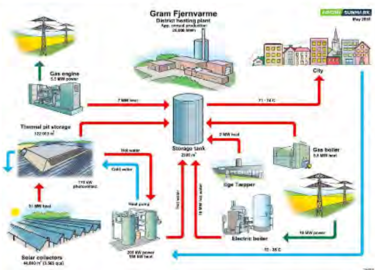
Energy policy
The holistic energy system and sector couplings
Important sector couplings
Danish show cases in EU/JRC and IEA/Annex73 reports

EU experience DH and DC 2016

Greater Copenhagen DH: A show case of cost effective low carbon heating in a metropol

- 1 million people in one system
- Owned by municipalities and consumers
- 30% heat from waste CHP
- 65% energy from biomass CHP
- Power to heat is booming

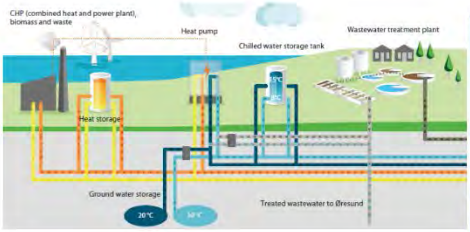
- **Gram:** A show case of demo-cratic ownership in a village
- Has established a virtual battery like many other communities
- Taken part in development of large-scale solar and heat storage pits



https://publications.jrc.ec.europa.eu/repository/handle/JRC104437

EU experience DH and DC 2021

Taarnby: A show case for smart sector couplings between power, district heating, district cooling, wastewater and gound water



Jægerspris: A show case for a new local energy community utilizing solar heating, gas CHP and heat pumps

https://publications.jrc.ec.europa.eu/repository/handle/JRC123771

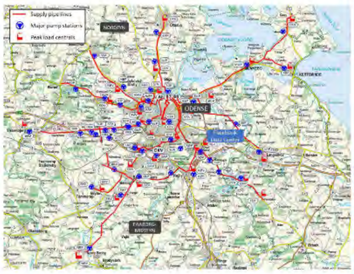
EU experience DH and DC 2022

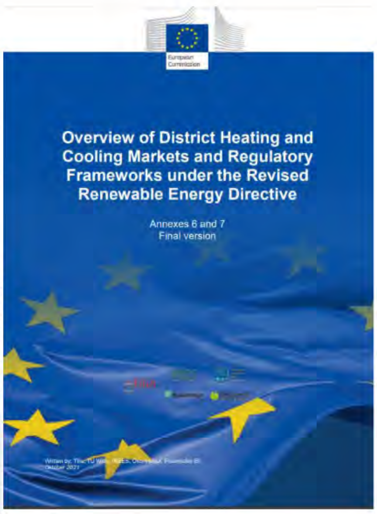
Fjernvarme Fyn: a remarkable district heating system:

- 70.000 buildings are supplied from one integrated network with direct connection without heat exchangers
- 70.000 m3 pressure less heat storage tank
- Consumers deliver <40 oC return
- CHP, Waste, biomass, electric boilers, large heat pumps

VEKS and Høje Taastrup

- Greater Copenhagen DH in transition for integration of wind
- District cooling
- Large heat pumps use heat from data centers, industries, drain water





https://op.europa.eu/en/publication-detail/-/publication/30058105-eac0-11ec-a534-01aa75ed71a1/language-en

IEA Annex 73, 2017 – 2022 Case studies and Guides

Ramboll https://annex73.iea-ebc.org/ 33

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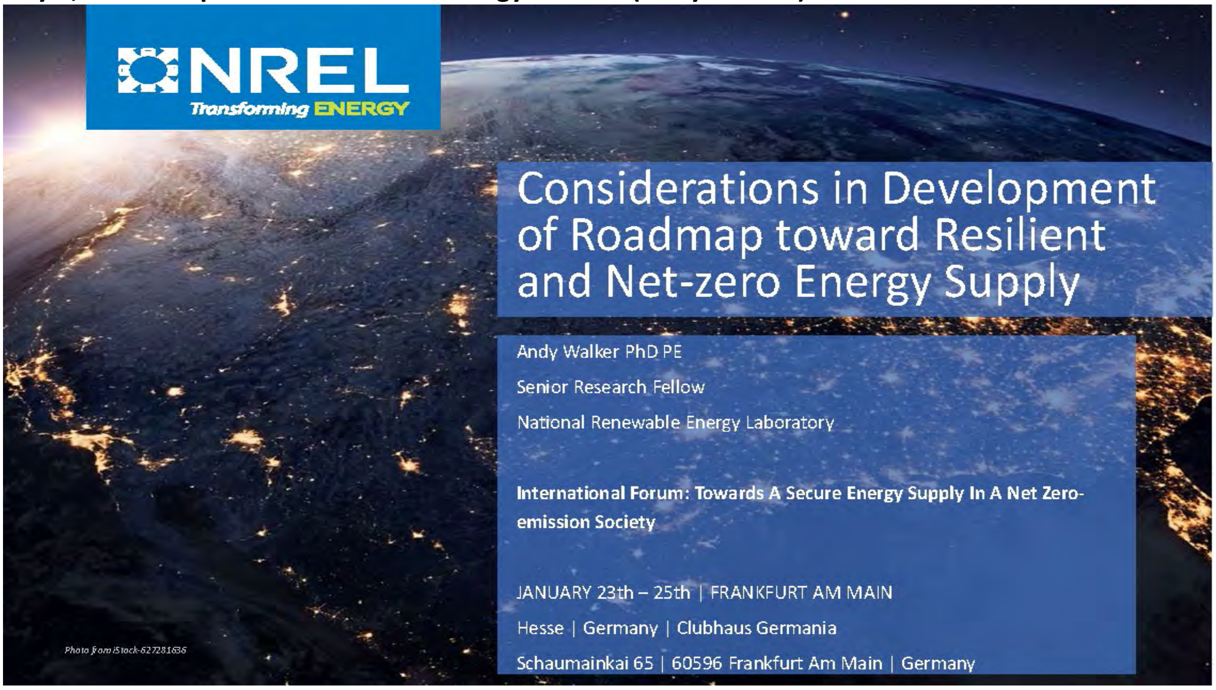
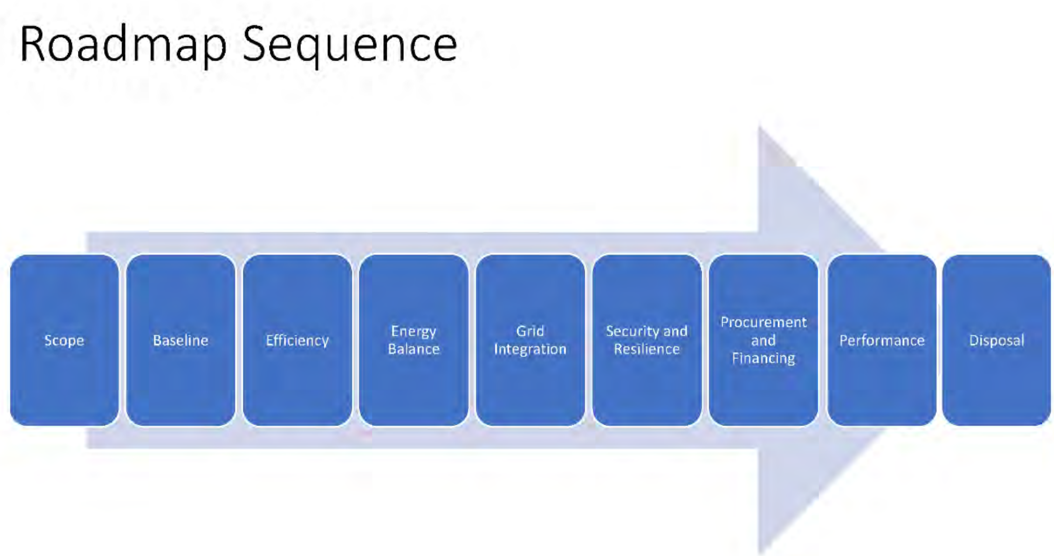
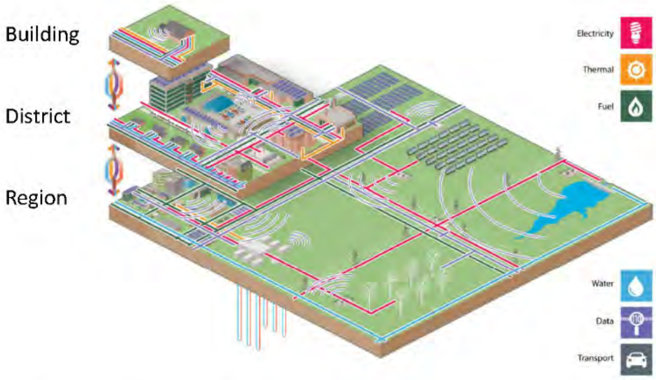
Day 2, "Roadmap to Resilient Clean Energy Future" (Andy Walker)





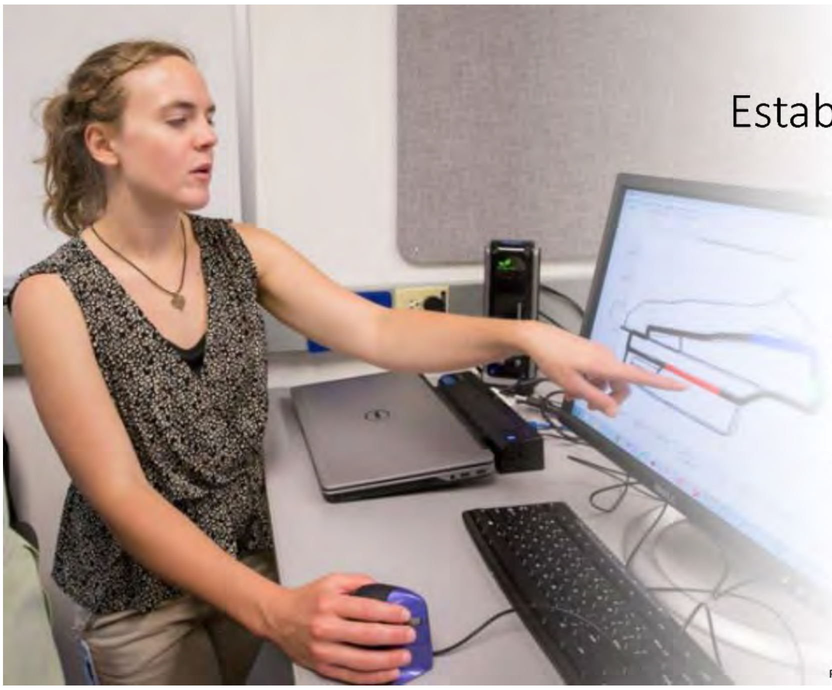
Establish scope of analysis

- Scale
  - Building-scale
  - Facility-scale
  - Utility-scale
  - National
  - Regional
- Systems
  - Electric
  - Fuels
  - Transportation
  - Water
  - Data



- Engage stakeholders
  - Owners, operators, utilities, regulators, financiers, insurance, technology suppliers

Photo: images.nrel.gov #66548



Establish Baseline

- Building Energy Consumption
- Transportation
  - Fuels consumption and infrastructure
  - Public transportation
- Industrial Processes
- End Uses
  - Requirements for heating, cooling, lighting, etc
- Resources
  - Electricity
  - Natural Gas
  - Other fuels
- Applicable laws, regulations, codes, standards

Photo: images.nrel.gov #34670

Conservation, Efficiency and Electrification

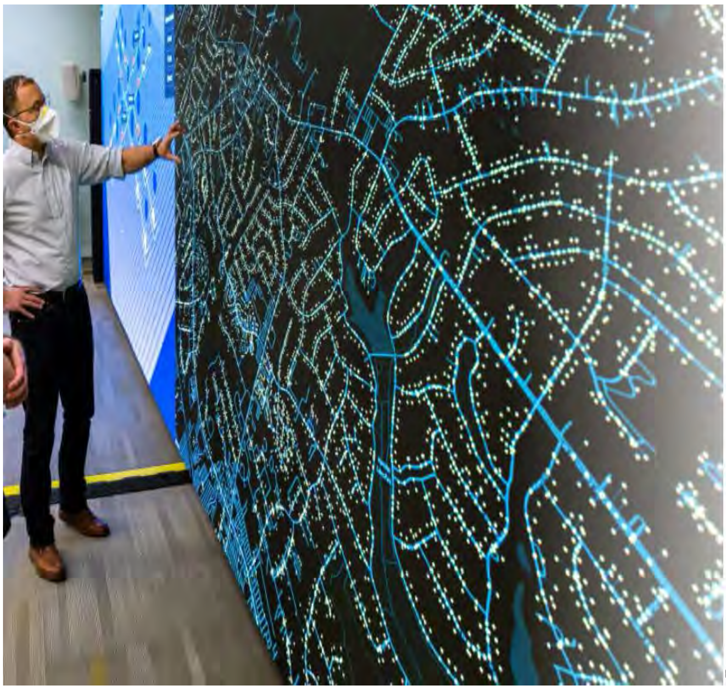
- Human Awareness and Behavior
- Sophisticated Controls (forecasting of loads and resources and optimal dispatch of storage)
- Equipment Improvements (efficiency)
- Alternatives for Industrial Processes (low carbon)
- Alternatives for Transportation

Photo: images.nrel.gov #17956

Energy Balance (Thermodynamics)

- Electrification and Fuel Switching
  - Heat Pumps, extraction dryers, induction cooking
  - Fuel switching (cleaner, renewably derived, or less expensive fuels)
- Alternative fuels
  - Electrification, renewable fuels (eg biodiesel)
- Cogeneration of Heat and Power
- Renewable Energy
  - Photovoltaics, wind, solar thermal, biomass, hydro, geothermal, marine
- Energy Storage
  - Thermal storage (diurnal, seasonal); building mass
  - Battery Energy Storage System

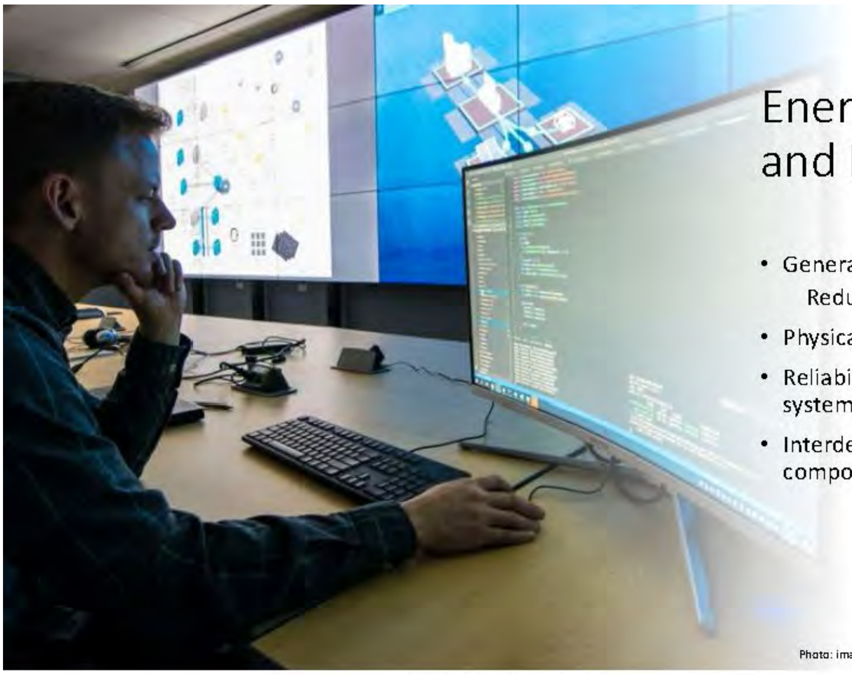
Photo: images.nrel.gov #61669



Grid Integration (Transport Phenomenon)

- Building integration (capacity of switchgear and service line)
- EV Charging
- Distribution Network topology and operations
  - Connect resources to loads; resilience, line losses, protection (location and setting of breakers), voltage regulation, frequency regulation, reactive power
- Substation capacity and configuration
- Transmission capacity and reservation (timing)
- Generation
  - Capacity, ramp rates, spinning reserve

Photo: images.nrel.gov #66955



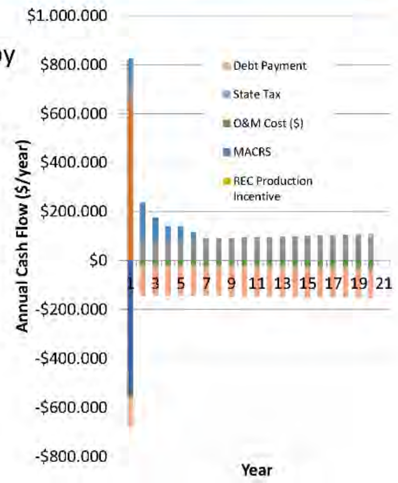
Energy Security and Resilience

- General Principles
  Redundancy, Interoperability
- Physical and Cyber-security
- Reliability of components and systems
- Interdependencies of components and systems.

Photo: images.nrel.gov #55310

Economics

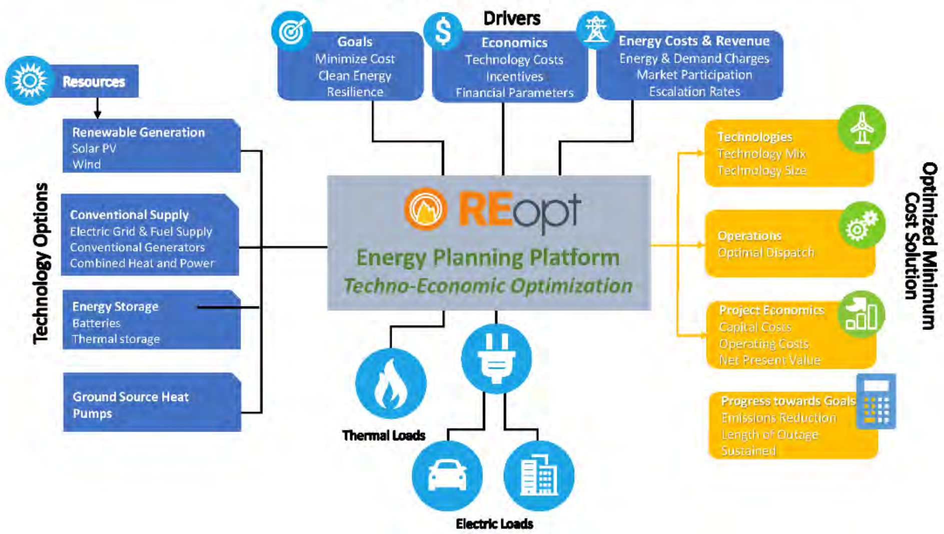
- Details of Utility rate schedule and policies
  - Fixed charges, demand charges, net metering, stand-by rates
- Economic Parameters: Discount rates, debt interest rates, inflation rates
- Capital Financing Alternatives
  - Appropriations, Equity Investors, Bank Debt
  - Financing authorities (ESPC, lease, power purchase agreement, etc)
- Operating Costs (O&M, replacements, insurance, etc)
- Performance Risk (under-performance of systems)
- Energy Justice and Equity (consider the disadvantaged)



REopt Energy Planning Platform

Formulated as a mixed integer linear program, REopt provides an integrated, cost-optimal energy solution

reopt.nrel.gov.



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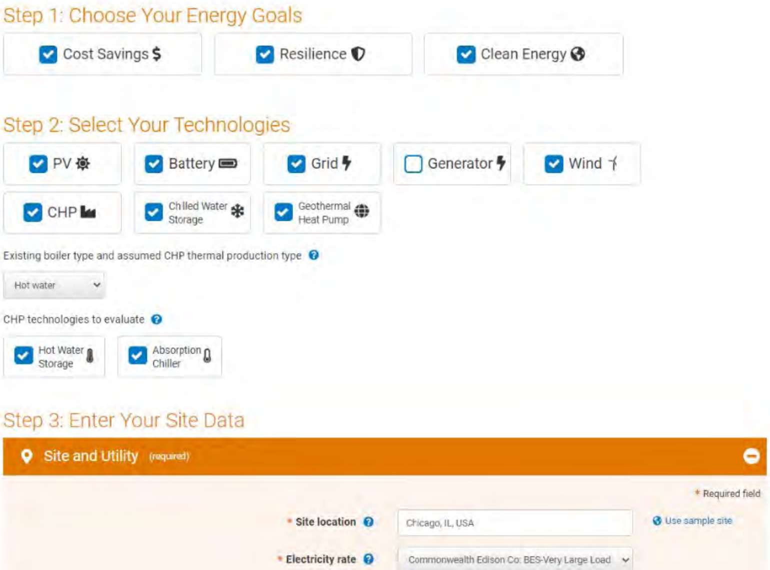
reopt.nrel.gov

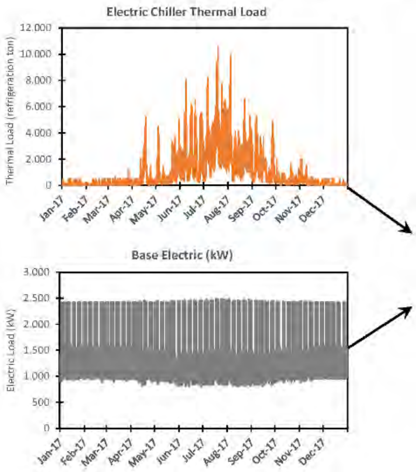


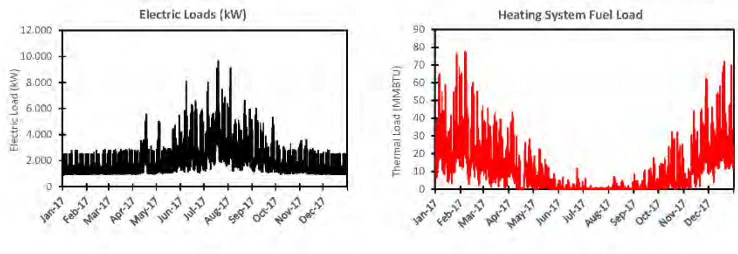
Example REopt Analysis

Representative Load from US Army Facility
Climate Zone 5A (Chicago IL)

Site-Specific Parameters	
IECC Climate Zone	Climate Zone 5A Cool– Humid 3000 < HDD18ºC ≤ 4000 [5400 < HDD65ºF ≤ 7200]
Annual Electric	19,289,875 kWh; $2,723,695/year
Annual Natural Gas	70,564 MMBtu; $423,381/year
Technologies	PV, BESS for electric loads Cold TES for reducing chiller thermal peaks GHP for electrification analysis
Rates (Electric and NG)	Electric: Commonwealth Edison Co - BES-Very Large Load Delivery Class (Secondary) *Demand: $8.12/kW* *Energy: Winter: $0.104/kWh* *Summer: $0.126/kWh* Natural Gas: $6/MMBTU

[1 MMBtu ≈ 1 GJ]



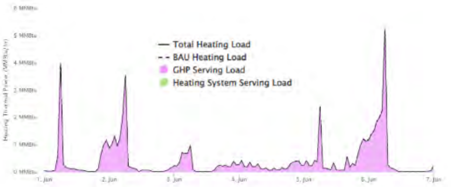


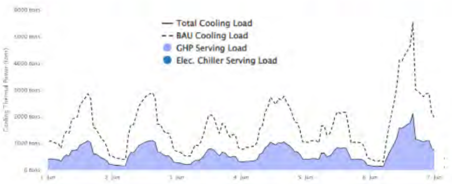
REopt analysis and graphics by Indu Manogaran, NREL

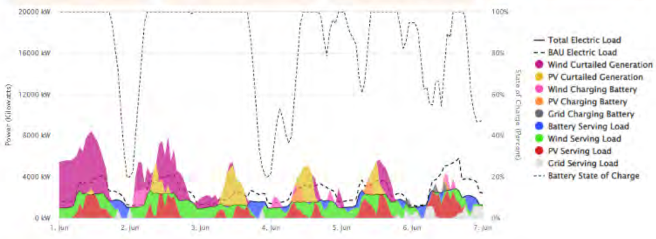
REopt Recommendations

Electrification of Thermal Loads

Photovoltaics, Wind, Energy Storage







	Base Case	REopt Case
Annual Electric Cost ($)	$2,723,695	$527,898
Annual Natural Gas Cost ($/year)	$423,384	$0
Capital Cost ($)	$0	$42,475,873
Life Cycle Cost ($ NPV)	$56,083,775	$62,280,333
Carbon Emissions (tons/year)	18,266	1,866

Photos: images.nrel.gov #35314, 26503, 06569. 61991

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Day 2, “Austrian Strategy Energy Security” (Anna Maria Fulterer)

Austrian strategy

Energy Communities, Grants for Renewable Energies and Electrification

Anna Fulterer

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2022

AEE - Institute for Sustainable Technologies was founded in1988 as a non-university research institute. It is today one of the leading institutions in the field of renewable energy and resource efficiency.

1988

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Our Main Research Topics

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Our Projects

~ 110
Ongoing Projects

~ 5,2
Million € Annual Turnover

70 x
Participation in EU projects

44 x
Lead Management of EU Projects and National Flagship Research Projects

43 x
Demonstration and Market Implementation (last 5 Years)

Disclaimer

- I present my view on recent developments
- Active since 2015 in private research institute AEE INTEC
- part of IEA EBC Annex 73 on Energy Resilient Communities
- from 2017 to 2022

- Official documents on public strategies and measures:
- Strategy for climate change adaptation
  www.bmk.gv.at/themen/klima_umwelt/klimaschutz/anpassungsstrategie/publikationen/oe_strategie.html
- Planned and ongoing measures for climate change mitigation
  www.bmk.gv.at/themen/klima_umwelt/agenda2030/bericht-2020/nachhaltigkeit.html
- Energy strategy:
  https://www.bmk.gv.at/themen/energie/energieversorgung.html

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Content

- **Development in last decades**
  Constant and low energy costs, high labor costs, automation of industry, little incentives for energy efficiency

- **Strategy until 2021**
  slow adaptation, with focus on location advantage and social peace, voluntary action supported by grants

- **Latest actions (from 2021)**
  Revised strategy, more F&E as well as demonstration of concepts, financial support to more renewable energy, adaptation of legal situation to promote renewables

- **Challenges and remaining problems…**

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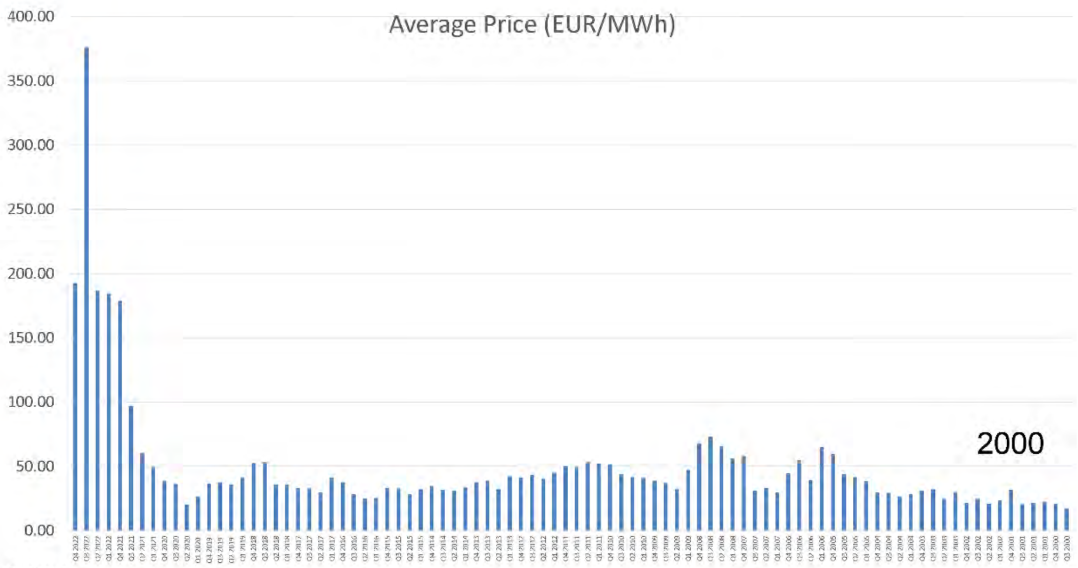
„In this way, I will be able to cut consumption by half"

Development in Last Decades

- **many years of constant, or even decreasing energy costs**
- **High level of energy security (>99.99%)**
- **rising dependence on cheap gas from Russia, especially for industrial use**
- **Low renovation rate (1.5%1) due to**
  - low energy costs and high labour costs
  - Incentives for new buildings rather than renovations
- **High rate of ‘Versiegelung’ (Sealing)**

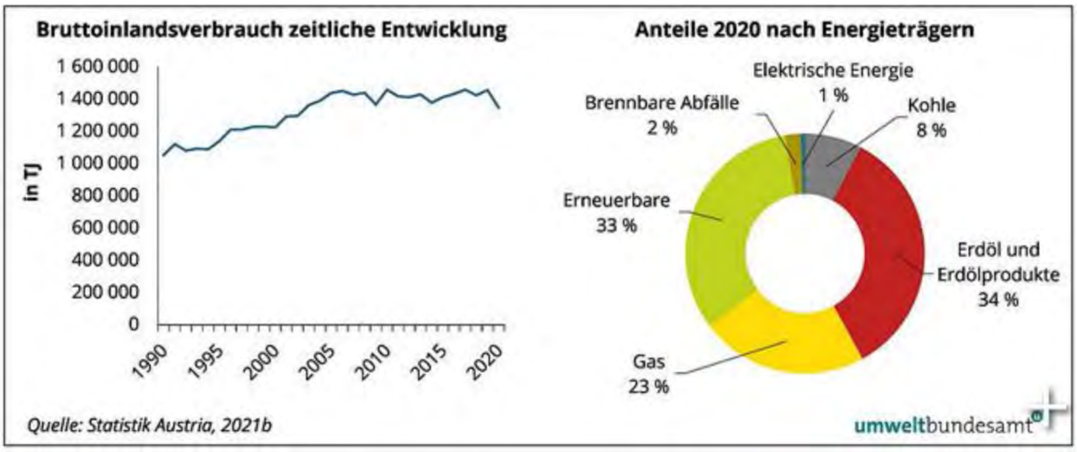
Development of Electric Energy Price



2022

Data source: EEX

Development of Energy Consumption

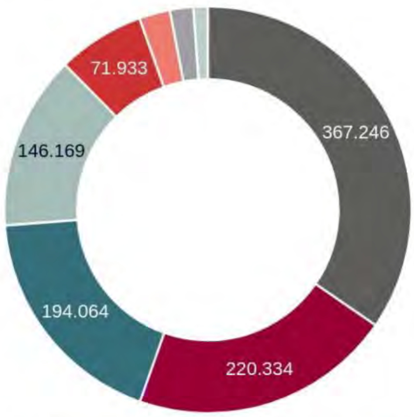


Energy consumption 2020 by carriers

Energieverbrauch nach Energieträgern

Energiebilanz von Österreich ab 1970

2020 in Terajoule



Erdöl, Strom, Erdgas, Biogene Treib- und Brennstoffe (inkl. Scheitholz), Fernwärme, Umgebungswärme etc., Kohle, Abfälle

Quelle: Statistik Austria

Grafik weiterverwenden

Quelle: Österreichsenergie.at

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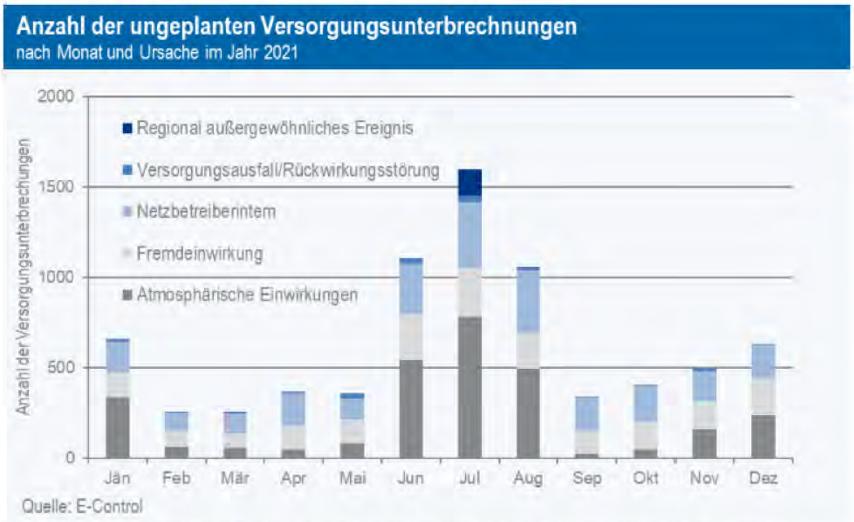
Electric Energy Outages

- Constantly low, 2021 at 38,07 minutes per year and client
- Half unplanned, half planned



Source: https://www.e-control.at/industrie/strom/versorgungssicherheit/ausfalls-und-stoerungsstatistik

www.aee-intec.at AEE – INSTITUTE FOR SUSTAINABLE TECHNOLOGIES Energy Security Austria | 24.1.2023

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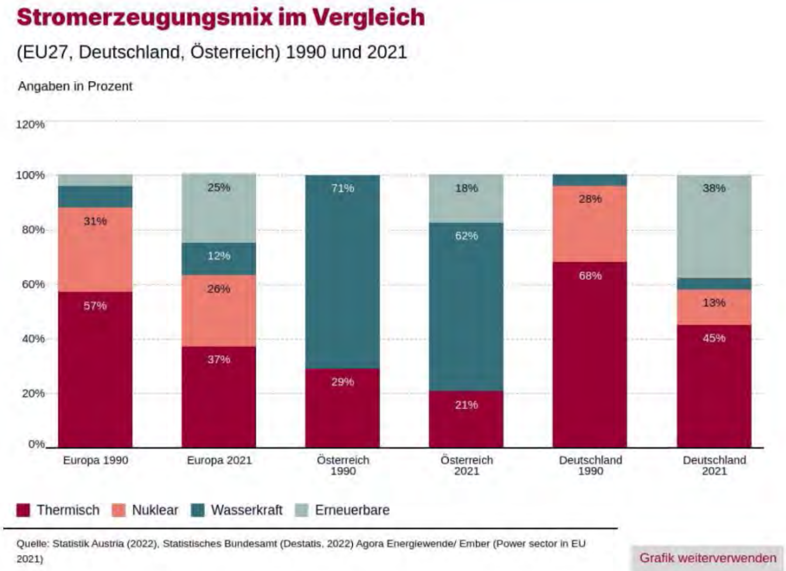
Energy Generation mix in Austria



Source:österreichsenergie.at

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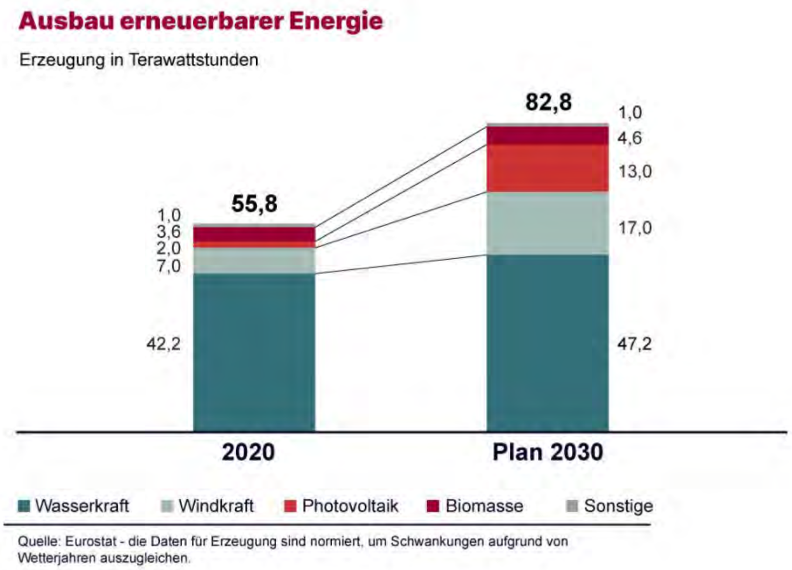
Strategy until 2021

- embedded in and driven by EU strategy
- continuous rise of required energy efficiency of buildings and equipment
- certificates and grants for high-efficiency and low climate impact buildings
- financial support to F&E and demonstration, as well as new generation plants (fixed feed in tariff and/or investment grant)

Plans for Renewables (2021)



Source: österreichsenergie.at

AEE INTEC

Latest actions (from 2021)

- Revised strategy:
  - more F&E as well as demonstration of concepts
  - More financial support to more renewable energy
  - faster adaptation of legal situation to promote renewables
  - Action by people and companies
  - Main challenge: shortage of material/devices and work power!

AEE INTEC

Recent actions

- Facilitation of creation of wind power plants and PV Plants (WIP)
- Financing of more F&E and demonstration projects as well as financial support for renewable energy plants (continuosly)
- Decision to enhance critical infrastructures of defense (Q4, 2022)
- Flat rate for public transport (2021)
- **Energy communities**
  - Legal backbones (2021)
  - Financial and organizational support (2021)
- **Flagship regions**
  - 120 climate and energy regions KEM (since 2010)
  - 79 climate change adaptation regions KLAR (initiated 2016)

But…

Some public action may counteract the developments driven by high energy prices:

- Public grants to counteract higher energy costs
  - For households (sept 2022) and companies (dec 2022)
- Still reduced taxes for
  - Gas fuel
  - Aircraft fuels
- Public grants or loans for failing energy companies to secure energy supply (e.g. Wien Energy)

Outlook

- Energy transition now driven by
  - Wish to increase energy security
  - High inflation
  - Grants
  - Making investments easiert (work in progress)
- Challenges
  - Availability of ressources
  - Work power
  - Source transition instead of efficiency?
  - Up to now: all efficiency was eaten up by using more devices, more square meters per person etc.

AEE – Institute for Sustainable Technologies (AEE INTEC)
8200 Gleisdorf, Feldgasse 19, Austria

Website: www.aee-intec.at
Twitter: @AEE_INTEC

Anna Fulterer
a.m.fulterer@aee.at

Day 2, "Decarbonization of Heating, Mobility and Industry" (Rainer Block)

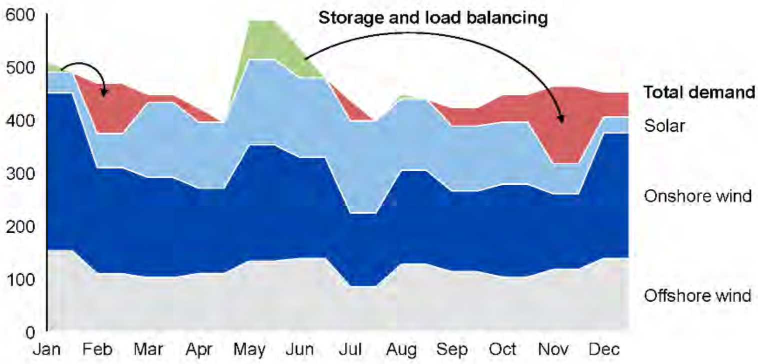
Energy & Transport account for a large share of emissions – what is to do?

1. Renewable Energy RE (PV, Wind Biomass etc.) and Nuclear with lowest carbon footprint
2. Energy Efficiency
3. Electrification wherever possible (transportation, buildings) = direct usage of RE
4. Energy storage with H2

Total global CO_2 emissions, 2020 (Gt)

Hydrogen storage of local REN across seasons and import from other regions

Seasonal forecasted demand and supply
2040 forecast, TWh

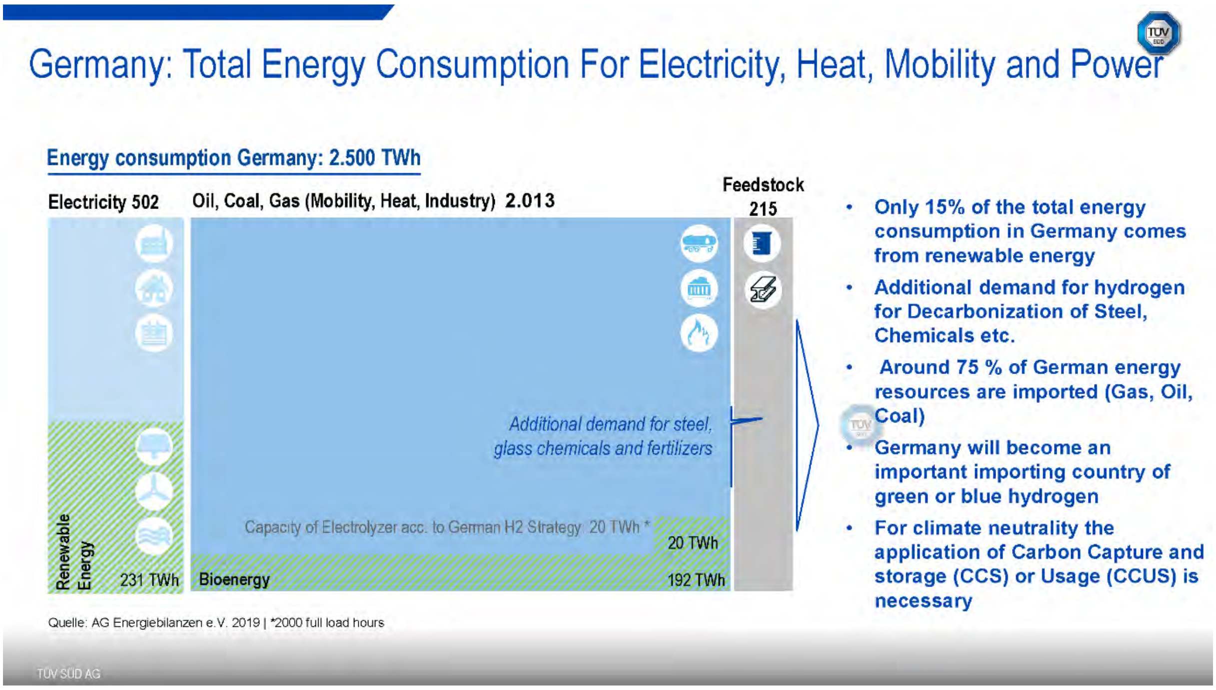


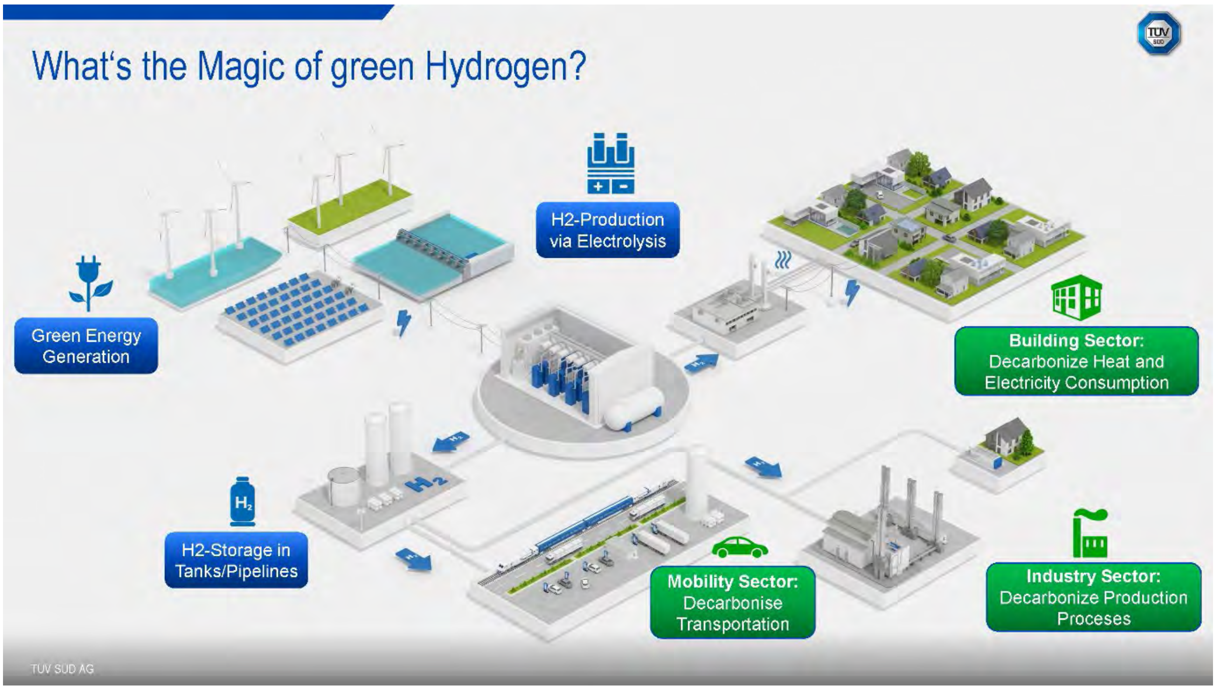
Source: McKinsey Power Model, Europe Net Zero Report, German Grid Agency

- Challenge for REN: seasonal and daily supply-demand gaps
- Hydrogen for longer-term storage to bridge the gaps and enabling import of RE

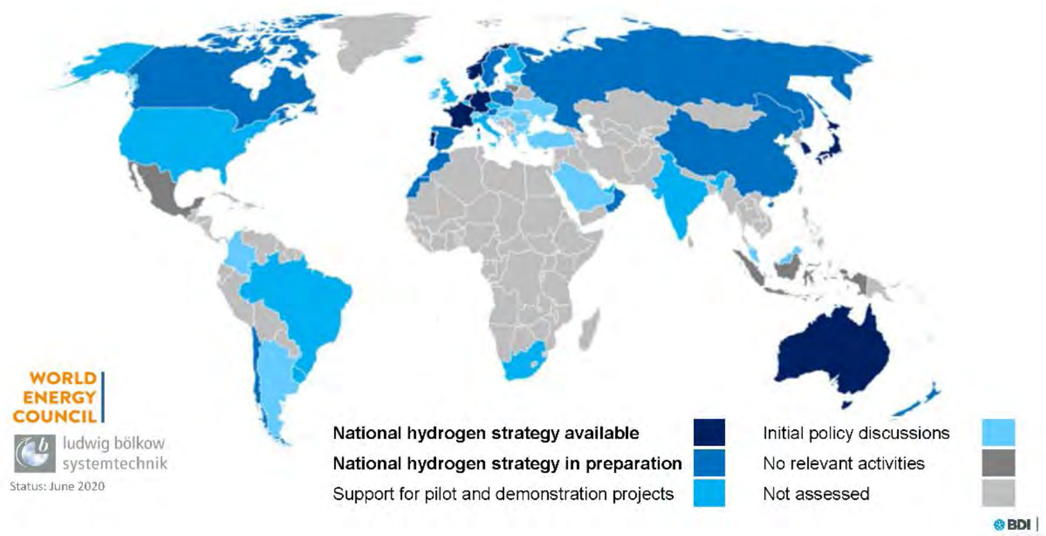
Oversupply which needs to be exported or curtailed

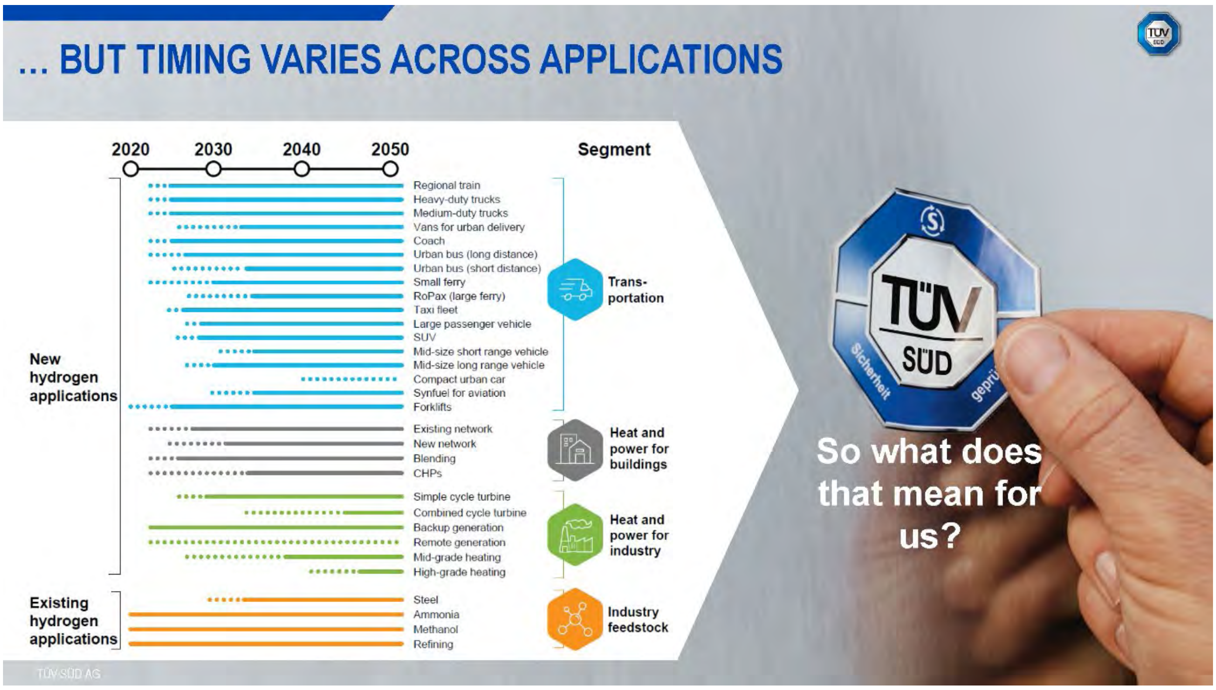
Undersupply which needs to be filled with imports or from non-renewable sources


Germany: Total Energy Consumption For Electricity, Heat, Mobility and Power
Energy consumption Germany: 2.500 TWh
Electricity 502
Oil, Coal, Gas (Mobility, Heat, Industry) 2.013
Feedstock 215
Additional demand for steel, glass chemicals and fertilizers
Capacity of Electrolyzer acc. to German H2 Strategy 20 TWh *
20 TWh
Renewable Energy
231 TWh
Bioenergy
192 TWh
• Only 15% of the total energy consumption in Germany comes from renewable energy
• Additional demand for hydrogen for Decarbonization of Steel, Chemicals etc.
• Around 75 % of German energy resources are imported (Gas, Oil, Coal)
• Germany will become an important importing country of green or blue hydrogen
• For climate neutrality the application of Carbon Capture and storage (CCS) or Usage (CCUS) is necessary
Quelle: AG Energiebilanzen e.V. 2019 | *2000 full load hours
TÜV SÜD AG

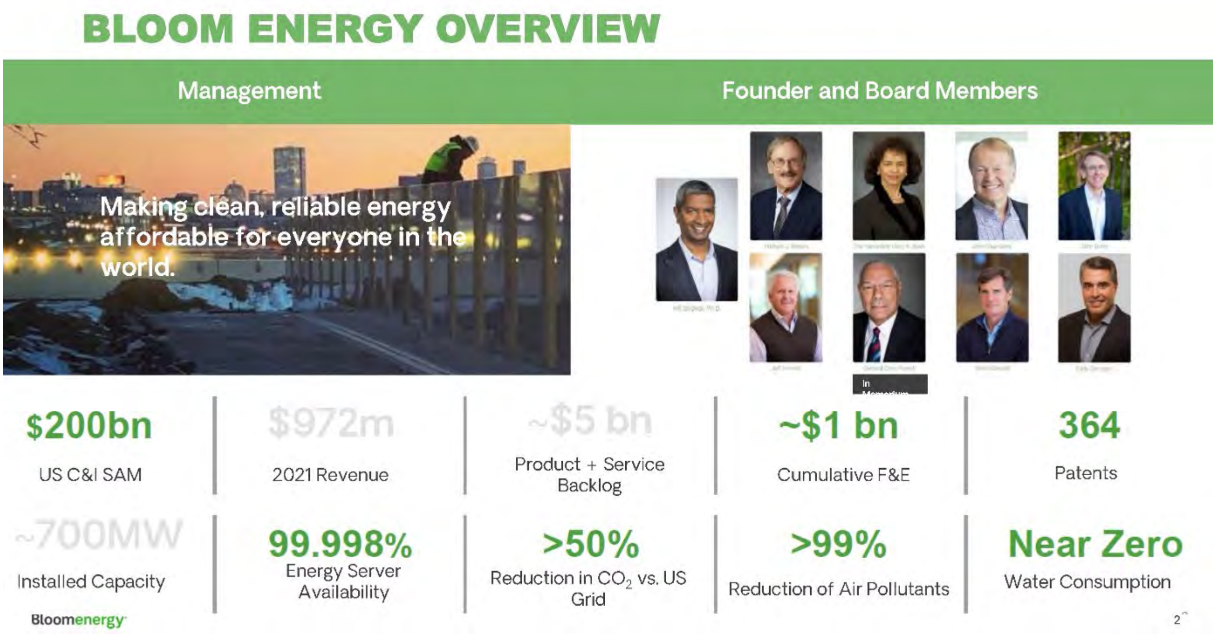

What's the Magic of green Hydrogen?
Green Energy Generation
H2-Production via Electrolysis
Building Sector: Decarbonize Heat and Electricity Consumption
H2-Storage in Tanks/Pipelines
Mobility Sector: Decarbonise Transportation
Industry Sector: Decarbonize Production Processes
TÜV SÜD AG

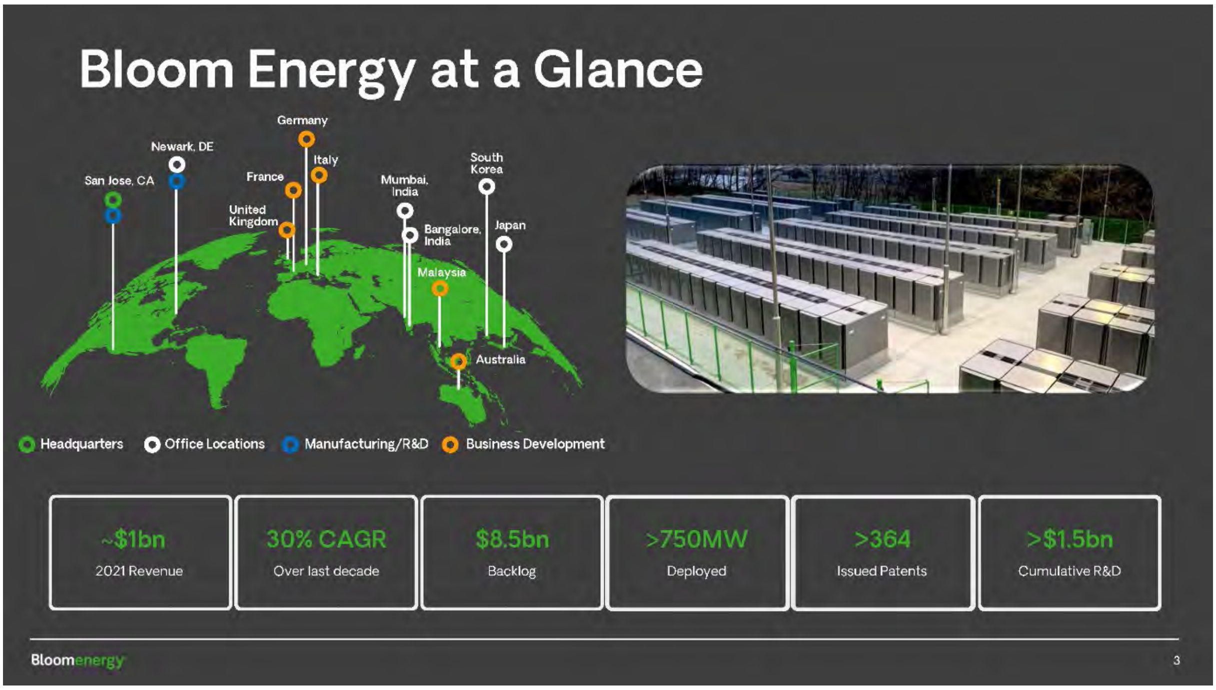
Over 30 Countries Have Hydrogen Strategies in Place





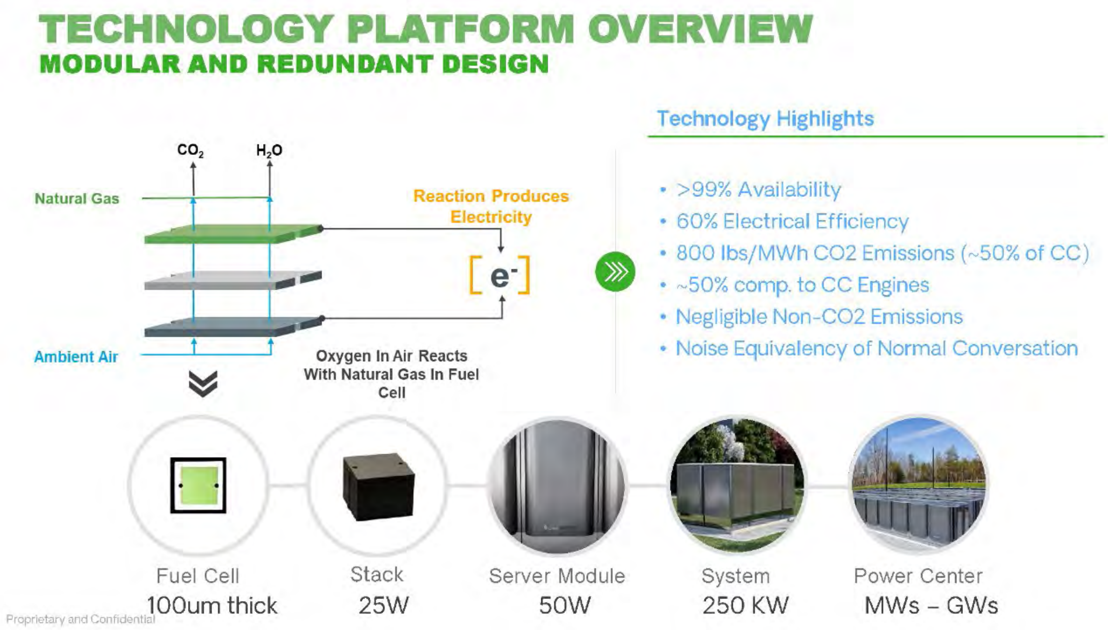
Day 2, "Role of Fuel Cells" (Stephan Reimelt)

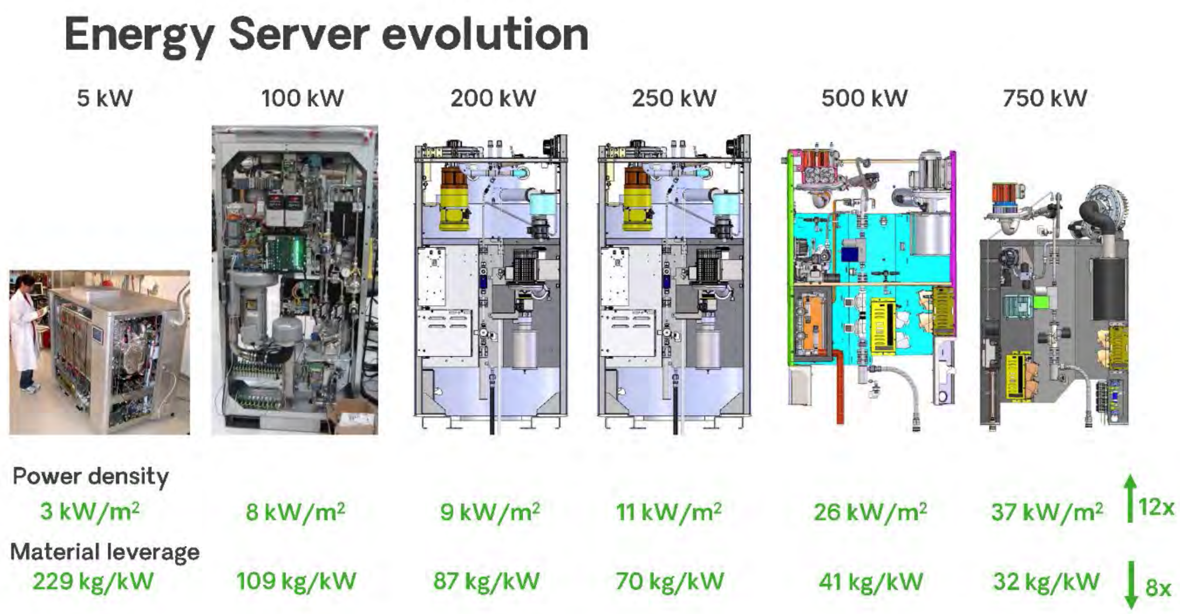

BLOOM ENERGY OVERVIEW
Management
Founder and Board Members
Making clean, reliable energy affordable for everyone in the world.
$200bn
US C&I SAM
$972m
2021 Revenue
~$5 bn
Product + Service Backlog
~$1 bn
Cumulative F&E
364
Patents
~700MW
Installed Capacity
99.998%
Energy Server Availability
>50%
Reduction in CO_2 vs. US Grid
>99%
Reduction of Air Pollutants
Near Zero
Water Consumption
Bloomenergy
2


Bloom Energy at a Glance
Germany
Newark, DE
Italy
San Jose, CA
France
Mumbai, India
South Korea
United Kingdom
Bangalore, India
Japan
Malaysia
Australia
Headquarters
Office Locations
Manufacturing/R&D
Business Development
~$1bn
2021 Revenue
30% CAGR
Over last decade
$8.5bn
Backlog
>750MW
Deployed
>364
Issued Patents
>$1.5bn
Cumulative R&D
Bloomenergy
3


Scaling to Gigawatt Capacity
• 210,000 square foot facility in Newark, DE
• Recently opened $200m, 164,000 square foot facility in Fremont, CA
• Over 1 GW SOFC capacity when fully utilized


A flexible energy platform
Inputs
Natural Gas
Biogas
Hydrogen
Intermittent Energy Sources
Electricity
Outputs
AC Power
DC Power
Flexible Voltage
Flexible Current
Hydrogen
Water
Oxygen


TECHNOLOGY PLATFORM OVERVIEW
MODULAR AND REDUNDANT DESIGN
CO_2
H_2O
Natural Gas
Reaction Produces Electricity
[e-]
Ambient Air
Oxygen In Air Reacts With Natural Gas In Fuel Cell
Technology Highlights
• >99% Availability
• 60% Electrical Efficiency
• 800 lbs/MWh CO2 Emissions (~50% of CC)
• ~50% comp. to CC Engines
• Negligible Non-CO2 Emissions
• Noise Equivalency of Normal Conversation
Fuel Cell
100um thick
Stack
25W
Server Module
50W
System
250 KW
Power Center
MWs – GWs
Proprietary and Confidential


Energy Server evolution
5 kW
100 kW
200 kW
250 kW
500 kW
750 kW
Power density
3 kW/m²
8 kW/m²
9 kW/m²
11 kW/m²
26 kW/m²
37 kW/m²
12x
Material leverage
229 kg/kW
109 kg/kW
87 kg/kW
70 kg/kW
41 kg/kW
32 kg/kW
8x

TECHNOLOGY SPECIFICATIONS
SOFC: PRODUCT OVERVIEW

Current Generation: 300kW Footprint*

Future Generation: 375kW Footprint

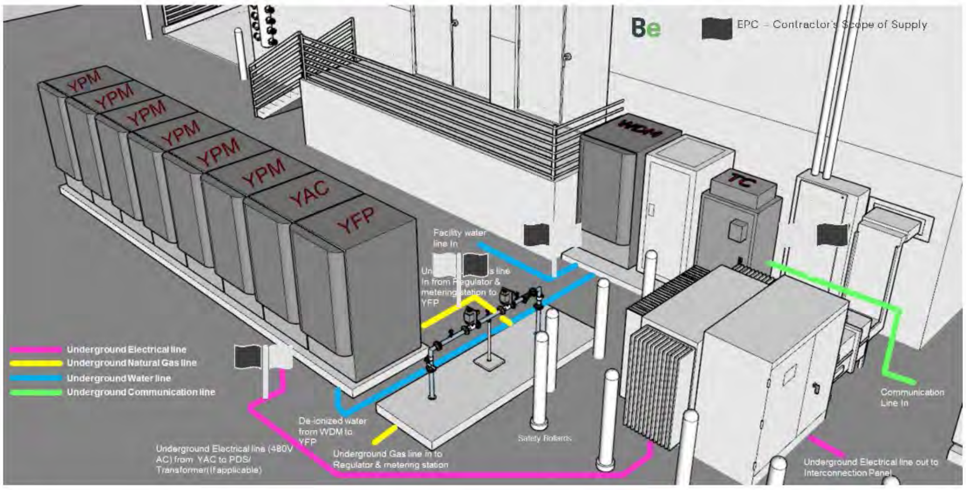
Energy Server 5

Technical Highlights (ES5-KA8AJ0)	
Outputs	
Nameplate power output (net AC)	300 kW
Base load output (net AC)	250 kW
Electrical connection	480 V, 3-phase, 50 Hz
Isolation transformer	Required to convert to 415 V and comply with local grounding scheme
Inputs	
Fuels	Natural gas, directed biogas
Input fuel pressure	70-125 kPa (100 kPa nominal)
Water	None during normal operation
Efficiency	
Cumulative electrical efficiency (LHV net AC)*	65-53%
Heat rate (HHV)	5,811-7,127 Btu/kWh
Emissions	
NOx	< 0.005 kg/MWh
SOx	Negligible
CO	< 0.025 kg/MWh
VOCs	< 0.01 kg/MWh
CO_2 @ stated efficiency	308-378kg/MWh on natural gas; carbon neutral on directed biogas
Physical Attributes and Environment	
Weight	14,316 kg or 13,957 kg
Dimensions (variable layouts)	5.60m x 2.64m x 2.14m or 10.04m x 1.36m x 2.26m
Temperature range	-20° to 45° C
Humidity	0% - 100%
Seismic vibration	IBC site class D
Location	Outdoor
Noise	< 70 dBA @ 6 feet
Codes and Standards	
Complies with Rule 21 interconnection and IEEE1547 standards	
Exempt from CA Air District permitting; meets stringent CARB 2007 emissions standards	
Designed to ANSI/CSA America FC 1-2014	
Additional Notes	
Access to a secure website to monitor system performance & environmental benefits	
Remotely managed and monitored by Bloom Energy	
Capable of emergency stop based on input from the site	

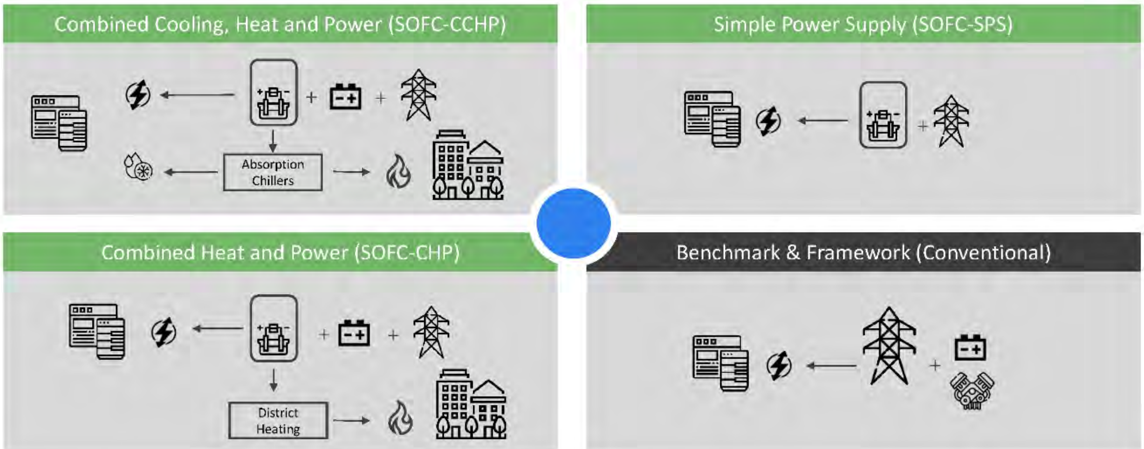
* 65% LHV efficiency verified by ASME PTC 50 Fuel Cell Power Systems Performance Test

* Includes gas filters and power inverter

TECHNOLOGY SPECIFICATIONS
GENERAL ISOMETRIC SITE LAYOUT



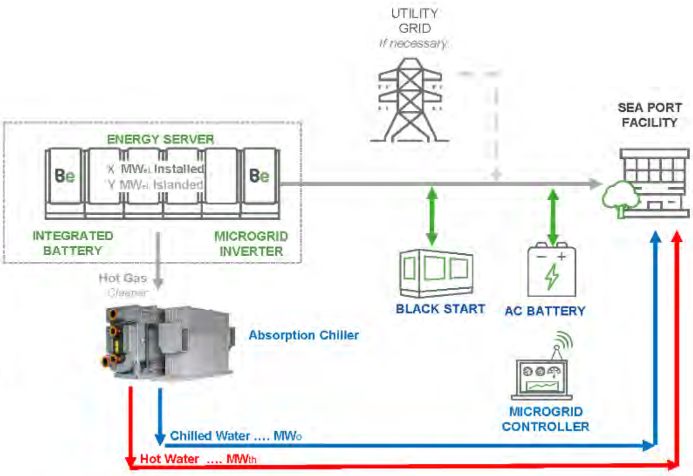
OVERVIEW - CONFIGURATIONS
FUEL CELL FOR DATA CENTERS: *300 KW TO 500 MW CAPACITY SIZES*



OFF GRID CONCEPTUAL ARCHITECHTURE

Roles within microgrid:

- Energy Server serves **base load primarily** with ability to modulate output
- Utility is used for peak shaving when available
- Battery covers short peaks and enables load shifting
- No Diesel generators need to be used sparingly for extended peaks
- Microgrid Controller dispatches generation sources and controls loads
- Bloom, Battery and Engine generator are grid-forming
- Black-Start Gas Engine Generator 75kW$_{GEG}$ per 1000kW ES-5.0



- *Taylor made other architectures possible.*

Bloom energy 12

VALUE PROPOSITION

Bloom Delivers

AlwaysON Microgrid
Proven microgrid platform to reliably cover your needs

Quick Time to Power
Access to the Power you need on your timeline

Predictable Energy Costs
Lock in energy costs over time to protect against rising rates at a lower LCoE than alternatives

Allowing for

Diesel Gen Avoidance
Including diesel storage & testing requirements

Temporary Dispatching
Potential to provide excess power to facilities that can use it

Reduction of Conventional Chilling
Lock in energy costs over time to protect against rising rates at a lower LCoE than alternatives

Sustainably

Fuel Flexible
Biogas and Hydrogen Ready*

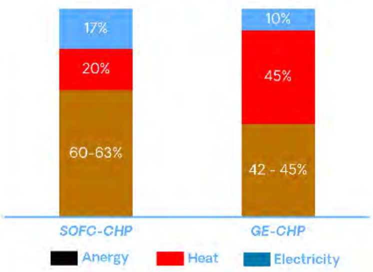
Better Air Quality for All
Non-Combustion technology results in lower CO_2 emissions with no particulate exhaust

Future: Path to Zero-Carbon
Future projects to provide a zero-carbon solution via F&B grade CO_2 Capture

- Option-1: Natural gas or BioMethane mixed operation: up to 50% H_2
- Option-2: 100% H_2 operation

COMPARISON
SOFC CHP VS. GAS ENGINE CHP

System Outputs



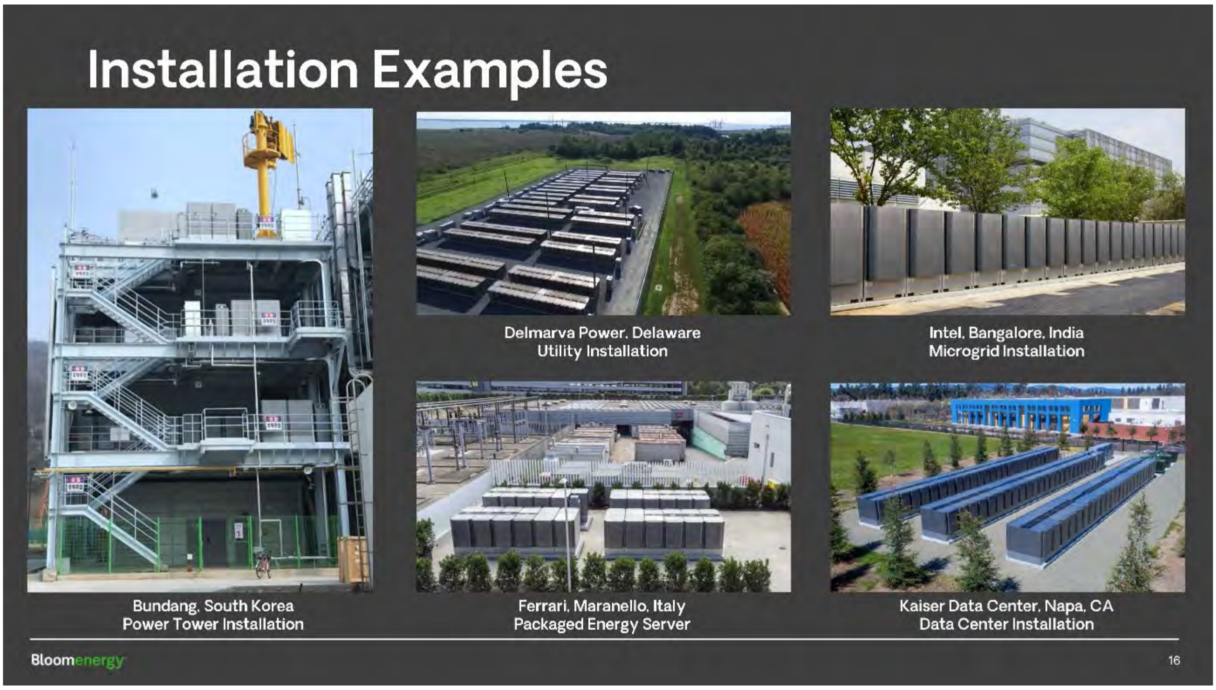
GE-CHP
- Higher **Total Efficiency**. *But is that important, when it comes to value creation?*

- Provides **higher value** per unit of fuel*
- Suitable for end-users that **prioritize electrical output** vs. heat.

Energy prices for consumers in Germany

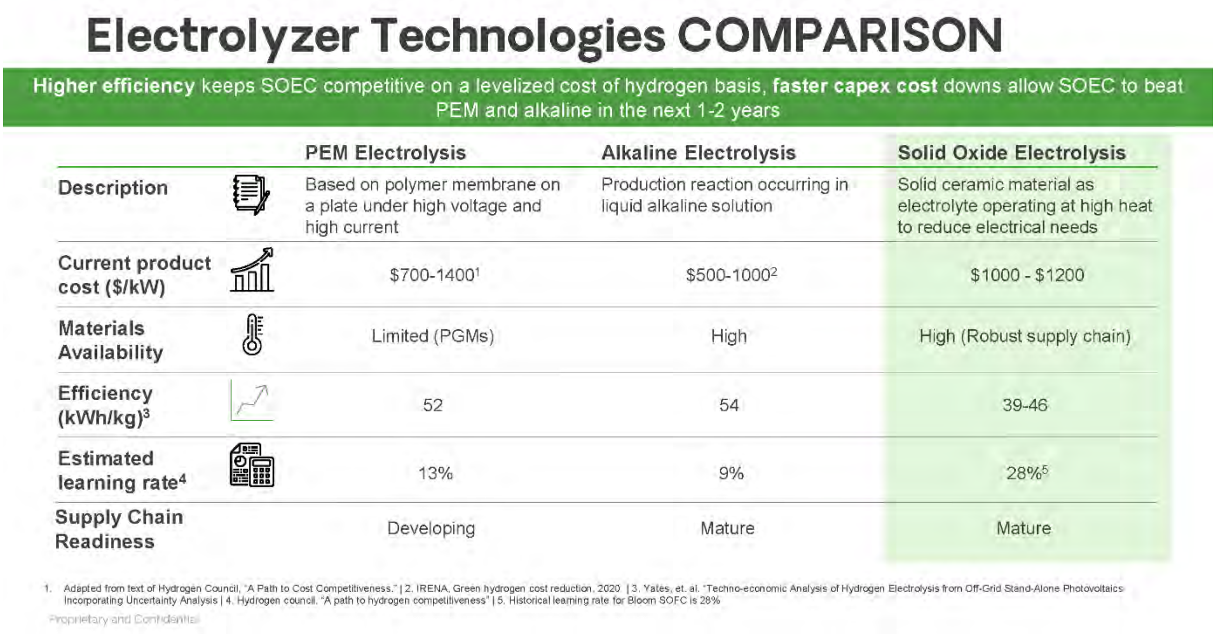
Element (netto prices 5/2022	Value	Unit
Heat (Hot Water Value)	46.7	€/MWh (th)
Natural Gas Price	35.0	€/MWh (LHV)
Grid-Electricity Tariff for C&I	174.0	€/MWh (el)

Pay-Back of SOFC-CHP's ca. 6 Yr. Better than Solar or Wind!


Installation Examples
Delmarva Power, Delaware
Utility Installation
Intel, Bangalore, India
Microgrid Installation
Bundang, South Korea
Power Tower Installation
Ferrari, Maranello, Italy
Packaged Energy Server
Kaiser Data Center, Napa, CA
Data Center Installation
Bloomenergy
16


APPLICATIONS & REFERENCES
FROM DIFFERENT INDUSTRIES
Data Center
Hotel
HYATT
District Power & Heat
SK
IKEA
Retail
Automotive
Bloomenergy
Bloomenergy
17

Blue chip customers



Electrolyzer Technologies COMPARISON

Higher efficiency keeps SOEC competitive on a levelized cost of hydrogen basis, **faster capex cost** downs allow SOEC to beat PEM and alkaline in the next 1-2 years

	PEM Electrolysis	Alkaline Electrolysis	Solid Oxide Electrolysis
Description	Based on polymer membrane on a plate under high voltage and high current	Production reaction occurring in liquid alkaline solution	Solid ceramic material as electrolyte operating at high heat to reduce electrical needs
Current product cost ($/kW)	$700-1400[1]	$500-1000[2]	$1000 - $1200
Materials Availability	Limited (PGMs)	High	High (Robust supply chain)
Efficiency (kWh/kg)[3]	52	54	39-46
Estimated learning rate[4]	13%	9%	28%[5]
Supply Chain Readiness	Developing	Mature	Mature

1. Adapted from text of Hydrogen Council, "A Path to Cost Competitiveness." | 2. IRENA, Green hydrogen cost reduction, 2020 | 3. Yates, et. al. "Techno-economic Analysis of Hydrogen Electrolysis from Off-Grid Stand-Alone Photovoltaics Incorporating Uncertainty Analysis | 4. Hydrogen council. "A path to hydrogen competitiveness" | 5. Historical learning rate for Bloom SOFC is 28%

Proprietary and Confidential

Day 2, "Utility Perspective" (David Petermann)

Key figures of our commitment

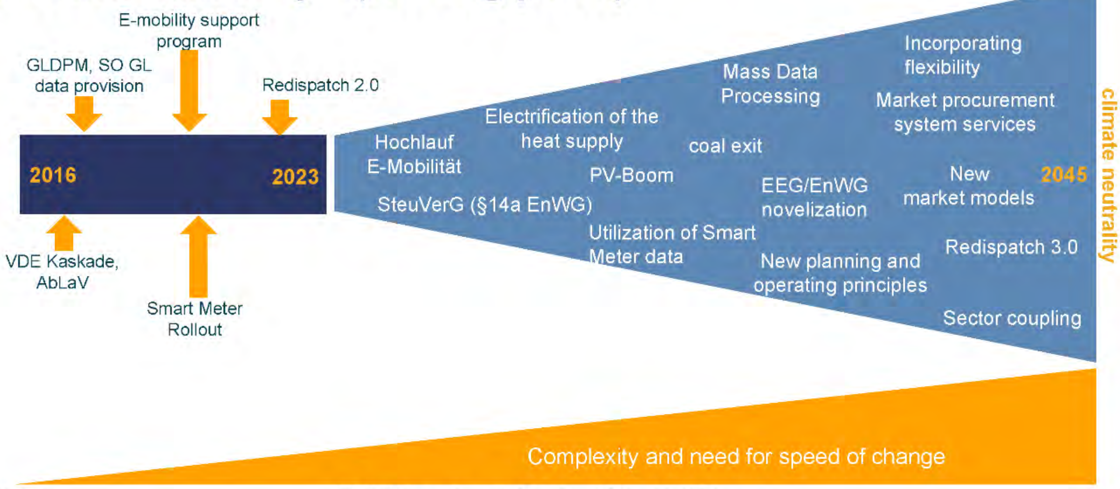
e·netz südhessen

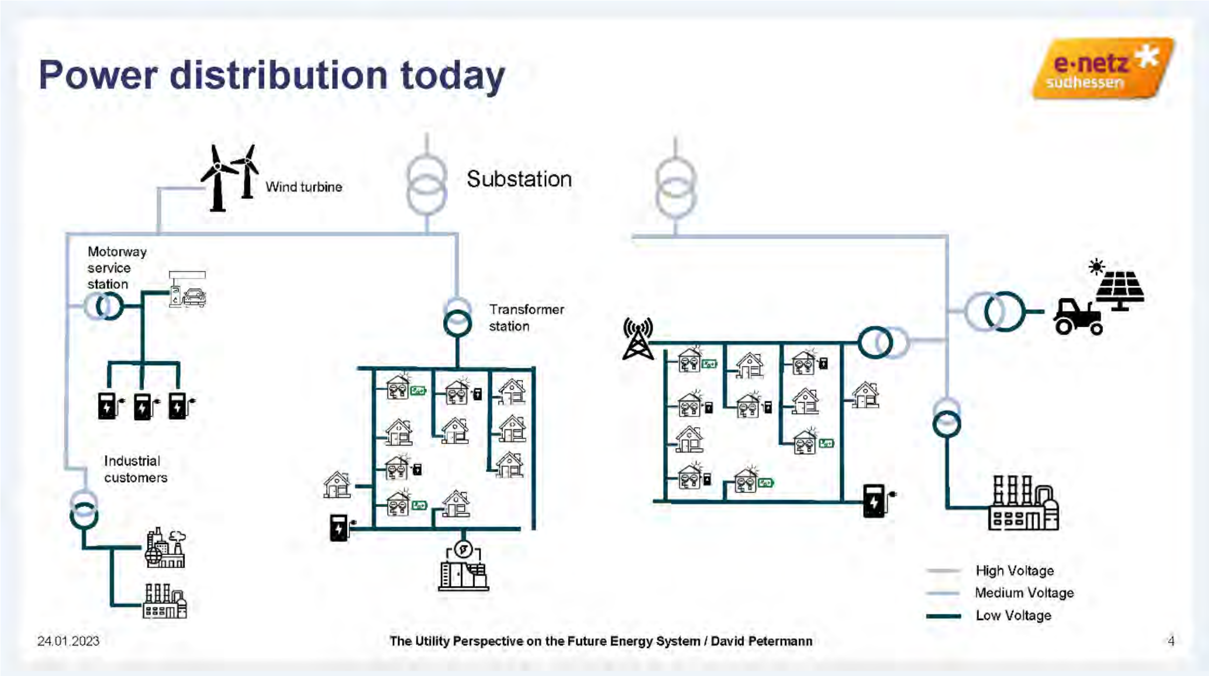
- **Distribution system operator for electricity and gas**
- **100 years of experience in infrastructure**
- **365 days, 24/7** as System operator available
- **Four regional offices**
- **12,800 (third-party) systems generate renewable energy, which we integrate into our grid.**
- **We invest around 56 million euros in the network infrastructure every year.**

Reliable supply Every day, we ensure that more than 1 million people are reliably supplied with electricity, gas and drinking water.

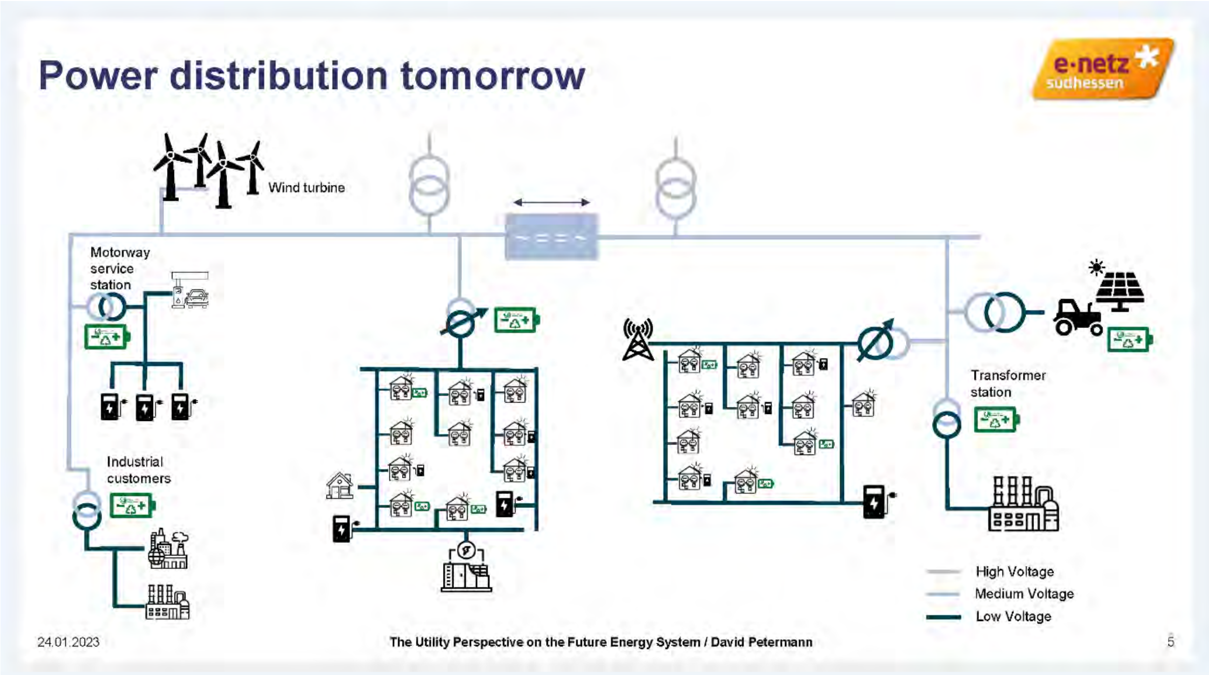
Political speed of change - massive pressure from climate neutrality - (turning point)

e·netz südhessen

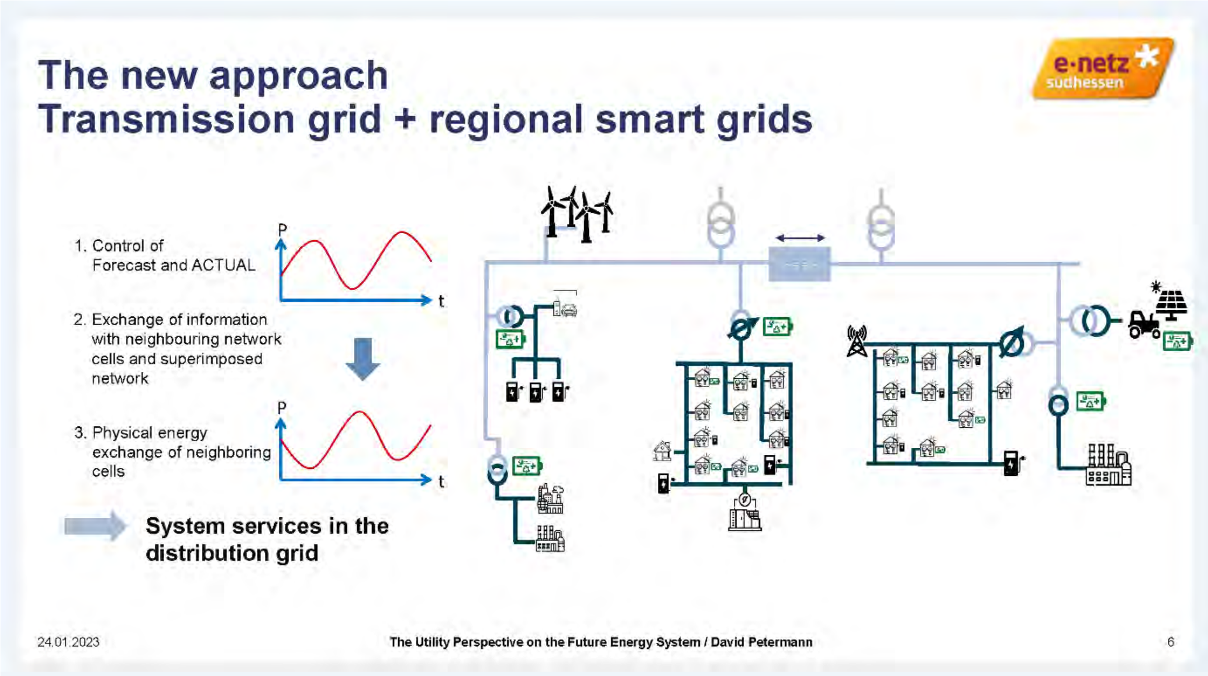




Power distribution today
e·netz südhessen
Wind turbine
Substation
Motorway service station
Transformer station
Industrial customers
High Voltage
Medium Voltage
Low Voltage
24.01.2023
The Utility Perspective on the Future Energy System / David Petermann
4



Power distribution tomorrow
e·netz südhessen
Wind turbine
Motorway service station
Industrial customers
Transformer station
High Voltage
Medium Voltage
Low Voltage
24.01.2023
The Utility Perspective on the Future Energy System / David Petermann
5


The new approach
Transmission grid + regional smart grids
e·netz südhessen
1. Control of Forecast and ACTUAL
2. Exchange of information with neighbouring network cells and superimposed network
3. Physical energy exchange of neighboring cells
P
t
P
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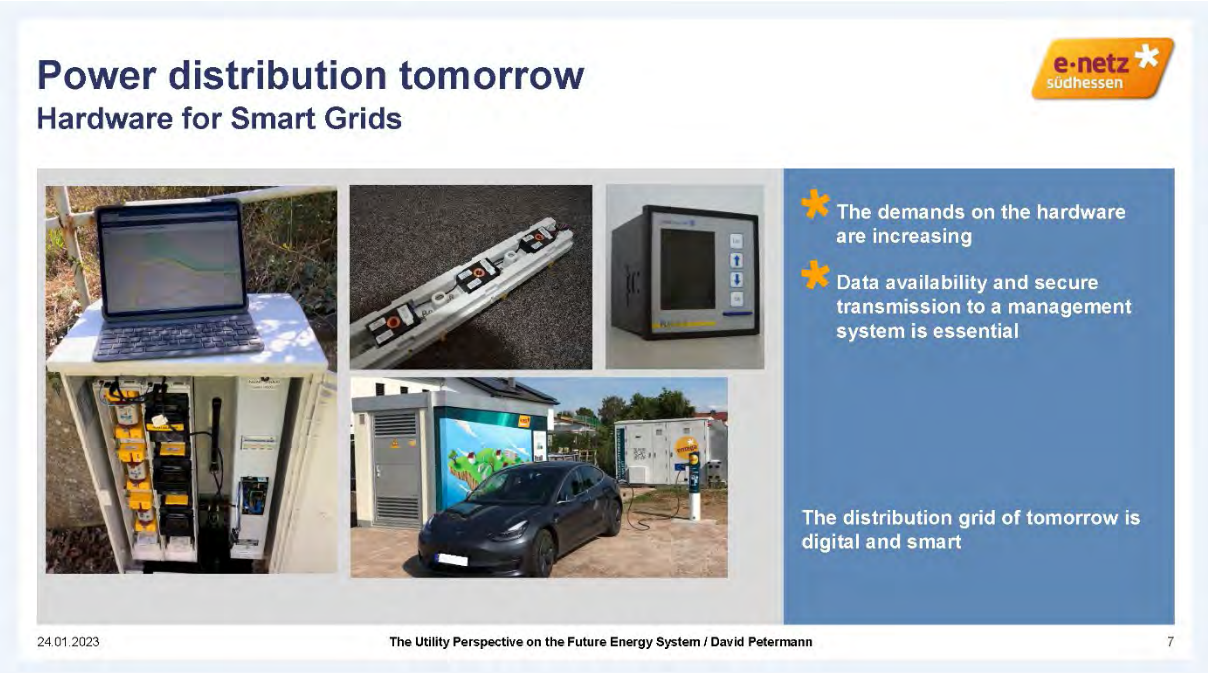
System services in the distribution grid
24.01.2023
The Utility Perspective on the Future Energy System / David Petermann
6


Power distribution tomorrow
Hardware for Smart Grids
e·netz südhessen
The demands on the hardware are increasing
Data availability and secure transmission to a management system is essential
The distribution grid of tomorrow is digital and smart
24.01.2023
The Utility Perspective on the Future Energy System / David Petermann
7

Power distribution tomorrow
Managment systems

e-netz südhessen

Long-term subdivision of "grid operation" electricity into two system levels

Mid Voltage control center

Low Voltage control Center with automatic data processing and grid management

24.01.2023 The Utility Perspective on the Future Energy System / David Petermann 8

Grid Research Projects

e-netz südhessen

WELL2WHEEL 2013-2016 | InnoSmart 2013-2016 | 2016-2019 | eLISA 2018-2025 | MAGDA 2019-2022 | AlgoRes 2019-2022 | DELTA 2021-2026 | *2022-2023

2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 …

WEB2ENERGY 2010-2012 | SolVer 2013-2015 | FLEX4ENERGY 2015-2018 | ESQUIRE 2017-2020 | NORA *2019-2020 | Grid4Regio 2020-2023 | MobiGrid 2020-2023 | CIRCULUS 2021-2024

*Seit 2019 investieren wir zusätzlich auch in komplett eigenfinanzierte Projekte ohne staatliche Förderungen, mit dem konkreten Ziel neue Produkte zu etablieren.

27.01.2023 G122 Forschung & Entwicklung 9

Day 2, "Data Security" (Thomas Blumenthal)


QGROUP
QGroup
30 Years of experience in Cyber
3 locations
48 Qs
>200K Systems under SecOps
2021
Specialised in military MLS and CrossDomain
Trusted Advisor for KRITIS
Research on federal and state level
Qualified APT-Responder regarding
§ 3 BSIG
Bundesamt
für Sicherheit in der
Informationstechnik
HESSEN
GENERAL DYNAMICS
Mission Systems
Center of Excellence


QGROUP
M.I.R.C.
MAN
F Q 8093

QGROUP

Forschung: Smart Grid Lab Hessen

The Smart Grid LAB will be established to test active control methods in the intelligent power grid and all necessary functionalities under practical conditions. Among other things, the questions should be answered, how to protect oneself preventively against cyber attacks or how to successfully ward them off.

Duration: 12.2020 to 03.2023

Financing: Total volume 3,31 Mio. EUR

Funded by: European Fund for Regional Development (EFRE)

SMART GRID LAB

Gefördert durch:
HESSEN
Hessisches Ministerium für Wirtschaft, Energie, Verkehr und Wohnen

EUROPÄISCHE UNION
Investition in Ihre Zukunft
Europäischer Fonds für regionale Entwicklung

QGROUP

Forschung: KRITEX - Kritische Infrastrukturen im technischen Wandel

Operate power grids digitally and flexibly with high resilience

The KRITEX project should create more security for network operators and realize the greatest possible resistance against attacks from outside through a holistic approach that also includes legal questions. The increased (cyber-)resilience should protect against the consequences of supply failures and the resulting cascade effects. The transferability of the KRITEX approach to other infrastructures is also a goal during the course of the project.

Duration: 01.09.2021 to 31.07.2023

Financing: Volume 483.000 EUR

Funded by: Bundesministerium für Bildung und Forschung (BMBF)

KRITEX

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

QGROUP

Cybersecurity in context of energy system transformation

Electrical engineering (OT, IoT)

- Not built with security in mind
- Primary focus on safety
- Lack of authentication and authorization
- Development highly dependent on standards
- Utilization of "Air-Gap" and segregation still in practice
- False sense of security in the industry

Future Development

- "Smart" equates to "online"
- "Online" enables attack vectors, similar to IT years ago
- Attackers will learn how to utilize this
- Energy systems will have the same learning curve as IT systems
- Future research will focus on defense and attacker sides

Conclusion

- The geopolitical situation is very critical
- Critical infrastructures and energy systems are increasingly becoming targets of attacks
- State actors are using cyber attacks as an established strategy in hybrid warfare
- A transdisciplinary research on resilience and securing of critical technologies needs to be established
- Regulation needs to pay more attention to the cyber topic

QGROUP

Day 2, “Future Energy Infrastructure_Chemical Industry” (Hannes Utikal)

Element Ihres Erfolgs.

FUTURE ENERGY INFRASTRUCTURE: A SNAPSHOT FROM THE CHEMICAL INDUSTRY

PROF. DR. HANNES UTIKAL

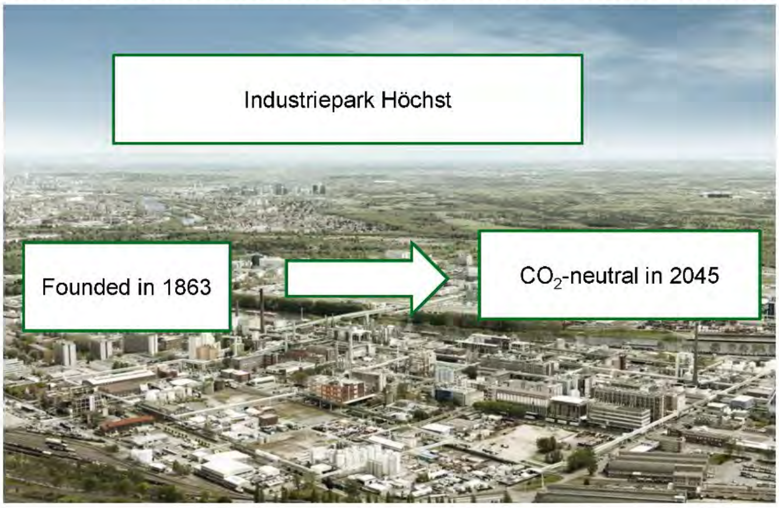
Agenda

1. About us
2. The energy challenge for the chemical industry in Germany
3. The energy transition as a societal challenge

19.01.2023 Prof. Dr. Hannes Utikal 2

The challenge

infraserv höchst

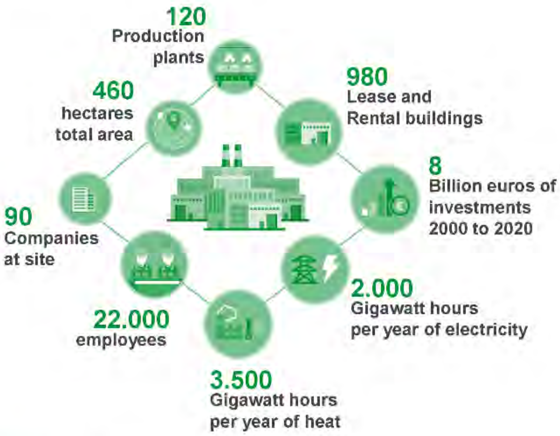


18.07.2023 Prof. Dr. Hannes Utikal 3

Our key performance indicators at Industriepark Höchst

infraserv höchst

Industriepark Höchst



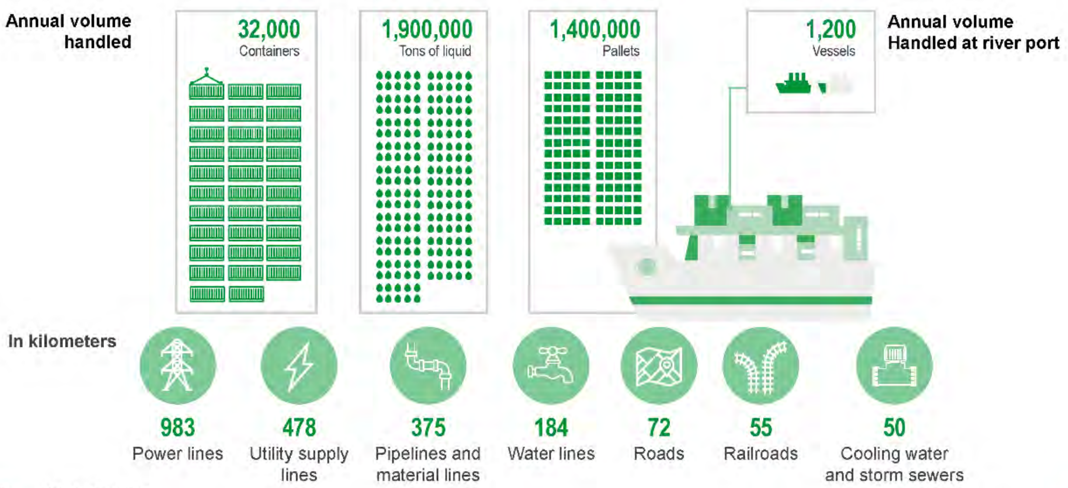
Infraserv Höchst

- In 1997, Infraserv Höchst began operating Industriepark Höchst, one of Europe's largest chemical and pharmaceutical sites.
- At home in the chemical and pharmaceutical industries, we are the leading site developer and expert for chemical-related services.
- Our customers are the Who's Who of the industry.
- Our turnover amounts to € 1 billion.
- With around 2,700 employees und 178 trainees we are the element of our customer's success.

18.07.2023 Prof. Dr. Hannes Utikal 4

Our key performance indicators at Industriepark Höchst

infraserv höchst



Some of our customers

infraserv höchst

Air Liquide	Nouryon	ALBEMARLE	AMG Lithium	BASF The Chemical Company	Baxter	BAYER	BK Giulini
Boehringer Ingelheim	Budenheim	CABOT	Cargill	Celanese	CORDENBIOCHEM	CLARIANT	CREATIVE CAMPUS MONHEIM
CSL Behring	DAIKIN	DB SCHENKER	DSM	ELW	FIZ	FlintGroup	FLUORCHEMIE GRUPPE
Fraport	Fraunhofer	GRILLO	GRÜNENTHAL	HVS	INVISTA	Italmatch Chemicals	kuraray
Lilly	lyondellbasell	mainova	MERCK	MERZ	mundipharma	NOVARTIS	OXEA
Pfizer	cvt	SIEMENS	SANOFI	SCA	SGL GROUP	Sika	SOL
Stadt Frankfurt am Main	SÜD-CHEMIE	TOPAS	TRANSWAGGON TWA	ucb Pharma	Westfalen	WEBER	WEYLCHEM

Industriepark Höchst
Energy Demand

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2.000 GWh/a	Electricity
3.000 GWh/a	Heat
80.000 MWh/a	Biogas

Equals the demand of
600.000+ households of electricity
240.000 single family homes with heat

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Zentrum für Industrie und Nachhaltigkeit (ZIN)
Think and do tank for a sustainable industry at Industriepark Höchst

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Mission:
We support the industry in its sustainable development

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Approach:
Identify a transformation pathway in a multi-stakeholder cluster

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CO_2 neutral chemical industry 2045 - What role can chemical parks play?

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Infrastructure

Energy supply
- Power generation
- Heat / Steam
- Hydrogen
- Biogas
- Biomethane
- ...

Disposal (circular economy)
- Wastes
- Phosphate
- CO_2
- ...

sustainable raw materials available

Innovation Campus

Initiative and coordination of funded innovation projects

Establishment of innovative start-up companies

Pilot and demonstration plants for PtG, PtL and PtX

First-of-its-kind plants for sustainable technologies

Industrial infrastructure in place

Networks

Formation and active participation in networks with chemical companies

Experience has shown that regional clusters offer significant synergies.

Close collaboration with Universities and Research organisations

entire value chain present

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Agenda

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1. About us
2. The energy challenge for the chemical industry in Germany
3. The energy transition as a societal challenge

CO_2-neutral chemical industry: Status quo

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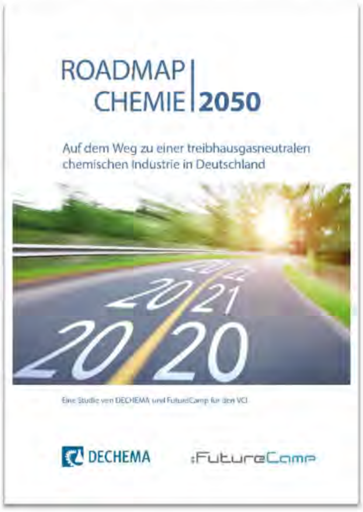
The chemical industry is energy-intensive

…and also uses fossile feedstocks as raw materials

Demand 2020	Chemical industry	Germany	CI's share
Electricity	54 TWh	512 TWh	10.5 %
Energy	205 TWh	2.514 TWh	8.2 %
Mineral oil	14 Mio. t (material use!)	90.3 Mil. t	15.5 %
Natural gas	3.3 Bil. m³ (material use!)	89 Bil. m³	3.7 %

In 2050: A climate neutral chemical production needs ca. 685 TWh green power



Sources: Federal Environment Agency, Association of the Chemical Industry: "Roadmap Chemie 2050"

CO_2-neutral chemical industry: Three scenarios with their projected energy demand in 2050

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Scenarios

Pathway 1: reference pathway
- Only efficiency gains

Pathway 2: technology pathway
- increased efficiency lowers total demand
- Increased renewable power demand due to electrification of many processes, thus a total increase of energy demand by 4.1 %
- About 45 % of fossile resources will be substituted by biomass, recycled plastics and CO2 as carbon feedstock

Pathway 3: GHG neutrality
- All above characteristics but the (near) total substitution of fossile resources, which has the highest demand for renewable power, resulting in +86 % additional energy

Year	Total need of energy and resources in TWh (and change from 2020 in %)	Energy from resources in TWh (and %)	Energy from external fuels and energies in TWh (and %)
2020	450	243 (54 %)	207 (46 %)
Pathway 1: 2050	430 (- 4.4 %)	245 (57 %)	185 (43 %)
Pathway 2: 2050	468 (+ 4.1 %)	164 (35 %)	304 (65 %)
Pathway 3: 2050	840 (+ 86 %)	84 (10 %)	756 (90 %)

Sources: Federal Environment Agency, Association of the Chemical Industry: "Roadmap Chemie 2050"

Energy Transition: Requirements of the chemical industry

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Green Electricity
- +1200 % power for the chemical industry (+2200 GWh) and +300 % to +1000 % for Germany.
- The German power grid is not suited to transport wind energy from the North sea to the Southern industrial areas today. Even **doubling** grid infrastructure is a challenge.

Green H_2
- A large pipeline network and/or other transport routes are necessary. Existing pipeline structures might be used to an extend.
- If produced locally, the need for green electricity for electrolyzers **is further increased**.
- Other forms of transportation include chemically bound H2 in NH3, CH4 or LOHC. This helps with the pipeline / power grid challenge but brings up **other challenges**.
- We need a better EU definition for green H2 and how it will be credited.

CO_2 Infrastructure
- A large pipeline network and/or other transport routes are necessary. Existing pipeline structures might be used to an extend.
- More designated storage sites (CCS).
- Technology providers for the individual sub-steps in CCUS (capture, upgrade, transport, storage, utilization).
- We need uniform CO_2 crediting mechanisms across the EU.

Technology Readiness

Societal Readiness

Business Case

Sources: Association of the Chemical Industry: "Roadmap Chemie 2050", Bing image search

Green Energy Infrastructure in Germany – significant update needed

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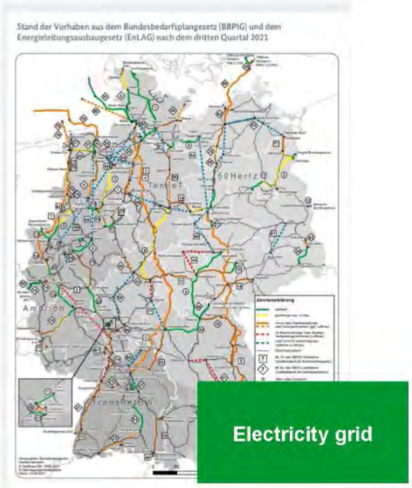

Eröffnungsbilanz Klimaschutz (bmwi.de)

Hydrogen fast track: OGE and RWE present national infrastructure concept "H2ercules"

Agenda

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1. About us
2. The energy challenge for the chemical industry in Germany
3. The energy transition as a societal challenge

Transition as a societal challenge

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Academia

Policy

Joint understanding of roles

Strong cooperation

Co-ownership of transition pathway

Society

Industry

Mobilising the necessary resources
Joint fulfilment of the CO_2 reduction goals

There is no better place than ...
... the Industriepark Höchst

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Customers, tenants and investors benefit from a highly competitive position:

- Green platform for sustainable and ecological chemistry – upstream and downstream
- Combining commercial success with sustainability
- Resource-conserving "Verbundstruktur"
- High quality and cost-efficient services
- Good investment conditions for R&D and production plants – cases pay off
- Pilot plant for CO_2 conversion
- New level of customer orientation
- High acceptance in society

The champions of tomorrow set a sustainable course today!

THE GREEN PLATFORM IS REALITY EVEN TODAY –
DESPITE MANY UNCERTAINTIES WE PURSUE OUR WAY TO SUSTAINABILITY

Thank you for your attention

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Day 2, "DOD Installations" (Andrew Knox)

ENVIRONMENT & ENERGY RESILIENCE
The Imperative for Resilient and Sustainable Installations

Andrew Knox
Director, Installation Energy
Office of the Deputy Assistant Secretary of Defense
(Environment and Energy Resilience)

International Forum:
Towards a Secure Energy Supply in a Net Zero Society
Frankfurt, Germany

January 24 2023

U.S. Department *of* Defense

DOD Installation Energy Resilience

- *Resilience – the ability to withstand, fight through, and recover quickly from disruption.*

  - 2022 National Defense Strategy

- *By joining with our Allies and partners in efforts to enhance resilience to climate change, we will both strengthen defense relationships, and reduce the need for the force to respond to instability and humanitarian emergencies.*

  - 2022 National Defense Strategy

- *The **effects of climate change are a national security issue**, impacting DOD's missions and operational plans, readiness, our installations, and the Department's budget."*

  - Deputy Secretary of Defense Dr. Kathleen Hicks

Source: https://www.defense.gov/News/Speeches/Speech/Article/2630071/deputy-secretary-of-defense-dr-kathleen-hicks-delivers-keynote-remarks-at-the-d/, https://www.defense.gov/News/Releases/Release/Article/2921646/dod-gsa-announce-rfi-to-gather-information-for-supplying-247-carbon-pollution-f/)

2

U.S. Department *of* Defense

Installation Energy Resilience/ Climate Change Goals

- *DOD's goals for Installation Energy resilience align with the government's sustainability and climate change goals.*

- Resilience Goals (selected)
  - 99.9%+ availability for critical missions
  - Cyber-resilient microgrids
  - Full-time generation sources over diesel generators

- Sustainability Goals (selected)
  - Zero Emissions Vehicle (ZEV) 100% of light vehicles purchased by 2027
  - 100% Carbon pollution-free electricity (CFE) by 2030
  - Net zero installations by 2045

On-site CFE

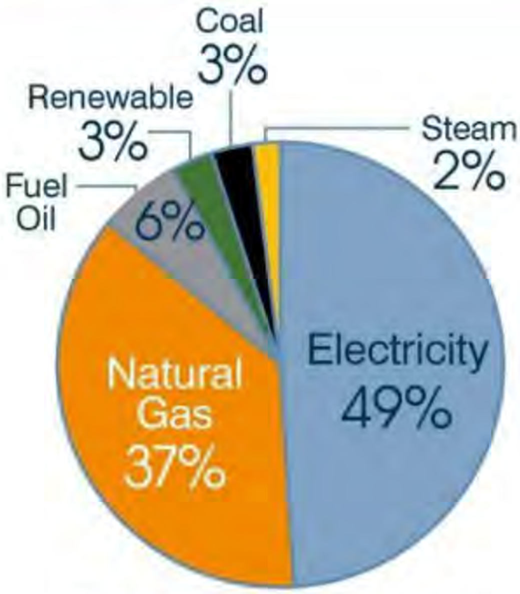
Efficiency Investments

Sources: OSD PDASD Memo: Metrics and Standards for Energy Resilience at Military Installations, May 20, 2021; Executive Order 14057; December 8, 2021;

3

DOD reliance on fossil fuel persists

- DOD installation energy use includes purchased steam, a portion of which is heated off-site by natural gas
- In accordance with the Executive Order 14057, DOD is transitioning towards carbon-pollution free sources
- DOD intends to increase the share of CFE in its electricity to 100% by 2030



DoD Energy Use by Fuel Type

Source: DOD Annual Energy Management and Resilience Report FY21, page 13

Methods of meeting DOD installation energy resilience goals

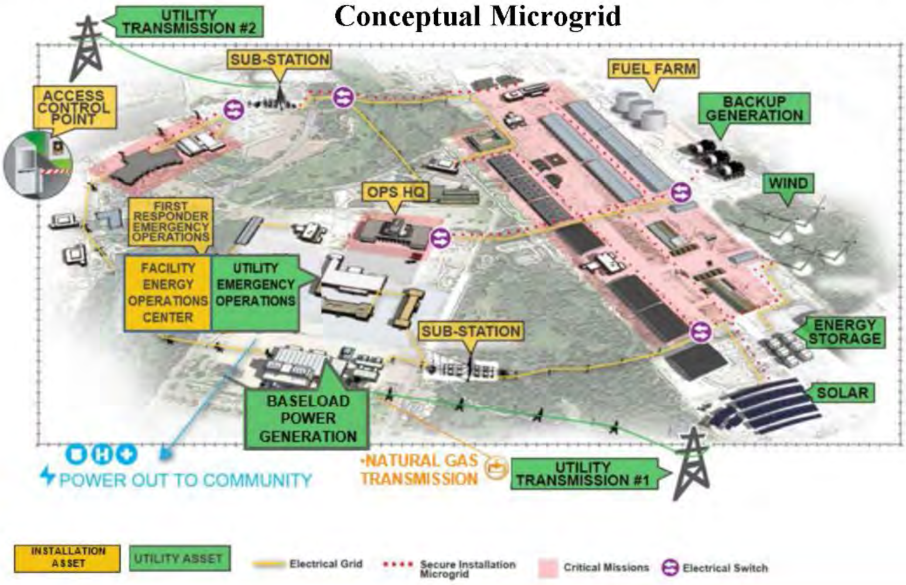
- To assess resilience risks, DOD tests gaps through "black start" and cyber security exercises
- DOD then addresses gaps through appropriated and alternative funding sources
- Microgrids increase independence from natural gas and electricity networks
- Electrification and efficiency further reduce fuel dependence
- Focus for on-site generation: solar/storage, advanced geothermal/ nuclear

Cyber secure microgrids with power generation, storage, and controls are central to DoD's approach to energy resilience
Example: Schofield Barracks, Hawaii

Microgrid as Tool to Achieve Resilience

- DOD intends to deploy microgrids as an effective resilience tool
- Examples of microgrids include MCAS Miramar and Schofield Barracks

Conceptual Microgrid



Questions

Day 2, Ploschke_Army Installations Strategy (AIS) Dec 2020

ARMY INSTALLATIONS STRATEGY

SUPPORTING THE ARMY IN MULTIPLE DOMAINS

DECEMBER 2020

Army Installations Strategy

FOREWARD

> **"It's all about taking care of People. Installations must be in a position to allow the Army to do its job. As we transform the Army, we have to transform installations along with it."**
>
> GEN James C. McConville, Chief of Staff, Army

Installations are the platforms from which we build Army culture, care for our People, and project and sustain forces. They provide critical capabilities essential to strategic readiness and the Army's ability to "*Deploy, Fight, and Win our Nation's wars*," enabling operations synchronization, training, critical research, maintenance, and production activities essential for Army modernization and strategic sustainment.

In the current operating environment, we expect adversary actions directed against the homeland. Installations are no longer sanctuaries. Together, we must ensure installations have the ability to care for our Soldiers, Families, and Civilians, while remaining resilient, and ready for Multi-Domain Operations (MDO). This strategy provides the framework to achieve those outcomes.

Current and emerging trends require us to examine installations and infrastructure through a new lens - we will revise doctrine, training, and investments accordingly. We will define the critical installation capabilities required to support Army operations in a persistently contested homeland, while providing services to meet the expectations of the all-volunteer force. Installations should serve to enhance recruitment and retention efforts, while supporting the Army's most important asset: its People.

This document takes a long-term view to build and harness the full capabilities required of installations, and enable the Army to compete, deter, and win in a complex security environment. The Army Installations Strategy describes how installations will transform by 2035 into MDO-ready platforms that protect, support, and enable the Total Army.

Supporting the Army priorities of People, Readiness, and Modernization, together we, the Army Team, will transform our installations to meet the Army's needs today, tomorrow, and into the future. People First! Winning Matters! Army Strong!

Michael A. Grinston Sergeant Major of the Army	James C. McConville General, United States Army Chief of Staff	Ryan D. McCarthy Secretary of the Army

Army Installations Strategy

END STATE

This document will guide Army actions over time to achieve the following end state:

Modern, resilient, sustainable installations, enhancing strategic readiness in a contested MDO battlespace, while providing quality facilities, services, and support to our Soldiers, Families, and Civilians.

The 2018 National Defense Strategy calls upon the Department of Defense to transition, "from large, centralized, unhardened infrastructure (to basing solutions) that are smaller, dispersed, resilient, adaptive (with) active and passive defenses." Due to changes in the Operational Environment, this guidance is as applicable in the homeland as in an operational theater. Accordingly, we envision at "end state" that each Army installation will be both a "platform" of mission specific capabilities as well as an active node within a broader "constellation" of installations connected across the Army enterprise.

As a platform, each future Army installation will employ a Common Operating Picture (COP) of its operational environment to guide decision making and resource allocations. It will have in place the latest generation wireless communication to connect an array of sensors as well as enable remote equipment diagnostics and distributed/virtual training. Facilities and infrastructure will be adaptable and multi-purpose by design and able to accommodate multiple tenants, systems, and missions. To the maximum extent feasible, each installation will have resilient power, water, and communications systems – prioritized by mission requirement. There will be both passive and active defenses in place across multiple domains. Installations will integrate with surrounding communities and civil authorities and provide information enabled public services and lifestyle-oriented features to the Total Army.

As a node within a constellation, each future Army installation will connect across the Army through a shared COP and secure communications. This will allow the constellation to form and reform quickly shifting mission and focus between installations based on function, contingency, and local conditions, thereby creating adaptability and resilience across the Army enterprise. The nature of a constellation of installations will permit distributed training over wide areas and the ability to combine "live" training with virtual, augmented, and/or synthetic training. Similarly, this approach will support knowledge sharing and collaboration between the Army's scientific and testing communities such as telemedicine, remote learning, and distributed work.

PURPOSE

This document sets strategic direction for Army installations to be "MDO-ready" for the Army of 2035 and beyond. It will guide decision making at all echelons across the Army regarding policies, planning, and practices. This document will provide stable, long-term direction to resource decisions that affect installation services, organizations, infrastructure, and capabilities. It applies to enduring bases and all Army installations in the Strategic Support Area (SSA), which the Army Training and Doctrine Command (TRADOC) describes as the area of cross-combatant command coordination that includes the strategic sea and air lines of communication and the homeland.

This strategy seeks to achieve four outcomes, each with a supporting line of effort.

Strategic Outcomes	Lines of Effort
1. Attract, Retain, and Enable People	Take Care of People
2. Project Combat Power & Sustain Operations from a Contested Environment	Strengthen Readiness and Resilience
3. Modernized Installations Supporting the Modernized Army	Modernize and Innovate
4. Healthy, Sustainable Training, Working, Living Environment	Promote Stewardship

Figure 1: Army Installations Strategy – Strategic Outcomes and Lines of Effort

These outcomes and lines of effort derive from characteristics of the Operational Environment (OE) to include: current and emerging threats, a technology influenced future, and the requirements of MDO.

THE OPERATIONAL ENVIRONMENT

The National Defense Strategy (NDS) states the "homeland is no longer a sanctuary." Threat assessments and national-level strategic guidance make it clear Army activities in the homeland and on our installations are at increasing risk of disruption and attack. Army installations also often depend on infrastructure and services in surrounding communities, both subject to adversarial actions:

NDS 2018:

> It is now undeniable that the *homeland is no longer a sanctuary*. America is a target, whether from terrorists seeking to attack our citizens; malicious cyber activity against personal, commercial, or government infrastructure; or political and information subversion. New threats to commercial and military uses of space are emerging, while increasing digital connectivity of all aspects of life, business, government, and military creates significant vulnerabilities. During conflict, attacks against our critical defense, government, and economic infrastructure must be anticipated.

Army Installations Strategy

The Army anticipates that adversaries will use sophisticated intelligence, surveillance, and reconnaissance (ISR) networks to target both military installations and soft targets associated with friendly forces, including private sector organizations, civilian infrastructure, institutional Army and joint targets, communication networks, and service members' families. Increasing access to cyberspace, space capabilities, and to weapons of mass effects dramatically increases both the uncertainty and the risk from adversary operations in the homeland.

In addition to deliberate and directed attacks from adversaries, Army installations exist within a natural environment increasingly characterized by the effects of climate change, extreme weather events, pandemics, and environmental degradation. Such conditions will require adaption of existing infrastructure.

A key feature of the OE is the accelerating rate of technological change. Future Soldiers will expect installations to modernize at pace with civilian sector smart cities initiatives. Opportunities that leverage technology through creation of data-informed, smart installations will allow the Army to pivot from an industrial-age paradigm, characterized by rigidity and purpose-built specialization, to a data-rich, reconfigurable, and technology-enhanced information-age construct. The Army must take advantage of American ingenuity, innovation, and culture of performance to learn and adapt in real time to rapidly evolving conditions enabling commanders to make better decisions about installation operations (IO) and quality of life for our People.

SMART CITIES

"Smart Cities" around the world are modernizing their infrastructure to improve the social, economic, and environmental wellbeing of their communities. These cities use information and communication technologies to increase operational efficiency, share information, and enhance the delivery of public goods and services. Examples include providing citizens with real-time information on weather, air quality, traffic conditions, and road hazards. Real-time requirements, not repeated inefficient routines, drive key city services, such as garbage collection and public safety. Many smart cities are creating a single information portal for access to all municipal functions serving as a one-stop shop to register for city services and community activities. Citizens in these cities often (or will soon) enjoy access to on-demand, app-enabled provision of transportation, food and entertainment.

Installations facilitate the Army's ability to mobilize, deploy, and sustain forces in support of Combatant Commanders. TRADOC Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028* (MDO 2028), redefined the battlespace, adding the SSA. The strategic importance of Army installations in the execution of the National Security Strategy through multi-domain power projection will continue to be a critical dimension of the military element of national power. The challenge for the Department of Defense and the Army is establishing the necessary conditions to ensure that Installations will be fully capable of supporting their increasingly critical role as Power Projection Platforms (PPPs).

Army Installations Strategy

Installations often work with outside agencies and organizations, both private and public sector, at the local, State, and Federal levels to support operations. Capabilities, such as real-time awareness of activities affecting operations, strategic sustainment, and installation/homeland defense, require in-depth analysis and evaluation for potential gaps, seams, and solutions. Currently, the Army does not have a comprehensive capabilities development effort underway to ensure the survivability and resilience of installations in the emerging operational environments.

The following assumptions concerning the OE and future Army operations will affect strategy implementation, timeline, and resourcing.

ASSUMPTIONS

1. Adversaries will subject Continental U.S. homeland, overseas installations, and surrounding communities to Anti-Access (A2) efforts by conventional and unconventional means, including but not limited to, cyber attacks, fomenting protests, and criminal activity.

2. Per the Army Modernization Strategy (AMS), installations are expected to modernize "at pace" with the rest of the Army.

3. The Army will have to compete for human capital: installation conditions and services are a factor in this competition.

4. The American public will expect mitigation of environmental risks.

5. Climate change and extreme weather will impose adaptation costs.

6. Internet of Things (IoT) technologies will become embedded, pervasive, and ubiquitous: it will be impossible to buy or build infrastructure that is not "connected."

7. The Army's requirement to mobilize and deploy formations to support combatant commanders will remain or increase over time.

CLIMATE CHANGE

Likely impacts that climate change will have on Army installations include damaged infrastructure (sea level rise, flooding, extreme weather, land degradation, wildfire), reduced access to training ranges, and/or loss of testing and training days, … heat-related illnesses, … increased energy and water demand (heat, drought), and loss of energy and water supply….

Report on Effects of a Changing Climate to the Department of Defense." DoD Report to Congress, January 2019.

Army Installations Strategy

RISK

Failure to modernize and enhance installation capabilities to project power, defend capabilities, create efficiencies, and preserve and protect resources risks the Army's ability to deploy forces in support of MDO to meet the requirements of the National Military Strategy.

STRATEGIC APPROACH

This Installations Strategy nests with the priorities of *The Army Strategy*; and complements and supports *The Army People Strategy* and *The Army Modernization Strategy*. The strategy specifically addresses people, readiness, modernization, and reform in the context of Army installations.

To achieve our end state, the Army Installation Strategy pursues four strategic outcomes supported by two critical enablers and organized along four Lines of Effort: Take Care of People; Strengthen Readiness and Resilience; Modernize and Innovate; and Promote Stewardship. See Figure 2 for a diagram of the strategy framework.

ARMY INSTALLATIONS STRATEGY FRAMEWORK

	LINES OF EFFORT	ENABLERS		STRATEGIC OUTCOMES	END STATE
1	TAKE CARE OF PEOPLE • Adapt Quality / Functional Facilities • Deliver Modern Services • Conduct Safe Operations	DATA ANALYTICS	PARTNERSHIPS	Attract, Retain, and Enable People	Modern, resilient, sustainable installations, enhancing strategic readiness in a contested MDO battlespace, while providing quality facilities, services, and support to our Soldiers, Families, and Civilians.
2	STRENGTHEN READINESS and RESILIENCE • Operationalize Installations • Expand Protection • Adopt Resilient Systems • Educate / Train the Team			Project Combat Power and Sustain Operations from a Contested Environment	
3	MODERNIZE and INNOVATE • Modernize and Secure the Information Backbone • Support Army Modernization Initiatives in the AMS • Transform Installation Operations • Reward Innovation			Modernized Installations Supporting the Modernized Army	
4	PROMOTE STEWARDSHIP • Preserve Natural Resources / Sustain the Mission • Remediate Contaminants • Implement Risk-Informed Metrics and Modern Technologies			Healthy, Sustainable Training, Working, Living Environment	

Figure 2: Army Installations Strategy Framework

Army Installations Strategy

Strategic Outcomes

Strategic Outcome 1: Attract, Retain, and Enable People. The Army wins through its People; they are the Army's greatest strength. Safe operations and adaptable and tailorable quality of life programs for Soldiers and Families improve Army readiness and reduce uncertainty. Modern, robust, and efficient facilities; training and education; and modern services are critical to the productive employment and development of Army talent. The Army People Strategy will only succeed with sufficient and trained professionals who provide key services and infrastructure. Our People promote the Army as a great team to join, and installations as the best places to work and live. Facility conditions; safe operations; modern services supporting the mind, body and spirit; Family programs and Morale, Welfare, and Recreation (MWR) functions are essential components to take care of People and help the Army compete and win the fight for talent.

Strategic Outcome 2: Project Combat Power and Sustain Operations from a Contested Environment. As the Army's initial maneuver platforms, installations must be able to operate and meet power projection requirements in and from a contested environment. Army installations support Total Army operations to mobilize and project forces and capabilities anywhere in the world at any time, even if contested. Installations must be "operationalized" to address their new requirements through integrated protection and defense that is resilient to disruptions with a staff trained to operate in wartime conditions. To ensure readiness, resilience, and Army mission success, installations must sustain critical capabilities and support dynamic projection of warfighter capabilities while simultaneously securing people, formations, and equipment from attack.

Strategic Outcome 3: Modernized Installations Supporting the Modernized Army. As indicated in the Army Modernization Strategy, installations must modernize 'at pace' with the rest of the Army to support a modernized MDO Army by 2035. To do this, installations must provide facilities, ranges, airfields, and support infrastructure that possess the appropriate physical characteristics required by new Army systems. Proactively, installations will strive to achieve the lowest feasible life-cycle costs through adaptive and integrative approaches to design, construction, and operations. Modernized installations will require a command and control structure and COP to predict and act on the operational environment and emerging conditions. Coordination, integration, and synchronization among Army Modernization Enterprise stakeholders are critical to the installation enterprise and Army success. The information environment must have sufficient connectivity to support fully instrumented and integrated virtual, synthetic, and distributed training and testing as well as the ability to support real-time, remote equipment diagnostics and maintenance. Finally, installations must modernize and streamline all base operations functions, processes, and services, and incentivize innovation and fiscal responsibility.

Strategic Outcome 4: Healthy, Sustainable Training, Working, Living Environment. The Army's readiness posture, modernization efforts, and our duty to protect the safety, health, and welfare of our Soldiers and their Families are key to the overall success of the Army. All reasonable and risk-informed actions must be taken to protect Soldiers, their Families, and the Department of the Army Civilians who live and work on Army installations. We must preserve Army training lands and ensure protection of wildlife, critical habitats, and key ecosystems. The Army will maintain its commitment to environmental protection.

Key Enablers: Two enablers support all four strategic outcomes: *data analytics* and *partnerships*, are both reflected within and across each line of effort.

Data Analytics: The Army Enterprise and Data Analytics Strategy (EDAS 2018-2022) identifies the incredible potential of big data analytics to drive innovation, accelerate operational improvement, and advance the achievement of organizational goals and objectives. The capability for the Army to see itself through data analysis will allow prioritized resource investment over the long term. Success across all four lines of effort requires increased use of data science techniques, to include artificial intelligence and machine learning. We will apply these techniques to connect resource allocation decisions to measurable outcomes as well as to create a data-informed COP across the Army's installation enterprise. This data-driven enterprise will demonstrate the EDAS characteristics of VAUTIS (Visible, Assessable, Understandable, Trusted, Inter-operable, and Secure) with the support of a secure, latest-generation broadband network, sensors, and a robust information technology infrastructure.

Partnerships: The Army has a long history of leveraging public-public, public-private, and/or 3rd party partnerships to optimize use of other than appropriated funds, improve Army readiness, and address underfunded requirements. These partnerships come in a variety of forms, but generally lead to increased investment on Army installations, enhanced provision of services, modernized infrastructure, and improved cooperation with other Services and organizations. Partnerships with Joint bases, major corporations, other government agencies, and local communities and businesses all provide benefit to the Army. Recognizable partnership programs include the privatization of utilities, privatized Army housing and lodging, deployment of energy savings/generation technologies financed by reduced energy bills, Installation Support Agreements with other services, and Federal agency partners and Intergovernmental Support Agreements with local and State governments for the improvement of facilities, and provision of base operations, maintenance, and sustainability services. The Army also seeks opportunities to work in a collaborative space with academia and private industry to find new and innovative partnerships to create efficiencies, save money, and modernize the Army. These shared resources and services enable enhanced protection and freedom of maneuver in the SSA by synchronizing installation measures with communities, DoD, and Federal agencies.

Army Installations Strategy

The need for continued support of the Army's partnership efforts will increase over time; partnerships can enable each line of effort outlined in this strategy. Partnerships allow installations to benefit from expertise and experience found in the private sector and/or local communities to overcome budget constraints, expand capacity of shared services, and build integrated public systems and services. The Army requires both expertise and sophistication to protect its interests during initial partnership development. Appropriate oversight mechanisms must be in place to protect Army interests over potentially multi-decade agreements. Cooperation and partnerships with local communities to enhance Quality of Life initiatives and environmental stewardship will build resilience within the Army enterprise. As the program continues to grow, installations and communities will work more closely to identify strategic partnerships.

Lines of Effort

LOE 1: Take Care of People. *Implementation Lead: Deputy Chief of Staff (DCS), G-9; Execution Lead: Army Materiel Command (AMC).* The Army priorities remain people, readiness, and modernization. It is People - Soldiers, Families, Civilians, Retirees, and Veterans - who will deliver them. People are the Army's greatest strength and we must take care of them. Quality of life (QOL) initiatives appear in both the Army People and the Army Installation Strategies to improve the full range of Army care, support, and enrichment programs. QOL efforts provide Soldiers and their Families safe, quality Family and unaccompanied housing; accessible, affordable, and quality childcare; Family programs; fitness facilities; services; and MWR opportunities.

a. Adapt Quality/Functional Facilities. The condition of Army facilities - living and working spaces - must rival the commercial sector in functionality, quality, resilience, and sustainability. Housing and dining facilities are critical components of Soldiers' experienced QOL. Similarly, Families should have ready access to quality childcare and chapel facilities to accommodate diverse spiritual needs. Ancillary facilities and green spaces that enhance living and work environments - such as walkable development patterns, fitness centers, and recreation areas - contribute to wellness and resilience. The Army must provide quality facilities, whether owned and operated by the Army or shared or leased facilities on or off the installation, that enable the readiness of Soldiers, Families, and Department of Army Civilians in an MDO environment.

b. Deliver Modern Services. Installations provide key QOL services and programs that acclimate Soldiers and Families into the military community. Future recruits will increasingly come from "smart cities" that streamline the provision of public goods and services in a responsive, user-centric environment. This next generation of potential Soldiers will expect similar levels of information, convenience, and choice when it comes to Soldier and Family programs and services offered on an Army installation. The Army will make all efforts to ensure its services and programs are easily accessible, customer focused, data enabled, and protected.

c. Conduct Safe Operations. The Total Army expects safe activities and operations on installations. The Army's systematic approach for management and execution of its safety, occupational, and environmental health (SO&EH) program emphasizes use of modern SO&EH practices and technology systems to better anticipate, recognize, evaluate, and control hazards that pose risks to the people who live, train, work on, and visit our installations. Initiatives include implementation of the Army Safety Occupational Health Management System (ASOHMS); increased oversight of Army housing to ensure the most effective and efficient safety, occupational, and environmental health services; and establishing or identifying Army centers, laboratories, and commands whose mission it is to explore future technology opportunities that improve mishap prevention and risk reduction.

LOE 2: Strengthen Readiness and Resilience. *Implementation Lead: DCS, G-9; Execution Lead: AMC.* AR 525-30 defines Strategic Readiness as "the Army's ability to provide adequate forces to meet the demands of the National Military Strategy." Installations, as part of the SSA, are critical to the Army's ability to train, equip, mobilize, deploy, and sustain forces in support of Dynamic Force Employment and homeland defense. They support military operations preparation and execution, providing sustainable and secure infrastructure and services. Adversaries challenge these functions when they seek to extend A2/AD capabilities to the SSA to undermine operations and our ability to mobilize and deploy. The Army must "operationalize installations" and apply the same traditional battlefield formations and capabilities development analysis to installations.

a. Operationalize Installations. The Army must holistically address the need to operationalize installations. The first step is a comprehensive Doctrine, Organizations, Training, Materiel, Leadership and Education, People, Facilities, Policy (DOTMLPF-p) analysis. Analysis outcomes will inform the capability development process, and assess installation operations (IO) in a contested environment. An Initial Capabilities Document to identify and address key capability gaps, required doctrine, and solution options will then move the Army forward toward "operationalizing installations." At the core of requirements for an "MDO-ready" Army is the ability to project power. Supported by Mobilization Force Generation Installations (MFGIs) and PPPs, multi-domain power projection encompasses the Army's ability to move and sustain troops and equipment over or through ports, roads, airfields, rail heads, and via Army Prepositioned Stocks (APS) to meet critical timelines associated with Army Operational Plans. All types of installations (power projection, forward based, training, organic industrial base, research laboratories, etc.) will require a thorough capabilities assessment to ensure their support of an MDO-ready Army.

b. Expand Protection. To enhance strategic readiness, Army installations must possess both active and passive protection measures that preserve critical capabilities, assets, and activities essential to meeting NDS requirements. To achieve this, the Army will develop comprehensive risk-based assessments for installations and reflect these risks in a COP at echelon. These assessments should inform a prioritized list of protection capabilities required to anticipate, prevent, or mitigate adversary actions.

c. Adopt Resilient Systems. Army energy and water systems will be resilient, cyber-secure, and efficient. Federal law mandates the Secretary of Defense "carry out military construction projects for military installation resilience" and "ensure readiness of the armed forces for their military missions by pursuing energy security and energy resilience" (10 U.S.C. 2815 and 2911, respectively). Electrical, water, and communications systems on Army installations and surrounding communities are essential to mission success, but remain vulnerable to natural and man-made disruptions creating a "weak link" in the Army's ability to generate strategic readiness. The Army will take actions to ensure the robustness of key systems and capabilities, including facility and industrial control systems of all types. Initial steps will determine the risks and cost of losing power/water (i.e., putting a 'price' on resilience); develop appropriate return-on-investment metrics to guide investments; and then prioritize those investments based on contributions to mission accomplishment.

d. Educate and Train the Team. Just as the Army expects every unit and formation to train as it fights, the Army should expect the same from its installations. Army education and training must acknowledge the critical roles installations play in mission accomplishment, and begin to change the Army culture to consider installation requirements in support of readiness preparation. The installation workforce must receive the education and training required to achieve Army modernization objectives as well as to operate increasingly complex, IOT-enabled infrastructure. Training events based on new or existing doctrine that exercise inter-operability with local, State, Federal, and host nation entities will improve installation readiness and adaptability in the face of constant change. In addition, installations' abilities to support operations in a contested environment require new models and simulation tools as well as active participation in training events and exercises to ensure systems function as intended.

LOE 3: Modernize and Innovate. *Implementation Lead: DCS, G-9; Execution Leads: AMC/CIO.* Army modernization requires that installations provide the facilities, systems, and connectivity to support the Army on its path toward full MDO readiness by 2035. Installation management practices must transform to accommodate new information-era technologies. Innovation efforts support the Army priority of Reform. We will prioritize those that create efficiencies, expand workforce productivity, and generate resilience.

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a. Modernize and Secure the Information Backbone. Army facilities systems and support infrastructure, including infrastructure funded through alternative finance methods, shall be cyber-secure and resilient through the full system life cycle. Execution of the Army Network Implementation Plan is essential to all installation and Army modernization efforts. Deployment of 5G and “next-Gen” communications networks must be able to handle massive amounts of data with near real-time production. A resilient and secure communications and network infrastructure is essential to the defense of the homeland against adversarial threats and natural adverse events. The backbone should enable key military applications such as augmented and virtual reality training, autonomous vehicles, Command and Control (C2), and remote diagnostics. At the same time, this infrastructure is critical to realize the benefits of “smart cities” technologies and create connected constellations of installations.

b. Support Army Modernization Initiatives in the AMS. The AMS states, “*The Army will plan for upgrades to maintenance facilities, motor pools, (ranges), network infrastructure, administrative facilities, housing, barracks, secure facilities, and utilities upgrades to keep pace with other modernization efforts.*” Force projection requirements also require assessment of roads and highways, bridges, ramps, marshaling yards, ammunition supply points, railways, and airfields. Real property master plan processes will expand in technical sophistication, using data-informed analysis and modeling to accommodate new specifications for modern equipment and achieve better environmental analysis necessary to fulfill requirements of the National Environmental Policy Act.

c. Transform Installation Operations. Installations must modernize operations, use data-driven “smart city” approaches to transform the delivery of goods, and modernize services and mission support. Sensors, scheduling applications, and remote monitors will create a COP of real-time conditions, occupancy, and availability of stationing capacity across an installation. Using Artificial Intelligence/ Machine Learning (AI/ML) tools, installations will operate in a proactive manner. The installation enterprise will place increased emphasis on modeling and simulation to support master planning and education of garrison personnel. Partnerships with the private sector will allow pilots and testing of new technologies. We must update facility standards and materials to adopt a total life-cycle cost mindset, resilience, modularity, and safety by “prevention through design.” Multi-use, multi-tenant, adaptable, modular buildings are a means to achieve balance between standardization and demands for future flexibility. Divestiture and modification of physical spaces will accommodate increases in remote or distributed work, reduce operating costs, and allow staff enhanced capability to customize work areas. Tailored services will match the mission, characteristics, and requirements of each installation.

d. Reward Innovation. Innovation occurs and must be encouraged and rewarded at every echelon. We must align incentives to inspire local, regional, and Army Command (ACOM)-wide initiatives to improve readiness, create efficiencies, and pilot potential capabilities for Armywide deployment in support of modernization and effectiveness. Army/LOE leads will evaluate proposed installation investments through the lens of return on investment to drive modernization, readiness, and savings to reflect total cost of ownership and life-cycle costs for financial planning. We will promote versatility in design/build (vs. purpose-built) infrastructure to speed restoration and construction and consolidate unit footprints. The Army will continue to pursue innovative acquisition methods, partnerships, and financial and performance analysis and management practices to enable modernization in the most strategic and fiscally responsible way. Utility cost reductions and energy resilience improvements accomplished with tools like cost-sharing initiatives and third-party financed contracts illustrate the dual benefits of infrastructure modernization and budget balancing achieved by innovative business practices. Collectively, we must cultivate and disseminate knowledge and best practices across the installation operations community to optimize innovation, efficiency, and modernization.

"REFoRM" for Energy

In the summer of 2020, the Army established the **Resilient Energy Funding for Readiness & Modernization (REFoRM)** account, allowing installations' energy cost savings (ranging from $30-70M per year, across the Total Army) to be collected into an account to fund quality of life projects at installations that saved energy, and to fund energy security and resilience projects across the Army. In an innovative twist, the Army has sourced these funds from expired appropriations, repurposing them for use in the REFoRM account.

LOE 4: Promote Stewardship. *Implementation Lead: DCS, G-9; Execution Lead: AMC.* The value of the Army's natural capital is immense and includes not only the worth of physical assets such as land, water, and bio-stock, but derived benefits like a healthy environment, recreation, and goodwill. Preserving these assets in a safe, sustainable manner is critical not only to Army readiness, but to the well-being of the Total Army and those communities that surround and support Army installations.

a. Preserve Natural Resources/Sustain the Mission. Training land is limited, and requirements for expanded-range complexes are growing. Army installations and facilities must comply with environmental laws, meet sustainable design and development requirements, and conserve natural and cultural resources. The Army must also address concerns of stakeholders and federally recognized entities about mission critical training areas and ranges which are statutorily protected natural and cultural areas. The Army will ensure that the testing, training, sustainment, and fielding of weapon systems and supporting platforms occur within environmental restrictions on installations. Early planning and strong community partnerships with engaged and informed cross-functional teams are required to address complex environmental issues.

b. Remediate Contaminants. The Army recognizes its responsibility to protect Soldiers, Families, and the public from identified hazards associated with military operations, past and present. Essential to QOL on and around our installations is the ability to limit installation and community exposure to contaminants released by Army activities into the air, land, and water. The Army implements remediation to protect human health and the environment, in compliance with applicable environmental laws and regulations, to investigate and respond to hazards posed by contaminants. The Army identifies and prioritizes sites for cleanup that represent the greatest risk to human health and the environment.

c. Implement Risk-Informed Metrics and Modern Technologies. The key to proactive stewardship on installations is understanding risk through identification, analysis, and prioritization. The Army will use existing risk-informed metrics to streamline reports, reduce waste, and enable mission modernization by advancing environment, safety, and occupational health technologies. The Army will use an array of innovative virtual and analytic tools to address high-priority environmental quality technology requirements to reduce total ownership costs, enhance mission capabilities, and fulfill the Army's environmental sustainability and stewardship responsibilities. New processes, tools, and materials are all precursors to ensuring freedom to act, train, and sustain the mission.

GOVERNANCE

The installation enterprise relies on numerous commands and supporting organizations to ensure operation and provision of capabilities consistent with Army priorities. To provide oversight and strategic direction for the Army Installation Enterprise, the II PEG co-chairs (the ASA (IE&E), and the Commanding General, AMC) will prioritize and synchronize implementation and execution of this strategy and ensure integration into the Planning, Programming, Budgeting, and Execution (PPBE) process, the Army Campaign Plan, the Army Review Council, and other decision forums as required. The G-3/5/7 will validate and approve prioritization requirements derived from Operation Plans (OPLANs) and Posture requirements. The DCS, G-9 will implement/integrate governance activities. The CIO, COE, G-3/5/7, and other providers and stakeholders will attend collective governance forums as needed. Requirements, prioritization, and funding associated with II PEG programs will remain a function of the II PEG co-chairs.

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IMPLEMENTATION/EXECUTION

The Army Installations Strategy covers years 2021-2035 and beyond, recognizing that decisions made today will have implications well into the middle of the century. The DCS, G-9 will develop the initial Army Installations Strategy Implementation Plan ensuring integration with the Army Campaign Plan and coordination across each line of effort. The DCS, G-9 will be the supported organization in this role with the establishment of a formal operational planning team and support from all installation operations stakeholders. AMC is the ACOM execution lead for all LOEs, responsible for developing an execution plan with metrics and associated outcomes. The G-9 will coordinate activities between the LOEs and establish an implementation framework and schedule, including periodic briefings to the governance body outlined above as needed, but not less than twice annually. Figure 3 (below) summarizes the strategy's initial guide for implementation and execution.

ARMY INSTALLATIONS STRATEGY FRAMEWORK
Initial Guide for Execution* Planning

LINES OF EFFORT & FOCUS AREAS	EXECUTION / OCRs	NEAR TERM: 2021 – 2024+	MID TERM: 2025 – 2030+	FAR TERM: 2030 - 2035+
Take Care of People • Adapt Quality / Functional Facilities • Deliver Modern Services • Conduct Safe Operations	**AMC** IE&E M&RA FM&C G-4 G-8 G-9 COE/USACE ACOMs ASCCs DRUs USAR ARNG MEDCOM	• Improve QOL Facilities IAW FIP • Document / Improve Services IAW QOL TF Objectives • Document Safety Objectives / Plans IAW SO&EH Strategy 2028 Objectives	• Improve QOL Facilities IAW FIP • Improve Services IAW ASL approved QOL TF Objectives • Implement/Monitor Safe IO	• QOL TF Initiatives Implemented • Automated Services • Culture of Safety SOP
Strengthen Readiness and Resilience • Operationalize Installations • Expand Protection • Adopt Resilient Systems • Educate / Train the Team	**AMC** IE&E FM&C CIO G-3/5/7 G-2 G-4 G-6 G-8 G-9 OPMG COE/USACE ACOMs ARNORTH USAR ARNG ARCYBER PEO-EIS	• Develop Implementation Plans for IO • IO DOTMLPF-p Analysis & CBA • Defender 22 & POM Plan Task Inform IO • Determine Installation Capabilities / Gaps • ICD(s) for Solutions • Pilot Promising Technologies • Initial Sensors link Protection / Facilities • Ensure Current Systems function	• Solutions Selected, Prioritized, Initiate prioritized fielding • Sensors - COP integration • Army Control System program • Initiate/execute IO training • Document IO in AS, Doctrine • Enhance IO protection worldwide • Systems function; link to COP	• Prioritized Army-wide solution fielding • Continue Sensor - COP integration; Control system monitoring • Enhance IO education / training • Enhance SOH education / training • Enhance IO protection worldwide
Modernize and Innovate • Modernize and Secure the Information Backbone • Support Modernization Initiatives in the AMS • Transform Installation Operations • Reward Innovation	**AMC / CIO** IE&E FM&C AL&T CIO G-3/5/7 G-2 G-4 G-6 G-8 G-9 COE/USACE ACOMs USAR ARNG ARCYBER PEO-EIS	• Define/Prioritize IT Requirements • Begin fielding 5G Capability - Protection • Initial fielding of COP / VTIME / Other • ID AMS sites for early NEPA coordination • Facilities plans / designs ISO AMS • Establish Innovation Mechanisms • ID consolidation opportunities • Share Best Practices thru COP forum • R&M for critical AMS Requirements • Publish SOH Enterprise Modernization	• Execute Changes to IO processes • Consolidate infrastructure; Initiate IO Capability Constellations • R&M for PPP / Ranges ISO AMS • Continue 5G prioritized fielding • ID innovative efficiencies–adapt worldwide • New Construction designs reflect modular adaptive infrastructure • Execute SOH Enterprise Mod	• Mob/Deployment Assurance • Culture of Innovation • R&M/MILCON ISO AMS • Tech/Processes Promulgated • COP - Promulgated • Installation Constellations SOP for capabilities • Community of Practice SOP
Promote Stewardship • Preserve Natural Resources / Sustain Mission • Remediate Contaminants • Implement Risk-Informed Metrics / Modern Technologies	**AMC** IE&E FM&C AL&T G-9 COE/USACE ACOMs Land Holding Commands	• Test / ID Remediation Requirements • Prioritized PFAS Remediation initiated • NEPA for identified AMS sites • ID Metrics / Improved solutions for safe operations	• Continue Tests / ID Remediation Requirements • Remediation/Coordination • Pilot Tech Solutions	• Continue Tests / ID Remediation Requirements • Remediation/Coordination • Promulgate Tech Solutions

*G-9 is the supported organization / implementation lead to synchronize and integrate all LOE activities

Figure 3: Army Installations Strategy Framework - Initial Guide for Execution Planning*

Army Installations Strategy

CONCLUSION

Installations, as capability-based platforms, provide the foundations for the Army's individual and unit readiness and resilience. Army People live, train, and work on installations, which provide the services that support them whether at home or abroad. The Army forges its culture on installations. Connected into constellations, installations provide enterprise-wide resilience and flexibility. Installations are a visible marker for the Army's transformation to an information-age organization, leveraging new technologies to support modern equipment, and connecting across the enterprise to project Army power worldwide. Installations will work in partnership with local communities, State, Federal, and other agencies to improve value to the Army, generate efficiencies, and create a living and working environment that is safe, secure, and sustainable. This vision will require deliberate decisions, focused resourcing, and action over the long term to build the right capabilities and enable the Army to compete, deter, and win in a complex security environment.

Together, the Army Team will modernize and maintain installations and their diverse capabilities long into the future to keep the Army strong and our People ready and resilient. People First! Winning Matters! Army Strong!

Glossary

Section I
Abbreviations

5G - 5th Generation mobile broadband network

A2/AD - Anti-access/Area Denial

AMC - U.S. Army Materiel Command

ASA (IE&E) - Assistant Secretary of the Army (Installations, Energy, and Environment)

ASA (M&RA) - Assistant Secretary of the Army (Manpower and Reserve Affairs)

COP - Common Operating Picture

DCS, G-9 - Deputy Chief of Staff, G-9

DOTMLPF-p - Doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy

IGSA - Inter-Governmental Support Agreement

IOT - Internet of Things

MDO - Multi-Domain Operations

SSA - Strategic Support Area

Section II
Terms

Anti-access. Action, activity, or capability, usually long-range, designed to prevent an advancing enemy force from entering an operational area. Also called A2. (JP 3-0)

Area denial. Action, activity, or capability, usually short-range, designed to limit an enemy force's freedom of action within an operational area. Also called AD. (JP 3-0)

Army Military Installation. The real property of a base, camp, post, station, yard, center, or other activity under the jurisdiction of the Secretary of the Army, including any leased facility, or, in the case of an activity in a foreign country, under the operational control of the Secretary of the Army, without regard to the duration of operational control. Army installations may consist of one or more real property sites. The term includes federally owned Army National Guard sites and facilities designated as depots, arsenals, ammunition plants, hospitals, terminals, and other special mission activities. It does not include any State-owned National Guard installation or facility. Such term does not include any facility used primarily for civil works, rivers and harbors projects, or flood control projects. (AD 2020-11)

Army Organic Industrial Base. The privately owned and government-owned industrial capability and capacity available for manufacture, maintenance, modification, overhaul, and/or repair of items required by the U.S. and selected allies, including the production base and maintenance base. The Army's Organic Industrial Base comprises manufacturing arsenals, maintenance depots, and ammunition plants in the U.S. (AR 700-90)

Battlespace. The area where military operations are conducted to achieve military goals consisting of all domains (air, land, maritime, space, and cyberspace), the electromagnetic spectrum, and the information environment (including human cognitive aspects). (TRADOC Pamphlet 525-3-1)

Climate change. Variations in average weather conditions that persist over multiple decades or longer that encompass increases and decreases in temperature, shifts in precipitation, and changing risk of certain types of severe weather events. (DODD 4715.21)

Enterprise. A unit of economic organization or activity

Fifth Generation (5G). A new global wireless standard for broadband capabilities after 1G, 2G, 3G, and 4G networks. 5G enables smart sensor technologies to connect machines, objects, and devices.

Force projection. The ability to project the military instrument of national power from the United States or another theater, in response to requirements for military operations. (JP 3-0)

Force protection. Preventive measures taken to mitigate hostile actions against Department of Defense personnel (to include family members), resources, facilities, and critical information. Also called FP. See also protection. (JP 3-0)

Installation Enterprise. The commands and organizations involved in oversight, direction, supervision, implementation, and execution of installation functions. (AD 2020-11)

Inter-Governmental Support Agreement. A legal instrument reflecting a relationship between the Army (Secretary) and a State or local Government that contains such terms and conditions as the Army (Secretary) considers appropriate to provide, receive, or share installation support services and protect United States interests.

Mobilization Force Generation Installations (MFGIs). Army installations including federally activated State-operated installations designated to provide continuous Regular Component/RC power projection, combat preparation, post-mobilization training, sustainment capabilities, and pre-mobilization training support. (AR 525-93)

Multi-Domain Operations. Operations conducted across multiple domains and contested spaces to overcome an adversary's (or enemy's) strengths by presenting them with several operational and/or tactical dilemmas through the combined application of calibrated force posture; employment of multi-domain formations; and convergence of capabilities across domains, environments, and functions in time and spaces to achieve operational and tactical objectives. (TRADOC Pamphlet 525-3-1)

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Multi-Domain Power Projection. The exercise of the military element of national power beyond the homeland through, into, and across all domains, the information environment, and the electromagnetic spectrum. It synchronizes the projection of forces with the projection of the physical, virtual, and cognitive effects created by capabilities that remain in the homeland.

Operationalize. To enhance an organization's role and capabilities to take a more operational approach to achieving stated objectives.

Operational approach. A broad description of the mission, operational concepts, tasks, and actions required to accomplish the mission. (JP 5-0)

Operational environment. A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander. Also called **OE**. (JP 3-0)

Platforms. An Army Military Installation that supports unit deployment, re-deployment, training exercises, or related power projection activities. (AR 525-93)

Power Projection Platforms. An installation capable of deploying a brigade-sized force or larger upon notification to meet CCMD OPLAN requirements within 10 days or less. (AR 525-93)

Protection. Preservation of the effectiveness and survivability of mission-related military and nonmilitary personnel, equipment, facilities, information, and infrastructure deployed or located within or outside the boundaries of a given operational area. (JP 3-0)

Readiness. The ability of U.S. military forces to fight and meet the demands of the National Military Strategy. Readiness is the synthesis of two distinct, but interrelated, levels: unit readiness and Joint readiness

Resilience. The ability to prepare for and recover from disruptions that impact mission assurance on military installations. (DoDI 4170.11)

Stakeholder. In public affairs, an individual or group directly impacted by military operations, actions, and/or outcomes, and whose interests positively or negatively motivate them toward action. (JP 3-61)

Strategic Support Area. The area of cross-combatant command coordination, that includes the strategic sea and air lines of communication and the homeland. (TRADOC Pamphlet 525-3-1)

Army Installations Strategy

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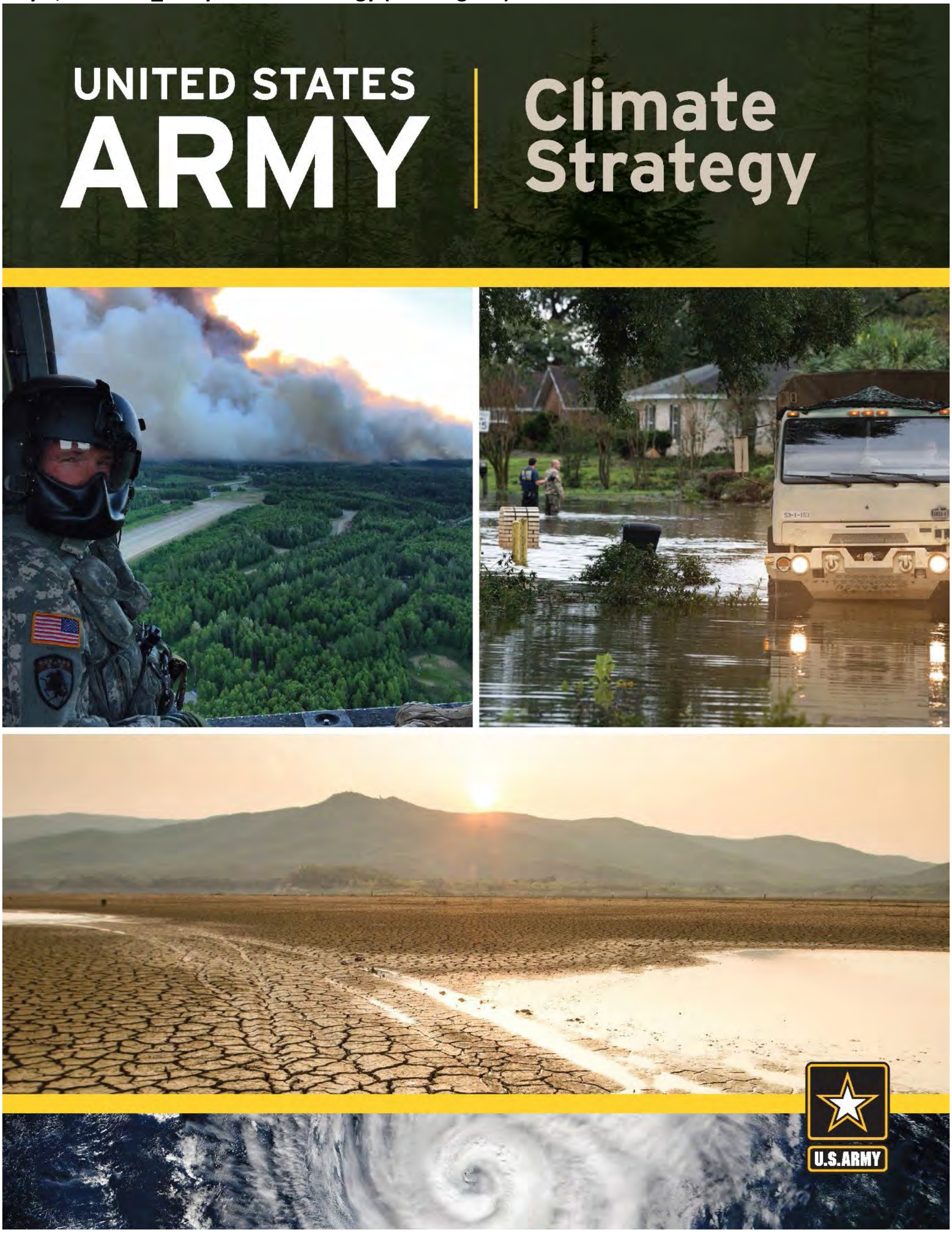

KEY TERMS USED THROUGHOUT THIS STRATEGY

Climate Change: Variations in average weather conditions that persist over multiple decades or longer that encompass increases and decreases in temperature, shifts in precipitation, and changing risk of certain types of severe weather events.

Adaptation: Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative efforts.

Mitigation: (specific to climate change) Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere.

Resilience: The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

PLEASE CITE THIS STRATEGY AS:

Department of the Army, Office of the Assistant Secretary of the Army for Installations, Energy and Environment. February 2022. United States Army Climate Strategy. Washington, DC.

Front cover: Top Left: The Alaska Army National Guard supports fire suppression efforts in ... near Willow, Alaska, in June 2015. Top Right: Soldiers assist residents of Escambia County, Florida after heavy rain from Hurricane Sally flooded the region, Sept. 16, 2020. (Photo Credit: U.S. Air Force, Tech. Sgt. Christopher Milbrandt) Middle: Stock photo, desertification. Bottom: Stock photo, imagery of hurricane from space.

FOREWORD

Climate change threatens America's security and is altering the geostrategic landscape as we know it. For today's Soldiers operating in extreme temperature environments, fighting wildfires, and supporting hurricane recovery, climate change isn't a distant future, it is a reality.

The time to address climate change is now. The effects of climate change have taken a toll on supply chains, damaged our infrastructure, and increased risks to Army Soldiers and families due to natural disasters and extreme weather. The Army must adapt across our entire enterprise and purposefully pursue greenhouse gas mitigation strategies to reduce climate risks. If we do not take action now, across our installations, acquisition and logistics, and training, our options to mitigate these risks will become more constrained with each passing year.

The Army will lead by example. We will tap into the creativity, capabilities, and commitment of Army professionals operating on every continent. We will use our buying power to drive change in industry and leverage best practices from many sources. We will engage with local communities and foreign partners to ensure mutual readiness and security in a rapidly changing environment.

The Army is on track to build on the progress we've achieved to date and reach every aspect of the Army enterprise. As the Army invests in modernization, readiness, and operations, we can create the land forces that our nation needs today while securing a sustainable, cleaner tomorrow. As the Army optimizes the use of fuel, water, electricity, and other resources, we increase our resilience while saving taxpayer dollars and reducing our impact on the planet. The Army will mitigate and adapt to climate change, and in doing so gain a strategic advantage, especially as we continue to outpace our near-peer competitors.

We have a unique opportunity to improve our defense capabilities and become a more efficient force, while securing a better future. I challenge our Army to examine climate threats, prioritize resources, and take swift action.

Christine E. Wormuth
Secretary of the Army

Climate change endangers national and economic security, and the health and well-being of the American people. The risks associated with climate change are broad, significant, and urgent. These risks will impact the Army at all levels: from how and where units operate and train, to how the service as a whole equips and sustains Soldiers to fight in multi-domain operations.

> "We face all kinds of threats in our line of work, but few of them truly deserve to be called existential. The climate crisis does. ... Climate change is making the world more unsafe and we need to act."
>
> – *Secretary of Defense*

Army tactical vehicles transport flood relief supplies along a highway in Denham Springs, Louisiana after more than 30 inches of rainfall caused severe flooding in southeast portions of the state. The Soldiers and vehicles are assigned to the Louisiana Army National Guard, which mobilized more than 1,000 personnel to respond to the flooding. (Photo Credit: Army National Guard, 1st Sgt. Paul Meeker)

Through the Army Climate Strategy (ACS), the Army will continue to lead by example. **The Army's core purpose remains unchanged:** *to deploy, fight, and win the nation's wars by providing ready, prompt, and sustained land dominance as part of the Joint Force.* Climate change will only make this mission more challenging, and the Army must proactively reduce the risks that climate change imposes. The Army can increase capability and installations' resiliency; prepare for new hazards and new environments; modernize processes, standards, and infrastructure; and decrease operational energy demand—all of which in turn will reduce greenhouse gas (GHG) emissions.

Guided by the ACS, the Army will build on its current progress in areas such as vehicle fuel efficiency and electrification, operational power generation, battery storage, land management, procurement, supply chain resilience, and workforce development. The Army will continue to reduce consumption of energy and other natural resources to improve operational readiness and modernization while adapting to and mitigating current and future climate threats.

Climate Threats and Risks

The world is already experiencing the compounding effects of climate change. Immediate hazards associated with climate change include higher temperatures; changing precipitation patterns; and more frequent, intense, and unpredictable extreme weather. These climate hazards will alter natural and social systems through primary and secondary impacts, leading to security implications for the Army.[1]

Consider changing rainfall patterns, for example. As GHG emissions increase global average temperatures, scientists have observed several primary impacts of this hazard—in particular, more and worsening droughts in some regions while other regions experience more frequent and severe flooding. As a result, some regions of the world will have less access to water supplies, while others will be subjected to widespread and prolonged inundation. This situation presents opposing challenges, but both conditions will increase competition for scarce resources and demand for humanitarian aid and disaster response. The Army will face simultaneous readiness challenges as units contend with limited access at flooded bases, alongside increased water scarcity and land degradation in other areas.

The secondary impacts of climate hazards could be even more dangerous. Chief among them is an increased risk of armed conflict in places where established social orders and populations are disrupted. The risk will rise even more where climate effects compound social instability,

[1] Adapted from: Department of Defense Climate Risk Analysis. Report submitted to the National Security Council, October 2021.

reduce access to basic necessities, undermine fragile governments and economies, damage vital infrastructure, and lower agricultural production. Adversaries and other malign actors may seize dwindling resources while seeking new opportunities to threaten U.S. national interests. Taken together, climate hazards will result in less economic and social stability, fewer goods to meet basic needs, and a less secure world.

The Army must remain ahead of adversaries seeking strategic positional advantages in a climate-altered world. For example, the Arctic is warming twice as fast on average as the rest of the world, and disappearing sea ice is opening new trade routes and access to new natural resources, inviting greater strategic competition. In regions across the globe, these changes foreshadow the demanding environmental conditions in which Army forces must be prepared to operate.

For the foreseeable future, climate impacts will disrupt Army activities, displace individuals and communities, and increase the frequency of crisis deployments. The Army must prepare for potential consequences including energy and water scarcity; damage to installations and infrastructure; displacement of and disruptions to operations, supply chains, and logistics; and imperiled Soldier health through exposure to airborne irritants like smoke and dust, disease vectors, and temperature extremes. In addition, the land on which the Army trains and operates may be altered, limited, or constrained. The Army must act decisively and urgently to address the risks associated with all these effects.

Army Climate Goals and Execution of the ACS

Executive Orders (EO) 14008 and 14057 instruct the U.S. government to work deliberately to put the world on a sustainable climate pathway, build resilience both at home and abroad, and catalyze beneficial private sector investment.[2] Starting from the policies and directives in the EOs, the Army will pursue three major goals to reach the ACS end state (see box). Initiatives throughout the ACS contribute to multiple government-wide EO targets including reduced pollution from multiple sources, net-zero installations, sustainable procurement, increasing energy and water efficiency, and building resilience against the impacts of climate change.[3]

ACS END STATE AND GOALS

The Army will be a resilient and sustainable land force able to operate in all domains with effective mitigation and adaptation measures against the key effects of climate change, consistent with Army modernization efforts.

- **Achieve 50% reduction in Army net GHG pollution by 2030,** compared to 2005 levels
- **Attain net-zero Army GHG emissions by 2050**
- **Proactively consider the security implications of climate change in strategy, planning, acquisition, supply chain, and programming documents and processes**

To advance these goals and achieve Army-wide unity of effort against climate change threats, **the ACS establishes three Lines of Effort** (LOE). **LOE 1: Installations** will *enhance resilience and sustainability by adapting infrastructure and natural environments to climate change risks, securing access to training and testing lands into the future, and mitigating GHG emissions.* **LOE 2: Acquisition & Logistics** will *increase operational capability while reducing sustainment demand and strengthening climate resilience.* Finally, **LOE 3: Training** will *prepare a force that is ready to operate in a climate-altered world.*

Implementing this strategy requires input from two important enabling enterprises that span all ACS LOEs. The first is Army modernization, the enterprise that will create and deliver technological solutions to problems not only within each LOE, but spanning multiple LOEs as well. The second enabler is the Army's research, development, test, and evaluation (RDTE) enterprise, which will both refine the requirements that drive technical solutions and combine technologies into effective systems that can be applied in the real world. Because of their cross-cutting nature and broad perspective, RDTE experts and modernization stakeholders must participate early and often in every ACS LOE.

The Assistant Secretary of the Army for Installations, Energy and Environment is the proponent for this strategy, and will approve an Army Climate Action Plan to guide implementation through specific actions across the Total Army: all components, Army Commands, Army Service Component Commands, and Direct Reporting Units.

[2] Executive Order 14008, Section 101; Executive Order 14057, Section 101.
[3] Executive Order 14008, Section 201; Executive Order 14057, Sections 202-206, 208, and 303.

LINE OF EFFORT 1: INSTALLATIONS	
STRATEGIC OUTCOME:	
Enhance resilience and sustainability by adapting infrastructure and natural environments to climate change risks, securing access to training and testing lands into the future, and mitigating GHG emissions	
INTERMEDIATE OBJECTIVES:	
1.1	Install a microgrid on every installation by 2035
1.2	Achieve on-site carbon pollution-free power generation for Army critical missions on all installations by 2040
1.3	Provide 100% carbon-pollution-free electricity for Army installations' needs by 2030
1.4	Implement installation-wide building control systems by 2028
1.5	Achieve 50% reduction in GHG emissions from all Army buildings by 2032, from a 2005 baseline
1.6	Attain net-zero GHG emissions from Army installations by 2045
1.7	Field an all-electric light-duty non-tactical vehicle fleet by 2027
1.8	Field an all-electric non-tactical vehicle fleet by 2035
1.9	Continue to advocate for an expanded Army Compatible Use Buffer
1.10	Include climate change threat mitigation into Army land management decisions
1.11	Incorporate the latest climate and environmental science into stationing, construction, and fielding decisions

LINE OF EFFORT 1: INSTALLATIONS

There are over 130 Army installations around the world that protect, support, and enable the force. They are the points where modernization and readiness efforts converge to create the trained and capable forces needed during crisis and conflict. Because of the systems and people they host, the communities they connect with, and the spaces they safeguard, installations anchor and guide some of the Army's most consequential efforts to improve itself while responding to climate change. Installation Senior Commanders are the Total Army leaders responsible for executing this LOE at the local level.[4]

As the Army evolves, leaders and units will take action on and through their installations to **enhance resilience and sustainability by adapting infrastructure and natural environments to climate change risks, securing access to training and testing lands into the future, and mitigating GHG emissions**. To these ends, the Army will pursue several related tracks, including *resilient energy and water supply, carbon-pollution-free electricity, efficient structures, non-tactical fleet electrification, land management, and enhanced planning.*

Resilient Energy and Water Supply

The Army must have resilient energy and water supply to complete its missions under all conditions. Because natural, physical, and cyber threats vary by location, the Army tailors its resilience investments to meet the circumstances of each installation. In the last five years

[4] Army Senior Commanders exercise command of Army installations. This is a direct delegation of the Secretary of the Army's command authority for the installation to the Senior Commander. See the Glossary.

Solar panel arrays form a canopy at a construction site in Fort Hunter Liggett, California. The construction site is for phase one and two of a solar microgrid project at the installation, managed by the U.S. Army Corps of Engineers Sacramento District. Along with energy production, the panel arrays provide shade for the majority of the post's vehicles. Fort Hunter Liggett is one of six pilot installations selected by the U.S. Army to be net zero energy, meaning the installation will create as much energy as it uses (Photo Credit: U.S. Army, John Prettyman)

alone, the Army enhanced installation-wide resilience by bringing systems online such as Fort Irwin's water treatment plant upgrade, Fort Knox's 2.1-megawatt solar field, and Fort Carson's 8.5-megawatt-hour lithium battery. There are 950 renewable energy projects supplying 480 megawatts of power to the Army today and 25 microgrid projects scoped and planned through 2024. The Army will continue these and other efforts under the Army Installation Energy and Water Strategic Plan to maximize resilience, efficiency, and affordability on every installation. In collaboration with adjacent communities and stakeholders, the Army and its partners will invest across all its installations in onsite, backup renewable generation; large-scale battery storage; microgrids; and utility systems updated to current industry standards.[5] The Army will install a microgrid on every installation by 2035. The Army will also pursue enough renewable energy generation and battery storage capacity to self-sustain its critical missions on all its installations by 2040. Because of their role in critical defense missions and preparing and deploying forces, Mission Assurance Installations, Mobilization Force Generation Installations, and Power Projection Platforms will have priority for energy and water resilience projects.

Carbon-Pollution-Free Electricity

The Army purchases over $740M of electricity from the national electric grid every year. In 2020, this electricity added 4.1 million metric tons of carbon dioxide as well as methane, nitrous oxide, and other GHGs into the atmosphere. While the Army has decreased overall installation GHG emissions by 20% since 2008, the service can do more to incentivize greening the grid. Going forward, the Army will actively pursue carbon-pollution-free electricity production and storage to and on its installations. The Army looks to its real property assets to continue providing space for new renewable energy projects that both reduce GHG emissions and increase energy resilience. In collaboration with other Department of Defense (DoD) components, the Army will also pursue opportunities to encourage the national electric grid's transition by purchasing electricity from carbon-pollution-free generation sources. The Army is committed to 100% carbon-pollution-free electricity to meet the needs of its installations by 2030.

Efficient Structures

Increasingly efficient structures conserve Army resources, enable flexibility in resource allocation, and reduce operating costs. The Army has been a member of the U.S. Green Building Council (USGBC) since 2001, and has so far received USGBC's Leadership in Energy and Environmental Design (LEED) certification on 1,041 facilities. LEED is a globally recognized set of standards for sustainable, efficient, and cost-conscious buildings, developments, and communities that covers every aspect of construction and operation from architectural details to user mobility, construction techniques, and building materials. There are more than 65 million square feet of LEED-certified facility space in the Army's inventory within the United States as well as on Army installations in Germany, Japan, and South Korea. The Total Army will continue to expand its LEED-certified footprint by seeking the latest LEED Silver certification as a minimum standard for all new construction and major renovations and by exploring opportunities for more LEED Platinum certifications—the system's highest level. The Army will also modernize its installation workforce to ensure they have the training and expertise needed to maintain facilities to LEED standards. The Army has also pursued efficiency gains at smaller scale, like replacing energy-

[5] Local electrical systems that can manage multiple generation sources and loads and disconnect from the regular power grid to operate independently. See the Glossary.

intensive bulbs with light-emitting diodes (LED) and upgrading existing wastewater treatment systems to add water reclamation capability. Consistent with the Army Installation Energy and Water Strategic Plan, the Army is pursuing installation-wide building control systems by 2028. By bringing these and associated efforts together, all Army buildings will achieve 50% reductions in GHG emissions by 2032 from a 2005 baseline, and by 2045 the Army will have a net-zero emissions installations portfolio. These efforts will enable the Army to maintain its effectiveness while keeping overall resource consumption and costs as low as is practical.

Non-Tactical Fleet Electrification

Throughout the global economy, motor vehicle technology is progressing rapidly. The Army can take advantage of this progress while modernizing its non-tactical vehicle (NTV) fleet, which includes commercially available vehicles such as sedans, station wagons, utility vehicles, trucks, vans, and buses. Cutting NTV GHG emissions to zero is an important component of reaching the Army's net-zero goal. Efforts to use less fossil fuel in the Army's NTV fleet and realize the associated operating cost savings have been ongoing since 2005. Through the end of 2020, the Army had removed 18,000 NTVs from its fleet while increasing its inventory of hybrid vehicles by almost 3,000 in the last 3 years alone.[6] These changes have already decreased NTV fleet costs by over $50 million, slashed Army fossil fuel consumption by more than 13 million gallons per year, and reduced the service's GHG emissions per mile by over 12%. The Army is continuing its transition to zero-emissions vehicles today, enabled by new policies like Army Materiel Command's (AMC) September 2021 mandate that all new vehicle leases, lease renewals, and purchases for AMC missions must select all-electric NTVs first, hybrids when electric solutions are not commercially available, and conventional gas vehicles by exception only. Steps like this are keeping the Army on track to field an all-electric light-duty NTV fleet by 2027, and use hybrid options as a bridging solution to field an all-electric Army NTV fleet by 2035.[7] However, fleet electrification will not be possible without the associated charging infrastructure. In 2022, the Army will invest in over 470 charging stations. All garrison commanders will work with industry and utility suppliers to determine how best to expand electric vehicle charging infrastructure on every Army installation. Recent electric vehicle pilot programs at Fort Benning and Fort Irwin demonstrate the way ahead to additional charging system investments across all Army installations in the coming years. To reduce costs, better leverage third party financing, and promote the adoption of electric vehicles throughout the Joint Force, the Army will explore potential partnerships with the Air Force and the Navy to jointly create a charging network on all DoD installations.

Land Management

Army land management and conservation are foundational to Army carbon sequestration. The Army manages over 13 million acres of land around the world. Senior Commanders rely on land management and conservation to preserve local environments in compliance with laws and regulations while maintaining access for training, testing, and mission requirements. Stewardship of Army lands can also help mitigate climate change threats by safeguarding forests and other beneficial environments alongside Army RDTE and training. Investments in land and ecosystem management for future access include programs such as the Army Compatible Use Buffer (ACUB) program, a voluntary system of local partnerships that preserves private land adjacent to Army installations, creating buffers that enhance physical security while also maintaining land in its natural state. The ACUB protects about 420,000 acres of privately owned lands. Camp Shelby, Mississippi, recently used ACUB to sequester the equivalent of 120,000 metric tons of carbon dioxide annually, or roughly 2,500 average households' carbon emissions every year. In addition to its immediate environmental benefits, the ACUB program also limits encroachment from incompatible development near installations, improves relationships between the Army and local populations, and increases safety stand-off distances for training areas. With so many concurrent benefits from one program, the Army must continue to advocate for and expand ACUB alongside continued access to lands and ranges. In addition, Senior Commanders bear important responsibilities for properly caring for and protecting designated habitats, ecosystems, and species. The Integrated Training Area Management (ITAM) program supports Senior Commanders and installation managers by optimizing decisions to repair, reconfigure,

[6] See the Glossary for expanded definitions of non-tactical and hybrid vehicles.
[7] "Light-duty" as used in the ACS refers to passenger cars, minivans, passenger vans, and pickup trucks and sport-utility vehicles under 8,500 pounds Gross Vehicle Weight Rating. Source: U.S. Environmental Protection Agency (EPA).

Integrated Training Area Management-constructed low water crossings are sustainable structures which facilitate maneuver through wetlands without precipitating erosion or obstructing the natural course of water. Fort Stewart, Georgia. (Photo Credit: U.S. Army)

This Centralized Biomass Pellet Silo in Umatilla, Oregon, is an Oregon Army National Guard renewable energy project with a resiliency component which uses biomass from local forests for heating several buildings. (Photo Credit: U.S. Army)

and maintain sustainable maneuver training areas. As a result, ITAM supports resilient bases, while ensuring spaces remain accessible to support Soldier training and mission requirements. Using ACUB, ITAM, and similar programs, land managers assist Senior Commanders in carrying out their responsibilities by managing soil, species, vegetation, coastlines, forests, wildland fire, waterways, wetlands, and watersheds using tools and techniques that account for climate change threat mitigation alongside Army and community needs.

Enhanced Planning

Army installations will use new tools, information, studies, and techniques for enhanced planning to precisely identify and correctly prioritize their operations, activities, and investments in light of expanding climate change threats. The Army is already considering climate resilience in master planning, natural resource planning, range management, and installation energy and water planning. The Army is also proactively implementing advanced planning tools, beginning with the Army Climate Assessment Tool (ACAT). Due to this tool's demonstrated ability to improve resilience, DoD has adopted and scaled ACAT as the Defense Climate Assessment Tool and is using it to prioritize highly exposed installations across DoD. Where Army modernization affects land use and facility changes, the Army must incorporate the latest climate and environmental science into stationing, construction, and fielding decisions. This will allow Senior Commanders and other decision-makers to understand the implications of land use, landscaping, and building design options early enough in the process to strike the appropriate balance between the infrastructure that a multi-domain, operations-capable, and ready Army needs and the effects that infrastructure could have on its environment and the climate. Army installation and range planning also depends heavily upon relationships with federal and state agencies, local communities, and other partners. The Army will continue to leverage its partners not only to inform installation adaptation and mitigation plans, but also as sources for useful innovations and assistance.

LINE OF EFFORT 2: ACQUISITION & LOGISTICS	
STRATEGIC OUTCOME:	
Increase operational capability while reducing sustainment demand and strengthening climate resilience	
INTERMEDIATE OBJECTIVES:	
2.1	Modernize existing Army platforms by adding mature electrification technologies
2.2	Field purpose-built hybrid-drive tactical vehicles by 2035 and fully electric tactical vehicles by 2050
2.3	Develop the charging capability to meet the needs of fully electric tactical vehicles by 2050
2.4	Develop predictive logistics that drive more precise and faster decisions
2.5	Establish policies that standardize contingency basing to increase resilience and reduce fuel requirements
2.6	Significantly reduce operational energy and water use by 2035
2.7	Achieve carbon-pollution free contingency basing by 2050
2.8	Adopt a Buy Clean policy for procurement of construction materials with lower embodied carbon emissions
2.9	Implement a revised energy key performance parameter
2.10	Attain net-zero GHG emissions from all Army procurements by 2050
2.11	Analyze all Army supply chain Tier 1 sources and contracts for climate change risks and vulnerabilities by 2025
2.12	Develop plans, policies, and contracts to ensure Army supply chain resilience by 2028

LINE OF EFFORT 2: ACQUISITION & LOGISTICS

Combat units deploy with large logistics formations that deliver, maintain, and sustain the combat power and bases needed to fight and win the nation's wars.[8] Enhanced operational capabilities are needed to gain future competitive advantage, and these capabilities will come in part from investment in a broad range of acquisition and logistics initiatives. When done correctly, such investments can also minimize certain Army GHG emissions and reduce the Army's climate impacts. In particular, the Army can better position itself for future conflict by more effectively deploying and staging combat power across the globe, optimizing supply and distribution networks, and creating flexibility for the Defense Industrial Base. In these and other ways, the Army will **increase operational capability while reducing sustainment demand and strengthening climate resilience**, and also reducing GHG emissions, cost, and risk. The Army sees great promise for sustainment demand reduction through advanced technology, future contingency basing, clean procurement, and resilient supply chains.

Advanced Technology

Tactical self-sufficiency supports independent, distributed, and echeloned maneuver, which will be essential in

[8] In this strategy and the Army Doctrine Publication 4-0, "logistics" refers to the maintenance, transportation, supply, field services, distribution, operational contract support, and general engineering support aspects of Army sustainment.

future contested environments. Reducing energy requirements and overall demands on Army distribution networks are two broad approaches that contribute to tactical self-sufficiency. Along those lines, advanced vehicle technology, more effective power solutions, alternative water sources, advancements in manufacturing, autonomous re-supply, next-generation material and packaging, and other new technologies and modernization efforts will reduce demand, increase combat effectiveness, and reduce GHG emissions.

A significant portion of the Army's sustainment demand comes from its fleet of tactical vehicles, including everything from light reconnaissance platforms to heavy transport trucks, and everything in between. The Army has been working to reduce the fossil fuel consumption of its vehicle fleets for many years, and recent gains are encouraging. For example, the Army is demonstrating Tactical Vehicle Electrification Kits (TVEK) on numerous tactical platforms, reducing average fuel consumption by approximately 25% while providing more on-board electric output per application. One extra benefit of TVEK is "anti-idle," a ground vehicle capability that shuts off a vehicle's engine during halts, while still providing power to vehicle accessories. Contemporary Army ground vehicles must continuously run their engines non-stop to power vital auxiliary systems like communications equipment even when the vehicle is not moving. Introducing anti-idle enables these systems to be powered even with the engine off, allowing the vehicle to serve its critical battlefield functions on "silent watch." This improved capability not only makes Army units harder for adversaries to find by lowering their thermal and acoustic signatures, these technologies also reduce fuel consumption and lower Army GHG emissions. To capitalize on the simultaneous combat and climate benefits of "silent watch," the Army will continue to modernize its existing platforms by adding mature electrification technologies like TVEK and anti-idle.

In the mid-term, the Army is using a robust network of partnerships in RDTE to develop promising technologies. The first prototype of an Electric Light Reconnaissance Vehicle (eLRV) is expected to enter testing before September 2023. Meanwhile, the Army is researching key questions about hybrid vehicle propulsion and power generation systems, developing advanced technologies, and working with vehicle Program Managers to integrate hybrid electric technologies into future and existing platforms. As a result, the Army will field purpose-built hybrid-drive tactical vehicles by 2035 and fully electric tactical vehicles by 2050.

Although fully electric tactical vehicles are still years into the future, the Army is already working on recharging capabilities for contingency operations. As one part of this approach, Army Futures Command, Army Materiel Command, and industry are collaborating within the Power Transfer Cohort to advance concepts, designs, and proofs of technology that help to fast-track the Army's move to electric vehicles. This and other partnerships between the Army, academia, and industry aspire to develop enhanced power generation and distribution technologies to keep Army forces moving in austere environments. As solutions become available, the Army will develop the charging capability to meet the needs of fully electric tactical vehicles by 2050.

Anticipatory logistics, rather than being solely reliant on requests from the field, is another way to reduce sustainment demand. Analyzing data at scale and translating insights into actionable information without the need for manual request procedures is the key to unlocking anticipatory logistics. For example, the Army relies on thousands of spare parts delivered through long supply chains to maintain tactical momentum and operational reach. Once the Army can predict repair and maintenance demand in advance, Army logisticians will be able to optimize parts inventories and gain supply chain efficiencies, thereby reducing associated GHG emissions. Army Prognostic and Predictive Maintenance (PPMx) is demonstrating predictive logistics in action. PPMx is a set of linked components that provide self-diagnosis and automated maintenance alerts—capabilities the Army aims to include on all new vehicles and weapons systems. That, in turn, enables predictive and proactive maintenance management with lower demand for spare parts and reduces mechanics' workload per system. The Army will continue to develop predictive logistics initiatives like PPMx to drive more precise and faster decisions.

Many other initiatives show promise for further reductions in sustainment demand. Increasing repair part, component, and weapons system commonality and interoperability reduces requirements placed on supply chains, distribution networks, and contested lines of communication. Greater commonality and interoperability also increases the Army's ability to acquire parts globally. Water production at points of need and advanced manufacturing increase maneuver units' operational readiness and lessen their vulnerabilities. As a whole, advanced technology will increase unit endurance, sustain combat power, minimize environmental impacts, reduce the amount of fossil fuel the Army consumes, and help lower Army GHG emissions.

A U.S. Army Green Beret with 1st Special Forces Group (Airborne) sets up solar panels for operational communications at the National Training Center, Fort Irwin, California. The solar panels enable special operations forces to operate their equipment in the most remote locations and continue training forward of conventional forces while moving as a team through rough desert terrain, simulated ambushes, and limited communications. (Photo Credit: U.S. Army, Pfc. Lisa-Marie Miller)

Future Contingency Basing

Contingency bases are non-enduring locations that support specific military operations and missions. The life-cycle process for planning, designing, constructing, operating, managing, transitioning, and closing such locations is known as "contingency basing." Contingency basing delivers forward, protected presence—a vital element of nearly every mission. Policies and practices for contingency basing moving forward must account for all emerging threats, including threats from climate change. Next-generation contingency basing must mitigate GHG emissions while enhancing Army force projection and persistence in austere environments.

Electric service is a key component of contingency basing, but the heavy reliance on fossil fuels for electricity is hampering the Army while increasing risk and cost. The Army is already working with its commercial partners to revolutionize deployable power generation and storage. In 2013, the Army began fielding the Advanced Medium Mobile Power Source (AMMPS) family of generators. At present, AMMPS delivers about 20% better fuel efficiency, 90% better system reliability, and 52% parts interoperability, and the AMMPS can integrate into tactical microgrids. To reach their full potential though, these generators need to be deployed as part of a microgrid system paired with battery storage. The necessary battery technology exists and is improving every year, and the Army will move to acquire, implement, and help advance this technology. In addition, the Army will enact a new policy, setting standards for using the most energy-efficient systems available for contingency basing, including renewable generation and battery storage where possible, to minimize base fuel demands.

To ensure protection and sustainment during Multi-Domain Operations (MDO), future contingency basing must employ the latest capabilities informed by the best available planning tools. As systems become more complicated, the Army increasingly relies on automated and computer-enabled planning. The Army's Joint Construction Management System (JCMS) provides some of the best tools for contingency base life-cycle management. The JCMS software suite enables site selection and master planning and provides a library of standard designs for initial, temporary, and semi-permanent construction. Another example, the Auto Distribution Illumination System, Electrical (Auto-DISE) is a planning and implementation tool that generates optimized layouts for command posts, field hospitals, and other forward-operating requirements. Planning informed by JCMS, Auto-DISE, and other advanced tools provides the insight needed to ensure that Logistics Civil Augmentation Program (LOGCAP) and operational contracts incorporate appropriate climate standards, and gives the Army flexibility to construct and maintain energy-efficient contingency basing. Once plans are set, the Army has a number of advanced technologies to deliver modern contingency basing. Force Provider Expeditionary (FPE) base camps, for example, offer a robust, self-contained, and transportable capability. From 2012 to 2017, FPE camps achieved over 30% reduction in their fuel and water usage. Since then, FPE camps have gained even more of the latest technology, including AMMPS generators with microgrids; efficient, lined shelters; water reuse capability; LED lighting; and better environmental control units. Through careful planning and execution, the Army will significantly reduce operational energy and water use by 2035, decrease risk to force, and achieve carbon-pollution-free contingency basing by 2050.

Clean Procurement

Army supply chains circle the globe and integrate thousands of vendors and other providers. Such a broad and diverse network can reduce emissions, promote environmental stewardship, support resiliency, drive innovation, and incentivize markets for sustainable products and services. The Army already complies with federal green procurement requirements supporting sustainable products made of recycled or recovered materials, which reduces waste and GHG emissions. In addition, the Army includes energy as a key performance parameter (KPP) in acquisition decisions and considers energy efficiency in contracting decisions. This allows the Army to deliberately evaluate competing options based on their efficiency and sustainability, among other factors. However, organizations across the Army have very different understandings of this KPP. To establish a common foundation for modernization, future acquisition, and contracts, the Army will revise the energy KPP for clarity and to better account for environmental impacts in decision-making. Once a shared understanding of the KPP has been reached, the Army will use the updated KPP to drive all future acquisition and contracting decisions.

Products made through clean and sustainable practices often cost less and require less maintenance than legacy equivalents. It is time to ask Army suppliers to further reduce both embodied emissions and the impact that supply chain activities have on the climate. To that end, the Army will adopt a Buy Clean policy for procurement of construction materials with lower embodied carbon emissions from manufacturing, transportation, installation, maintenance, and disposal sub-processes. The Buy Clean policy and potential future policies will facilitate an ambitious goal of net-zero GHG emissions from all Army procurements by 2050.

Resilient Supply Chains

Army supply chains are networks of military, governmental, and private organizations that create and deliver products and services to the Army, the Joint Force, and selected allies and partners. Resilient Army supply chains satisfy customer requirements while reacting quickly and efficiently to disruptions occurring within their networks. There are many potential sources of supply chain disruption, including tornados, hurricanes, and extreme weather events; land degradation; raw material shortages; and adversary actions. Achieving resilient supply chains requires a better understanding of the sources of disruption, deciding how much adaptation is needed in response, and selecting what portions of which supply chains merit Army attention. Army Materiel Command's ongoing supply chain optimization analysis is one of several strategic-level initiatives seeking exactly these results. The service will build on such efforts and adapt Army supply chains through a multi-step process. By 2025, the Army will analyze all of its Tier 1 sources and supply chain contracts for climate change risks and vulnerabilities. Wargames and simulations that "stress test" a supply chain will be particularly useful. By 2028, plans, policies, and contracts must be in place to ensure Army supply chain resilience. Finally, Army supply chain management must aggressively implement and proactively support the necessary initiatives to deliver Army supply chains capable of sustaining operations in competition, crisis, and conflict.

LINE OF EFFORT 3: TRAINING

STRATEGIC OUTCOME:

Prepare a force that is ready to operate in a climate-altered world

INTERMEDIATE OBJECTIVES:

3.1	Beginning in 2024, publish climate change lessons and best practices every two years
3.2	Update Army programs of instruction for leader development and workforce training to incorporate climate change topics no later than 2028
3.3	By 2035, increase the number of Soldiers and Army civilians serving in strategic headquarters with advanced credentials on climate change topics
3.4	Ensure that all Army operational and strategic exercises and simulations consider climate change risks and threats by 2028
3.5	Consider reduction of GHG emissions as a factor in planning to optimize the Army's mix of distributed learning, virtual learning, and resident courses
3.6	Develop ways to reduce direct GHG emissions resulting from Army individual and collective training by 2028

LINE OF EFFORT 3: TRAINING

Although the Army already trains its people to become world-class teams in a wide variety of environments and scenarios, the immediate and pressing nature of climate change means that today's training must account for this new, harsher reality. The Army as a whole must understand how future combat and non-combat operations will differ as a result of climate change.

To achieve this shared understanding, the Army must proactively train its people and **prepare a force that is ready to operate in a climate-altered world** while simultaneously maintaining the ability to win in combat. Such preparation requires shifts in *what* and *how* the Army trains its people, units, and headquarters. This effort not only seeks to adapt training to consider climate change implications, but also to update certain Army training practices to mitigate a portion of Army GHG emissions from training.

What the Army Trains

Army training must continually evolve to prime the force for new environments and threats. The next such evolution will account for climate change threats. The Army has already started building climate literacy into current training. This effort aims to provide an understanding of the Army's influence on the climate and climate change's influence on the planet. Army Materiel Command's "Climate 101" Course gives installation planners and garrison commanders an introduction to climate science and its implications for lands, energy, water, soil, and other installation issues. Over 450 professionals from across the Total Army have completed the course so far. The U.S. Army Corps of Engineers offers other courses on sustainability, resilience, energy, and master planning and will incorporate climate literacy into them. This is only the beginning. For some audiences, there will be purpose-built courses. For others, the next evolution means making smart decisions to integrate climate topics

Nearby wildfires cause a heat wave and heavy smoke that blocks out the sun at Fort Hunter Liggett, California, while Soldiers from the California Army National Guard's 79th Infantry Brigade Combat Team conduct a Warfighter exercise at the fort. (Photo Credit: Maj. Jason Sweeney)

into existing instruction and associated educational exercises. Overall, program of instruction (POI) updates will balance existing critical learning requirements and available time with the urgency of climate change. No matter how a particular course changes, revised training will always incorporate the latest climate science into training modules. To do so, the Army will publish climate change lessons learned and best practices every two years starting in 2024. The Army will fully implement climate-informed POIs no later than 2028, ensuring all Army people—and especially those on track for strategic leadership—are well educated in these critical issues.

There are also many existing programs through which dedicated Army professionals can develop climate-related expertise, including Advanced Civil Schooling and professional certifications. The Army needs only to encourage Soldiers and civilians to seize these opportunities and then apply their new knowledge when they return to the force. By 2035, the Army will have increased the number of professionals with civilian credentials in climate change topics serving in Army Command, Direct Reporting Unit, and Army Service Component Command headquarters. The Army will also request the resources needed to increase installation-level climate expertise to assist senior and garrison commanders.

How the Army Trains

At every echelon, the Army prepares for war through tough and realistic training. Imperatives to train today are just as strong as they have ever been. Going forward, the ways in which the Army trains will account for observed changes in both potential adversaries and in the Arctic, desert, mountain, and jungle environments where the Army could be employed. One example of such adaptation is an ongoing series of Army cold weather exercises with Canada, Norway, and Iceland, which featured six events in 2020 alone. Other similar initiatives are needed to make Soldiers, equipment, and units ready for hot, cold, wet, and dry extremes beyond what they have previously experienced. By working purposefully, all Army operational and strategic exercises and simulations will consider climate change risks and threats by 2028.

In the past, face-to-face instruction was the Army's preferred method of professional education. This sometimes involved relocating personnel, families, and household goods multiple times between assignments. This practice can adjust in light of better information technology, the proliferation of broadband internet service, and new collaborative platforms that enable desired training outcomes through remote instruction. Today, the Army must factor in climate impacts when comparing the costs and benefits of different ways of training the force, balancing training in person when necessary, while minimizing disruption and GHG emissions when practical. By evaluating the options at its disposal, the Army will optimize the mix of distributed learning, virtual learning, and resident courses in its strategic training plans by 2028.

To develop the expertise, trust, and capabilities of its units, the Army relies on a series of successively larger collective training exercises. Posturing for these training events often involves moving large numbers of personnel, rolling stock, and shipping containers. The training events themselves also demand significant run time from fossil-fuel-burning vehicles and generators in austere environments. All of this results in substantial Army GHG emissions. While training may look different in the future, the Army will ***not*** simply cancel training or other readiness-generating activities to mitigate climate change. Rather, Army collective training will adapt through better policy, improved technology, and innovative approaches. In conjunction with greater efficiencies through modernized equipment, the Army will assess and update how units prepare for, rehearse for, deploy to, and execute collective training exercises. The Army must train, and units should train as they will fight. The key is to train smarter and develop ways to reduce direct GHG emissions resulting from Army individual and collective training by 2028, while maintaining the Army's ability to win decisively in combat.

Conclusion

The Army will remain ready for its primary mission first and foremost: to deploy, fight, and win the nation's wars by providing ready, prompt, and sustained land dominance as part of the Joint Force. To do this most effectively, the Army must address the impacts of climate change. The service is undertaking many efforts already, but action must be diversified and expanded to fit the magnitude of today's climate change threats.

Now is the time to create irreversible momentum that enhances readiness and resilience for the next 30 years. By building upon decades of research, development, and innovation, the Army will become the resilient and sustainable land force the Nation needs. The imperative is clear: The Army must help the United States mitigate climate change while ensuring competitive overmatch in crisis and conflict, and adapting to a rapidly changing landscape.

Climate change poses unique challenges to the Army at all levels. Bold actions now will ensure the Army is ready to support our nation in competition, crisis, and conflict far into the future.

By implementing this strategy, **the Army will be a resilient and sustainable land force able to operate in all domains with effective mitigation and adaptation measures against the key effects of climate change, consistent with Army modernization efforts.**

GLOSSARY

Adaptation. Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative efforts. (DoD Directive [DoDD] 4715. 21)

Army Senior Commanders. Designated by Army senior leadership to exercise command of Army installations. The command authority over the installation derives from the Secretary of the Army's Title 10 authority over installations and is a direct delegation of command authority for the installation to the Senior Commander. The delegated authority includes all authorities inherent in command. The Senior Commander is normally, but not always, the senior General Officer at the installation. The Senior Commander uses the garrison command as the primary organization to provide services and resources to customers in support of accomplishing the installation command mission. (Army Regulation [AR] 600-20)

Carbon-pollution-free electricity. Electrical energy produced from resources that generate no carbon emissions, including marine energy, solar, wind, hydrokinetic (including tidal, wave, current and thermal), geothermal, hydroelectric, nuclear, renewably sourced hydrogen, and electrical energy generation from fossil resources to the extent there is active capture and storage of carbon dioxide emissions that meets U.S. Environmental Protection Agency (EPA) requirements. (Executive Order [EO] 14057, Section 603d)

Climate change. Variations in average weather conditions that persist over multiple decades or longer that encompass increases and decreases in temperature, shifts in precipitation, and changing risks of certain types of severe weather events. (DoDD 4715. 21)

Extreme weather events. Occurrences of unusually severe weather or climate conditions that can cause devastating impacts on communities and agricultural and natural ecosystems. (U.S. Department of Agriculture)

Greenhouse gases (GHG). Gases that trap heat in the Earth's atmosphere. They include carbon dioxide, methane, nitrous oxide, and chlorinated and fluorinated gases, and can be natural or anthropogenic. (EPA)

Hybrid vehicle. A road vehicle powered by an internal combustion engine in combination with one or more electric motors that uses energy stored in on-board batteries. The Army considers hybrids a potential bridging solution between legacy vehicle fleets powered entirely by internal combustion engines and future fleets powered entirely by zero-emission powertrains.

Installation. The real property of a base, camp, post, station, yard, center, or other activity under the jurisdiction of the Secretary of the Army, including any leased facility, or in the case of an activity in a foreign country, under the operational control of the Secretary of the Army, without regard to the duration of operational control. Army installations may consist of one or more real property sites. The term includes federally owned or federally supported (state-owned but operated and maintained with federal funds) Army National Guard sites and facilities designated as depots, arsenals, ammunition plants, hospitals, terminals, and other special mission activities. It does not include any state-owned/state-supported (owned, operated, and maintained with state funds) National Guard installation or facility. Nor does it include any facility used primarily for Civil Works, rivers and harbors projects, or flood control projects.

Land degradation. Long-term changes in land and soil (especially as a consequence of human activity), which result in soil loss, reduced soil fertility, coastal erosion, land subsidence, a reduced ability of the land to support native plants and animals, and reduced agricultural yields. Desertification is one type of land degradation. (DoD Installation Exposure to Climate Change at Home and Abroad, April 2021)

GLOSSARY CONTINUED

Microgrids. Local electrical systems with the controls to manage multiple generation sources and loads. They can also disconnect from the power grid to operate independently during outages of the regular grid. A microgrid may reduce energy costs by providing grid services to the regular utility provider, such as demand response and frequency regulation. (Army Installation Energy and Water Strategic Plan, October 2020)

Mitigation. As it relates to climate change: Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere. (DoD Climate Risk Analysis, October 2021)

Net-zero emissions. A condition achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals of those same gases over a specified period (Special Report: Global Warming of 1.5 °C, 2018). In this strategy, the "specified period" is a rolling 12 months generalized as, but not necessarily synchronized with, a given calendar year.

Non-tactical vehicle. A motor vehicle or trailer of commercial design acquired and assigned on the basis of authorization documents and used for providing administrative, direct mission, or operational transportation support of military functions. These roles include common support of installations and personnel; dedicated support to a specific unit or training activity; and conducting combat, tactical, and training operations. (AR 58-1)

Operational Energy. The energy required for training, moving, and sustaining military forces and weapons platforms for military operations. It includes energy used by power systems, generators, logistics assets, and weapons platforms employed by military forces during training and in the field. It does not include either the energy consumed by facilities on permanent DoD installations (except installations supporting military operations), or the fuel consumed by non-tactical vehicles. (DoDD 5134.15)

Resilience. The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions. (DoDD 4715. 21)

Sustainability. The property of being environmentally **sustainable**; the degree to which a process or enterprise is able to be maintained or continued while avoiding the long-term depletion of natural resources. (Oxford English Dictionary)

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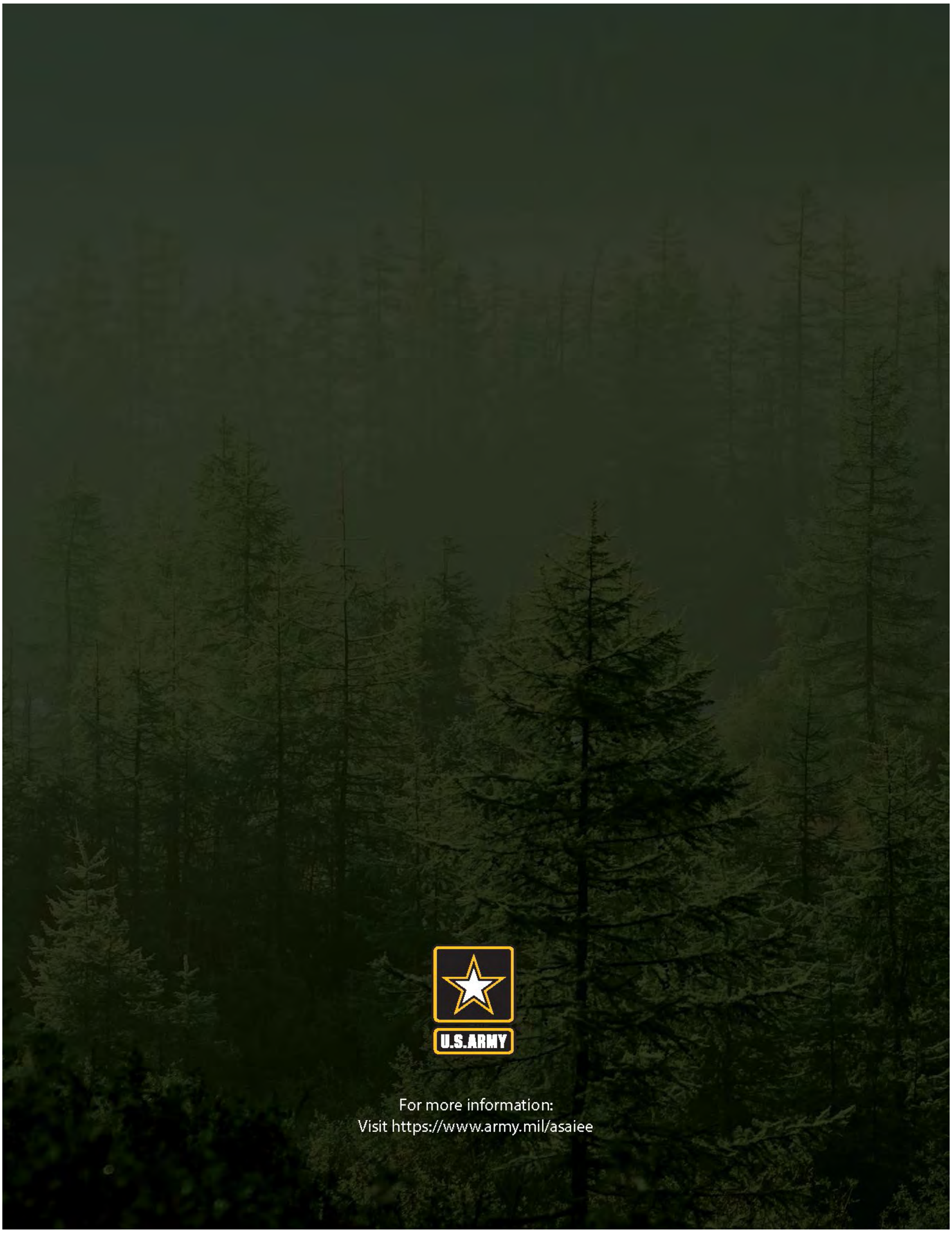

U.S.ARMY
For more information:
Visit https://www.army.mil/asaiee

Day 2, “Net-Zero and Energy Supply for USAF Buildings” (Kirk Phillips)

UNCLASSIFIED

Headquarters U.S. Air Force

Integrity - Service - Excellence

Air Force Office of Energy Assurance Overview

24 Jan 2023

Mr. Kirk Phillips, Director,
Air Force Office of Energy Assurance

Kirk A. Phillips

Director, Air Force Office of Energy Assurance

U.S. AIR FORCE

UNCLASSIFIED *Mission Assurance through Energy Assurance* 2

Air Force Installation Energy: Vision

PRINCIPLES:

- Resilience and Mission Focused
- Climate-Informed Solutions
- Creatively Leverage All Acquisition Tools
- Leverage Available Funding Types for Comprehensive Solutions (DoD, Vendor, Federal Agencies, State, Financiers)
- Move at Commercial Speed
- Long-Term Planning with Concrete Near- and Medium-Term Milestones
- **Teaming for Success - Air Force, DoD, Federal Government, States, Host Nation, EU/NATO, Utilities, Vendors**

Example Energy Strategies for EUCOM:

- Thermal Energy Alternatives
- Smart Microgrids with Energy Storage
- Renewable Generation (e.g. solar, wind, geothermal, biomass)
- Demand Reduction Through Smart Buildings

Executing Energy Assurance

Move to backup for sake of time?

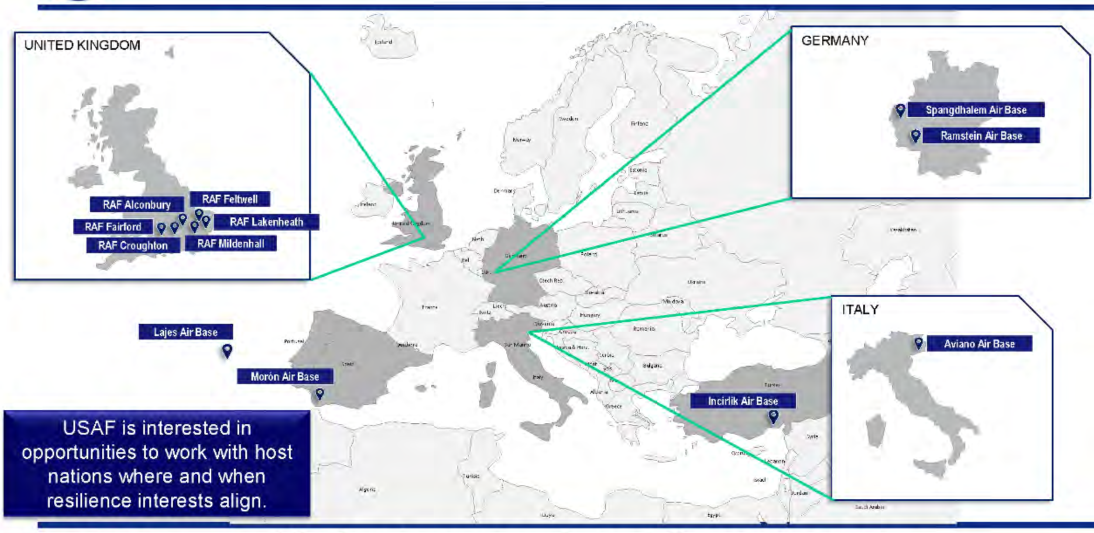
With energy resilience at the core, the Department of the Air Force is aligning every installation energy effort with mission needs

Combating Military Reliance on Russian Energy

- National Defense Authorization Act for FY2023 (Sec. 1086)
  - (1) reliance on Russian energy poses a critical challenge for national security activities in the area of responsibility of the United States European Command; and
  - (2) in order to reduce the vulnerability of United States military facilities to disruptions caused by reliance on Russian energy, the Department of Defense should establish and implement plans to reduce reliance on Russian energy for all main operating bases in the area of responsibility of the United States European Command.
- **<u>Goal:</u>** eliminate the use of Russian energy on each main operating base in the area of responsibility of the United States European Command by not later than five years after the date of the completion of an installation energy plan for such base, as required under this section.

UNCLASSIFIED *Mission Assurance through Energy Assurance*

Resilience Activities at USAFE Installations



UNCLASSIFIED *Mission Assurance through Energy Assurance*

AF OEA Acquisition Toolbox for EUCOM

- **Energy Savings Performance Contract (ESPC)**
  - Allows the Air Force to procure energy conservation measures (ECMs) and facility improvements with no up-front capital costs or special appropriations from Congress
  - A partnership between an agency and an energy services company (ESCO)
  - Projects awarded as Task Orders to the Department of Energy Indefinite-Delivery Indefinite-Quantity (IDIQ) contract
- **Energy Resilience and Conservation Investment Plan (ERCIP)**
  - A subset of the Defense-Wide MILCON Program specifically intended to fund projects that improve energy resilience, contribute to mission assurance, save energy, and reduce DoD's energy costs
  - ERCIP accomplishes this through construction of new, high-efficiency energy systems and technologies or through modernizing existing energy systems
- **On-Base/Adjacent Third-Party Generation**
  - Agreements with third party providers to generate resilient power on or near installations
  - Examples: Enhanced Utilities Contracts, Power Purchase Agreements, Land Use Agreements

Crucial: Coordination to support host nation goals and meet any pertinent requirements.

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Partner with EUCOM

EUCOM is looking for innovative, executable solutions which increase resilience while addressing climate concerns

Identification

EUCOM works with industry to enhance your installation's energy resilience

Exploration

EUCOM examines new technologies advantageous to the host region

Integration

EUCOM teams with host nations to deploy solutions using creative acquisition pathways

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Back-Up

Climate and Water Focus

Align Department of the Air

GB – recommend move to backup – added climate informed to first slide

to assess water risk to continuity of installation operations and Enterprise missions

Addressing EO Climate Objectives

Climate requirements as outlined in President Biden's December 8, 2021, Executive Order 14057

It is DOD policy (DOD 2016a. DoDD 4715.21) that all operations, planning activities, business processes and resource allocation decisions include climate change considerations

AFCEC LEADS / SUPPORTS

100% Carbon-Free Electricity - 2030	Through navigating relationships with utility and community partners, develop power sources for Air Force installations which are carbon-free considerations
Zero-Emission Fleet-2035	Securing a fleet of electric vehicles is not the largest challenge to the Air Force—planning and installation of EV supply equipment on our installations
Net-Zero Carbon Buildings - 2045	Review building features and designs, such as heating and cooling, to identify opportunities and processes for carbon reduction and efficiency
Net-Zero Procurement Supply Chain - 2050	Include carbon reduction concepts when considering procurement actions across the supply chain
Climate Resilience & Adaptation	Accelerate current climate resilience efforts and prepare for weather impacts

Climate Action Plan Overview

- Climate change introduces challenges that impact our mission capabilities and combat readiness
- The Air Force has three climate priorities:

1. Maintain Air and Space Dominance in the Face of Climate Risks	IEPs* assess current and future energy and water requirements at installations to remain resilient during climate-driven disruptions **ICRPs also a critical planning document*
2. Make Climate-Informed Decisions	Increased focus on collaborative planning with other Federal agencies, Congress, state and local entities and industry to exchange lessons learned and technologies to address climate change
3. Reduce Future Risk through Maximizing Energy Efficiency and Alternative Sources	▪ DoD's first microreactor pilot at Eielson AFB promotes energy security and a resilient carbon-free energy source ▪ Electrifying vehicles to reduce greenhouse gas emissions and promote energy resilience

AFCEC Installation Climate Resiliency Plan (ICRP)

- **FY20 NDAA & FY22 establishes requirement to develop Military Installation Resilience Component to Installation Development Plans for major military installations**
- **DAF execution**
  - **FY22 NDAA requires 2 complete ICRPs NLT Jan 23 (JBLE, Vandenberg SFB)**
  - **AFCEC actively collaborating w/ JBLE & VSFB on ICRP development**
  - **JBLE & VSFB Draft ICRPs – ECD Aug 2022**
- **ICRPs allow AF to:**
  - **Plan for and mitigate risk to infrastructure**
    - **Build higher than flood line**
    - **Risk of fire due to climate change**
    - **Installation ICRP results can help identify solutions that are designed to address climate**
  - **Integrate ICRP elements into new IEPs & IEP updates**
  - **Several IEP & ICRP plan elements & data capture overlap**

Installation resilience plans help preserve mission readiness by identifying climate risks and mitigation actions

Public Private Partnerships for Resilience

Public Private Partnerships are central to DoD's Energy Resilience Strategy

- Energy Resilience is Central to DoD Energy Policy
- Building Distributed Generation (adjacent to or behind-the-fence line) is a priority
- Funding values seen in the budget are primarily for operational energy
- Installation energy is funded as a purchasable commodity through the value in the system
- DoD is not in the utility business; we prefer to have energy experts design, build, own, operate, and/or maintain resilient energy infrastructure at our facilities
- Congress provided DoD numerous acquisition tools to include public private partnerships

Technologies of Interest and Potential Sites

Technology	Potential Sites
Microgrids	Multiple installations
Small Modular Reactors	Eielson AFB
Geothermal	Mountain Home AFB, JB San Antonio, FE Warren AFB
Solar	Multiple installations
Energy Storage (including long-duration storage)	Multiple installations
Electric Vehicle Support Equipment	JB Andrews, JB McGuire-Dix-Lakehurst, JB Anacostia-Bolling, Los Angeles SFB, Tyndall AFB, US Air Force Academy, Dover AFB, Fairchild AFB, Hanscom AFB, Holloman AFB, JB San Antonio, Little Rock AFB, Mountain Home AFB, Plant 42, Robins AFB, Travis AFB, Tinker AFB
Hydrogen Production	Multiple installations

Day 2, "Nations and Natos Partnership for Energy Security" (Sean Granier)

NATO
OTAN

Nation's and NATO's Partnership for Energy Security

Maj Sean V. Granier (USA - Air Force)
SHAPE SO (Infrastructure Assessment)
Sean.GRANIER@shape.nato.int

NATO
OTAN

Aim

- To provide you with an understanding of how NATO views Energy Security

Outline

- Why
- Energy Security
  - Awareness
  - Energy Efficiency
  - Protection of Critical Infrastructure
- Partnerships and Initiatives

3

- Energy
  - Strategic asset for nations
  - Source of conflict – Energy as a “Geo-Political Weapon”
    - Energy dependency and energy cut-offs
- Energy security
  - Essential domain of interest for NATO
    - Including security of supply (nations and forces)
    - Economic and financial implications
    - Strategic use of energy security
  - Vital component of national and regional resilience
    - Increasingly important in the new security context
  - Not treated as a single topic

4

Why

- *A stable and reliable energy supply, the diversification of routes, suppliers and energy resources, and the interconnectivity of energy networks are critical importance and increase our resilience against economic pressure. While these issues are primarily the responsibility of national authorities, energy developments can have significant political and security implication and also affect our partners.*

  -NATO Summit 2018

- Modern living standards rely on energy. Large disruptions and fluctuating prices can cause civil unrest and instability
- Military Forces and current western way of living require energy sources to live, move, and fight

6

Energy Security in NATO

- 3 Pillar approach
  - Awareness
  - Critical Energy Infrastructure Protection (CEIP)
  - Energy Efficiency for Military Operations

7

Strategic Awareness

- Engagements
- Incorporation of energy-related scenarios in exercises
- Increased Partnerships and Relationships (Nations, Industry, International Agencies)
- NATO's Science for Peace and Security (SPS) Programme
- Fully established NATO training and education
  - ENSEC Strategic Awareness Course – NSO
  - NATO Infrastructure Assessment in Support of Planning Course

8

Critical Energy Infrastucture Protection

- MARSEC COE – Protection of Undersea Critical Infrastructure
- Partnerships:
  - Upcoming taskforce with EU on resilience and critical infrastructure
  - Stronger ties with infra owners/operators regarding CEIP
  - NATO Energy Security COE

9

Energy Efficiency

- Understanding Energy Efficiency can solve issues for commanders
  - Reduction in logistic convoys and logistic footprint
  - Reduced reliance on fossil fuels
  - Reduction in release of green house gases (CO_2, methane)
- NATO Strategic Concept
  - Reduction of GHG by 45% by 2030 (static installations/facilities)
  - Net-Zero by 2050 (based on 2019 figures)
- NATO Energy Transition by Design

10

Takeaways

- Energy is critically interdependent infrastructure
- Energy demand will increase, transition takes time
- Partnerships

Knowing is not enough; we must apply. Willing is not enough; we must do.

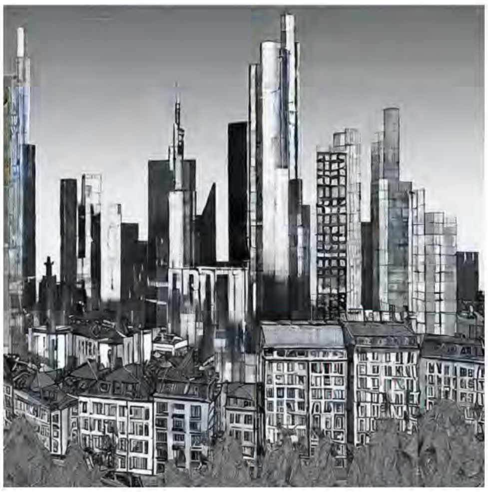
\- Johann Wolfgang von Goethe

11

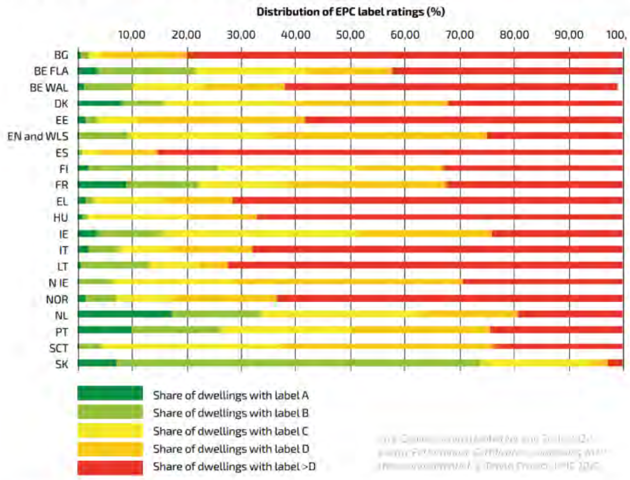
Day 2 "Future Proof Energy Standards for New and Existing Buildings" (Julian Bischof)

Contents

- Overview of Energy Performance Certificates in Europe
- Current developments in building energy standards
- Phases of the building life-cycle
- Impact of embodied carbon in building life-cycle
- What is future proof?
- Targets for new buildings and building refurbishment
- Influence of building, supply systems and material choice
- Summary



Overview of Energy Performance Certificates in Europe



- **Energy Performance Certificates (EPCs) attest the building operational energy** either by **calculation** of the energy demand or by the **measurements** taken by the energy meters.
- **Great diversity of EPCs across EU** due to differences in their calculation and definitions of classes.
- Germany has no central accessible EPC database.

Current developments in building energy standards

IWU

- Proposal on Energy Performance of Buildings Directive (COM(2021) 802 final)
  - **first steps** on consideration of the **Greenhouse Gas Emissions (GHGE) of the entire building's life-cycle**
  - **Optional quantification of GHGE** on new EPCs
    - Mandatory **life-cycle-GHGE** for construction of buildings with **more than 2,000 m² from 2027**
    - Mandatory **life-cycle-GHGE for construction of all new buildings from 2030**

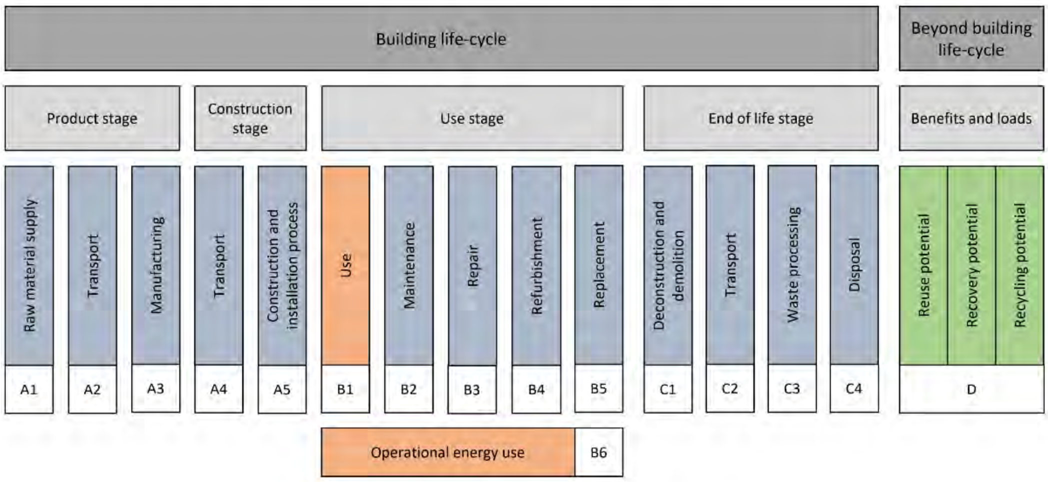
- Requirement for reaching **target values of the BNB** (Rating system sustainable building) for all **new federal state buildings**
- **Subsidies for new construction** of domestic buildings, in case of compliance with **QNG (Sustainable Building Quality Seal) target values**.

Stein et al. 2022. Dokumentation der Darmstädter Arbeitsgruppe - Graue Energie und graue Emissionen im Gebäudelebenszyklus. Project: sne - System innovation für nachhaltige Entwicklung, Institut Wohnen und Umwelt, Darmstadt, Germany.

24.01.2023 Julian Bischof (IWU), at the International Forum, Frankfurt, January 24th 2023 4

Phases of the building life-cycle

IWU



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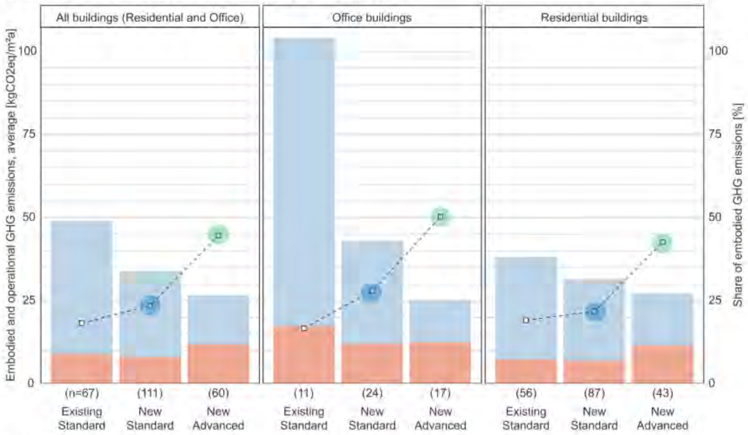
Impact of embodied carbon in building life-cycle

a) Global trends in embodied and operational, life cycle GHG emissions



Röck, Martin; Saade, Marcella Ruschi Mendes; Balouktsi, Maria; Rasmussen, Freja Nygaard; Birgisdottir, Harpa; Frischknecht, Rolf et al. (2020): Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. In: Applied Energy 258, S. 114107. DOI: 10.1016/j.apenergy.2019.114107

- **The share of the embodied GHG emissions in buildings** in compliance with **current building energy standards** (New Standard) lies in the range **between 20% and 30%.**
- **Highly efficient buildings** compliant with the EH 40 or the passive house standard (New Advanced) reach shares **in the range of 40% to 50%.**

What is future proof?

"**Climate neutrality** refers to the idea of achieving net zero greenhouse gas emissions by balancing those emissions so they are equal (or less than) the emissions that get removed through the planet's natural absorption"

UNFCCC - a-beginners-guide-to-climate-neutrality

Typical target values for the year 2050, based on different assumptions

Reduction of 80 – 95 % in comparison to 1990 (German Federal Ministry for Economics and Energy (BMWi) 2015)	Maximum of 1 $t_{GHGE\ in\ CO2\ equivalent}$/(Person · a) (SIA 2040 and Habert et al. 2020)	Maximum of 2,000 W/Person (Bilanzierungskonzept 2000-watt-gesellschaft and SIA 2040)

Establishing and projecting these targets to the building stock is a important step on the way to a climate neutral – future proof building stock.

Targets for new buildings and building refurbishment

Building operational phase target for the 95% reduction in 2050

For **domestic buildings 2,6 kg $CO_{2eq}/(m^2 \cdot a)$** have to been reached (IWU – Großklos et al. 2019). Non-domestic buildings targets are varying, depending in building usage.

Embodied emission target (GHGE) for **new construction** projects

The embodied GHGE of new constructed buildings should be below **9 kg $CO_{2eq}/(m^2 \cdot a)$ or 450 kg CO_{2eq}/m^2.** (Mahler et al. 2019; Idler et al. 2019; Habert et al. 2020; SIA 2040)

Embodied emission target (GHGE) for **refurbishment** projects

The embodied GHGE of building refurbishment measures should be below **6 kg $CO_{2eq}/(m^2 \cdot a)$ or von 300 kg CO_{2eq}/m^2** (SIA 2040)

QNG – **„Qualitätssiegel Nachhaltiges Gebäude" domestic building target values for life-cycle over 50 years**

QNG PLUS	max. 24 kg $CO_{2eq}/(m^2 \cdot a)$
QNG PREMIUM	max. 20 kg $CO_{2eq}/(m^2 \cdot a)$

Influence of building and supply systems

Single family house with a usable area of 121 m²				Currently	including PV	95% reduction target	
Building energy standard	**Heating system**	**Final energy** [kWh/a]	**Final energy** [kWh/(m²a)]	**GHGE** specific [kg/(m²a)]	**GHGE** specific [kg/(m²a)]	**GHG** specific [kg/(m²a)]	required **GHGE-factors of supply system** [g/kWh]
GEG	Gas condensing boiler	9.945	82	20,1	16,4	2,6	39
	Air/Water heat pump	4.561	38	17,2	11,6	2,6	85
	Brine/Water heat pump	3.890	32	14,6	9,9	2,6	99
	Wood pellet boiler	13.362	110	3,1	2,7	2,6	29
EH 55	Gas condensing boiler	7.331	61	12,7	12,2	2,6	53
	Air/Water heat pump	4.092	34	15,4	10,5	2,6	95
	Brine/Water heat pump	3.541	29	13,3	9,0	2,6	109
	Wood pellet boiler	11.525	95	2,8	**2,4**	2,6	34
EH 40	Air/Water heat pump	3.288	27	12,4	8,4	2,6	118
	Brine/Water heat pump	3.007	25	11,3	7,7	2,6	129
	Wood pellet boiler	8.189	68	3,0	**2,4**	2,6	47
GHGE-factors	Electricity			560			
[g/kWh]	Gas			240	*(kept constant due to uncertainties)*		
(according to GEG)	Pellets			20			

23.06.2022

Bischof and Swiderek. 2022. *Auf dem Weg zu einem klimaneutralen Gebäudebestand.* Schlaglicht 01|2022. Institut Wohnen und Umwelt, Darmstadt, Germany.

Influence of material choice

IWU

Embodied energy per square meter building component. Own summary based on (EnergieSchweiz 2017a, 2017b).

Einfluss der Maßnahmen (hoch → niedrig)	min.	max.						
Fensterrahmen-material und Verglasung	10,1	23,4	Holz, 2-IV 10,1	Holz, 2-VSG 14,5	Holz, 3-IV 16,3	Holz/Metall, 3-IV 18,3	Kunststoff, 3-IV 21,3	Metall, 3-IV 23,4
Dämmung, Kompaktfassade, U-Wert 0,2	2,3	5,4	EPS-Graphit, 15 kg/m^3 2,3	Steinwolle, 100 kg/m^3 2,5	Weichfaser-platten, 150 kg/m^3 3,1	EPS, 20 kg/m^3 3,5	PUR/PIR, 33 kg/m^3 3,9	XPS, 33 kg/m^3 5,4
Kellerdecken-dämmung, U-Wert 0,25	1,7	4,3			Glaswolle 1,7	EPS 1,8	Steinwolle 1,9	XPS 4,3
Dämmung, hinterlüftete Fassade (mit Befestigungs-system), U-Wert 0,2	0,5	3,5	Zellulose (Holz) 0,5	Schafwolle (Holz) 0,5	Glaswolle (Holz) 0,7	Steinwolle (Holz) 0,8	EPS (Metall) 2,6	PUR/PIR (Metall) 3,5
Zwischen-sparrendämmung, U-Wert 0,2	0,3	0,8	Zelluloseflocken, 60 kg/m^3 0,3	Schafwolle, 30 kg/m^3 0,4	Steinwolle, 32 kg/m^3 0,6	Glaswolle, 22 kg/m^3 0,7	Zelluloseflocken mit 10 mm Dreischichtplatte, 60 kg/m^3 0,8	Weichfaser-platte, 55 kg/m^3 0,8

niedrig — **Einfluss der Maßnahmenausführung** — hoch

Bischof and Swiderek. 2022. Auf dem Weg zu einem klimaneutralen Gebäudebestand. Schlaglicht 01|2022. Institut Wohnen und Umwelt, Darmstadt, Germany.

Summary

IWU

- Form and size,
- construction type,
- **material choice**,
- replacement cycles,
- energy system,
- efficiency standard

influence the life-cycle GHGE.

Besides further improvement of **building energy standards** and the **implementation of renewable energies** the **consideration of the entire life-cycle** of new constructions or the refurbishment of existing buildings need to be considered. Therefore the importance of the **material choice** increases.

Further Details

- Bischof and Swiderek. 2022. *Auf dem Weg zu einem klimaneutralen Gebäudebestand*. Schlaglicht 01|2022. Institut Wohnen und Umwelt, Darmstadt, Germany.
- Stein et al. 2022. *Dokumentation der Darmstädter Arbeitsgruppe - Graue Energie und graue Emissionen im Gebäudelebenszyklus*. Project: s:ne - Systeminnovation für nachhaltige Entwicklung. Institut Wohnen und Umwelt, Darmstadt, Germany.

24.01.2023 12

IWU

24.01.2023 Julian Bischof (IWU), at the International Forum, Frankfurt, January 24th 2023 13

Applying ASHRAE Standards for Success

ANSI/ASHRAE/IES Standard 100 – Energy Efficiency in Existing Buildings

Terry R. Sharp - PE, CMVP
Oak Ridge National Laboratory, USA

Wayne Stoppelmoor
Industry Standards Manager – Energy Efficiency
Schneider Electric

Topics

ASHRAE Standard (Std.) 100

- Why it’s so important
- What is it and how can it help energy code authorities?
- Compliance requirements

ASHRAE Std. 100 – The Need

- **Existing U.S. Buildings**
  - 5.9 million commercial buildings (CBECS 2018[1])
  - 124 million residential buildings (RECS 2020[1])
  - Consume 40% of energy use and ~70% of electricity use
  - Produce ~40% of all CO_2 emissions

Conclusion 1: "What we already know --The efficiency of buildings must be addressed to significantly impact climate change"

[1]U.S. Energy Information Administration (EIA) commercial & residential building surveys

ASHRAE Std. 100 – The Need

- **U.S. Building Facts**
  - 91% built before 2010[1] (commercial)
  - 92% built before 2010[1] (residential)
  - ~90% of all buildings that will exist 10 years from now exist today![2]

Conclusion 2: "EXISTING buildings need to be a highest priority - the greatest opportunity, by far, to reduce emissions from buildings is through the improvement of EXISTING buildings"

[1]2018 & 2020 U.S. EIA CBECS and RECS building surveys
[2]Based on comparison of historical CBECS and RECS surveys

ASHRAE Std. 100 – The Need

Primary Energy Codes/Standards in Force

- International Energy Conservation Code (IECC)
- ASHRAE Std. 90.1
- ASHRAE Std. 90.2

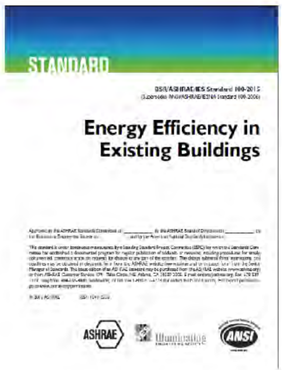
Existing codes/standards provide limited help:

1. They apply to new buildings/ limited renovations
2. Newer U.S. commercial buildings (2000-2018) appear more energy intensive than older ones (on average)[1]
3. New buildings are often moderate or low performers
4. Moderate/low performers can persist long term

[1]2018 CBECS, Preliminary Consumption and Expenditures Highlights, p. 16

ASHRAE Std. 100 – What is it?

FEATURES THAT WILL HAVE IMPACT:



1. Targets existing buildings (residential, commercial, and institutional)
2. Sets minimum requirements for energy efficient design and operation
3. Requires improvement of moderate and low performing buildings -- over 50% of our current buildings are low to moderate performers

ASHRAE Std. 100 – What is it?

- **Supports building owner/operators:**
  - Provides process and procedures to reduce energy use (and emissions) of their buildings
- **Supports state and local jurisdictions**
  - Provides code-ready standard that can be written directly into building codes
- **Supports authorities and utility companies**
  - Provides verifiable process that can support tax incentive, rebate, and other programs

ASHRAE Std. 100 – What is it?

Basic Index

1. Purpose
2. Scope
3. Definitions
4. Compliance Requirements
5. Energy Management Plan
6. Operation and Maintenance Requirements
7. Energy Use Analysis & Target Requirements
8. Energy Audits Requirements
9. Implementation & Verification
10. Residential Buildings & Dwelling Units

Focus areas

ASHRAE Std. 100 – Compliance

Section 5 – Energy Management Plan

- Annual building energy use intensity (EUI) is tracked -- Measure so you can manage!
- Minimum standards for new equipment
  - ASHRAE Std. 90.1, *Energy Standard for Buildings, Except Low-Rise Residential Buildings,* and
  - ASHRAE Std. 90.2, Energy Standard for Residential Buildings

ASHRAE Std. 100 – Compliance

Section 6 – Operation and Maintenance (O&M)

- Requires O & M Program
- Sets minimum O & M requirements (Annex L - generally follows ASHRAE Std. 180)
- Requirements are
  - Feasible for buildings of all sizes and occupancies
  - Practical for the average owner
  - Help achieve energy efficiency

ASHRAE Std. 100 – Compliance

Section 7 - *Energy Use Analysis and Targets*

Offers Simple Compliance Via Energy Use Intensity (EUI) Targets

- **For 53 building types in 16 climate zones** ← *ROBUST!*
- **Authority can choose different levels of compliance via different EUI targets** ← *FLEXIBLE!*
- **Enables extremely simple compliance for efficient buildings!** ← *FINALLY!*

No.	Commercial Building Type	EUIs by Building Type by Climate Zone (kBtu/sf-yr)												
		ASHRAE Climate Zone												
		1A	2A	2B	3A	3B	3B	3C	4A	4B	4C	5A	5B	6A
1	Admin/professional office	39	40	39	42	33	39	33	46	40	40	48	42	54
2	Bank/other financial	55	57	56	59	46	55	47	65	56	57	68	59	76
3	Government office	49	50	49	52	41	48	42	57	49	50	60	52	67

ASHRAE Std. 100 – Compliance

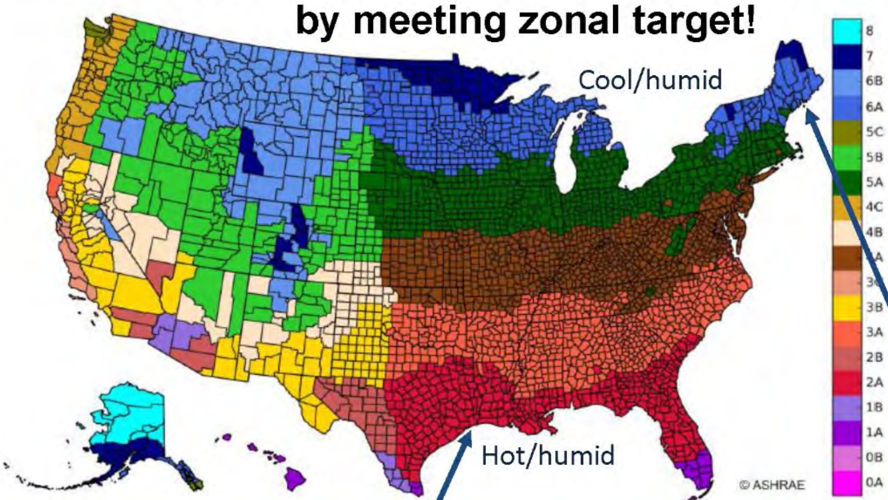
Section 7 – Energy Use Analysis and Targets

- **Building owner calculates building EUI (kBTU/ft^2-yr or MJ/m^2-yr) using utility bills**
- **Compares building EUI to target EUI[1] for compliance**
  - **If below target, energy use requirement is met**
  - **If exceed target or if building is rare type with no target, must do energy audit and implement improvements (Sections 8 & 9)**

[1] Standard 100 target EUIs are derived from the energy use of actual U.S. buildings, they do not rely on modeling or simulated analyses like some existing standards.

ASHRAE Std. 100 – Compliance

Office building example: Comply with energy requirement by meeting zonal target!



No.	Commercial Building Type	EUIs by Building Type by Climate Zone (kBtu/sf-yr)												
		ASHRAE Climate Zone												
		1A	2A	2B	3A	3B	3B	3C	4A	4B	4C	5A	5B	6A
1	Admin/professional office	39	40	39	42	33	39	33	46	40	40	48	42	54

ASHRAE Std. 100 – Compliance

Section 8 – Energy Audit Requirements

- ASHRAE Level 2 energy audit (identifies measures to enable building to meet energy target)

Section 9 – Implementation & Verification

- Develop/Implement an Energy Efficiency Plan
  - Implement measures
    - Buildings with targets - As required to meet EUI target
    - Buildings without targets – Implement measures with simple payback of 5 years or less
  - Train building staff

Conclusions

- Standard 100 offers simple path to achieve high performance
- For the whole sector, U.S. survey results suggest current standards have minimal affect on reducing commercial sector energy use (and emissions)
- New buildings become existing buildings, and Standard 100 will not let moderate and low performing buildings persist
- Standard 100 can complement current codes

THANK YOU VERY MUCH!

Questions?

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Day 2, “Air Leakage Testing” (Barry Cope)

ATTMA

Reduce Demand to Reduce Supply

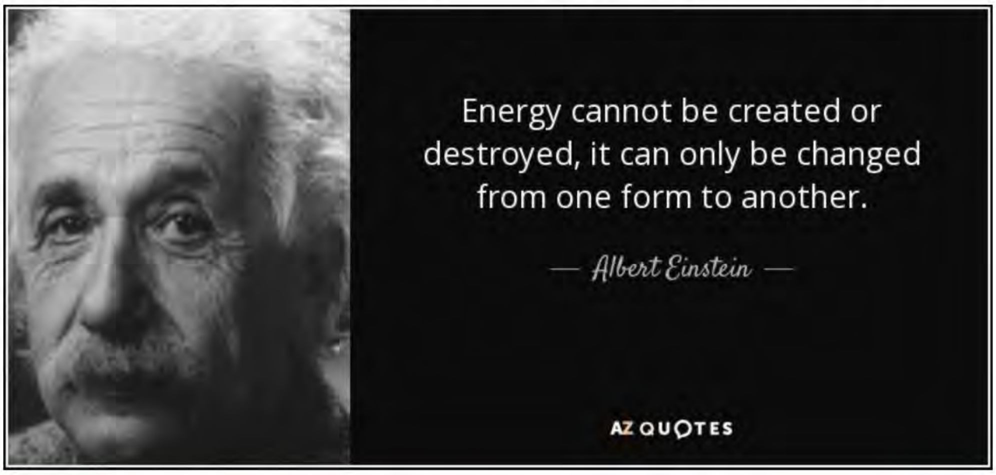
Using air leakage testing to reduce energy demand from buildings

Presented by:
Barry Cope
Group Managing Director

ATTMA

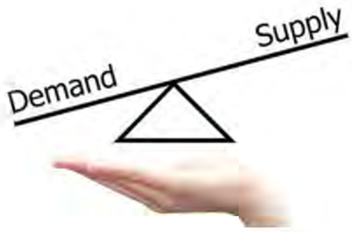
Reduce Demand to Reduce Supply

Using air leakage testing to reduce energy demand from buildings



Reduce Demand to Reduce Supply

Using air leakage testing to reduce energy demand from buildings



Blower Door Testing

What is Air Tightness Testing?

Air tightness testing is the process of measuring the amount of conditioned (heated or cooled) air entering or exiting a building through uncontrolled infiltration.

Blower Door Testing

How is Air Tightness Measured?

A calibrated fan is installed into the external envelope of the building and supplies air into, or extracts air out of, the property creating a controlled building pressure differential.

In simple terms, the amount of air going into, or out of the property when the building is subject to a pressure differential is the amount of 'air leakage'.

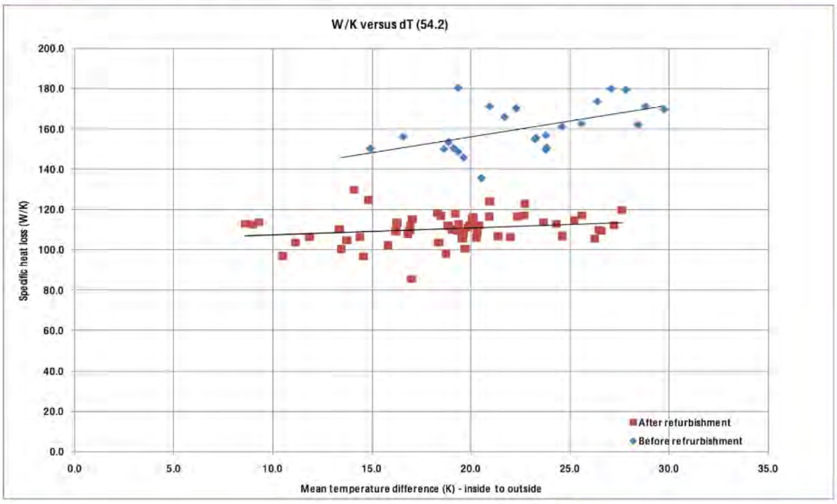
Blower Door Testing

Why is Blower Door Testing Relevant?

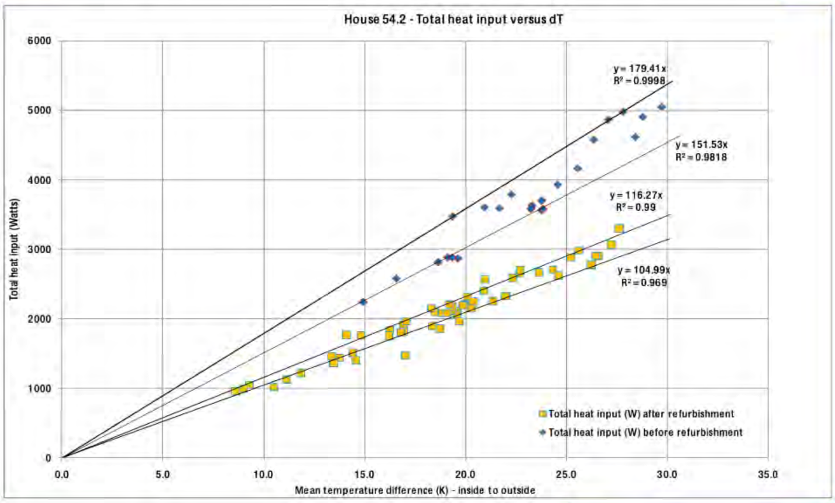
Substantial Energy Reduction

In 2011, An independent British Research Establishment concluded that a reduction from 15 $m^3.h^{-1}.m^{-2}$@50Pa (an average UK Building) to a 5 $m^3.h^{-1}.m^{-2}$@50Pa (a slightly worse than average new-build) resulted in a 35% reduction in heating load during a typical winter period

Why is Blower Door Testing Relevant?



Why is Blower Door Testing Relevant?



Reducing Demand will Reduce Supply

Proposal

What if we conducted a blower door test on all properties in Germany? How much would it cost? And how much will it save?

Reducing Demand will Reduce Supply

Proposal

There are 43 million homes in Germany for circa 83 million people.

Let's assume we tackle the worst 50%

An air tightness tester could feasibly test 10 dwellings per day and identify areas of infiltration. That's approximately 220 homes per year, 2200 homes per annum.

Reducing Demand will Reduce Supply

Proposal

An average air tightness tester in the UK is paid £20,000 per annum, which translates to approximately €18,000 per annum. Let's say €20,000 after taxes.

Annual overheads for conducting these tests would be say €17,400 (small car, sealing film, equipment, calibration, fuel).

€37,400 / 2200 homes is €17 per home.

ATTMA

Reducing Demand will Reduce Supply

Proposal

€37,400 / 2200 homes is €17 per home.

To fix the homes? Let's assume each home has a tradesperson for 1/3 day at a cost of €25 per hour, €75 per home.

Let's also give each home a budget of €200 in materials (sealing boards, tapes, silicone etc).

ATTMA

Reducing Demand will Reduce Supply

Proposal

Let's also give each home a budget of €200 in materials (sealing boards, tapes, silicone etc).

Each home could have their peak demand slashed by 35% when the energy grid is at its most vulnerable for a cost of

€17 – Blower Door Testing

€75 – Tradesperson

€200 - Materials

ATTMA

Reducing Demand will Reduce Supply

Proposal

€17 – Blower Door Testing
€75 – Tradesperson
€200 - Materials
€292 – total

Add some administration

€307 total

ATTMA

Reducing Demand will Reduce Supply

Proposal

€307 total could save 1Kw/h.

The total cost of the project to Germany?
€ 6.6bn

Reducing Demand will Reduce Supply

Alternatives

To build a nuclear power plant?

Hinckley Point C in the UK has cost £26bn.

Adding solar panels?

Won't generate demand during the winter.

Coal Powered Generators?

Bad for the planet

Wind Farm?

10,000 turbines would need to be installed.

Reducing Demand will Reduce Supply

Summary

These numbers are approximate but it shows that reducing power demand by reducing air leakage in homes will

- reduce the costs for homeowners,
- increase their comfort levels,
- reduce the costs to the country
- reduce the need for planned blackouts if the power supply is reduced.

Day 2, “Does Your Building Suck?” (Steven Tratt)

A Video Which Clearly Illustrates Building Envelope Air Leakage:

Air Barrier Continuity- Identifying breaches :

The Basics of Air leakage

– Continuity is the most important characteristic of the air barrier system prevents…..

Infiltration / Exfiltration which is

- Diffusion Flow
- Orifice Flow
- Channel Flow

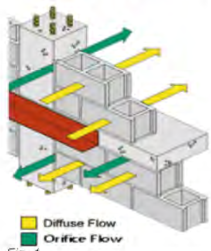


Fig. 1

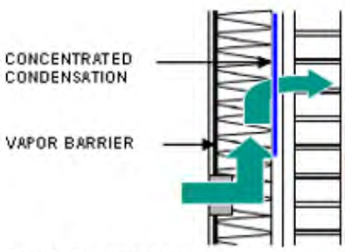


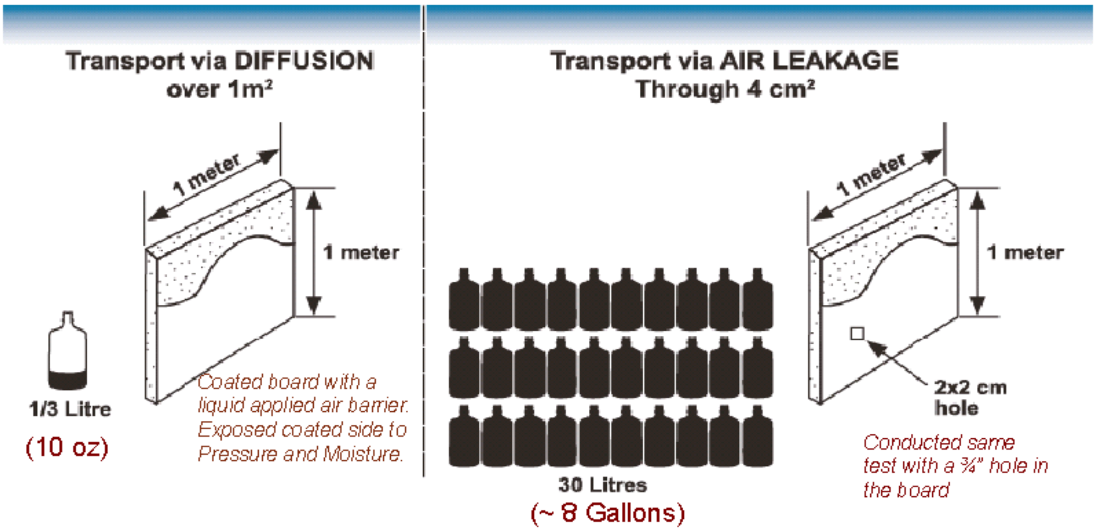
Fig. 2: Channel Flow

– Allows the proper control of air movement into and out of building enclosures

– All six sides of a building enclosure must be continuous within themselves and in conjunction with each other

Air Leakage & Moisture

Test simulating a Ottawa, Canada winter comparing an intact air barrier vs. a ¾" hole in the air barrier



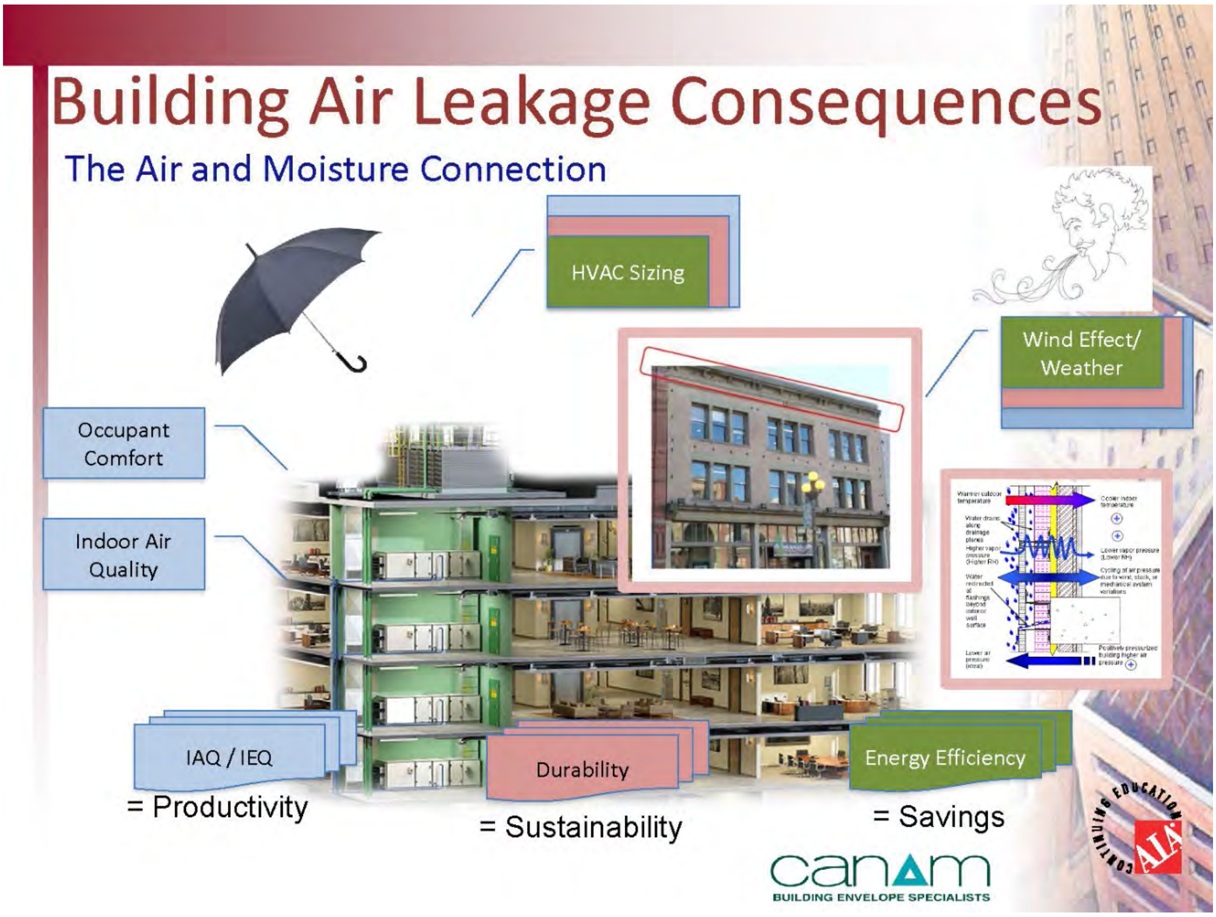
100 times more moisture diffused through the board!

Influences- the Building Science has been there; Now becoming relevant!

Codes Standards and Recommendations

Factors that continue to push the construction industry to higher performance and more energy efficient buildings

- ASHRAE 90.1- 2010, 2013
- IECC 2012
- IBC
- USACE
- ABAA
- NABA
- National Institute of Building Sciences
- Specialty Niche Organizations, (e.g. Joint Commission)



Base Diagnostic Tools:

For the forensic field assessor- identifying the source

Trained Assessor
with camera &
intake form

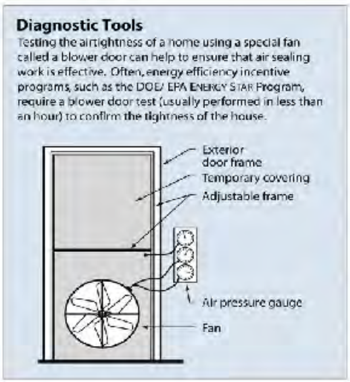
Smoke Pencil
or similar tool to
Provide show
of air flow

Flir E50 BX
IR camera

Velocicalc 9565
IAQ Probe 980 for:
Temp- RH
CO2 – Pressure
Mold and BIO snaps

Advanced Diagnostic Tools:

Optional cost, additional set-up- measured leakage



Blower Door

Standard Pressurization Kit and gauges used by Building Science Engineer Partner

Multi-fan or larger

Air Barrier Continuity:

Failure of air barrier systems

- Breaches in the air barrier and it's connections / continuity will make buildings:
  - Less healthy
  - Unsafe
  - Less durable
  - Uncomfortable
  - Energy inefficient

Importance of Continuity Intro to IAQ/ IEQ:

According to the Environmental Protection Agency

- North Americans spend 80-90% of their time indoors, so IAQ is very important, for health and productivity reasons
- Sick Building Syndrome (SBS) involves health and comfort effects linked to time spent in a building
- Building Related Illness (BRI) involves symptoms of diagnosable illness attributed directly to airborne building contaminants (Asthma, aggravated allergies,

The byproduct / financial benefit of air sealing:

Is a cost justifiable process, not sole driver

- Energy Efficiency that will save you MONEY!
  - More efficient ventilation in the HVAC system
  - More efficient use of pumps and fans within the system
  - Better performance of the system could mean longer operation life of the equipment
- 3 recommendations for all buildings (in order)
  - Air Sealing – *inexpensive, is a building maintenance issue that is often ignored, should be looked at as long-term investment*
  - Insulate- *ALWAYS done after air sealing to enhance the conditioned space*
  - HVAC- *upgrade / redesign- done in this order will maximizes system efficiency*

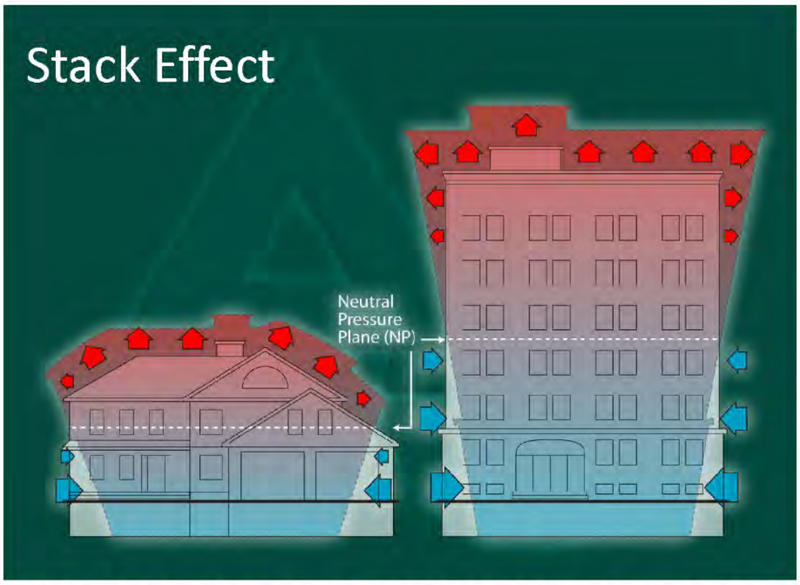
Air Barrier Continuity:

Failure of air barrier systems

- Leads to:
  - Uncontrolled and uncontrollable air leakage..
  - Infiltration / Exfiltration
- Caused by:
  - Stack effect
  - Wind effect
  - Mechanical effect

The Building Science of Air Barrier Continuity

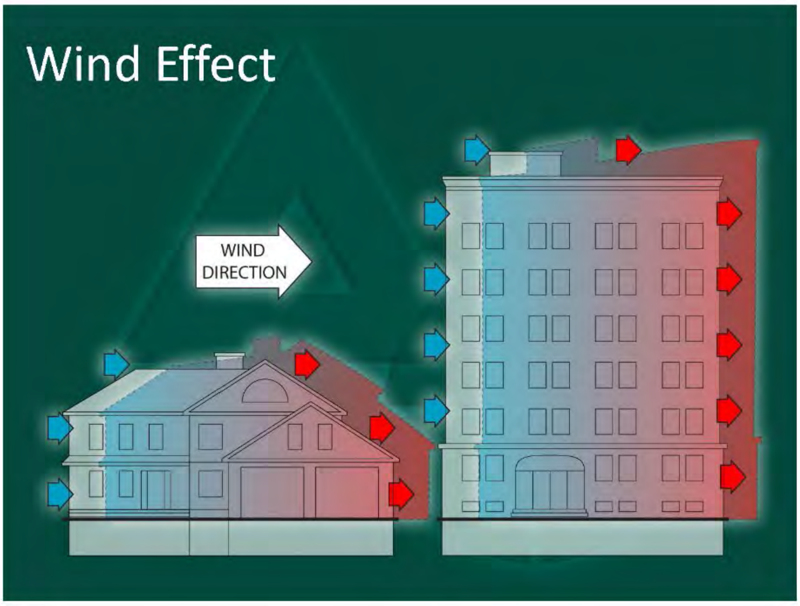
Failure of air barrier systems



Stack effect is a temperature-driven phenomenon, which is especially noticeable in cold weather, when warmer indoor air, which is more buoyant than the colder outdoor air, tends to rise in the building.

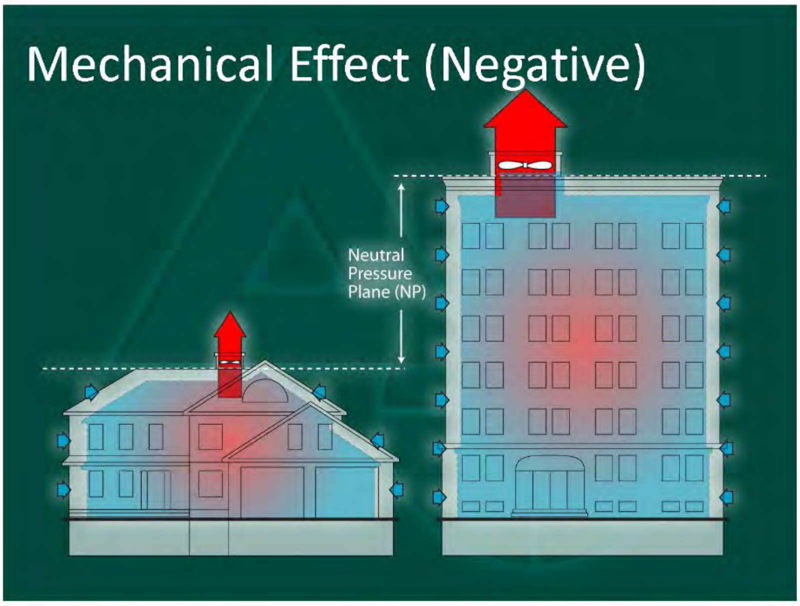
The Building Science of Air Barrier Continuity

Failure of air barrier systems



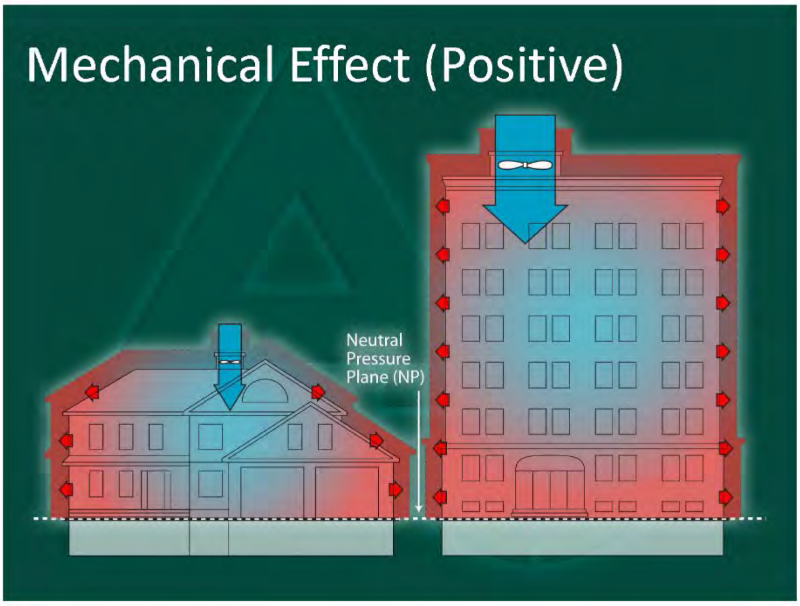
The Building Science of Air Barrier Continuity

Failure of air barrier systems



The Building Science of Air Barrier Continuity

Failure of air barrier systems



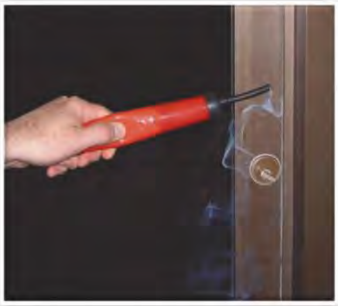
How Do We Implement??

There is a process for Assessment

Air Barrier Continuity

Diagnosing the problems

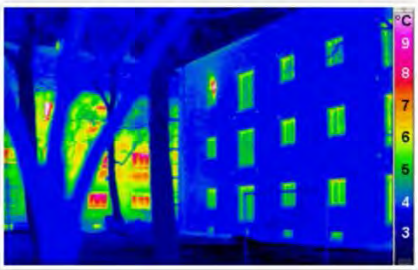
- Building envelope assessment
- Depressurization testing
- **Locating air leakage paths**

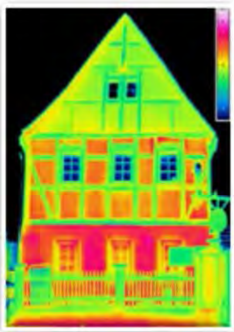


Air Barrier Continuity

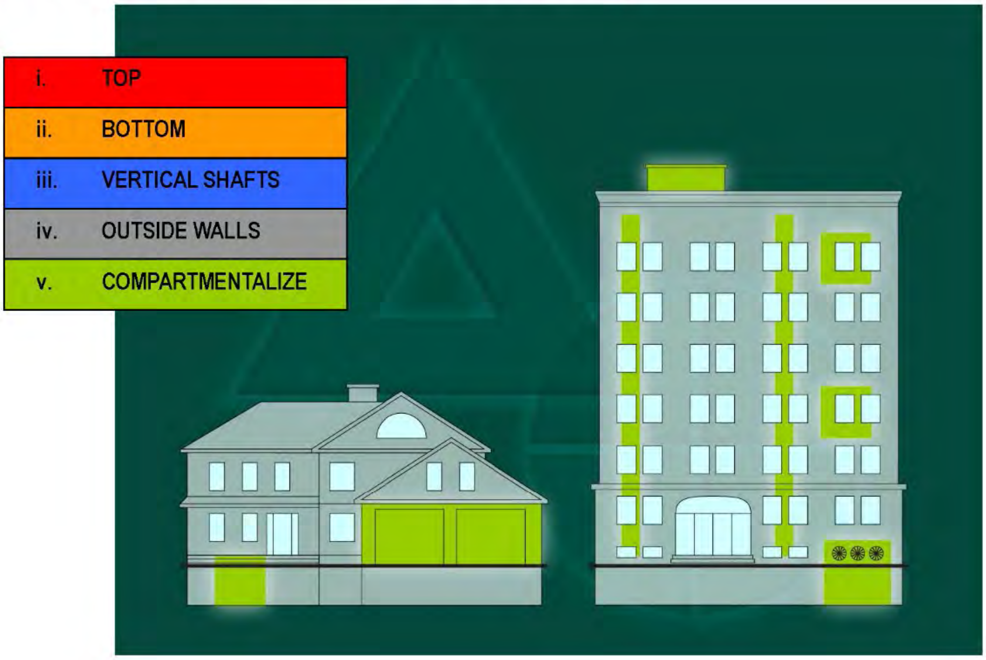
Diagnosing the problems

- Building envelope assessment
- Depressurization testing
- Locating air leakage paths
- **Infrared thermography**

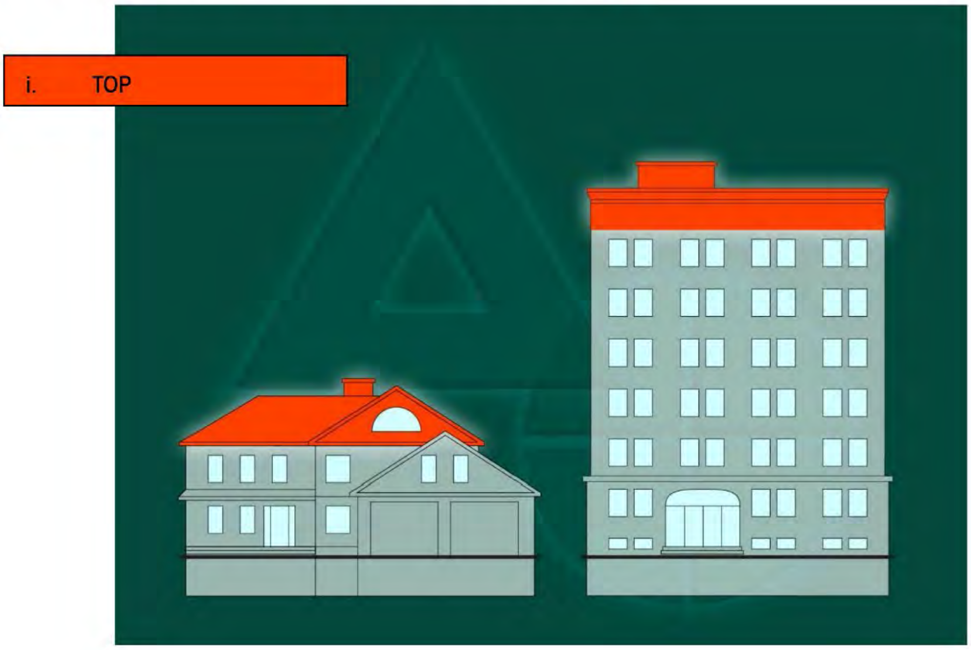




Air Barrier Continuity



Air Barrier Continuity



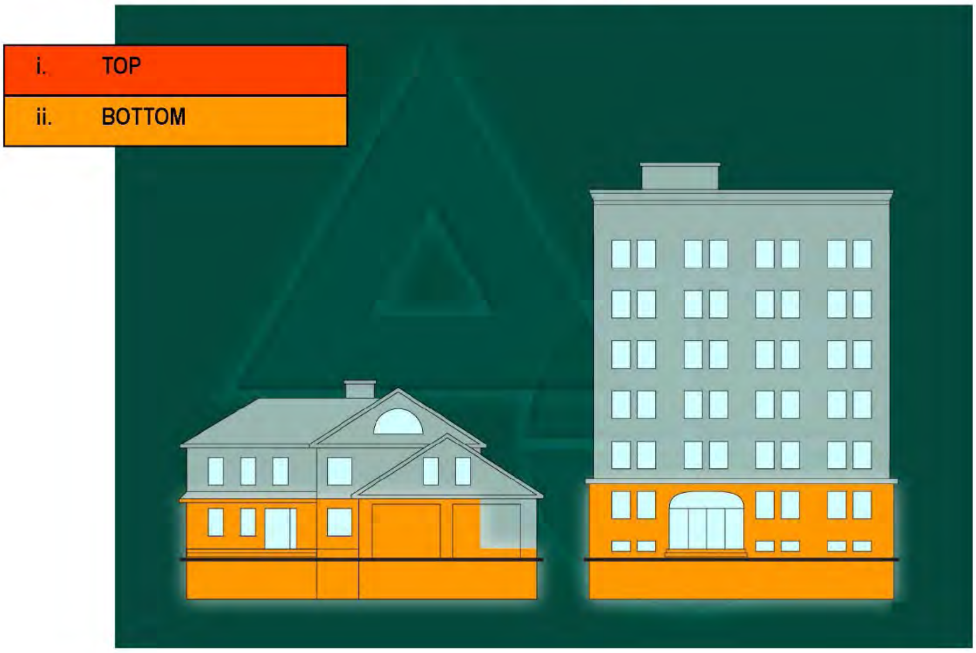
Air Barrier Continuity

Seal top of building

- Attics
- Roof/wall intersections and plenum spaces
- Mechanical penthouse doors and walls
- HVAC equipment
- Other roof penetrations

Air Barrier Continuity

Air Barrier Continuity



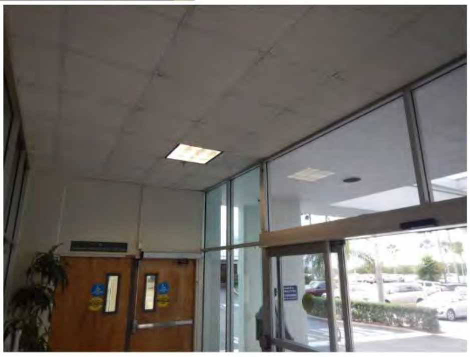
Air Barrier Continuity

Seal bottom of building

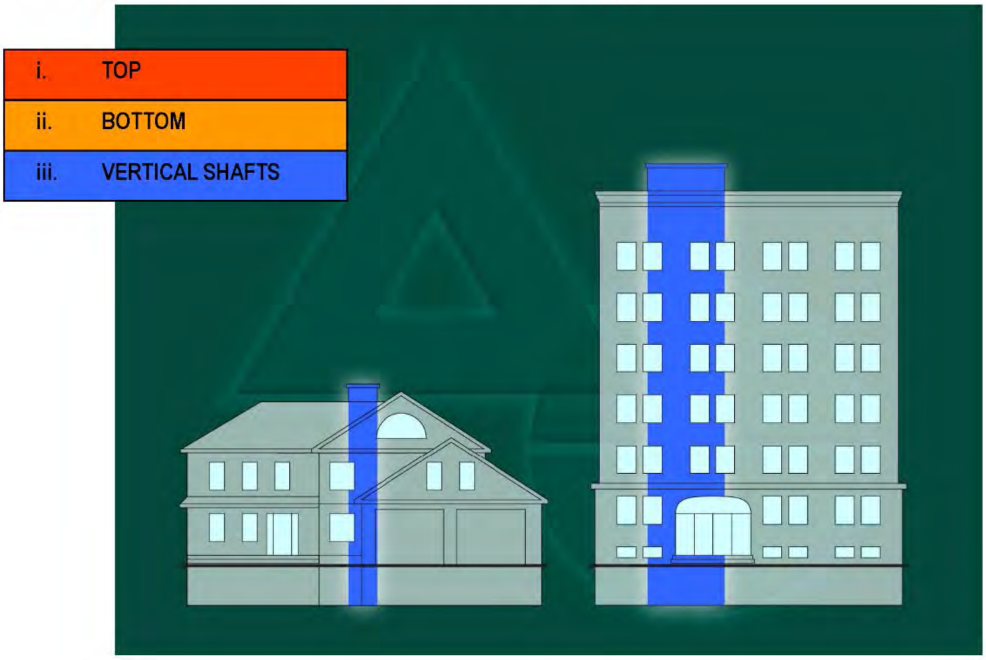
- Defined as: "the ground floor and anything below grade
- Typically a unique area of the building
- Soffits and ground floor access doors
- Underground parking access doors
- Exhaust and air intake vents
- Pipe, duct, cable and other service penetrations into core of building
- Sprinkler hangar penetrations, inspection hatches and other holes
- Seal core wall to floor slab
- Residential crawl spaces

Air Barrier Continuity

Seal the bottom of the building



Air Barrier Continuity



Air Barrier Continuity

Seal vertical shafts

- Stairwell fire doors
- Fire hose cabinets
- Plumbing, electrical, cable and other penetrations within service rooms
- Elevator rooms- cable holes, door controller cable holes, bus bar openings

Air Barrier Continuity

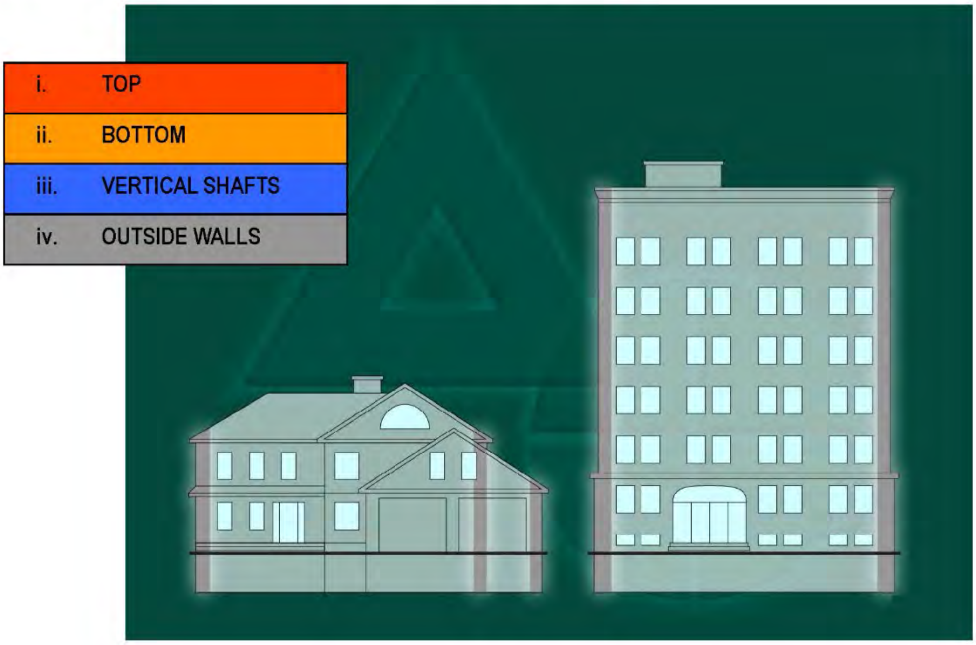
Seal vertical shafts

- Garbage chute perimeter and access hatches
- Hallway pressurization grille perimeters
- Smoke shaft access doors
- Elevator shaft smoke control grilles
- Service shafts

Air Barrier Continuity

Seal vertical shafts

Air Barrier Continuity



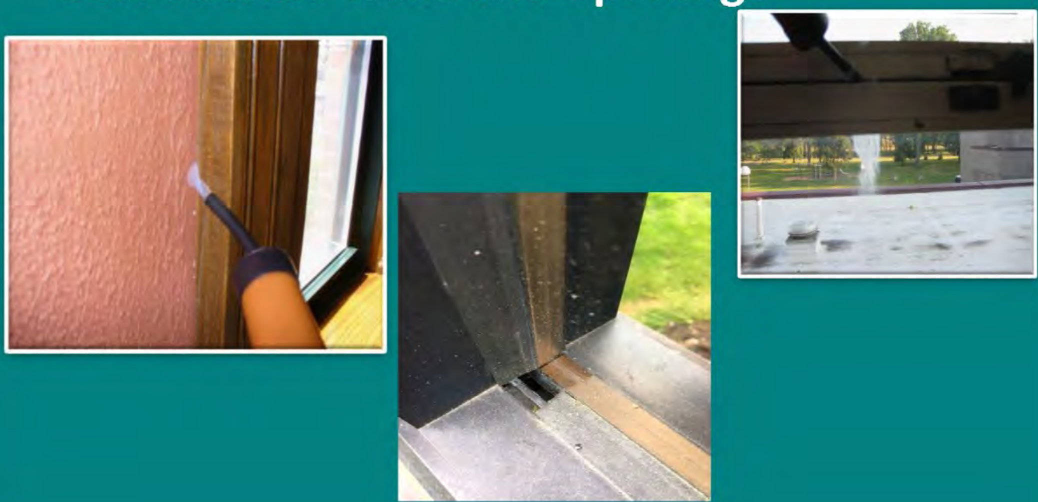
Air Barrier Continuity

Seal outside walls and openings

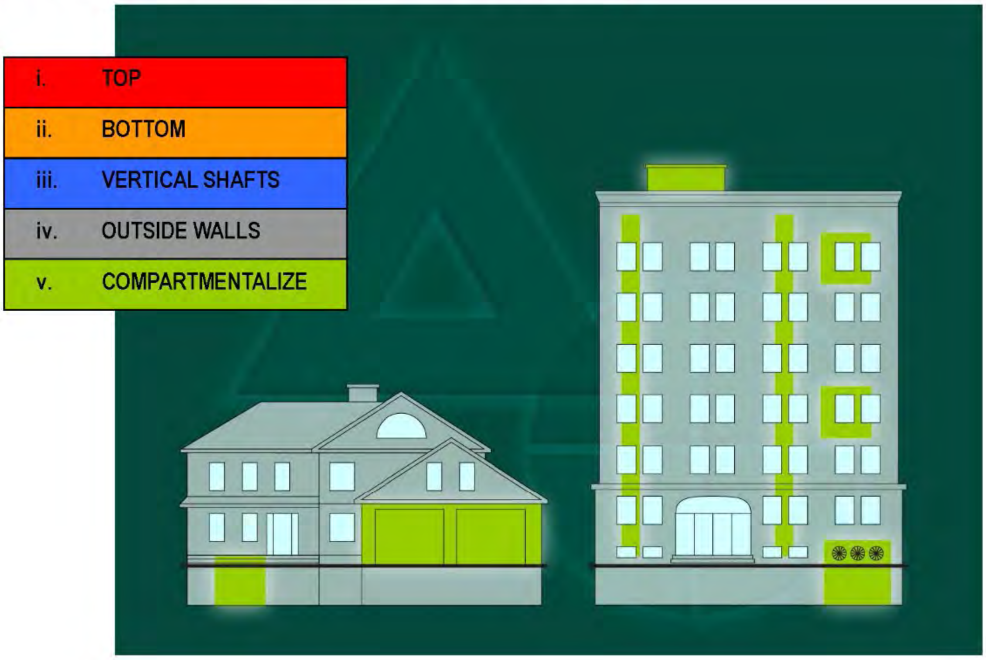
- Weather-strip windows, doors, including balcony/patio doors and seal window trim
- Exhaust fans and ducting
- All service penetrations
- Baseboard heaters
- Electrical receptacles
- Baseboards

Air Barrier Continuity

Seal outside walls and openings



Air Barrier Continuity



Air Barrier Continuity

Compartmentalize

- Garages
- Vented mechanical rooms
- Garbage compactor room
- Emergency generator room
- High voltage rooms
- Shipping docks
- Elevator rooms
- Workshops

Air Barrier Continuity

Compartmentalize

Air Barrier Continuity

Fixing and preventing air leakage paths

- Conduct building assessment
- Determine location and severity of air leakage pathways
- Identify internal pathways
- Develop scope of work to create air barrier continuity

Air Barrier Continuity Financial Impact

Canam Markets Served

- Education
- Healthcare
- Commercial
- Industrial
- Multi-unit Residential
- Private & Public Sectors
- Rec Centers/Arenas
- Federal/Military

Canam Metrics: 2022 Projected Savings:
➢ Canam's Air Barrier Upgrades result in average annual energy savings (heating/cooling) of $0.087/SF/year

i.e.: 1,000,000 SF x $0.09 = $90,000/year in energy savings

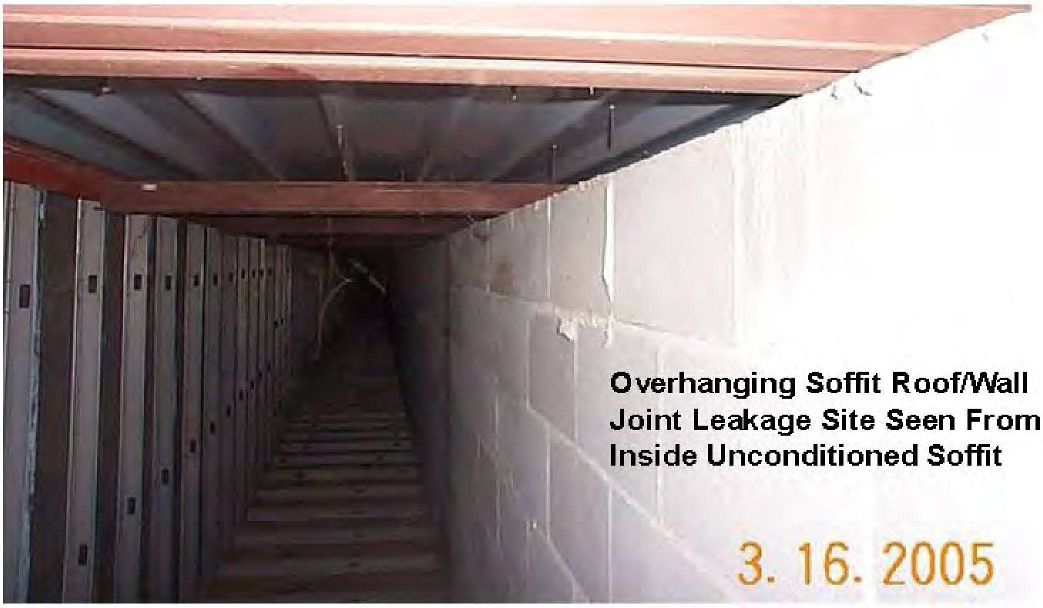
$90,000 x 5 years = $450,000 available capital to help fund building maintenance projects such as roofing.

Air Barrier Continuity

Improving health, safety, durability, comfort and energy efficiency in healthcare, commercial, institutional and multi-family buildings is as easy as ABC

Case Study

Case Study



canam BUILDING ENVELOPE SPECIALISTS

Case Study

canam BUILDING ENVELOPE SPECIALISTS

Case Study

Other Project Profiles ◆ Healthcare & Higher Ed

BUILDING ENVELOPE SPECIALISTS

PROJECT SPECS:

LOCATION:	Naperville, Illinois
BUILDING SF:	366,000
# OF BUILDINGS:	1 - Main Building Connected to the Education Center
BUILDING AGE:	Built 1920, Many Additions and Renovations

Balancing the Mechanical System With Air Sealing Provides More Even Temperatures Throughout Edward Hospital Buildings

Air sealing measures resolve stack effect pressure issues.

Problem

Edward Hospital had relied on Tremco's assistance to manage their roof assets for many years. When the hospital's facility team mentioned they were interested in saving money by making the building more energy efficient and durable, while also creating a more healthy, safe and comfortable environment, they allowed Tremco's allied companies WTI and CANAM to show them what could be done to achieve their desired results.

Canam inspected the Main Building and the Education Building, which is connected to the Main Building. The original building was built in 1920 with a brick facade, but has had many additions and renovations over the years. In addition to typical issues that affect a building of this age, such as failing weather-seals around doors and windows, Canam discovered extreme pressure differences throughout the building. Stack effect was very prevalent, bringing in outside cold air along with dirt, moisture, pollutants, etc.

Testing window shows air infiltration before caulk.

Solution

Canam inspected both buildings, totaling 366,000 square feet, using the air leakage detector and digital and infrared photos, identifying temperature differences through air leakage. Most of the issues identified were a result of common air leakage areas such as windows, doors and roof exhausts. Canam concluded that the gaps, cracks and holes throughout the buildings were the main cause of the strong stack effect.

Air sealing measures that Canam recommended to Edward Hospital, to rectify the air leakage issues, were typical, and included replacing worn and missing weather-stripping to doors and windows and sealing roof exhausts and leaky roof/wall intersections.

Window complete shows no air movement.

Results

Air sealing and insulation measures conducted on Edward Hospital have reduced the air leakage issues, but more importantly have helped to eliminate the extreme pressure differences that stack effect caused. Canam projected annual savings for the Main Building to be approximately $13,351, with a payback of 3.2 years, and the Education Center to expect approximate annual savings of $8,237, with a payback of 4.8 years. The majority of these repairs have a duration life of 15-20 years. The simple payback actually provides an accumulated investment value for an additional 10-15 years, or a total savings from utility costs of $123,000-$224,297, over this period.

In addition, less than six months later, the Edward Hospital facility team asked Canam to return and assess four more buildings on its campus.

Sealing perimeter of ducting at RTE.

Roofing & Building Maintenance Division

For more information on how Canam can help reduce your energy consumption and improve indoor air quality and comfort, contact us at 888-250-1570 or info@canambuildingenvelope.com.

3735 Green Road // Beachwood, Ohio 44122
50 Beth Nealson Drive // Toronto, Ontario M4H 1M6
T 800-562-2728 // T 800-668-9879
CANAMBUILDINGENVELOPE.COM

Thank You!

Steve Tratt

stratt@canambuildingenvelope.com

519-217-6336

Day 2 “Does Your Building – Smoke Test (Video Content)

Day 2 “Building Technical Measures to Ensure Sustainable Thermal Supply” (Oddgeir Gudmundsson)

Energy savings potentials of optimizing the building technical installations

- Vast majority of the existing buildings stock does not operate efficiently
- Just by getting the basics right can achieve >20% savings
- Going for a high performance can lead to 33%-41% savings

ECOFYS

Get The Basics Right Scenario
Energy savings using TRV, automatic hydronic balancing

High-Performance Scenario
Energy savings. As Get The Basics + More advanced building automation and control measures

Source: Ecofys, 2017: 'Optimising the energy use of technical building systems – unleashing the power of the EPBD's Article 8'

Energy savings potentials of optimizing the building technical installations

- Danfoss manufactures control equipment necessary for achieving the basic scenario
- Danfoss offers advanced automation and control measures to reach a high-performance scenario

ECOFYS

Get The Basics Right Scenario
Energy savings using TRV, automatic hydronic balancing

High-Performance Scenario
Energy savings. As Get The Basics + More advanced building automation and control measures

Source: Ecofys, 2017: 'Optimising the energy use of technical building systems – unleashing the power of the EPBD's Article 8'

Single Family House

Multi-Family Houses

Non Residential Buildings

Improving the technical building installation is cost-effective

- **2017 payback periods:**
  - Get the basics right:
    - Single-family 3.5 years
    - Multi-family and offices <1.5 years
  - High performance:
    - Single family 6 years
    - Multi-family and offices <4.5 years

- <u>The payback periods has only become shorter</u>

Table 9. Overview about optimisation packages

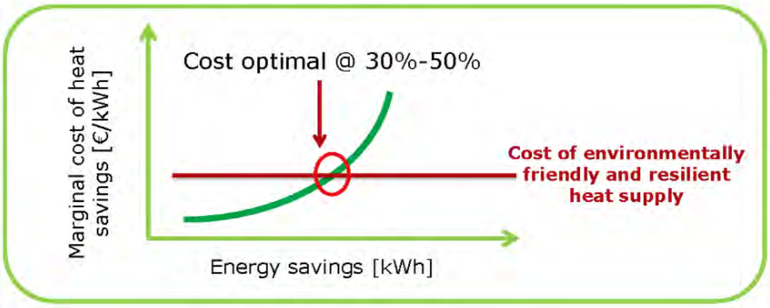
Reference building	Packages	Final energy savings [%]	Energy cost savings[45] [Euro]	Investment [Euro]	Payback period [years]
Single-family house	Get the basics right	21%	390	1,400	3.5
	High performance	33%	630	3,700	6.0
Multi-family house (Gas)	Get the basics right	28%	10,330	14,110	1.5
	High performance	40%	14,660	63,840	4.5
Multi-family house (District heating)	Get the basics right	29%	16,520	14,110	1.0
	High performance	40%	23,320	63,840	2.5
Multi-family house (Heat pump)	Get the basics right	34%	19,140	14,110	0.5
	High performance	46%	25,780	69,280	2.5
Office (Radiators)	Get the basics right	20%	7,970	7,150	1.0
	High performance	41%	18,560	78,350	4.0
Office (Air heating)	Get the basics right	18%	8,600	5,170	0.5
	High performance	44%	21,220	64,800	3.0

Remarks: The analysis is from 2017
Energy costs:
Gas: 5.9 ct/kWh; District heat: 9.6 ct/kWh; Electricity: 21.9 ct/kWh

Energy costs in 2022

Energy efficiency is required on both the demand and supply side

- To reach the goal of cost-effective, environmentally friendly and resilient heat supply it is necessary to look on the thermal supply systems as well



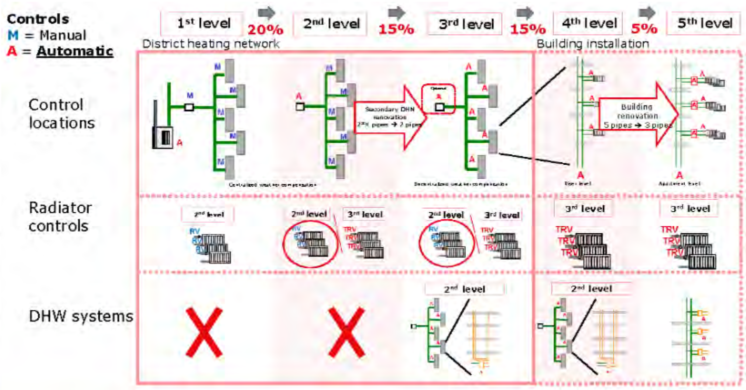
District energy

- District energy systems provide high level of flexibility to the heat generation

Importance of automatic controls in district energy systems

- Energy efficiency of district energy system is **directly** related to the penetration of automatic control equipment

- **Benefits of automatic controls:**
  - Matching of supply and demand
  - High system temperature difference
  - Ability to accommodate multiple heat sources distributed around the system
  - Enables software-based optimization



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Danfoss Leanheat®
- Software Suite & Services enables an end-to-end optimization of district heating systems
Leanheat® Production (LHP)
Leanheat® Network (LHN)
Leanheat® Monitor (LHM)
Leanheat® Building (LHB)
PRODUCTION & DISTRIBUTION
PRIMARY SIDE
DEMAND
SECONDARY SIDE
9 | District Energy & Buildings (DBL)
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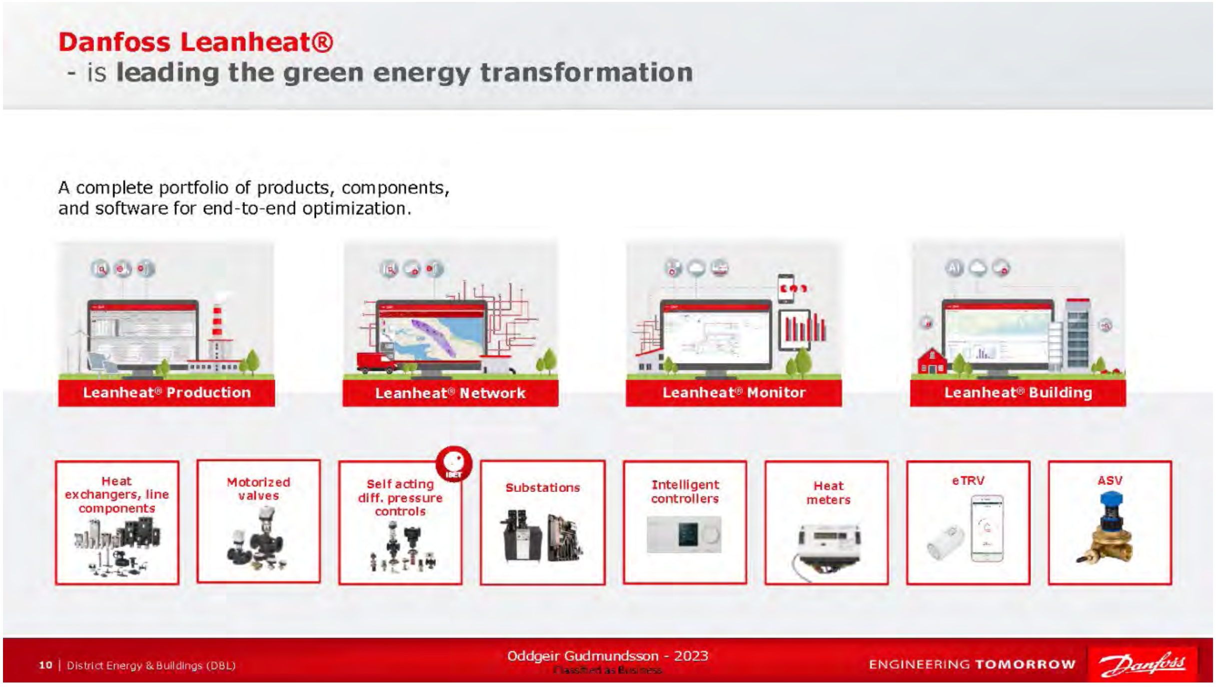
Danfoss Leanheat®
- is leading the green energy transformation
A complete portfolio of products, components, and software for end-to-end optimization.
Leanheat® Production
Leanheat® Network
Leanheat® Monitor
Leanheat® Building
Heat exchangers, line components
Motorized valves
Self acting diff. pressure controls
Substations
Intelligent controllers
Heat meters
eTRV
ASV
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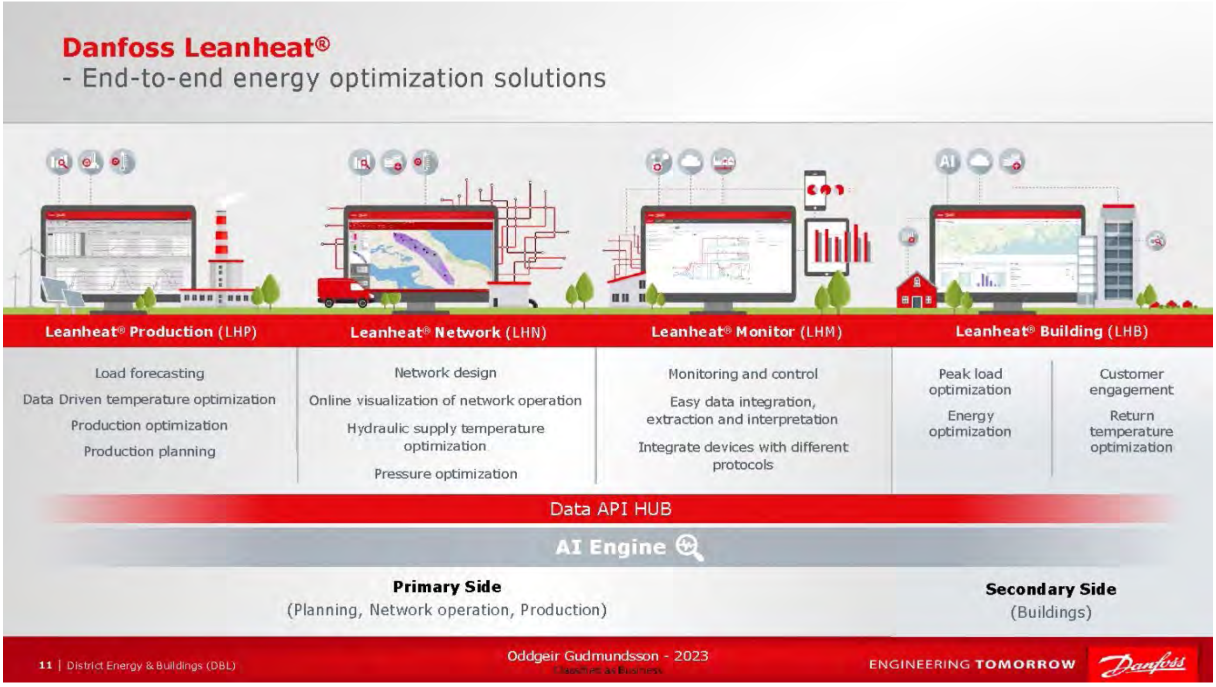
Danfoss Leanheat®
- End-to-end energy optimization solutions
Leanheat® Production (LHP)
Load forecasting
Data Driven temperature optimization
Production optimization
Production planning
Leanheat® Network (LHN)
Network design
Online visualization of network operation
Hydraulic supply temperature optimization
Pressure optimization
Leanheat® Monitor (LHM)
Monitoring and control
Easy data integration, extraction and interpretation
Integrate devices with different protocols
Leanheat® Building (LHB)
Peak load optimization
Energy optimization
Customer engagement
Return temperature optimization
Data API HUB
AI Engine
Primary Side
(Planning, Network operation, Production)
Secondary Side
(Buildings)
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Thank you for your attention
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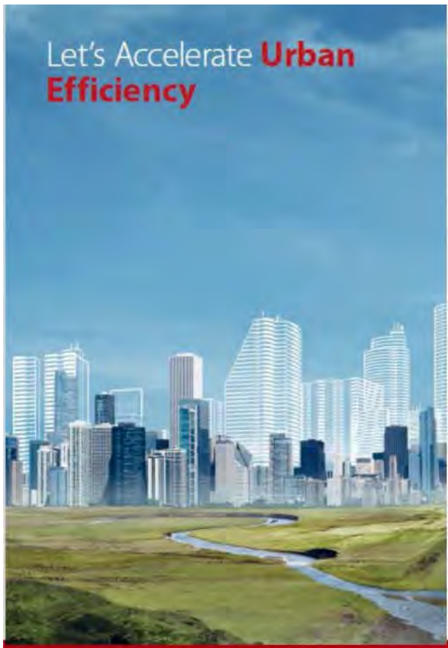

Setting the scene

- **Putting energy efficiency first** - 38% of emissions reductions needed by 2050 could come from EE
- Energy efficiency is the most **cost-effective way** to decarbonize our economy, while helping to decouple GDP growth from energy use
- Energy-efficient technologies that are **ready for implementation** exist and it is a good business case
- Cities are key to unlock energy efficiency
- **Urban efficiency:** Buildings, energy systems, industry, water, food infrastructure

15 | District Energy & Buildings (DBL)

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Political targets

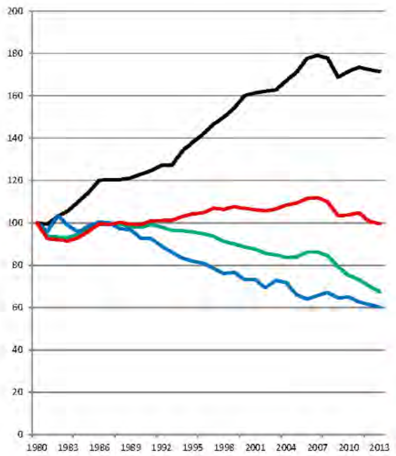
Political Targets in Europe by 2030

- 40% reduction of CO2
- 27% share of renewables in energy mix
- 27% increased Energy Efficiency

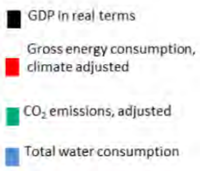
Political targets in Denmark

- All Buildings fossil free by 2035
- Transport fossil free by 2050
- Building Energy consumption frame: 20-25kWh/m2

Decoupling of Growth and Energy Consumption



- Since 1980, the Danish economy has grown by almost 80 per cent without increasing gross energy consumption.
- And total water consumption has been reduced by 40%.



Source: State of Green 2014

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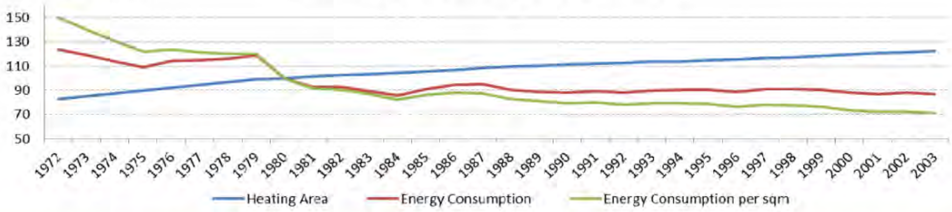
Denmark is a pioneer in district heating

- From 1972-2002 Denmark doubled its heating energy efficiency
- District energy as backbone for
  1. Decoupling of growth and energy consumption
  2. Green transition through integration of renewables
- Today, district heating supplies around 63% of all households in DK

Index: 1980=100

Efficiency of buildings in Denmark



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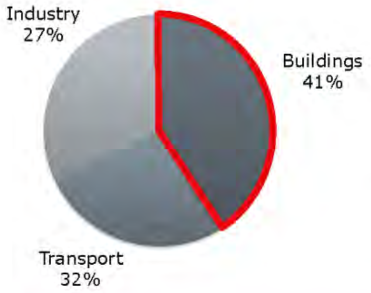
Large potential for energy savings

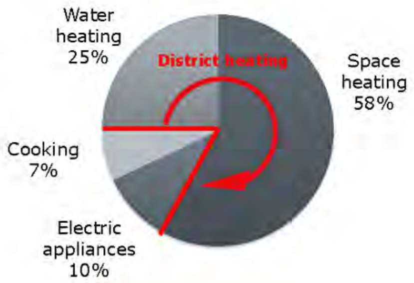
Buildings account for one-third of total final energy consumption in the world ...

EU example:

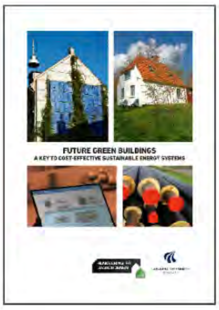


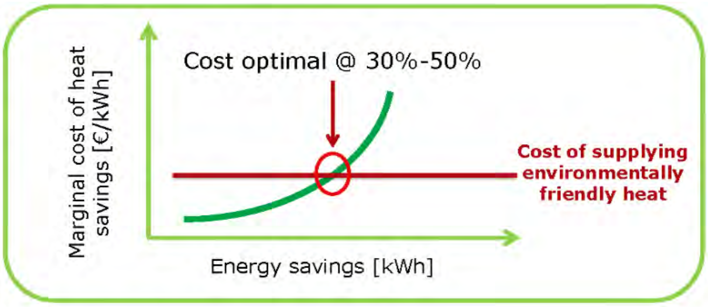
Globally, space heating, cooling and DHW account for approximately two-third of all energy consumed in buildings...

EU building example:



Energy efficiency is required on both the demand and supply side





Energy-efficient solutions with short payback time

- Well-proven solutions already exist. Why wait?

Energy renovation	Estimated savings	Repayment period	Estimated investments (EUR)
Replacing manual valves w thermostats	20 – 25%	2 – 3 years	70 EUR per radiator*
Balancing valves	5 – 15%	2 – 3 years	30 EUR per radiator**
Replacing the oil or gas boilers with heat pump (air-water heat pump)	50 – 75%	10 – 15 years	13 – 17.000 EUR*
Replacing an older oil boiler with modern condensing boiler	20 - 30%	5 - 7 years	7.000 EUR ***
New low energy windows	20 – 25%	20 – 25 years	20.000 EUR****
Insulation of exterior walls and roof	10 – 12%	15 – 25 years	20 – 27.000 EUR****

* Calculations are based on an average Danish household of approx. 130 m^2 equivalent to the average of the approx. 1.6 million households that the Danish District Heating companies supplies

** Based on buildings with several apartments – investment will vary with the number of apartments

*** Based on data from the Danish Oil Industry Association (EOF)

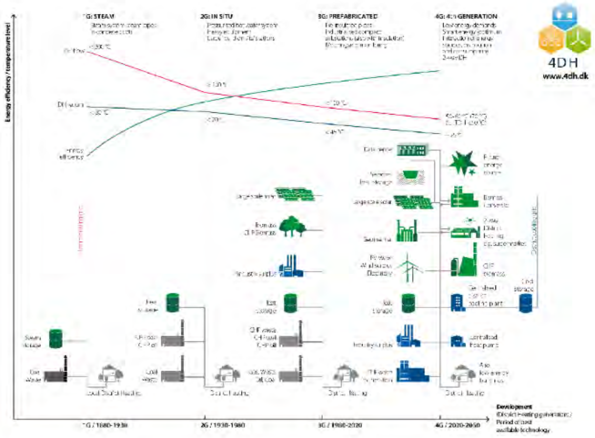
**** Figures from the Danish portal Bolius – knowledge center for homeowners

District energy

- Urban leaders are embracing a new vision for supplying energy to their cities, one that combines local renewables, cogeneration plants and district energy in one low-carbon network

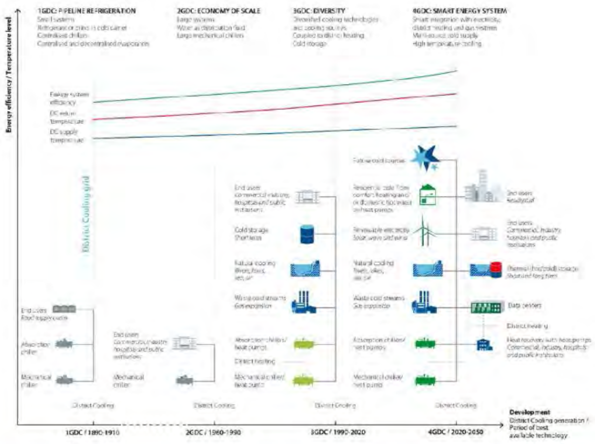
Generations of district heating

- **Generations conceptual ideas**
  - Collective / centralized systems
  - Best available technology of the period
  - Increased efficiency
  - Integration of the energy sectors
  - Smart energy system
  - Renewable energy
  - Historical trends to predict the future
- **Decarbonization of the heat supply**

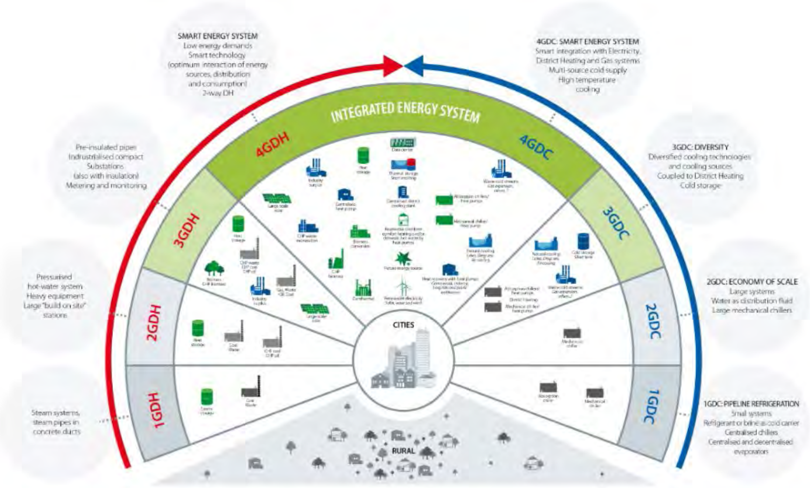


Generations of district cooling

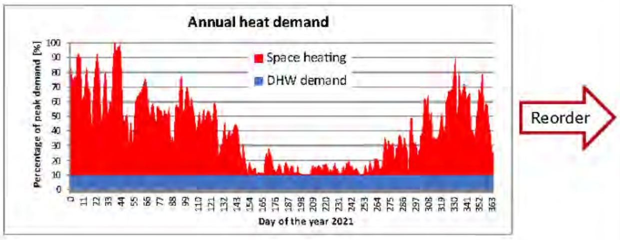
- **Generations conceptual ideas**
  - Collective / centralized systems
  - Best available technology of the period
  - Increased efficiency
  - Integration of the energy sectors
  - Smart energy system
  - Renewable energy
  - Historical trends to predict the future
- **Decarbonization of the cold supply**

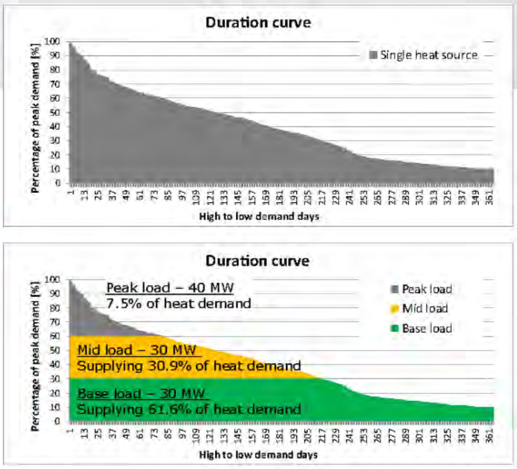


The future of district energy is the merger of district heating and cooling



District Energy
- Heat generation optimization





Important messages:

- Individual solutions need to cover the whole demand using the same energy vector
- A multi-source district heating system enables diversification
  - More than >60% of the yearly demand can be covered with 30% of the peak power!
  - In district energy systems it is very easy to cover the peaks with alternative sources, such as gas

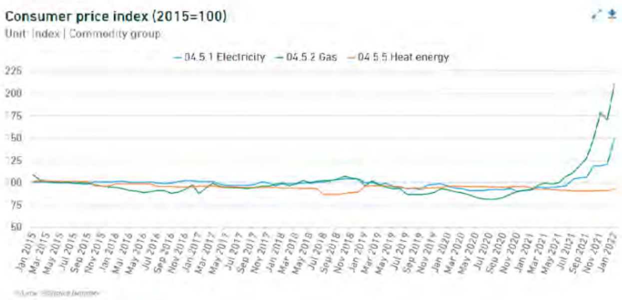
Price stability of heat from district heating

- **District heating is exceptionally cost stable**

- **Key reasons:**
  - Multiple heat plants feeding the DH system
  - Diversified primary fuels / heat sources
    - Literally any thermal source is applicable!
  - Long term energy source contracts

- **Benefits from high electricity prices**
  - High electric prices increase CHP operation which leads to lower heat costs to consumers

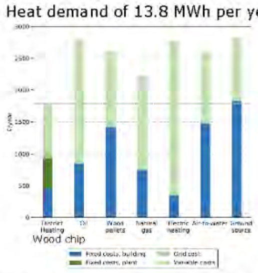
- **Decoupling of heat demand and generation**
  - Minimizes expensive peak generation capacity
  - Minimizes strain on other energy carriers



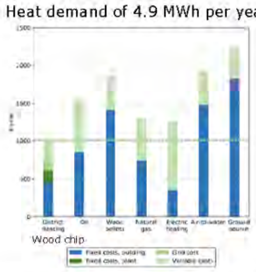
https://www.dst.dk/en
Data table: *Pris111*,
Data series:
04.5.1 – Electricity
04.5.2 – Natural gas
04.5.5 – District heating

District heating and energy efficient buildings

- Traditional single-family building
  - Heat demand of 13.8 MWh per year

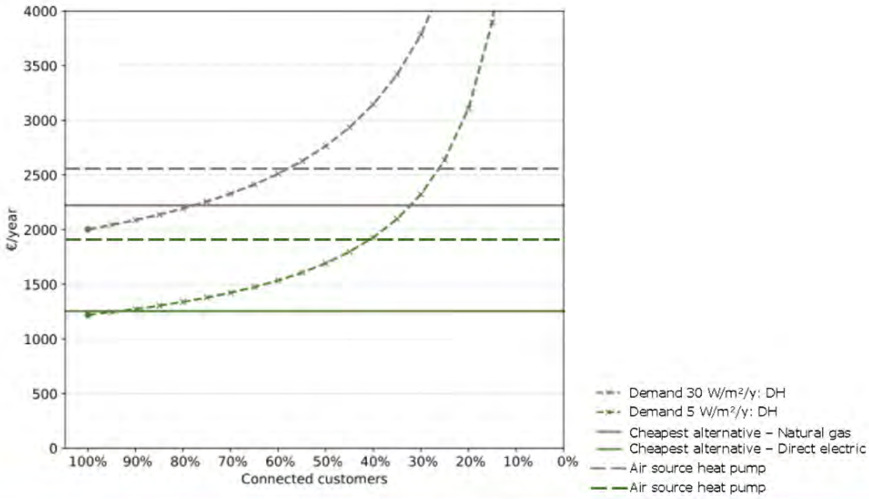


- Low energy single-family building
  - Heat demand of 4.9 MWh per year



- The publication shows that district heating competitiveness is, contrary to popular beliefs, higher with low energy buildings compared to individual heating solutions
- Major share of the cost of heat from district heating is originating from initial investments, which has exceptional long lifetime
  - This leas to variations in the cost of primary energy supply is effectively damped
- Changing primary fuel is simple
  - Only needs a new central heat plant, distribution grid and building installations are unaffected
- In **rural** areas heat pumps are the most efficient renewable based heat generation solution

Heat planning is a key
- Impact of percentage of connected costumers



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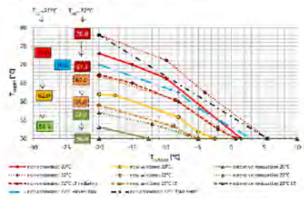
District heating should be installed alongside building renovation
- No need to wait for a renovated building stock

- For district heating systems supplying the existing building stock a supply temperature of 80°C is sufficient. Such systems generally have a return temperature of 40°C
- For energy renovated building stock, a supply temperature of 60°C will be sufficient, and a return temperature of 30°C is to be expected



- As the building stock is renovated, in the north of 30%, both the heat demand and the supply temperature requirement are reduced
  - This allows the district heating system to effectively follow the energy renovation process by simultaneously lower the supply temperature and increase its heat generation efficiency
    - The distribution system continuous to be optimally dimensioned!
- In case of cold spells district heating is a uniquely positioned heat supply system to temporarily increase the supply capacity, by e.g. increasing the supply temperature or operating with higher flow velocities
  - A resilient, robust and reliable heat supply system

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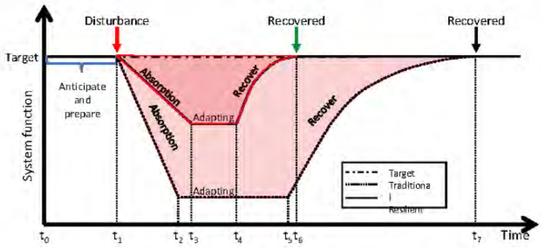
District heating is a resilient infrastructure



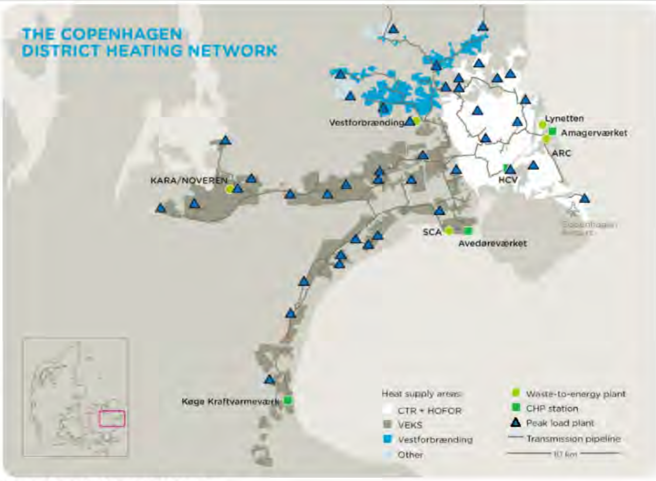
- The resilience of DH comes from:
  - Buried robust infrastructure
  - Multi heat/fuel source capabilities
  - Local nature of the system
  - Low technology level
  - "Slow" failures and fast repairs

Resilient infrastructure example
- Case: Sønderborg, Southern Denmark

- Population: ~38.000 persons
- Households: ~10.000
- District heating coverage: ~99%

Resilient infrastructure example
- Case: Copenhagen, Denmark

- Supplies heat to 1 million residents
- One large heat supply system supplying 21 communities
- Heat sources:
  - 3 biomass CHP plants
  - 3 waste incineration CHP plants
  - Several heat pumps & electric boilers
  - Waste heat recovery from industry
  - >50 peak load boilers

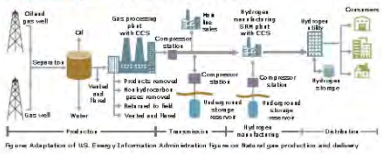


Copenhagen District Heating.
Source: Ramboll A/S

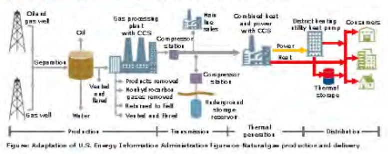
District heating or hydrogen for building heating demands?

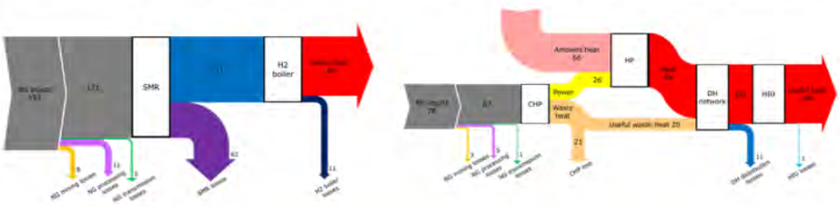
- The article analyzes the energy efficiencies of district heating and hydrogen-based heat supply

Blue hydrogen – From source to sink



Blue district heating – From source to sink





District heating or hydrogen for building heating demands?

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Green hydrogen – From source to sink

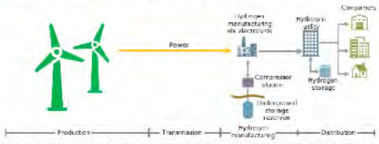


Figure: Adaptation of U.S. Energy Information Administration figure on Natural gas production and delivery

Green district heating – From source to sink

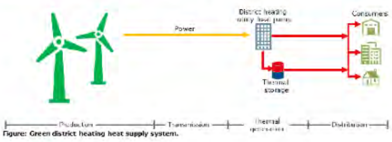
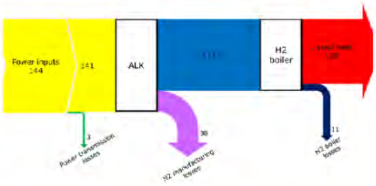
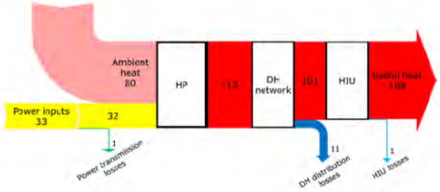


Figure: Green district heating heat supply system.





District heating or hydrogen for building heating demands?

Primary fuel efficiency

- **Blue hydrogen** → 50% efficient
- **Blue district heating** → **130% efficient**
- **Natural gas boiler** → 75% efficient

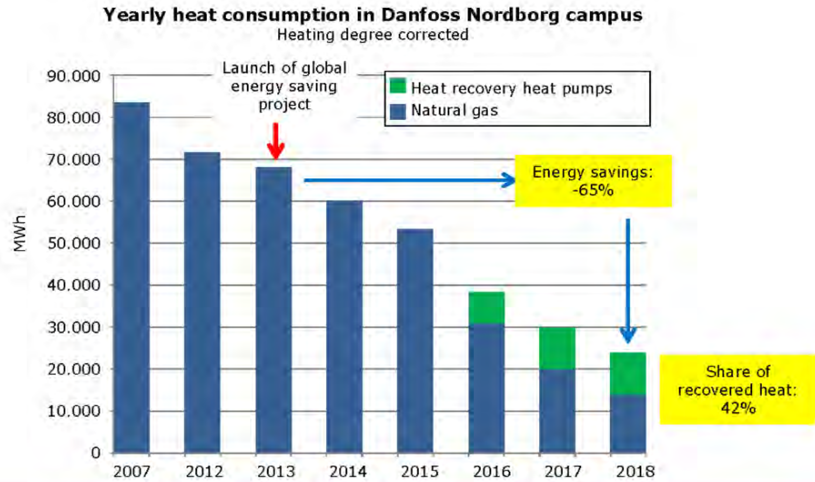
GWP of natural gas scenarios	CH4 emissions per 100 useful energy units	CO2 emissions per 100 useful energy units	GWP potential of greenhouse gas emissions								
			Year 0			Years 0 to 20 average			Years 0 to 100 average		
			CH4	CO2	Combined	CH4	CO2	Combined	CH4	CO2	Combined
Average GWP potentials at given years from utilization:			120	1	-	86	1	-	34	1	-
Blue hydrogen	4,2	22,6	503	23	526	361	23	383	143	23	165
Blue district heating	1,6	8,9	198	9	207	142	9	151	56	9	65
NG boiler (reference)	3,1	104,3	372	104	477	267	104	371	106	104	210

- **Green hydrogen** → 70% efficient
- **Green district heating** → **300% efficient**

- The **only** role hydrogen has towards building heating demands is to be a waste heat source for district heating systems
  - Either in relation to hydrogen manufacturing or potential hydrogen-to-power in a CHP plant

Danfoss Campus Energy Renovation Project

Danfoss Campus Energy Renovation Project



Examples of the technical solutions - providing large energy savings

Large Industrial ventilation systems with heat-recovery by connecting exhaust from production processes into the main ventilation system.

The energy savings varies from area to area – but range between -30% to -75%.

This application uses;
Danfoss drives, motorized valves, actuators and pressure transmitter.

Examples of the technical solutions - providing large energy savings

Four 500 kW Industrial heat pumps recovering the excess heat in process cooling water. Before the excess heat was removed by the use of cooling towers.

Producing ~10.000MWh
Could produce ~15.000MWh

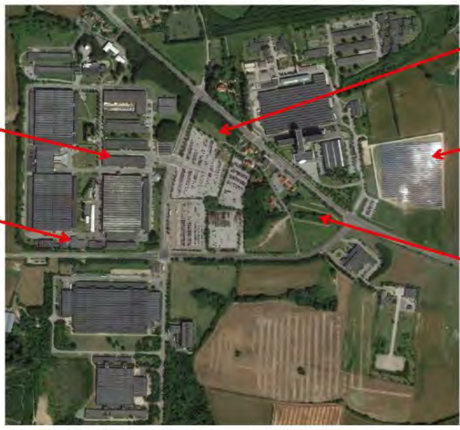
Cooling water circulated ~250-350 m3 per hour at 26-30 degree – and cooled down to ~21 degree.

This application uses;
Danfoss drives, motorized valves, actuators, pressure transmitter and level sensors.

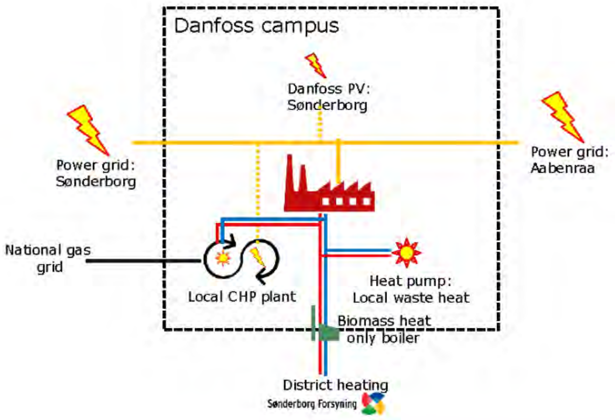
Business case:

Estimated yearly heat recovery	9.900	MWh		
Investment	14,0	mDKK		
Energy subsidy	4,7	mDKK		
Net investment	9,3	mDKK		
Annual savings				
Saved heat consumption	9.900	MWh	5,81	mDKK
Power consumption of HP	2.475	MWh	1,39	mDKK
Waste heat tax			0,90	mDKK
Annual savings			3,52	mDKK
Simple payback	2,6	Years		

Danfoss Campus Energy Renovation Project



The campus has high energy security and very high level of thermal resilience



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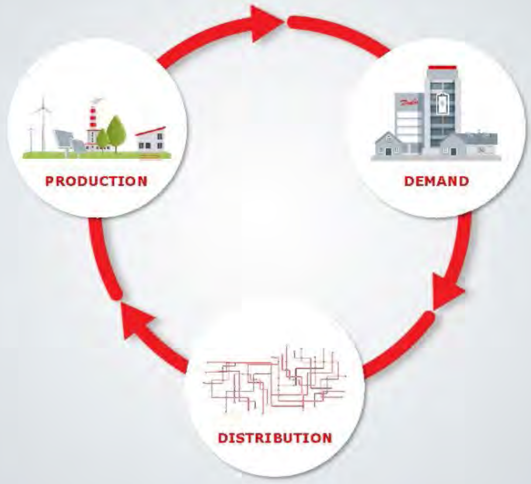
Increase operational efficiency and reduce cost with smart, **end-to-end optimization**

Danfoss Leanheat® is an innovative suite of **end-to-end optimization solutions** that harness the power of digitalization to help users in the entire district energy network increase operational efficiencies, decrease costs, and accelerate the green transition.



Danfoss Leanheat® software suite & services End-to-end energy optimization solutions

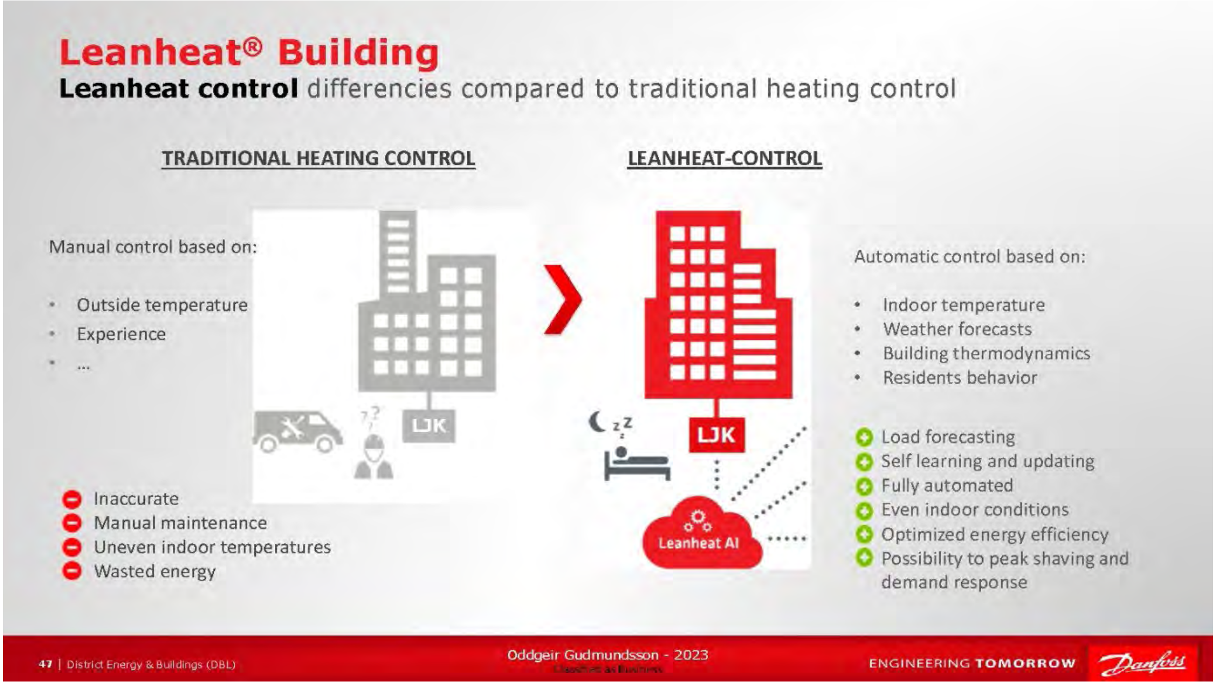
Leanheat® Production (LHP)	Leanheat® Network (LHN)	Leanheat® Monitor (LHM)	Leanheat® Building (LHB)	
Load forecasting Data Driven temperature optimization Production optimization Production planning	Network design Online visualization of network operation Hydraulic supply temperature optimization Pressure optimization	Monitoring and control Easy data integration, extraction and interpretation Integrate devices with different protocols	Peak load optimization Energy optimization	Customer engagement

Data API HUB

AI Engine

Primary Side
(Planning, Network operation, Production)

Secondary Side
(Buildings)



Leanheat® Building
Leanheat control differencies compared to traditional heating control
TRADITIONAL HEATING CONTROL
LEANHEAT-CONTROL
Manual control based on:
Outside temperature
Experience
...
LJK
Inaccurate
Manual maintenance
Uneven indoor temperatures
Wasted energy
LJK
Leanheat AI
Automatic control based on:
Indoor temperature
Weather forecasts
Building thermodynamics
Residents behavior
Load forecasting
Self learning and updating
Fully automated
Even indoor conditions
Optimized energy efficiency
Possibility to peak shaving and demand response
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Leanheat Network
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Leanheat® Network - what it consists of?

OFF-LINE	OPTIMIZATION	
LHN Designer	**LHN Online**	**LHN Optimizers**
Network Design + Hydraulic Analysis	Visualization of the temperature, flow and pressure at any point in the network Real time measurements from SCADA + Load forecast (Weather Forecast)	Temperature Optimization + Pressure Optimization

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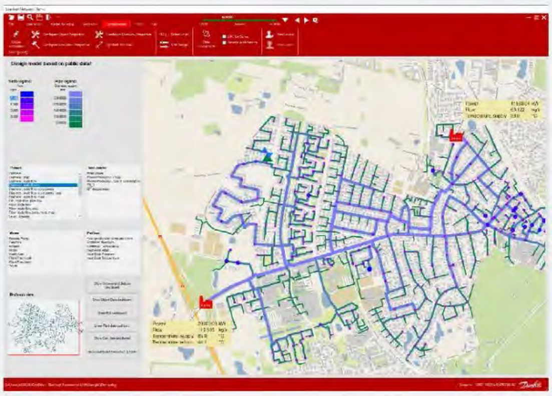
Leanheat® Network Designer

LEANHEAT® NETWORK | HYDRAULIC ANALYSIS | FEATURES | HIGHLIGHTS



Leanheat® Network as a planning/support tool

- Hydraulic and thermal simulations of states (pressure, flow and temperature) in district heating/cooling networks
- Design of new networks. Extension of existing networks
- Development of contingency plans
- Feasibility studies
- Detection of bottlenecks
- Making "What if scenarios"

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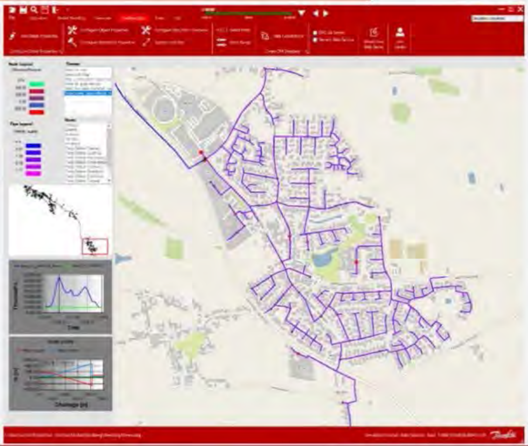
Leanheat® Network Online

ONLINE | FEATURES | HIGHLIGHTS



- Digital twin
- Overview of dynamic state of pipeline network, e.g. pressure, flow and temperature including state of devices.
- Possibility to follow the operational state back in time, now and in the near future
- Possibility to see the consequences of any interaction into the network. E.g. what happens when a valve is being closed, a pump started, or changes are made in the production
- Unlimited access to real and virtual measuring points throughout the whole network
- Operators will understand what happens in network

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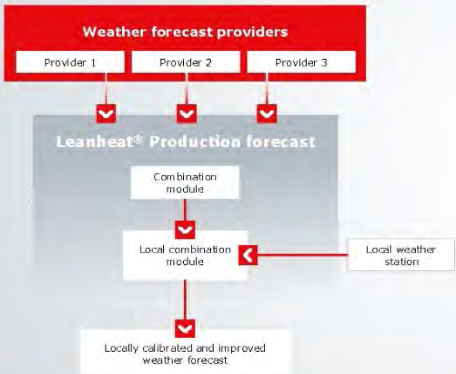
Leanheat® Load Forecaster

WEATHER FORECAST | LOAD FORECAST | HIGHLIGHTS



- Software solution for locally optimized weather forecasts
- Accurate weather forecast improves heat demand forecasting, temperature optimization and production optimization
- By combining and weighting 2-3 weather forecast providers, accuracy is improved & reliability increased
- Measurements from a local weather station used for calibration and improvement of accuracy

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Leanheat® Network Temperature Optimization

TEMPERATURE OPTIMIZATION | HEAT LOSS REDUCTION | HIGHLIGHTS

$$Heat\ loss = Constant\ (T_{media} - T_{soil})$$

where T is the temperature

Heat loss is reduced if average media temperature is reduced!

The basis for temperature optimization is a reduction of supply temperature.

What is Temperature Optimization?

- Optimization of the supply temperature
- Reduction of the network heat loss

What does TO offer?

- Ability to predict the heat demand up to 5 days ahead
- Possibility to optimize the thermo-hydraulic balance of the distribution network
- Minimizing pressure fluctuations hence extending the lifetime of the network
- Considerable savings and reduction of carbon emissions

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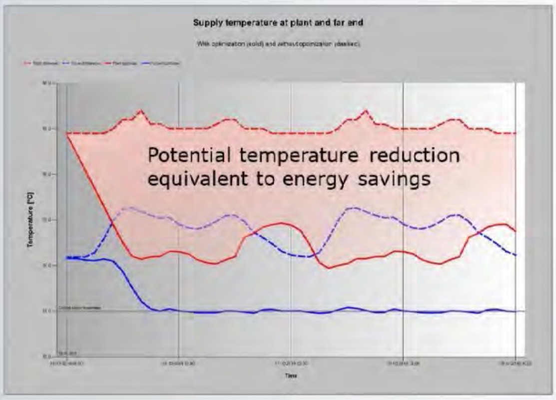
Leanheat® Network Temperature Optimization

TEMPERATURE OPTIMIZATION | HEAT LOSS REDUCTION | **HIGHLIGHTS**



- Reduce the annual supply temperature by app. 6 to 8°C
- Reduce the production cost up to 2%
- Minimize pressure and temperature fluctuations in the network
- Heat loss reduction makes it possible to add new customers without extending the network
- Considerable energy savings. Minimize carbon emission and protect environment
- Reduce maintenance and support of pipeline network

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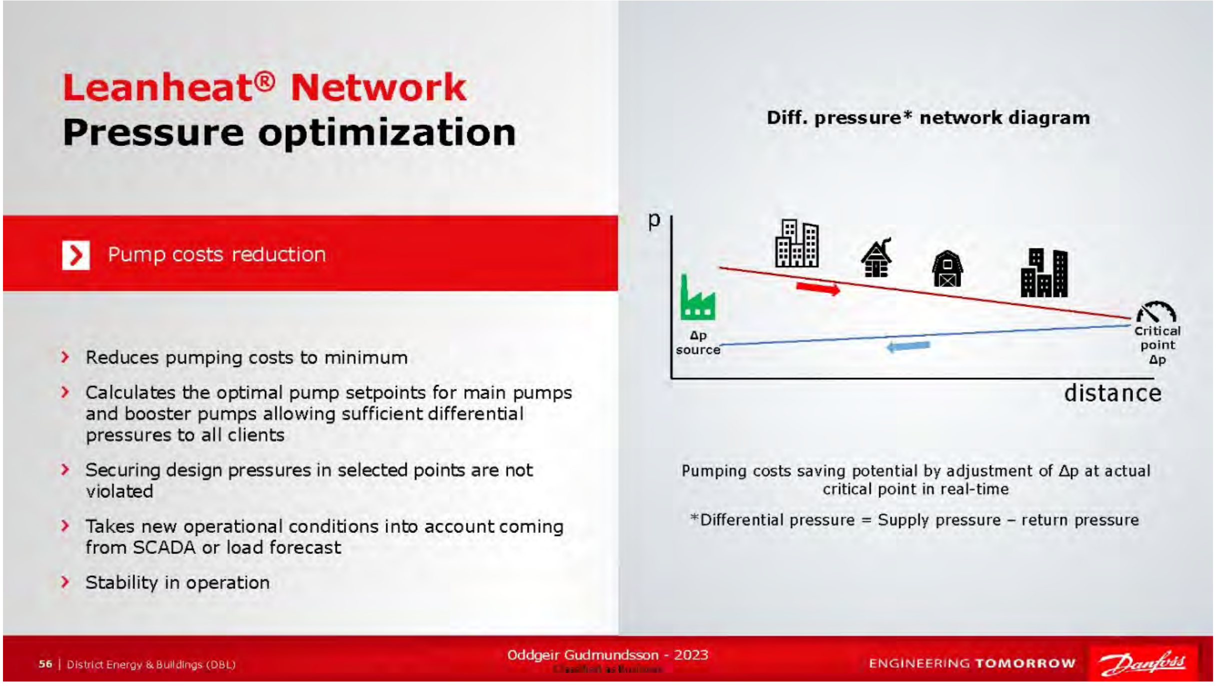

Leanheat® Network
Pressure optimization
Pump costs reduction
Reduces pumping costs to minimum
Calculates the optimal pump setpoints for main pumps and booster pumps allowing sufficient differential pressures to all clients
Securing design pressures in selected points are not violated
Takes new operational conditions into account coming from SCADA or load forecast
Stability in operation
Diff. pressure* network diagram
p
Δp source
Critical point Δp
distance
Pumping costs saving potential by adjustment of Δp at actual critical point in real-time
*Differential pressure = Supply pressure – return pressure
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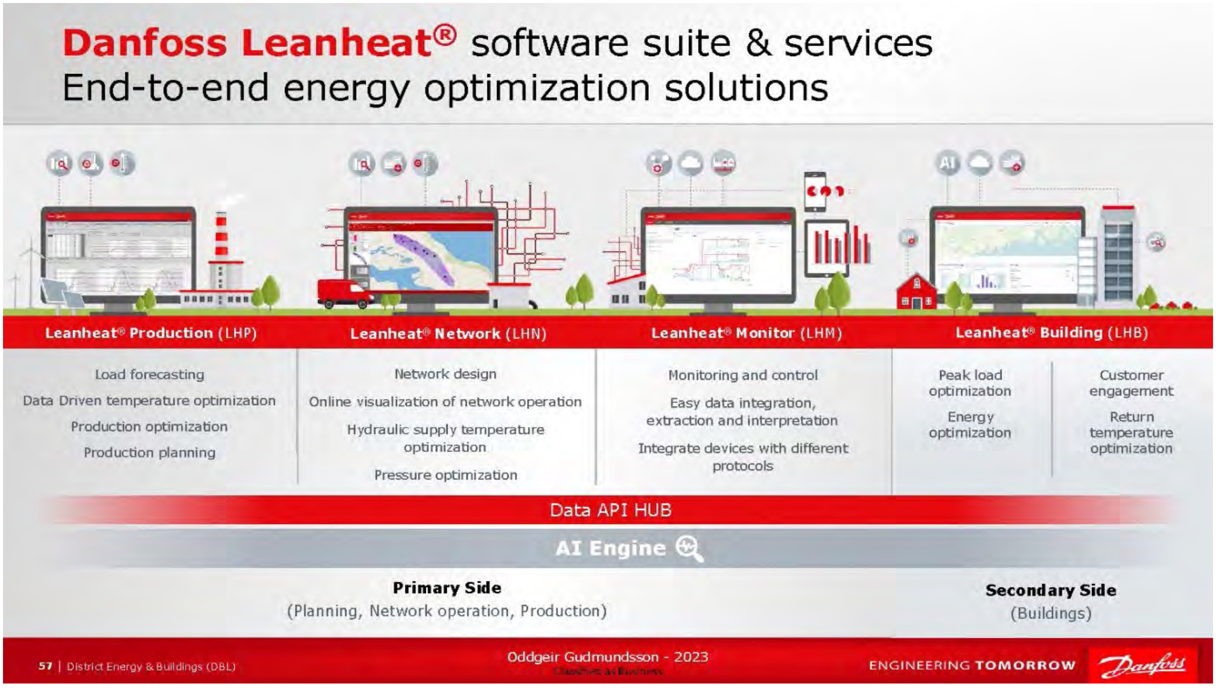

Danfoss Leanheat® software suite & services
End-to-end energy optimization solutions
Leanheat® Production (LHP)
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Load forecasting
Data Driven temperature optimization
Production optimization
Production planning
Network design
Online visualization of network operation
Hydraulic supply temperature optimization
Pressure optimization
Monitoring and control
Easy data integration, extraction and interpretation
Integrate devices with different protocols
Peak load optimization
Energy optimization
Customer engagement
Return temperature optimization
Data API HUB
AI Engine
Primary Side
(Planning, Network operation, Production)
Secondary Side
(Buildings)
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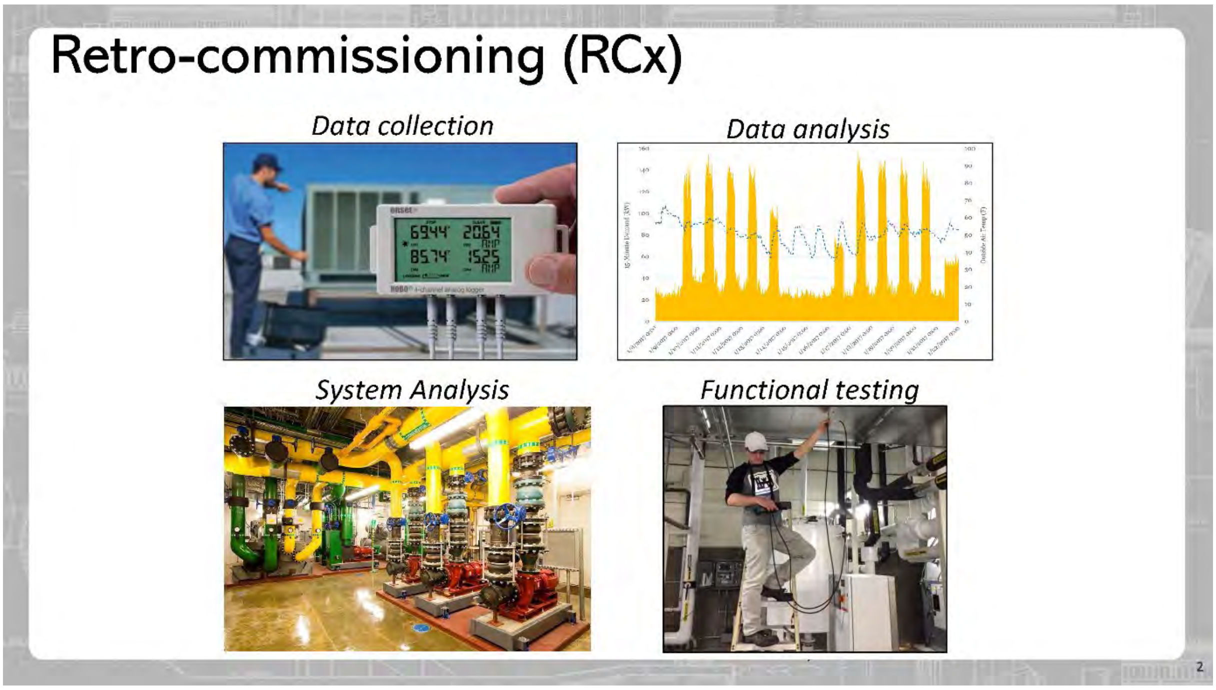
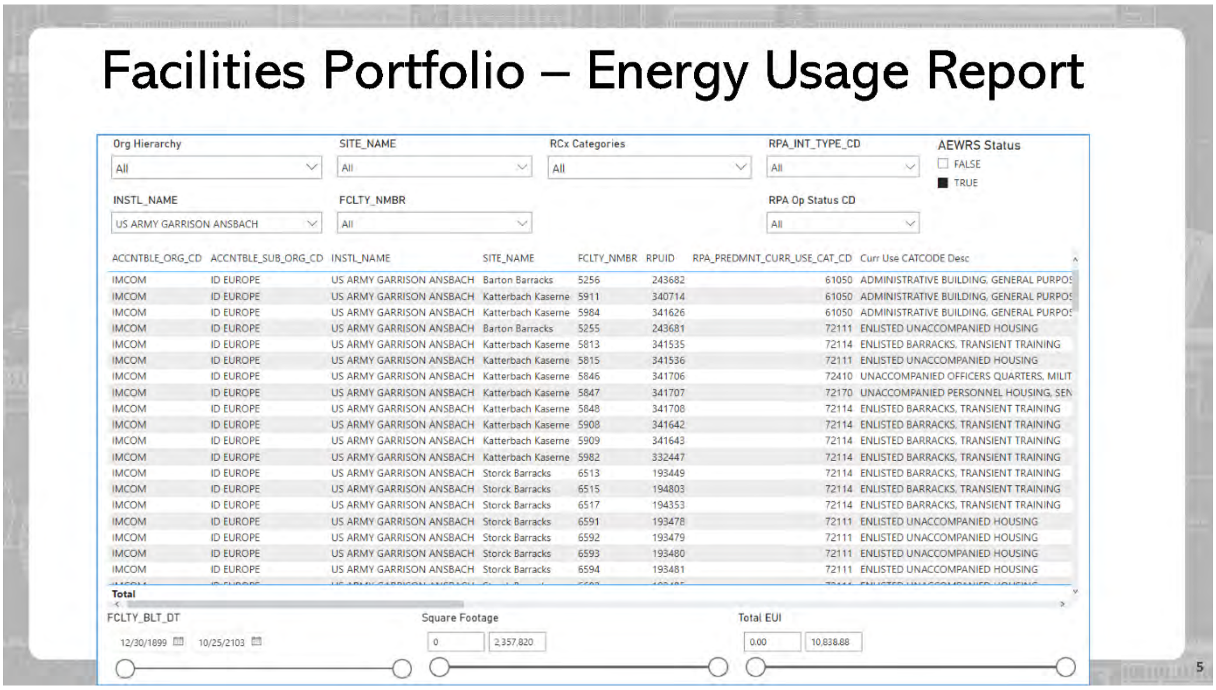
Day 2, "Retro-commissioning" (Jay Tulley and Chris Battisti)



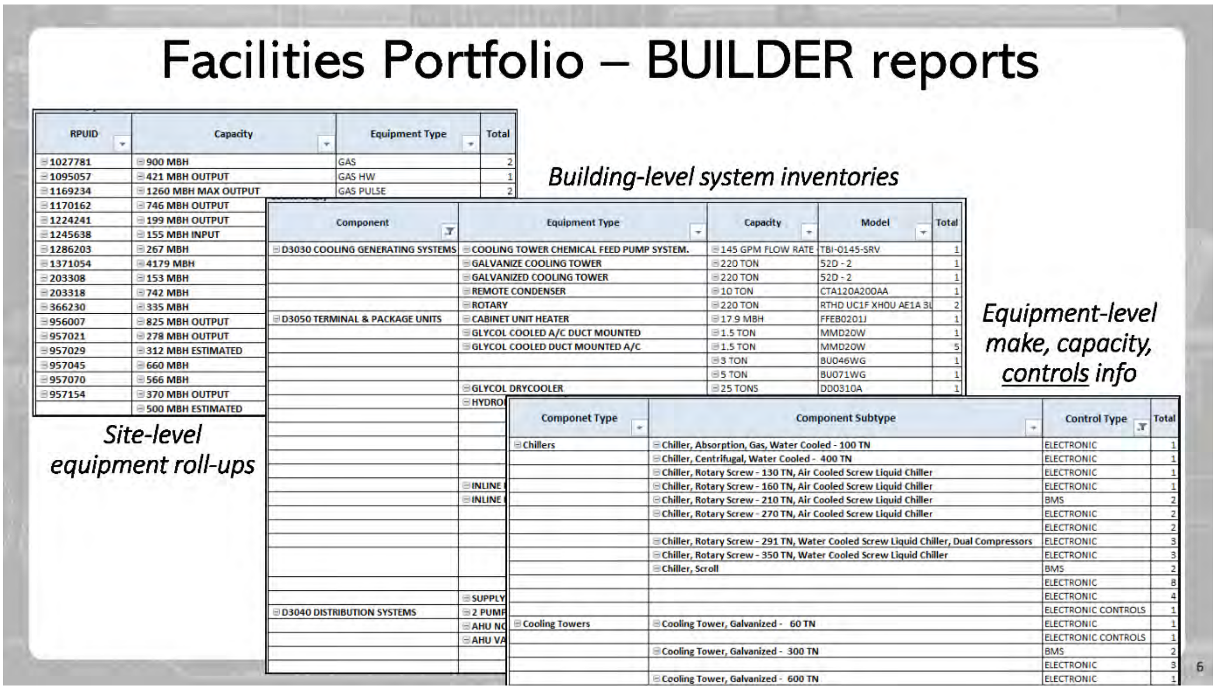
We focus on three levels

1. Facilities Portfolio
2. Energy Systems
3. Building Controls

4



ACCNTBLE_ORG_CD	ACCNTBLE_SUB_ORG_CD	INSTL_NAME	SITE_NAME	FCLTY_NMBR	RPUID	RPA_PREDMNT_CURR_USE_CAT_CD	Curr Use CATCODE Desc
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Barton Barracks	5256	243682	61050	ADMINISTRATIVE BUILDING, GENERAL PURPOS
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5911	340714	61050	ADMINISTRATIVE BUILDING, GENERAL PURPOS
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5984	341626	61050	ADMINISTRATIVE BUILDING, GENERAL PURPOS
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Barton Barracks	5255	243681	72111	ENLISTED UNACCOMPANIED HOUSING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5813	341535	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5815	341536	72111	ENLISTED UNACCOMPANIED HOUSING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5846	341706	72410	UNACCOMPANIED OFFICERS QUARTERS, MILIT
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5847	341707	72170	UNACCOMPANIED PERSONNEL HOUSING, SEN
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5848	341708	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5908	341642	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5909	341643	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Katterbach Kaserne	5982	332447	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6513	193449	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6515	194803	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6517	194353	72114	ENLISTED BARRACKS, TRANSIENT TRAINING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6591	193478	72111	ENLISTED UNACCOMPANIED HOUSING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6592	193479	72111	ENLISTED UNACCOMPANIED HOUSING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6593	193480	72111	ENLISTED UNACCOMPANIED HOUSING
IMCOM	ID EUROPE	US ARMY GARRISON ANSBACH	Storck Barracks	6594	193481	72111	ENLISTED UNACCOMPANIED HOUSING
Total							



RPUID	Capacity	Equipment Type	Total
1027781	900 MBH	GAS	2
1095057	421 MBH OUTPUT	GAS HW	1
1169234	1260 MBH MAX OUTPUT	GAS PULSE	2
1170162	746 MBH OUTPUT		
1224241	199 MBH OUTPUT		
1245638	155 MBH INPUT		
1286203	267 MBH		
1371054	4179 MBH		
203308	153 MBH		
203318	742 MBH		
366230	335 MBH		
956007	825 MBH OUTPUT		
957021	278 MBH OUTPUT		
957029	312 MBH ESTIMATED		
957045	660 MBH		
957070	566 MBH		
957154	370 MBH OUTPUT		
	500 MBH ESTIMATED		

Component	Equipment Type	Capacity	Model	Total
D3030 COOLING GENERATING SYSTEMS	COOLING TOWER CHEMICAL FEED PUMP SYSTEM.	145 GPM FLOW RATE	TBI-0145-SRV	1
	GALVANIZE COOLING TOWER	220 TON	52D - 2	1
	GALVANIZED COOLING TOWER	220 TON	52D - 2	1
	REMOTE CONDENSER	10 TON	CTA120A200AA	1
	ROTARY	220 TON	RTHD UC1F XHOU AE1A 3L	2
D3050 TERMINAL & PACKAGE UNITS	CABINET UNIT HEATER	17.9 MBH	FFEB0201J	1
	GLYCOL COOLED A/C DUCT MOUNTED	1.5 TON	MMD20W	1
	GLYCOL COOLED DUCT MOUNTED A/C	1.5 TON	MMD20W	5
		3 TON	BU046WG	1
		5 TON	BU071WG	1
	GLYCOL DRYCOOLER	25 TONS	DD0310A	1
	HYDRO			
	INLINE			
	INLINE			
	SUPPLY			
D3040 DISTRIBUTION SYSTEMS	2 PUMP			
	AHU NC			
	AHU VA			

Componet Type	Component Subtype	Control Type	Total
Chillers	Chiller, Absorption, Gas, Water Cooled - 100 TN	ELECTRONIC	1
	Chiller, Centrifugal, Water Cooled - 400 TN	ELECTRONIC	1
	Chiller, Rotary Screw - 130 TN, Air Cooled Screw Liquid Chiller	ELECTRONIC	1
	Chiller, Rotary Screw - 160 TN, Air Cooled Screw Liquid Chiller	ELECTRONIC	1
	Chiller, Rotary Screw - 210 TN, Air Cooled Screw Liquid Chiller	BMS	2
	Chiller, Rotary Screw - 270 TN, Air Cooled Screw Liquid Chiller	ELECTRONIC	2
		ELECTRONIC	2
	Chiller, Rotary Screw - 291 TN, Water Cooled Screw Liquid Chiller, Dual Compressors	ELECTRONIC	3
	Chiller, Rotary Screw - 350 TN, Water Cooled Screw Liquid Chiller	ELECTRONIC	3
	Chiller, Scroll	BMS	2
		ELECTRONIC	8
		ELECTRONIC	4
		ELECTRONIC CONTROLS	1
Cooling Towers	Cooling Tower, Galvanized - 60 TN	ELECTRONIC	1
		ELECTRONIC CONTROLS	1
	Cooling Tower, Galvanized - 300 TN	BMS	2
		ELECTRONIC	3
	Cooling Tower, Galvanized - 600 TN	ELECTRONIC	1

Example Modeling Summaries

Installation	Site Count	Building Count (AEWRS)	Total SF	AEWRS Energy (MBtu)	# of MDMS Meters	# Facilities in BUILDER	# Buildings to Audit	RCx Building Candidates	RCx Savings Estimate
Installation A	3	1,374	15,529,497	2,842,382	223	1,531	82	31	$3,475,218
Installation B	2	63	2,023,138	218,250	-	70	4	2	$479,237
Installation C	1	401	1,451,773	71,421	21	533	6	1	$358,695
Installation D	5	451	13,817,950	1,125,410	190	527	30	19	$2,596,775
Installation E	2	254	3,513,541	847,250	48	287	33	8	$1,534,498
Installation F	1	325	12,235,525	644,531	-	390	12	3	$3,409,613
Installation G	2	166	3,272,602	417,181	-	255	17	9	$269,415
Installation H	1	416	3,056,274	545,310	308	590	77	3	$718,954
Installation I	1	1,171	16,541,936	1,105,374	247	1,434	21	6	$1,846,266
Installation J	1	123	6,412,309	524,677	25	228	17	13	$872,611

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We focus on three levels

1. Facilities Portfolio
2. Energy Systems
3. Building Controls

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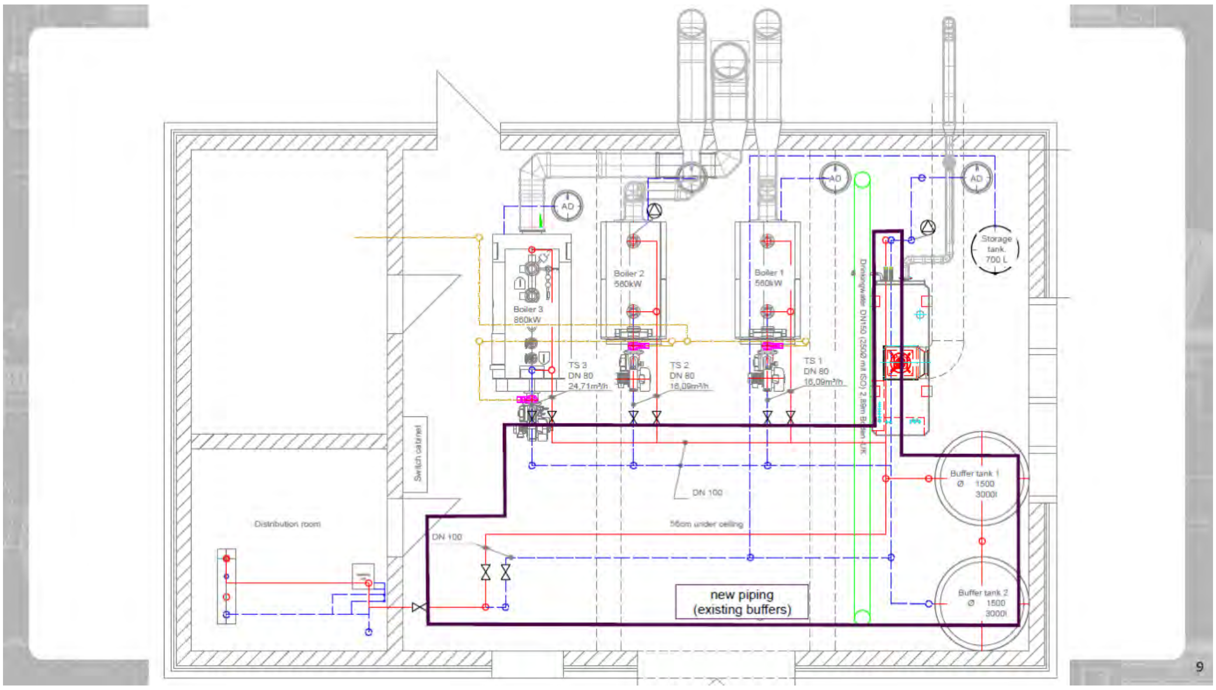

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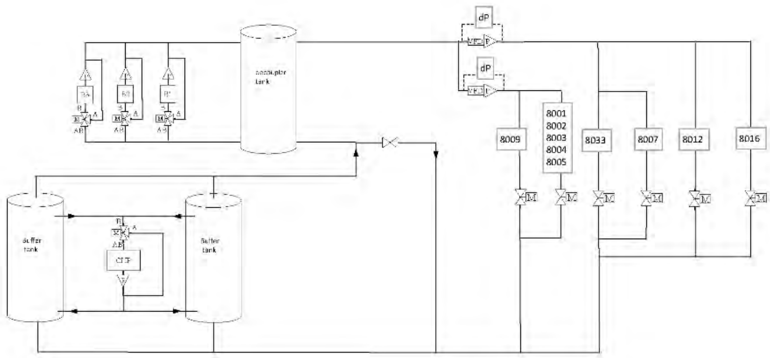
System Diagram (simplified)



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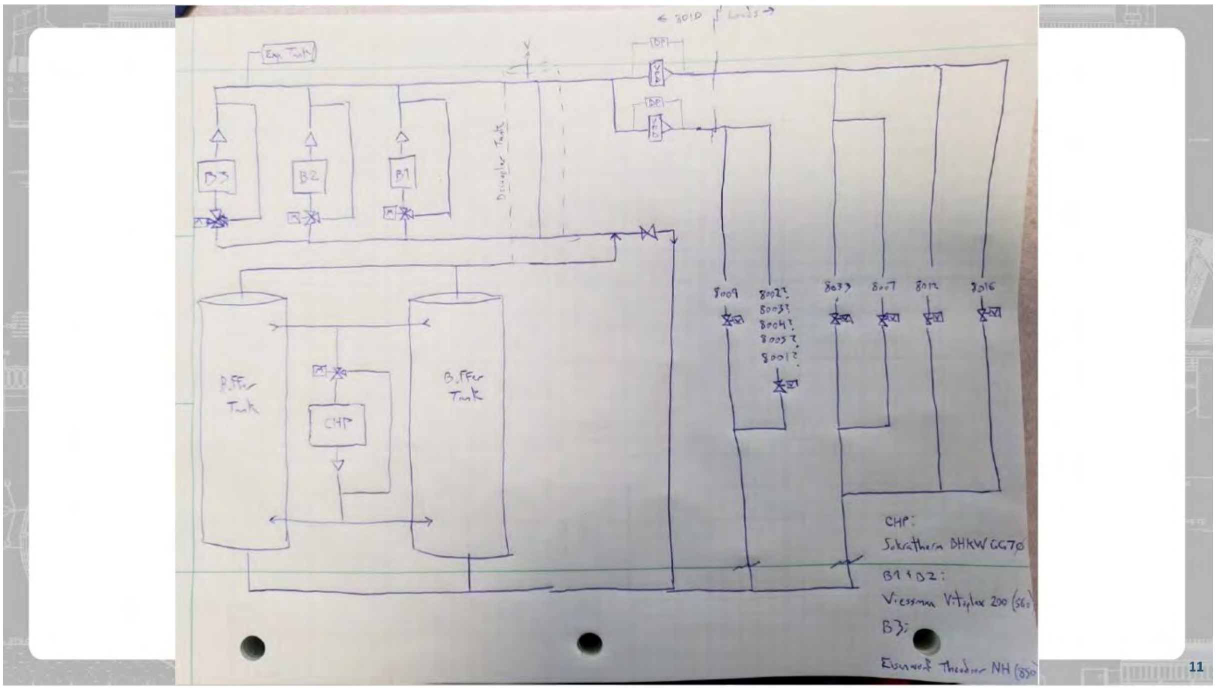
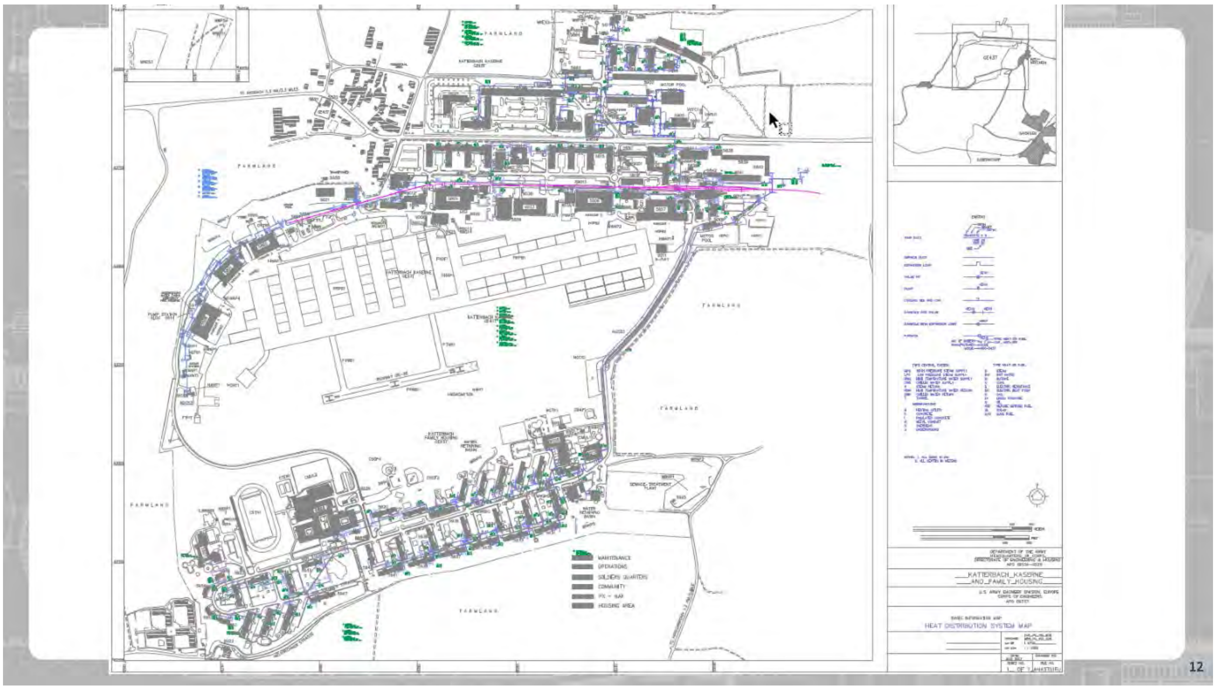
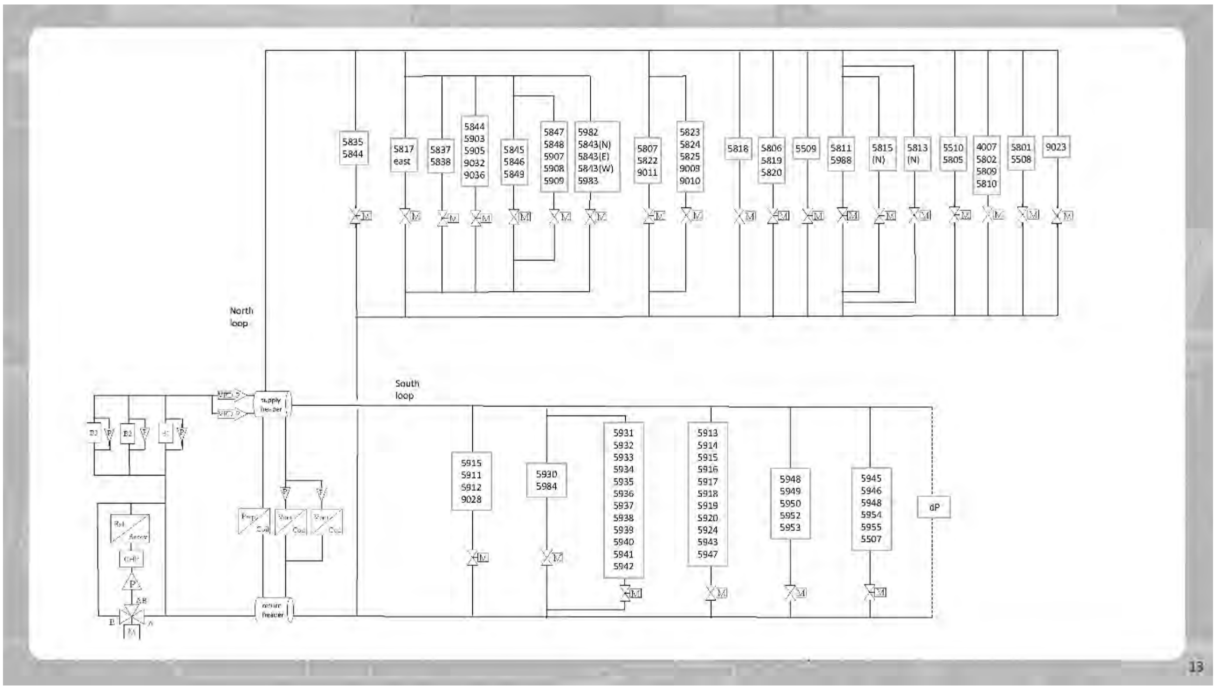

Exp. Tank
B3
B2
B1
Decoupler Tank
Buffer Tank
Buffer Tank
CHP
8009
8002?
8003?
8004?
8005?
8001?
8033
8007
8012
8016
CHP:
Sokratherm BHKW GG70
B1 + B2:
Viessmann Vitoplex 200
B3:
11


FARMLAND
MAINTENANCE
OPERATIONS
SOLDIERS QUARTERS
COMMUNITY
HOUSING AREA
KATTERBACH KASERNE
AND FAMILY HOUSING
HEAT DISTRIBUTION SYSTEM MAP
12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5909
5982
5843(N)
5843(E)
5843(W)
5983
5807
5822
9011
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9010
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5811
5988
5815
(N)
5813
(N)
5510
5805
4007
5802
5809
5810
5801
5508
9023
North
loop
South
loop
supply
header
return
header
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dP
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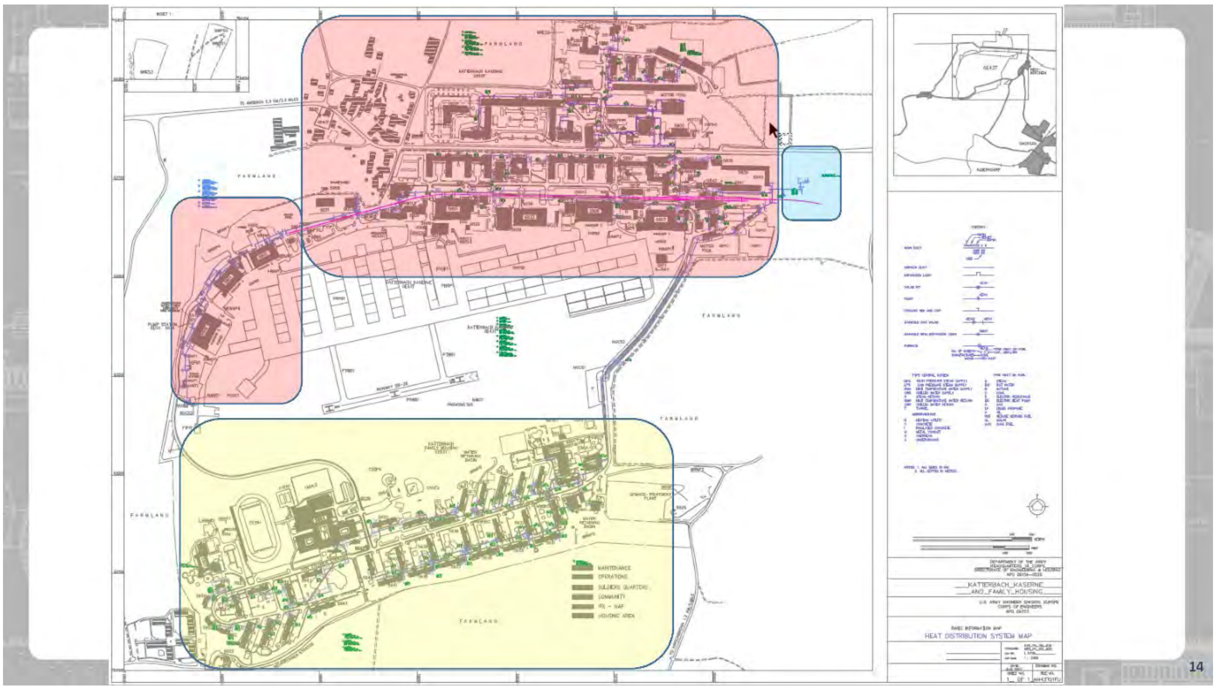
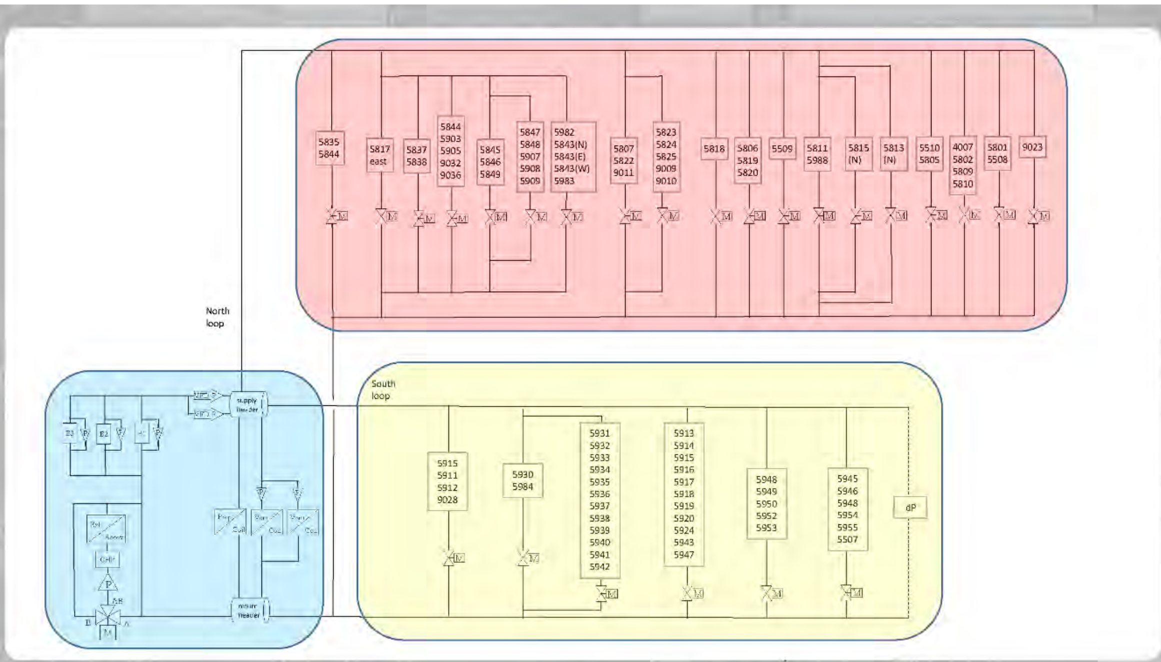

KATTERBACH KASERNE
AND FAMILY HOUSING
HEAT DISTRIBUTION SYSTEM MAP
14

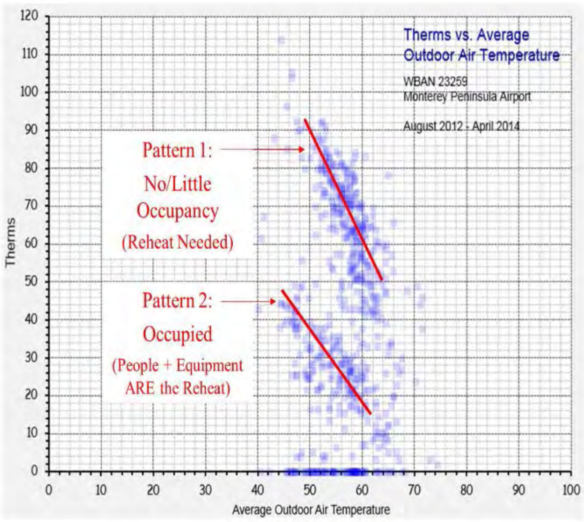


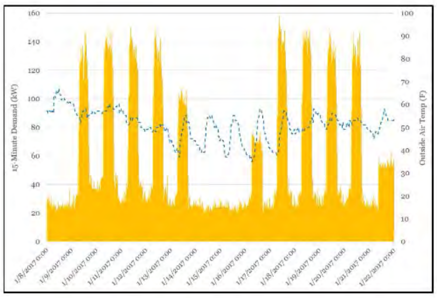
15

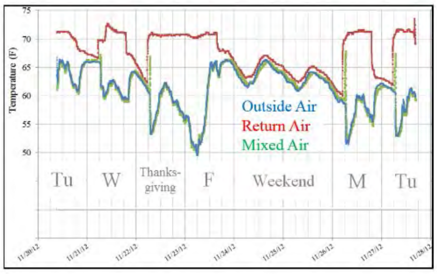
Data collection

16

Data analysis





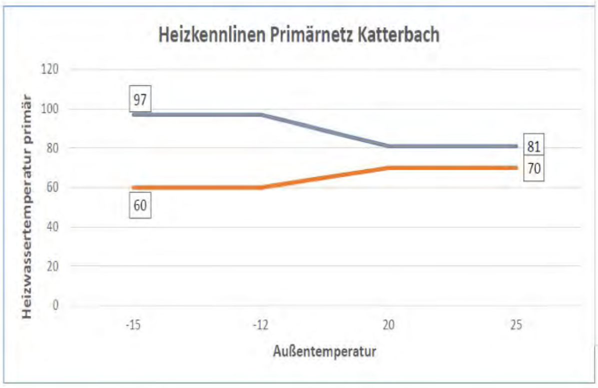


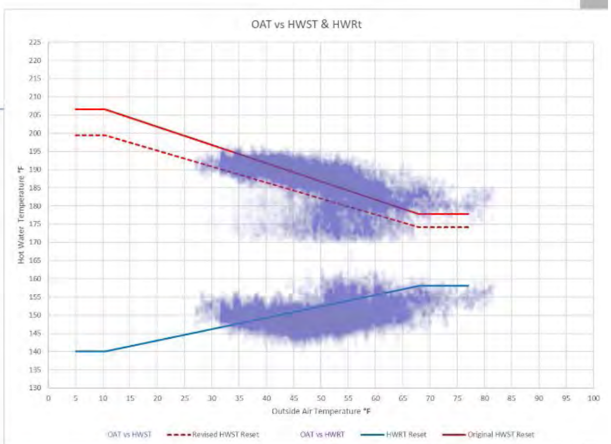
17

Katterbach

Außentemperatur	Vorlauftemperatur primär	Rücklauftemperatur primär
-15 °C	97 °C	60 °C
-12 °C	97 °C	60 °C
20 °C	81 °C	70 °C
25 °C	81°C	70 °C

Data analysis





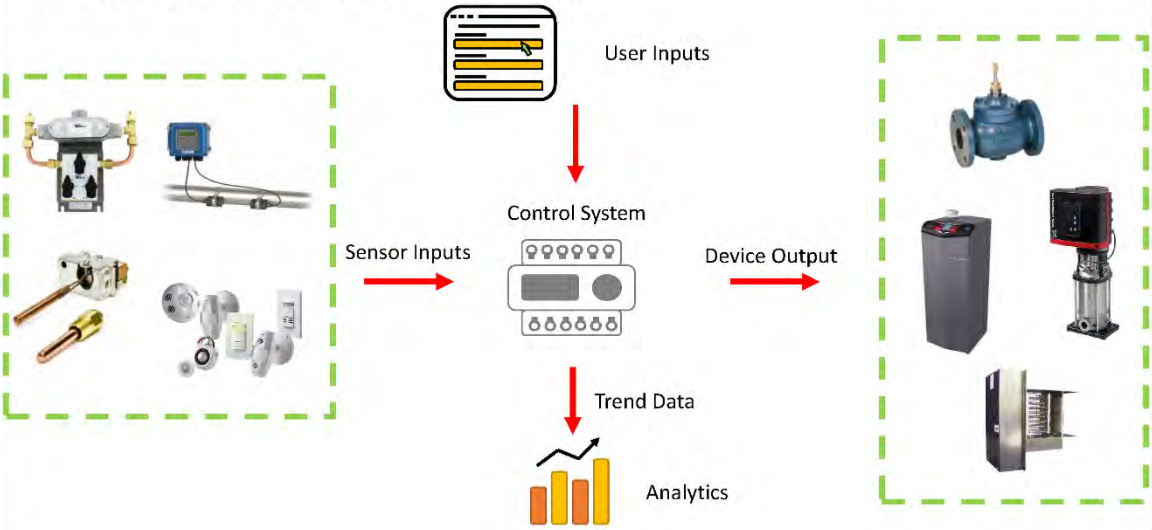
18

We focus on three levels

1. Facilities Portfolio
2. Energy Systems
3. Building Controls

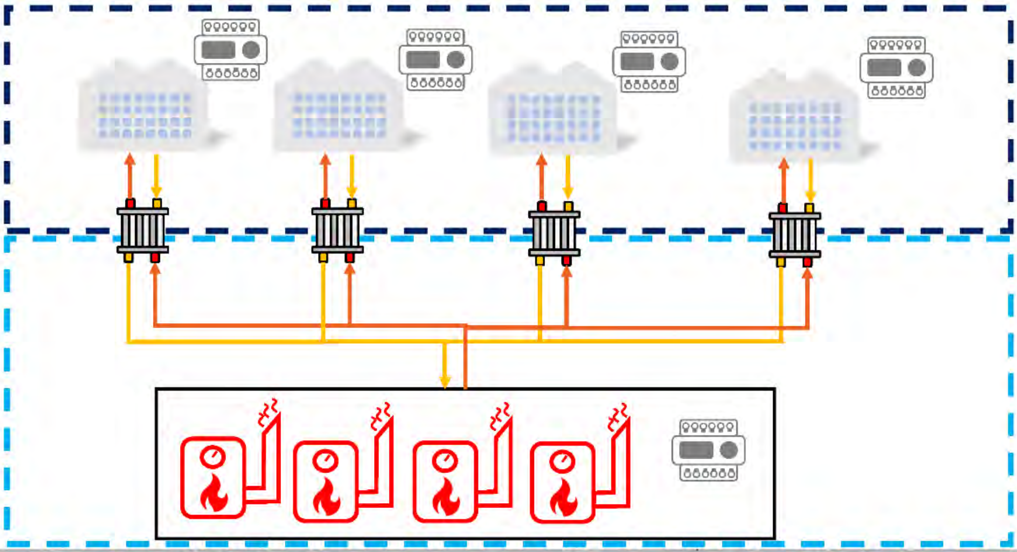
19

Control System Utilization



20

Controls Opportunities – Separated Systems



Monitoring System Performance

Installation:
Building:

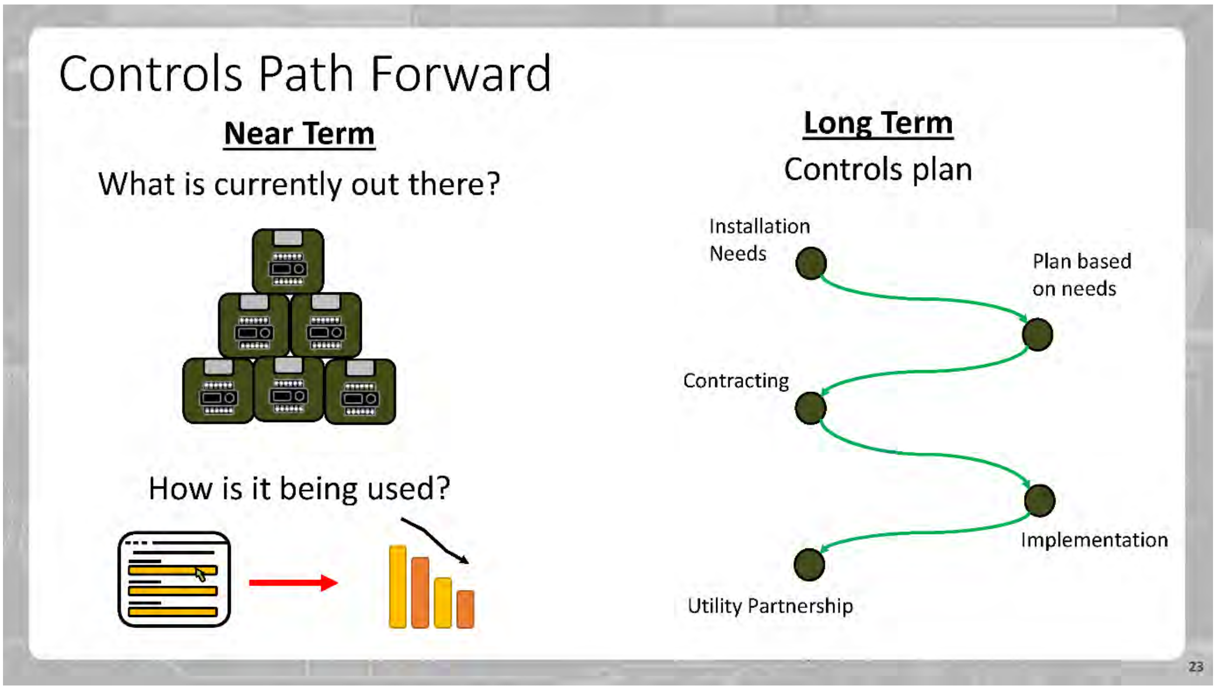
Monitoring Plan

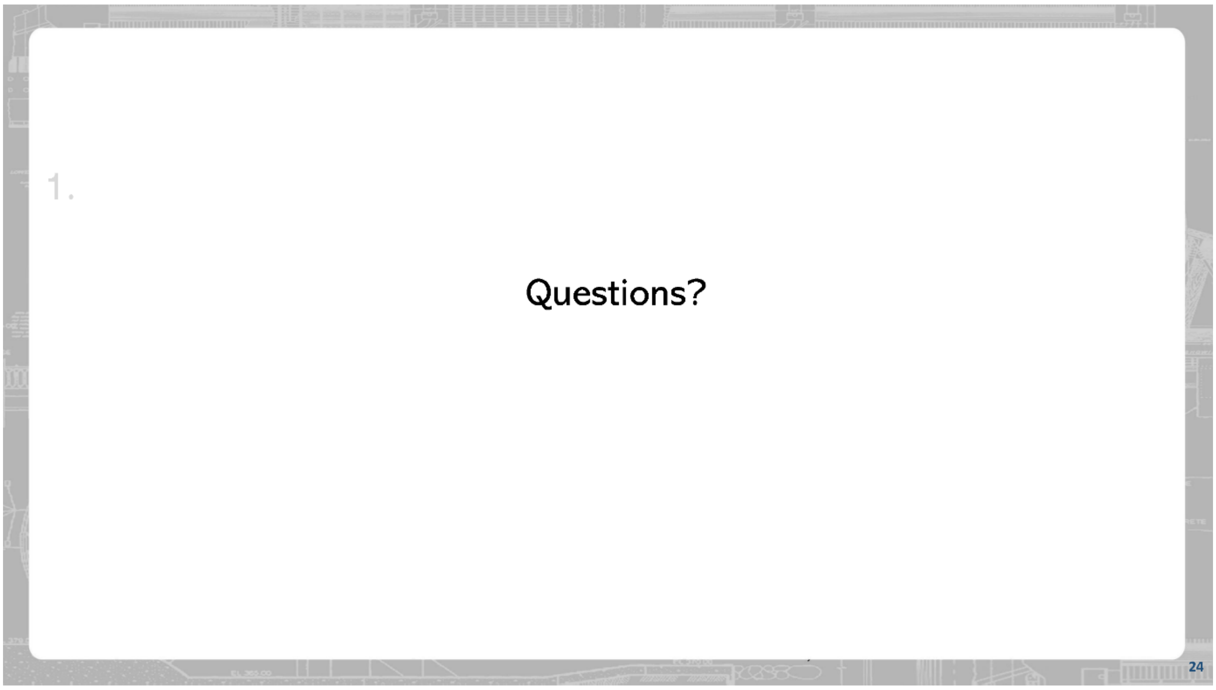
POC:

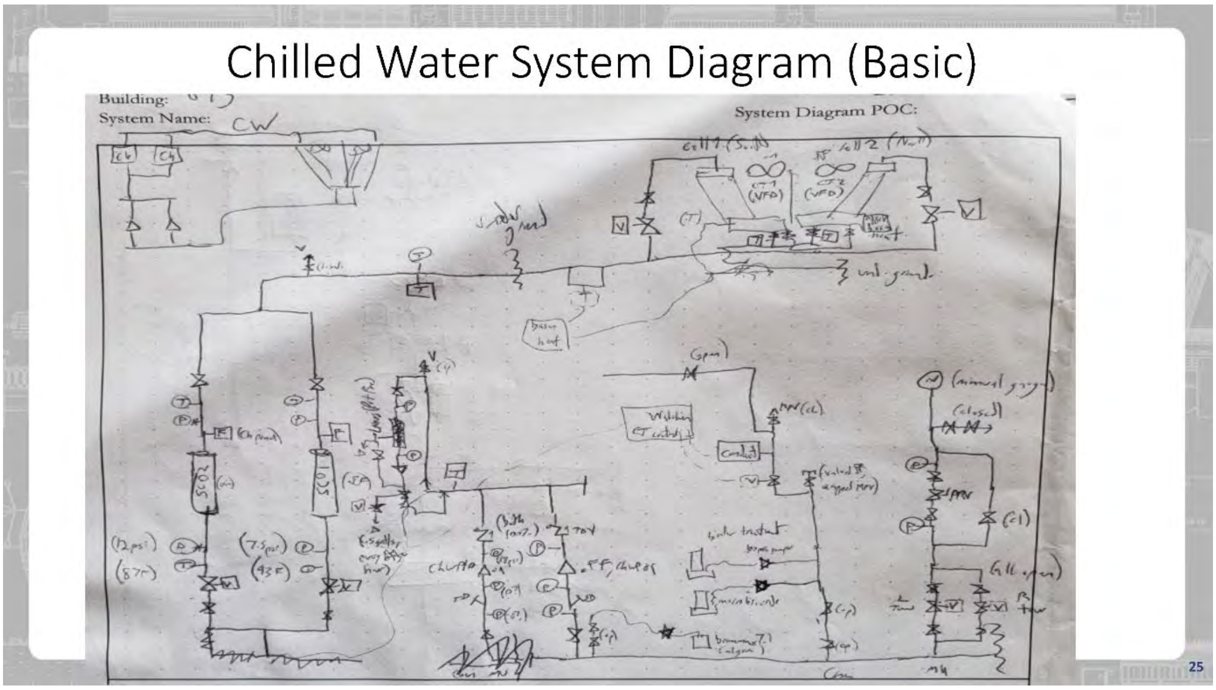
Date:

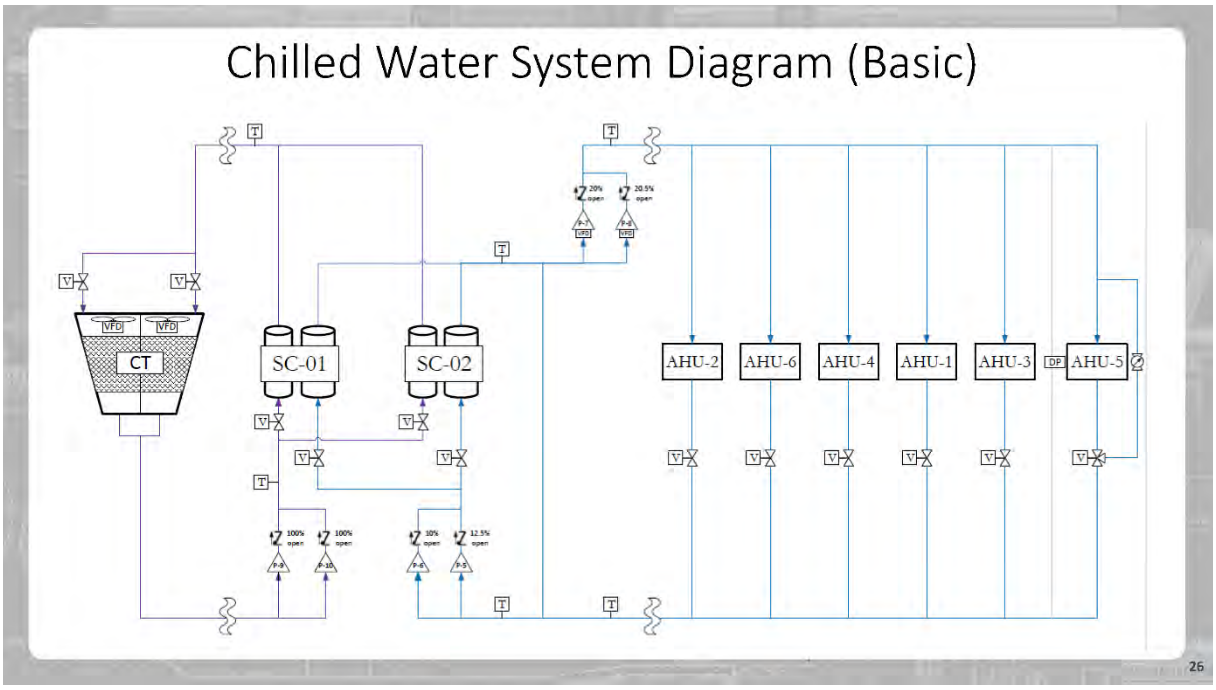
ECM	System	Location	Type	Point Name or Logger ID	Trend Interval	Trend Length	Dates			Status	Notes
							Launch	Download 1	Download 2		
	Heat	Boiler Plant	DDC	Boiler 1 Start/Stop	COV	4 weeks					
	Heat	Boiler Plant	DDC	Boiler 1 Status	COV	4 weeks					
	Heat	Boiler Plant	DDC	Boiler 2 Start/Stop	COV	4 weeks					
	Heat	Boiler Plant	DDC	Boiler 2 Status	COV	4 weeks					
	Heat	Boiler Plant	DDC	HW Supp Temp	5-min	4 weeks					
	Heat	Boiler Plant	DDC	HW Return	5-min	4 weeks					
	Heat	Boiler Plant	DDC	HW Flow	5-min	4 weeks					
	Heat	Building HWS	DDC	Pump Start/Stop	COV	4 weeks					
	Heat	Building HWS	DDC	Pump VFD Speed	5-min	4 weeks					
	Heat	Building HWS	DDC	HW Supp Temp	5-min	4 weeks					
	Heat	Building HWS	DDC	HW Return	5-min	4 weeks					
	Heat	Building HWS	DDC	HW Flow	5-min	4 weeks					
	Heat	Room #1	Logger	Radiator Temperature	1-min	4 weeks					
	Heat	Room #1	Logger	Room Temperature	1-min	4 weeks					
	Heat	Room #2	Logger	Radiator Temperature	1-min	4 weeks					
	Heat	Room #2	Logger	Room Temperature	1-min	4 weeks					

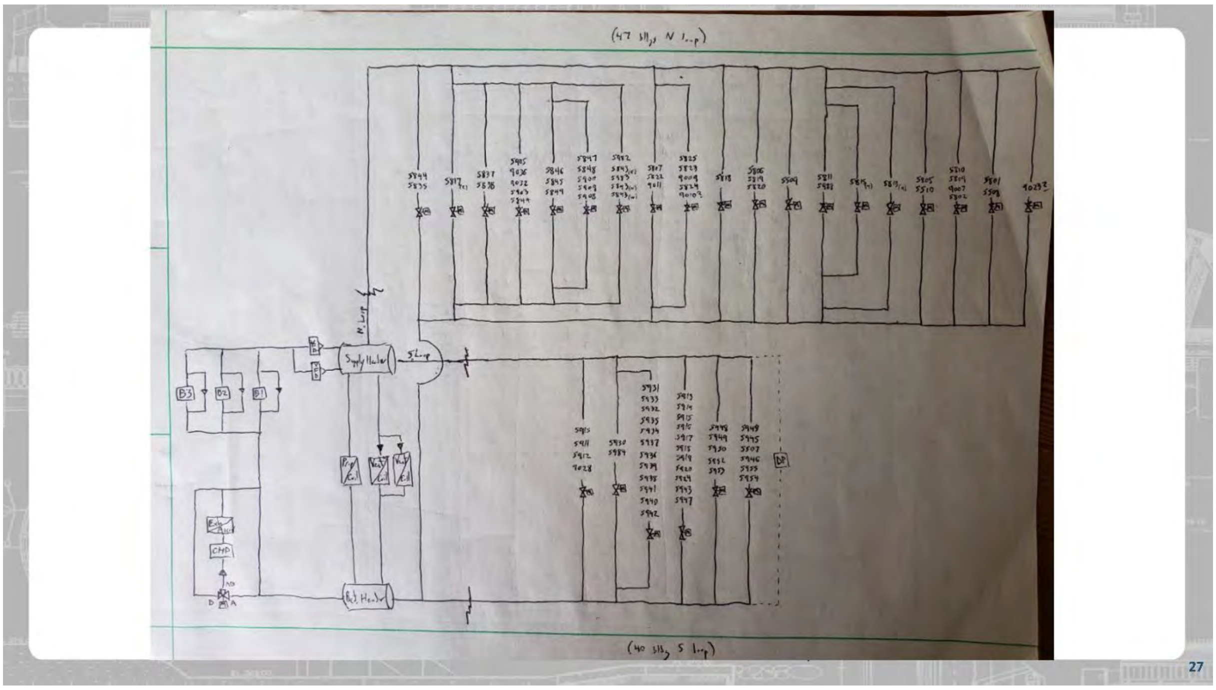
What data is needed must dictate the control system


Controls Path Forward
Near Term
What is currently out there?
How is it being used?
Long Term
Controls plan
Installation Needs
Plan based on needs
Contracting
Implementation
Utility Partnership
23

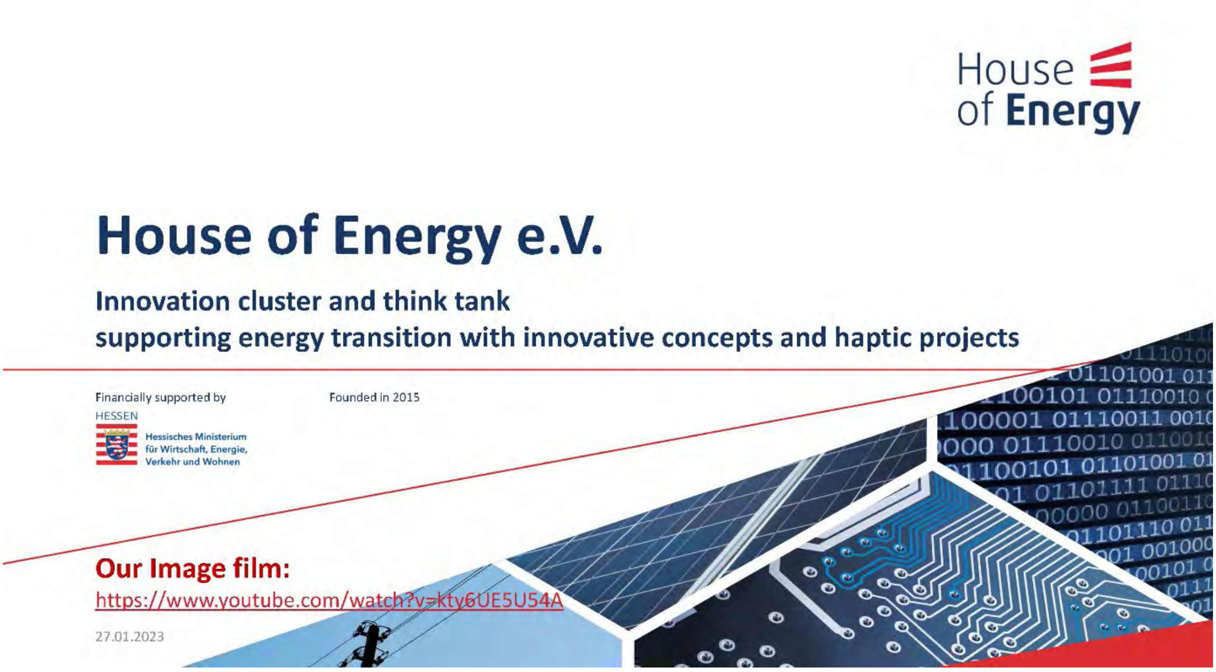

1.
Questions?
24


Chilled Water System Diagram (Basic)
Building:
System Name: CW
System Diagram POC:
SC-02
SC-01
25


Chilled Water System Diagram (Basic)
CT
VFD
SC-01
SC-02
AHU-2
AHU-6
AHU-4
AHU-1
AHU-3
AHU-5
DP
T
V
20% open
20.5% open
100% open
100% open
10% open
12.5% open
26



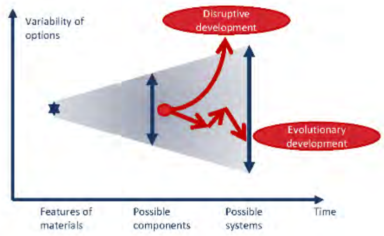
Day 2, Introduction Session 3 (Peter Birkner)



Strategies towards net-zero emission future and energy security

Technical pillars of a sustainable energy system – Economy, ecology, society

- **Three time periods to be considered:**
  Technologies in place – Transformation technologies – Target technologies
- **Limited time for decarbonization:**
  Transformation of infrastructure necessary during operation – Decarbonization is key
- **Different consistencies of target system:**
  Place and specific conditions – Technologies involved
  Available technologies – Time of investment – Innovation



Strategies towards net-zero emission future and energy security

Technical pillars of a sustainable energy system – Economy, ecology, society

Carbon neutral energy sources

- Green sources
- Nuclear fission
- Fossil sources including carbon capture and storage
- Nuclear fusion (some day)

Reduction of final energy demand

- Higher efficiency of applications
- Less applications, higher sufficiency
- Electrification and digitalization

Decarbonization of processes

- CCS, CCU

Strategies towards net-zero emission future and energy security

Technical pillars of a sustainable energy system – Economy, ecology, society

New set of final energies
- Electricity, hydrogen
- Synthetic fuels – Ammonia, methanol, kerosene
- Decarbonized fossil fuels – Natural gas
- District heating and cooling

Circular economy
- Dematerialization
- Recycling of rare and expensive materials

Sectors involved
- Electricity
- Mobility
- Heating & Cooling

27.01.2023 4

Strategies towards net-zero emission future and energy security

Technical pillars of a sustainable energy system – Economy, ecology, society

Supporting elements
- Digitalization
- Finance
- Legal framework
- Qualified workforce

Social aspects
- Acceptance of change
- Integration, participation, cooperation

System stability
- Flexibility
- Storage
- Digitalization
- Coupling of sectors and multimodal systems

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Strategies towards net-zero emission future and energy security

Technical pillars of a sustainable energy system – Economy, ecology, society

Geographical Scope

- Domestic production
- Import and export

27.01.2023 6

Contact us

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https://www.linkedin.com/company/house-of-energy-ev

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European Regional Development Fund

HESSEN
Ministry for Economic Affairs, Energy, Transport and Housing
State of Hessen

27.01.2023 7

Day 2, “Energy Transition at Princeton University” (Edward Borer)

A Time of Energy Transition At Princeton University

International Forum:

“TOWARDS A SECURE ENERGY SUPPLY IN A NET ZERO-EMISSION SOCIETY”

Frankfurt , Germany

January 2023

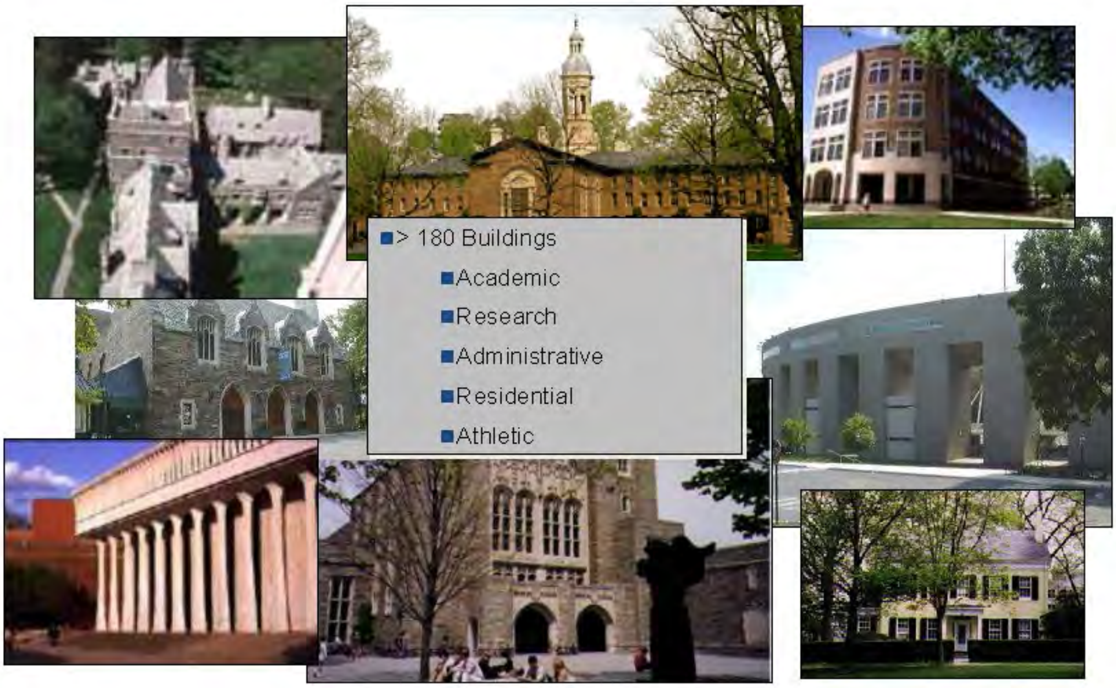
Edward “Ted” Borer, PE, CEM, LEED[AP]
etborer@princeton.edu

The Problem

Reduce CO_2 footprint & other negative environmental impact with:

- Good financial stewardship
- Existing buildings & campus aesthetics
- Space limitations
- Existing technologies
- Existing codes, tariffs
- No interruption of education and research
- Additionality
- Replicability
- No discomfort
- Reliability

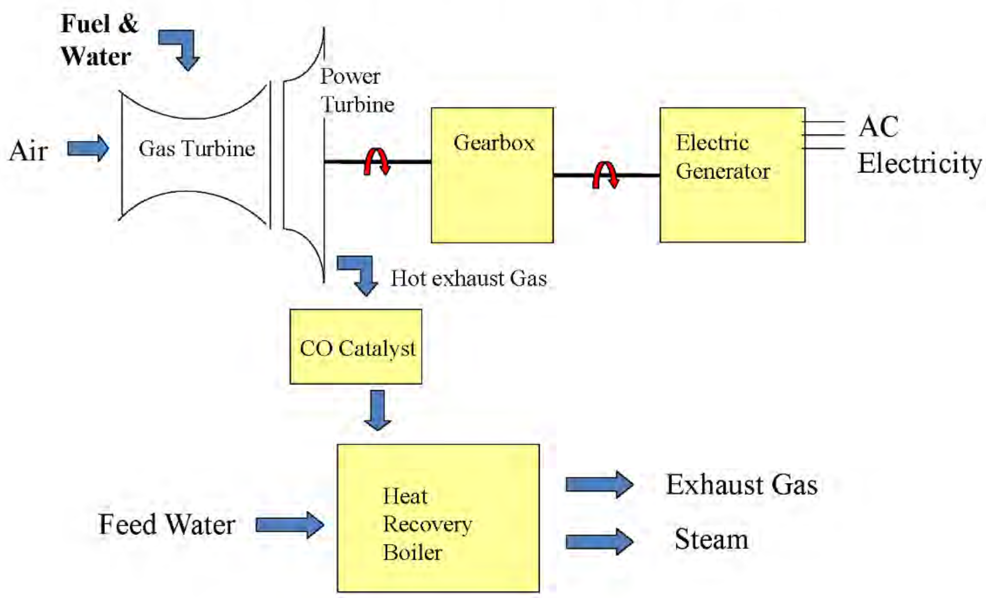
Energy Demands at Princeton



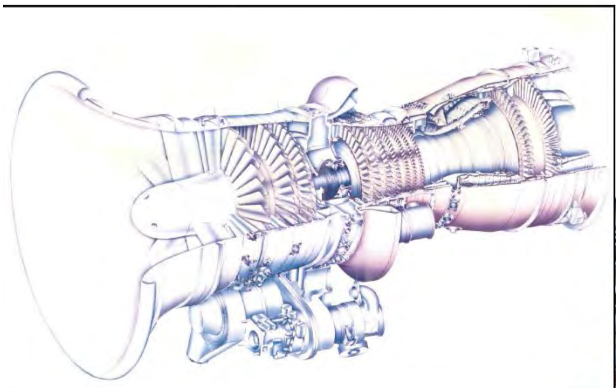
Energy Equipment & Peak Demands

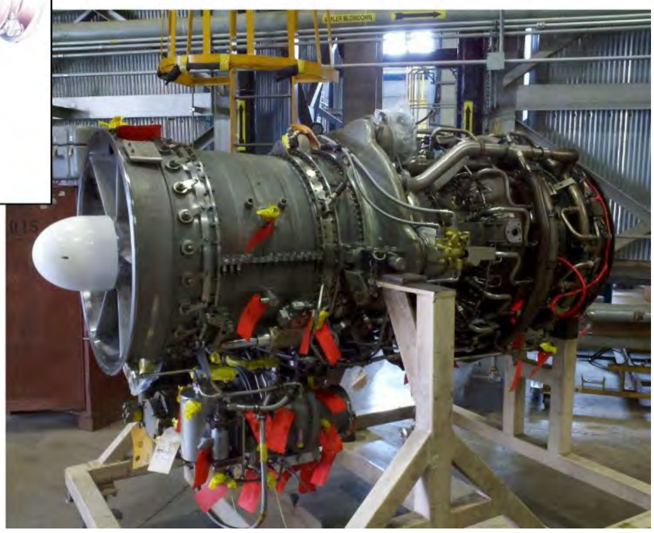
	Capacity	Peak Demand
• **Electricity**		
– (1) Gas Turbine Generator	15.0 MW	27 MW
– Solar Photovoltaic System	16.5 MW	
• **Steam Generation**		
– (1) Heat Recovery Boiler	180,000 #/hr	
– (2) Auxiliary Boilers @ 150 ea.	300,000 #/hr	240,000 #/hr (70.3 MW heating)
• **Chilled Water Production**		
– (3) Steam-Driven Chillers	10,100 Tons	
– (5) Electric Chillers	10,700 Tons	15,000 Tons (52.7 MW cooling)
– (1) Thermal Storage Tank	40,000 Ton-hours	
• *peak discharge	10,000 tons (peak)	

Combined Heat & Power, "Cogeneration"

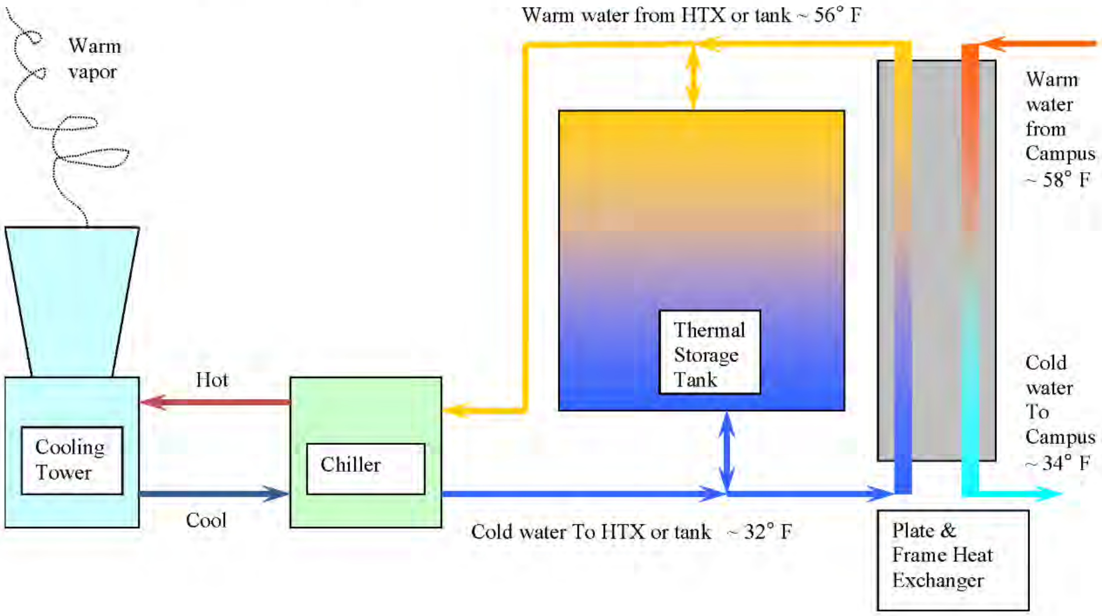


The GE LM-1600 Gas Turbine

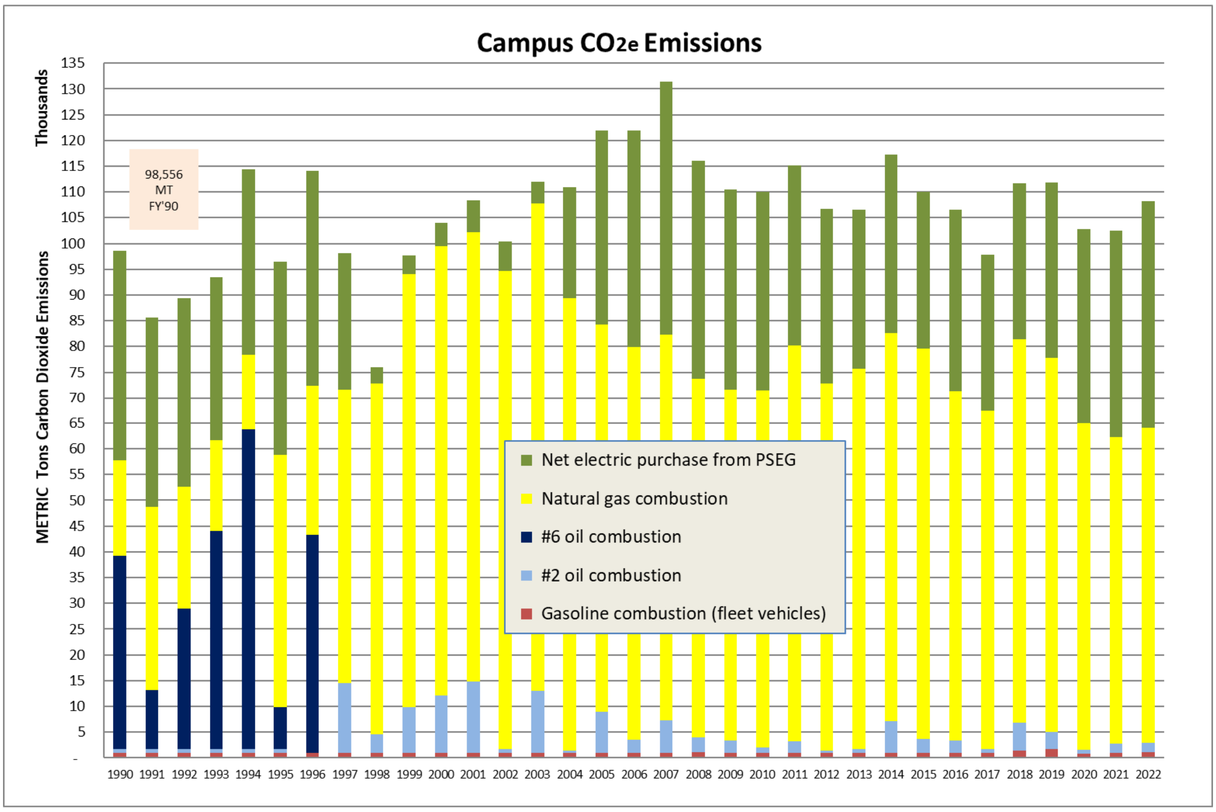




Chilled Water Thermal Storage

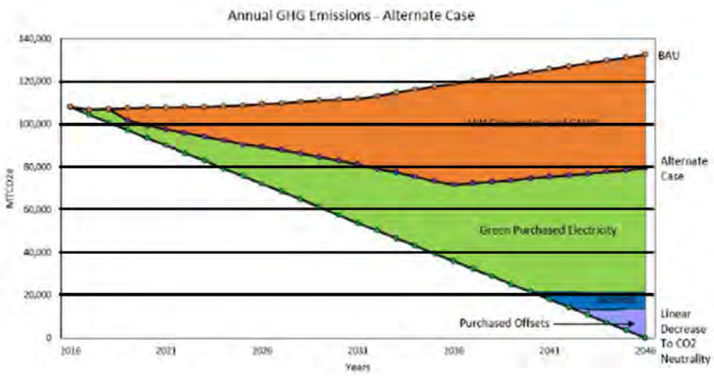


Princeton University Energy Plant



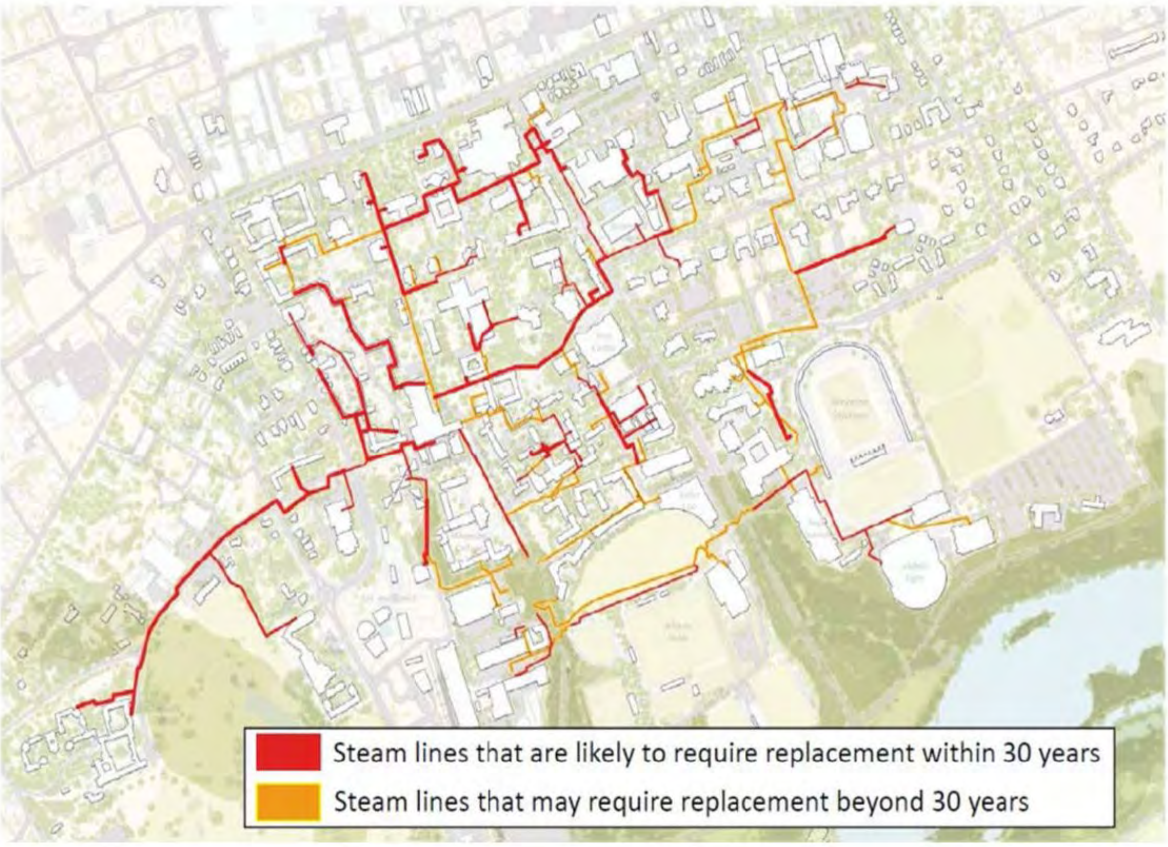
Goal: Carbon Neutrality

- Carbon Neutrality by 2046
- Continuous downward slope from present

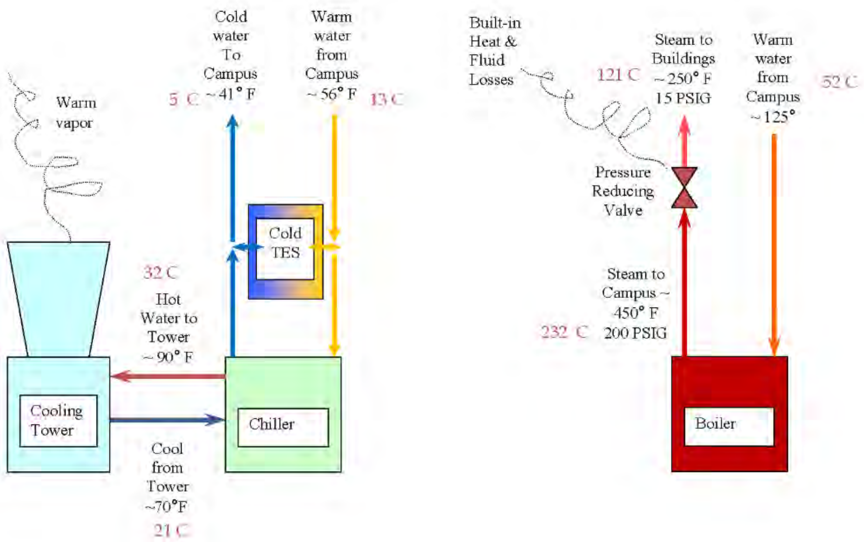


Major Areas of Work to Minimize Carbon Footprint:

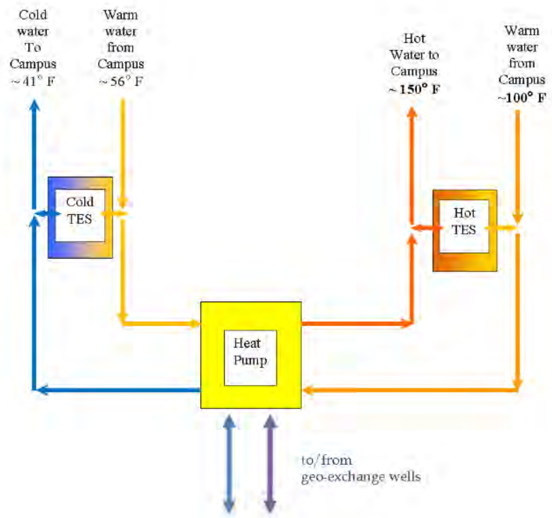
- High performance envelope, passive design, use of hot water for heating
- Replace district steam system with district hot water system
- Create electric-powered Heat Pump facility
- Create daily thermal storage – tanks
- Create seasonal thermal storage – geoexchange
- Install on-site renewable energy production – solar PV
- Supplement with off-site renewable energy

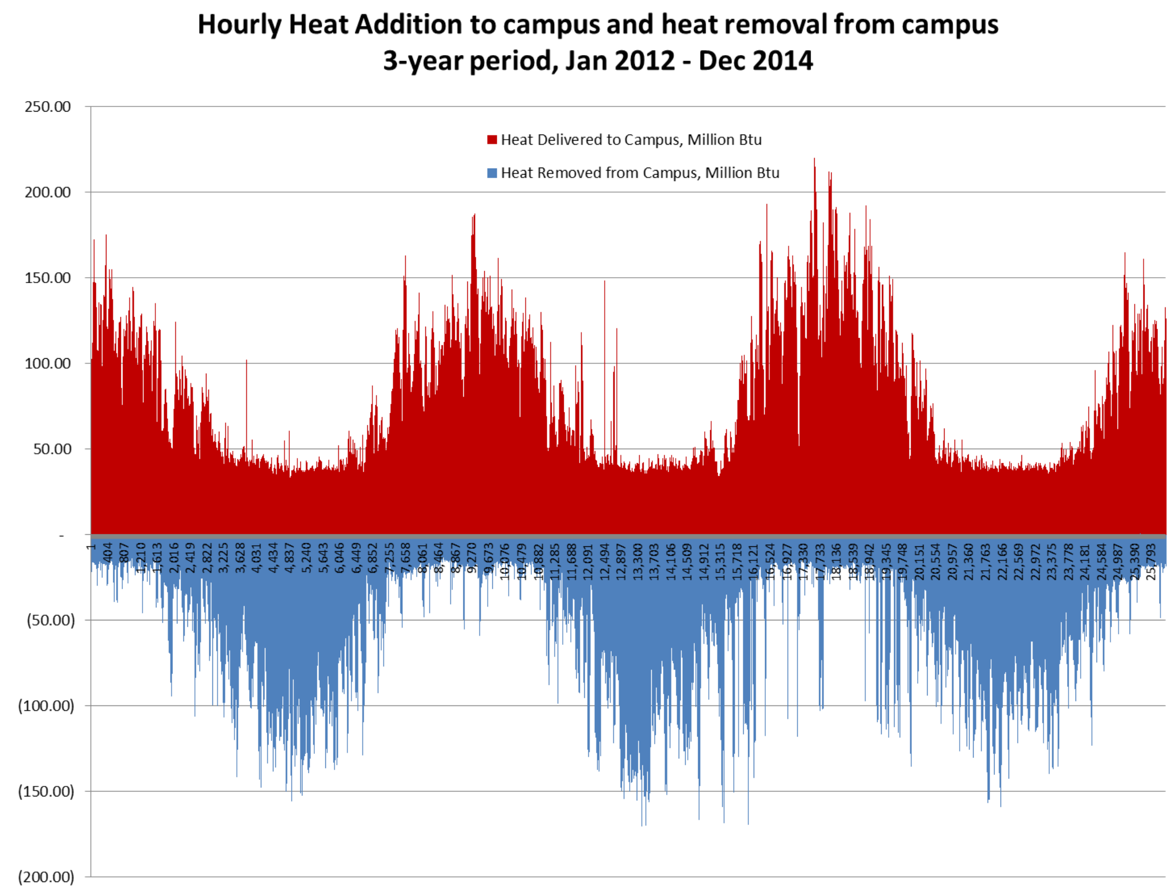


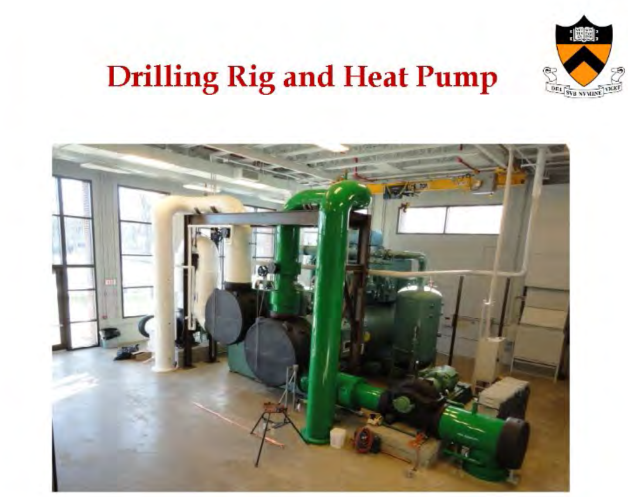
Separate Heat Removal (CHW) & Addition (Steam)



Combined Heat Removal (CHW) & Addition (HTW)



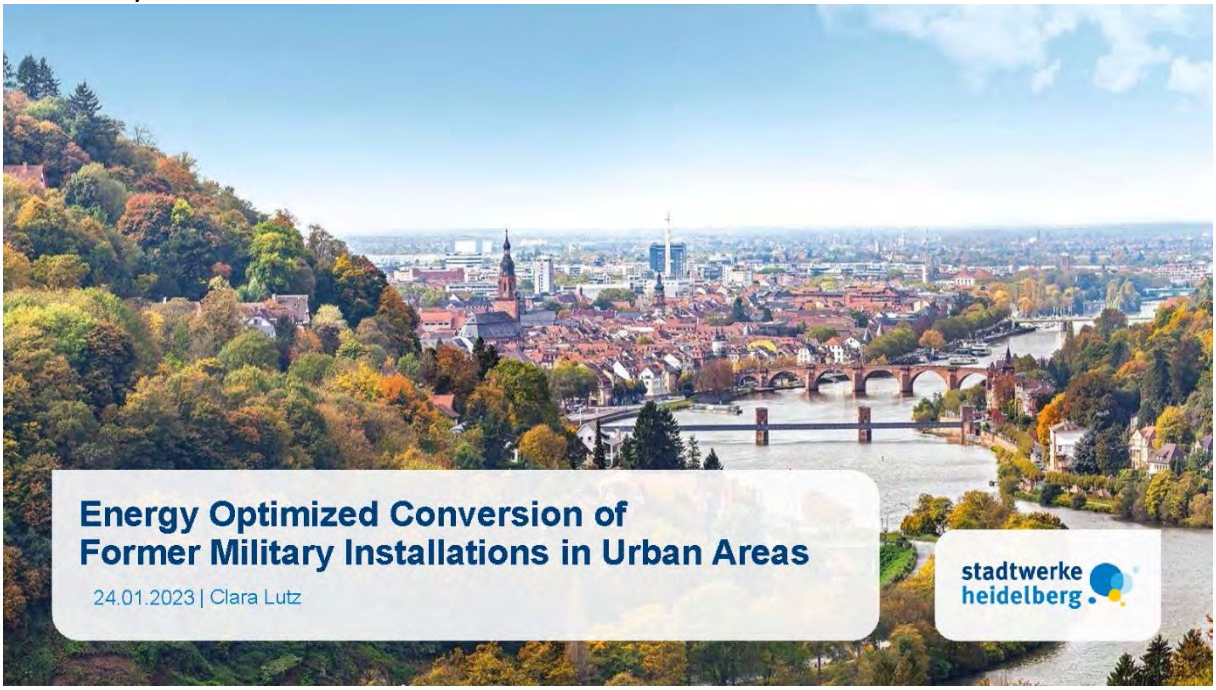

Hourly Heat Addition to campus and heat removal from campus
3-year period, Jan 2012 - Dec 2014
Heat Delivered to Campus, Million Btu
Heat Removed from Campus, Million Btu
250.00
200.00
150.00
100.00
50.00
-
(50.00)
(100.00)
(150.00)
(200.00)


Drilling Rig and Heat Pump

1.5" HDPE Geoexchange Pipe

TIGER Plant Rendering

Day 2, “Energy Optimized Conversion of Former Military Installations in Urban Areas” (Douglas Mackenzie)



The Patrick Henry Village (PHV) in Heidelberg – History, Development and Future Prospects

Location and dimension:

- About 6 km from the old Town of Heidelberg
- Covering an area of about 100 hectares

1954-2014:

- Residential area for members of the US-Army Europe
- Different buildings and building structures (Over 250 buildings with around 1,400 residential units)
- Former heating system: district heating system with coal, heating plant located in the north of the area
- Connection with the district heating system of Stadtwerke Heidelberg in the 80s, new usage of the heating plant

Energy Optimized Conversion of Former Military Installations in Urban Areas - The "Local Two-Way Heating System" 24.01.2023 2 | stadtwerke heidelberg

The Patrick Henry Village (PHV) in Heidelberg – Future Prospects

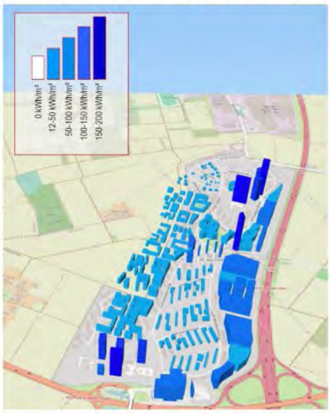
Source: www.kcap.eu/projects/8/phv-heidelberg

Energy Concept for the New City District – Simulation of Heating and Cooling Demand

stadtwerke heidelberg | RWTH AACHEN UNIVERSITY | ENERKO changing energy | bbh

Heating density [kWh/m²]

Cooling density [kWh/m²]



Energy Concept for the New City District – The Heating Systems

Heat distribution

Low-temperature heating System

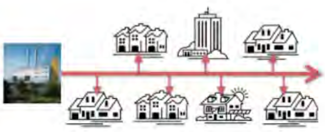
- For the existing buildings (Cluster A1, B1, B3, B4, B5)
- Hydraulic decoupling from the long-distance heating system through the energy control center
- Flow temperature ~ 70-85°C
- Reuse of the existing heating pipeline as far as possible

'Local Two-Way Heating System' (heating + cooling)

- For new buildings with high energetic standard
- Flow temperature: for heating 10-20°C, for cooling 4-14°C
- Direct integration of lost heat from production processes or environmental heat, like heat from sewage and from geothermal probes → Temperature increase via heat pumps utilized by the consumers
- Pipelines: no thermal insulation, higher volume flow rate

Characteristics of the Heating Systems

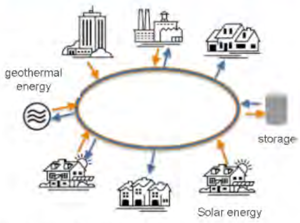
Low-Temperature Heating System



Unidirectional System:

- Central heat energy production
- Energy flow in one direction
- Two-pipe system for heating: flow and return flow

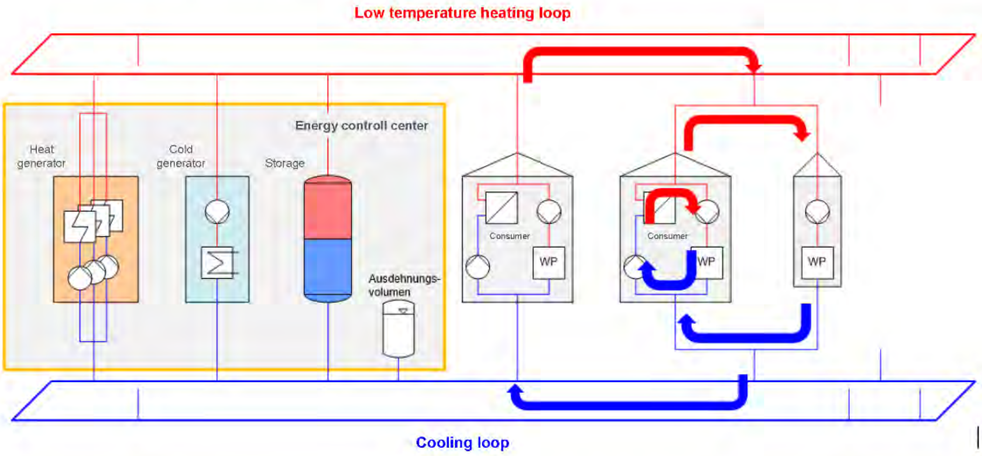
'Local Two-Way Heating System'



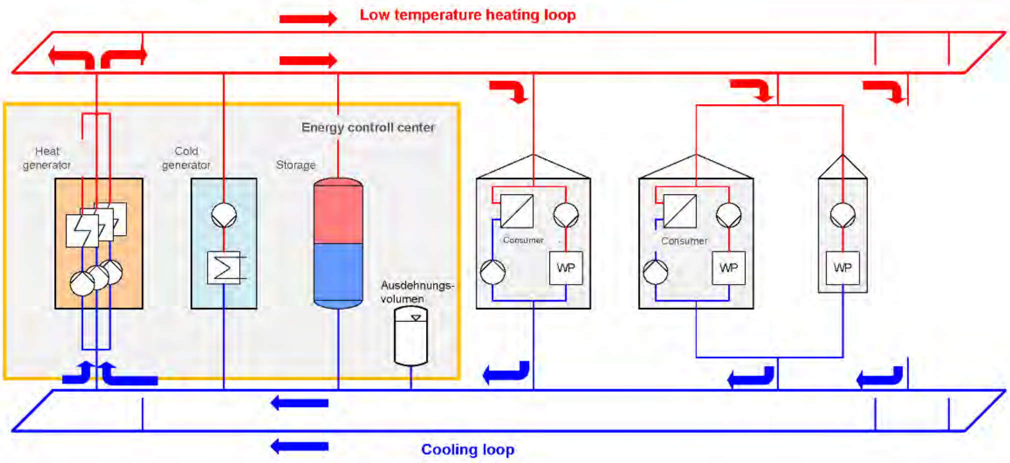
Bidirectional System:

- Decentral pumps on the consumer level
- Positive and negative energy flows
- One pipe for heating and one pipe for cooling

„The Local Two-Way Heating System“ – Energy Optimization



„The Local Two-Way Heating System“ – Energy Optimization



“The Local Two-Way Heating System“ – Energy optimization for the Patrick Henry Village in Heidelberg

Summary

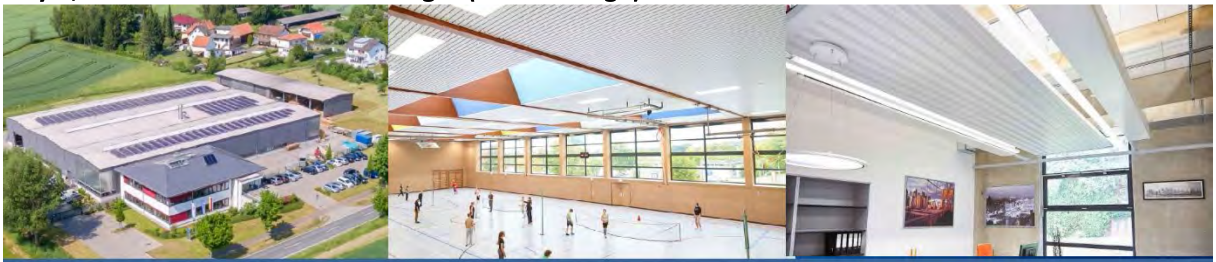
- ✓ Bidirectional heating system with one pipe for heatig and one pipe for cooling
- ✓ Low temperature (ambient temperature)
  → low energy losses
  → direct integration of local environmental heat sources
- ✓ Energy balancing on three levels: consumer, cluster and loop
  → savings in energy production
  → balancing of energy supply and demand

wechsel-warmes NETZ

2020 | 2021 INNOVATIV DURCH FORSCHUNG Ausgezeichnet durch den Stifterverband HYD3577FRE

Energy Optimized Conversion of Former Military Installations in Urban Areas - The "Local Two-Way Heating System" 24.01.2023 10 stadtwerke heidelberg

Day 2, "Net-Zero Industrial Buildings" (Klaus Menge)



January 20, 2023

International Forum Towards a Secure Energy Supply
in a Net Zero Emission Society

Net-zero industrial buildings

Dr.-Ing. Klaus Menge

FRENGER SYSTEMEN BV

Who is FRENGER?

FRENGER SYSTEMEN BV

FRENGER SYSTEMEN BV
An international leader in radiant heating

- Energy efficiency by radiant heating systems is FRENGER`s core business
- A lot of know how exists in heat sources, chillers, control units
- Further know how does exist in thermal envelopes
- Concept on building and technology describes future
- To understand all efforts FRENGER`s core business needs to be explained

1/27/2023 2

FRENGER`s project

FRENGER SYSTEMEN BV

Factsheet

- Location: Heubach near Frankfurt
- Application: Development and production of radiant heating and cooling systems; chilled beams
- Size of Warehouse and manufacturing area: 7.000 m²/77,000 sq.ft.
  Size of office:
  1.500 m²/16,500 sq.ft.
- Radiant heating and cooling paired with chilled beams for heating, cooling and de-humidifying
- No mechanical ventilation system

➢ **Task: FRENGER`s building shall be a „PLUS BUILDING“, not just Net-Zero**

1/27/2023 3

FRENGER`s project

FRENGER SYSTEMEN BV

➢ Located in beautiful countryside
➢ Area is protected nature area
➢ No industrial zone

➢ Responsibility to people living around, nature and landscape 4

FRENGER`s project

FRENGER SYSTEMEN BV

The new home of energy efficiency – where the future starts

General task:
-Compared to ENEV 2007 60% lower energy consumption
-Compared to ENEV 2009 30% lower energy consumption

All calculation had to be made using condensing boilers
Results will be even another 25% better when using heat pumps

Multiple ways for reducing energy consumption

➢High efficiency radiant panels for heating and cooling with 81% radiant output

➢Perfect building envelope (insulation and air tightness)

➢Multiple thermal zones correlating to user`s requirements and workflow

➢Efficient way of generating heat (not clear how at beginning of planning)

➢Efficient lighting and computer technology

➢**Task: FRENGER`s building shall be a „PLUS BUILDING“**

5

FRENGER`s project

FRENGER SYSTEMEN BV

Energy concept

➢High efficiency heat pumps shall provide heat at 35°C/95°F for heating of all offices, production building and warehouses

➢Cooling shall be provided free of energy consumption

➢Process heat for painting shall be provided by heat pump

➢COP > 7 to meet FRENGER`s environmental policy →**“Plus building“**

➢COP > 7 can be met with innovative concept

➢Natural energy needs to be at high level

➢Bore holes >= 800 m / 2640 ft deep

➢Wood chip boiler as backup system if heat pump is switched off for temperature/ground studies by Kassel University

➢Wood chip boiler to be fed with wood chips from waste only

FRENGER`s project

FRENGER SYSTEMEN BV

Energy savings start with right choice of heating/cooling system…

➢Warehouse and manufacturing areas are being heated with high efficiency radiant panels

➢radiant output of 81% to achieve another 15% lower energy consumption compared to any other radiant panel

➢Offices heated, chilled and de-humidified by radiant ceiling and chilled beams

FRENGER`s project

FRENGER SYSTEMEN BV

Energy savings go on with the right choice of windows, rooflights and insulation…

Task: As much daylight as possible and lowest heat loss
Problem: Windows and rooflights have worst U-values of building envelope

→Solution FRENGER: Triple-glazed windows in all parts of buildings (U-value 0.8)

→Solution FRENGER: Transparent polycarbonate elements for much daylight (U-value 0.8)

→Solution FRENGER: 200 mm mineral wool as roof insulation

→Solution FRENGER: 100 mm insulation below concrete floor even in warehouse and production

FRENGER`s project

FRENGER SYSTEMEN BV

…and ends up with lighting, a building management system and clever server choices

Task:

→Solution FRENGER: Installation of modern dimmebale light fittings with daylight and movement detectors connected to a building management system

→Light fitting to be equipped with latest technologie of illuminant – studies guided us to T5-35 W techologie with overhead mirrors (no LED due to several reasons)

→Building management systems controls heating, cooling, lighting, roof lights

→Only green mode servers, online USV`s and no print servers/backup servers shall be used

FRENGER`s project

FRENGER SYSTEMEN BV

What about primary energy and water?

➢Electrical energy is being generated in a 55 kWp PV-System (2012)

➢55 kWp provide enough electrical energy to cover consumption of heating and cooling with heatpump and lighting

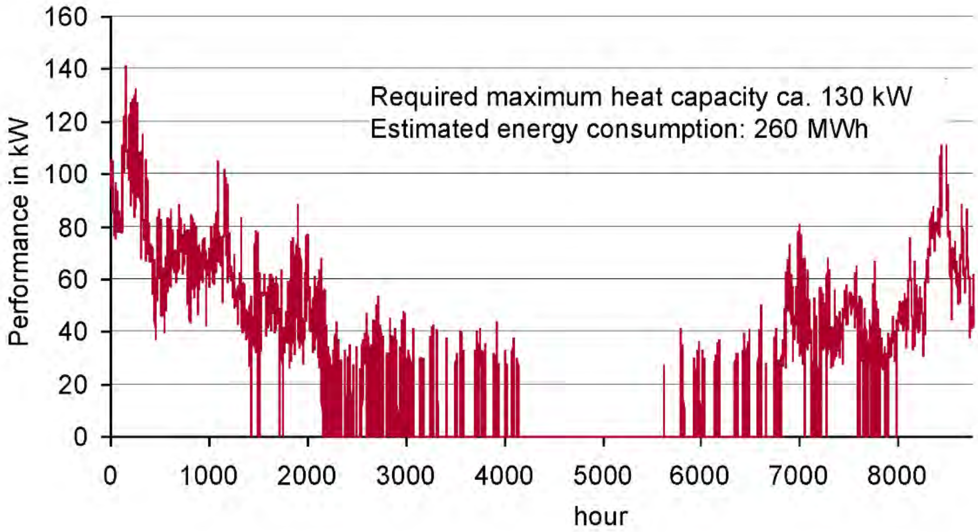
➢Rainwater is being collected and used as graywater for toilets

➢Rainwater is being collected in a reservoir after thunderstorms to prevent floodings

FRENGER`s project

FRENGER SYSTEMEN BV

Course of the year of heat requirement



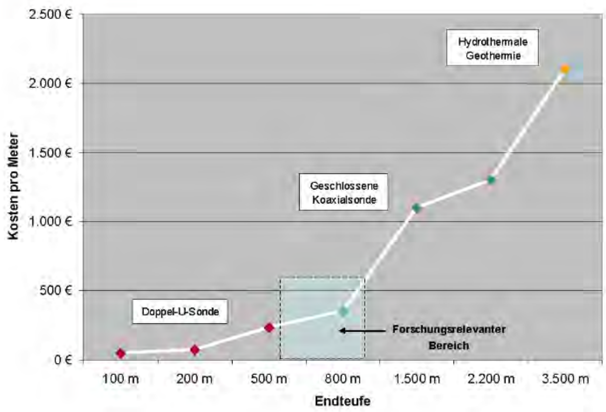
FRENGER`s project

FRENGER SYSTEMEN BV

Introduction: Ground soure

- Deep ground source:
  - Bore hole: > 400 m
  - Application: Heating or generating electricity
  - Bore holes: coaxial heat exchangers
  - Generation of electricity: Steam turbines

  CHP (Flow > 90°C)



FRENGER`s project

FRENGER SYSTEMEN BV

Reasons for choosing a deep coaxial heat exchanger

- Advantages compared to standard ground source (<100 m; 333 ft):
  - just one hole – minimizes land requirement
  - Estimated COP of 7-8 due to very high ground temperature
  - Water can be used as fluid (no anti-freeze required)

- Advantages compared to very deep ground source
  - Mobile drilling machine
  - Moderate costs due to acceptable hole diameter

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FRENGER`s project

FRENGER SYSTEMEN BV

General design parameters

- Heat capacity P_{th} = 130 kW, Flow temperature 35 °C
- Cooling capacity P_{th} = 45 kW, Flow temperature 13 °C
- Tiefe Koaxialsonde für heating: ca. 800 m / 2700 ft.
- Double-U-pipe heat exchanger for cooling: 800 lin.m / 2700 ft.
- Two heat pumps
  - deep ground source 90 kW
  - standard ground source 40 kW

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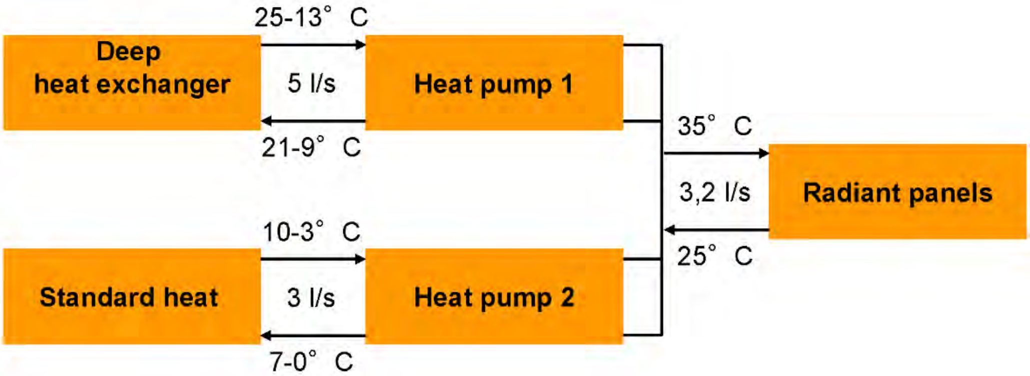
FRENGER`s project

FRENGER SYSTEMEN BV

Working concept



FRENGER`s project

FRENGER SYSTEMEN BV

Results:

- Successful energy concept
- Blower-Door test confirmed air exchange rate of 0.06/h
- Heat demand 10 kWh/m² a for heating
- 1,4 kWh/a of electricity for heat pumps

- **Perfect combination of radiant panels, heat pump and building**
- **Perfect combination to be energy efficient and independent from energy suppliers**

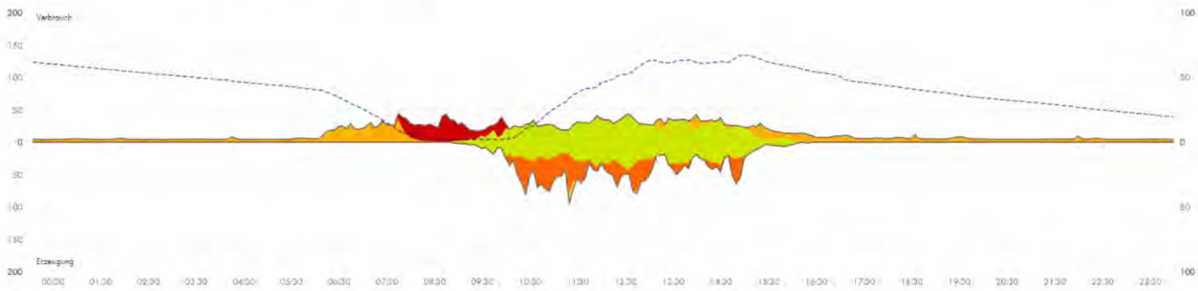
FRENGER`s project

FRENGER SYSTEMEN BV

Recent project development:

- ➢Additional PV-System with 600 kWp in total
- ➢304 kWh battery system
- ➢Optimisation of existing light fittings/installations

→ Whole energy demand of production process is now covered nearly all year round, too!



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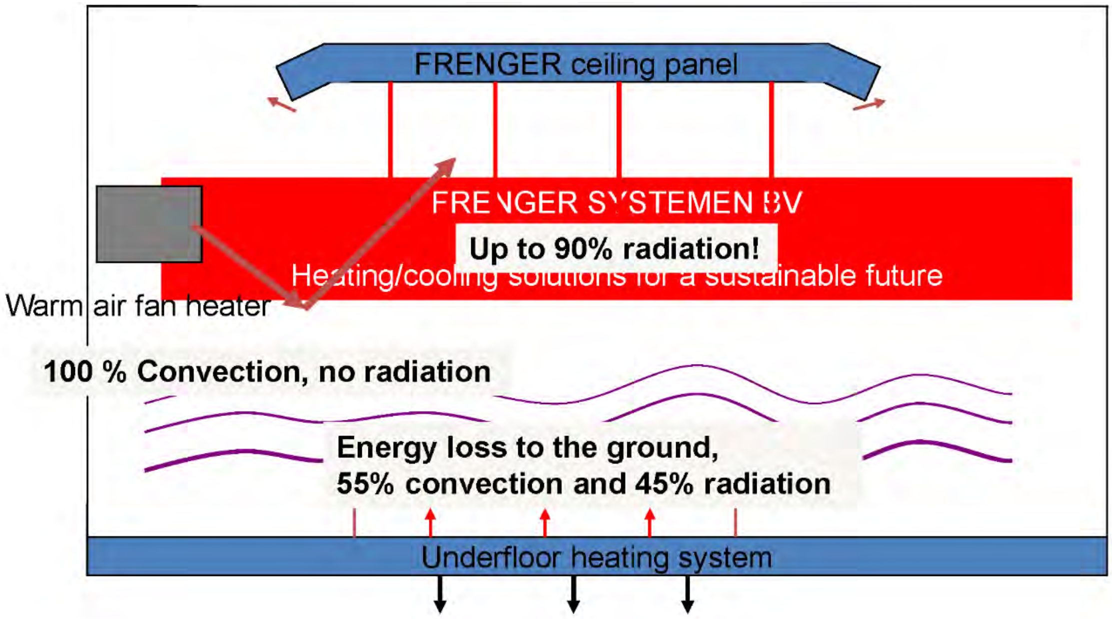
Basics – working principle

FRENGER SYSTEMEN BV



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Army reference

FRENGER SYSTEMEN BV

Case Study – Wiesbaden Army Airfield – Hangar 1035
Installation of radiant panels

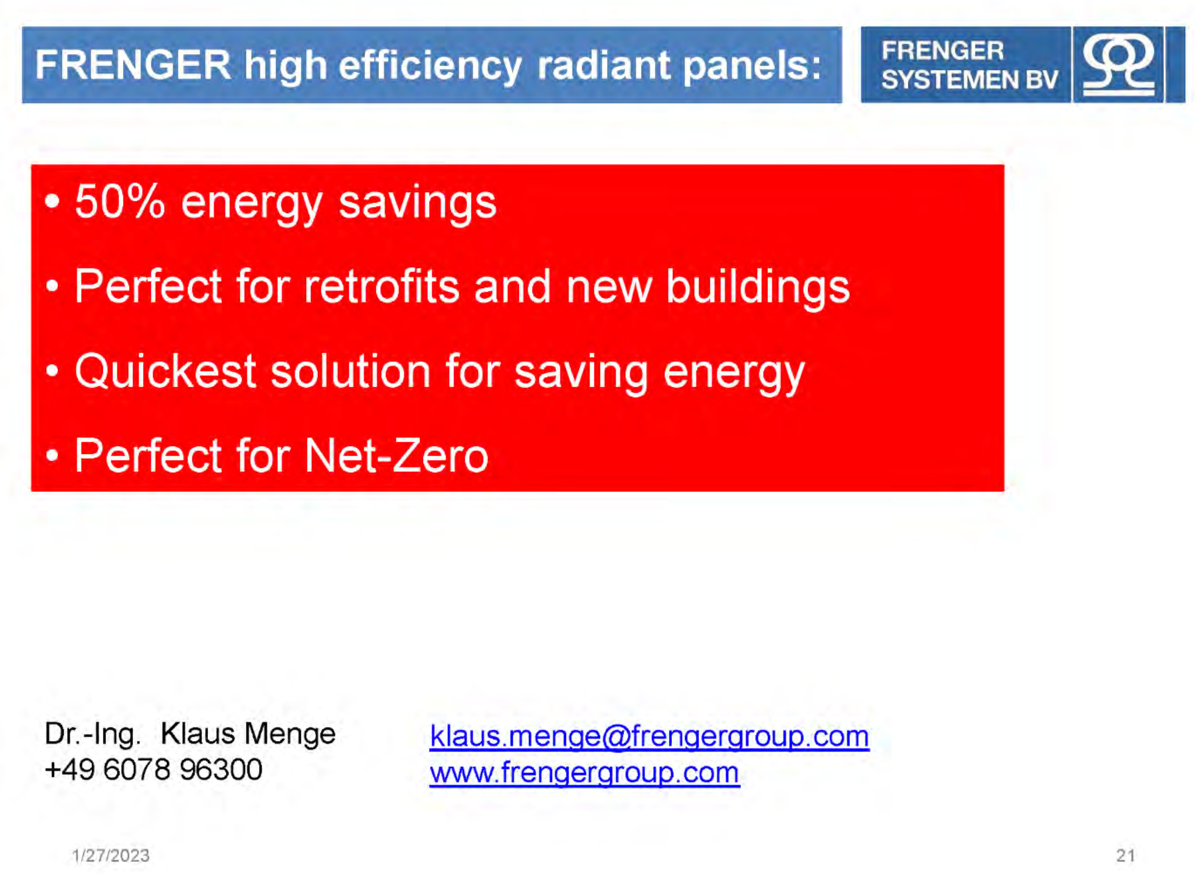
Project Data	
Size of structure	11,329 sq.ft.
Type of building	Hangar
Height	33 ft
Radiant panel model	ECO EVO PLUS
Originally installed heat capacity	228 kW 778,500 BTU/h
Heat capacity of radiant panels	149 kW 509,000 BTU/h
Reduced heat capacity of radiant panels	**79 kW** **270,000 BTU/h**
CO_2 - reduction (average)	**50,000 kg/year**
Energy consumption reduction	**853 M BTU**

Product benefits

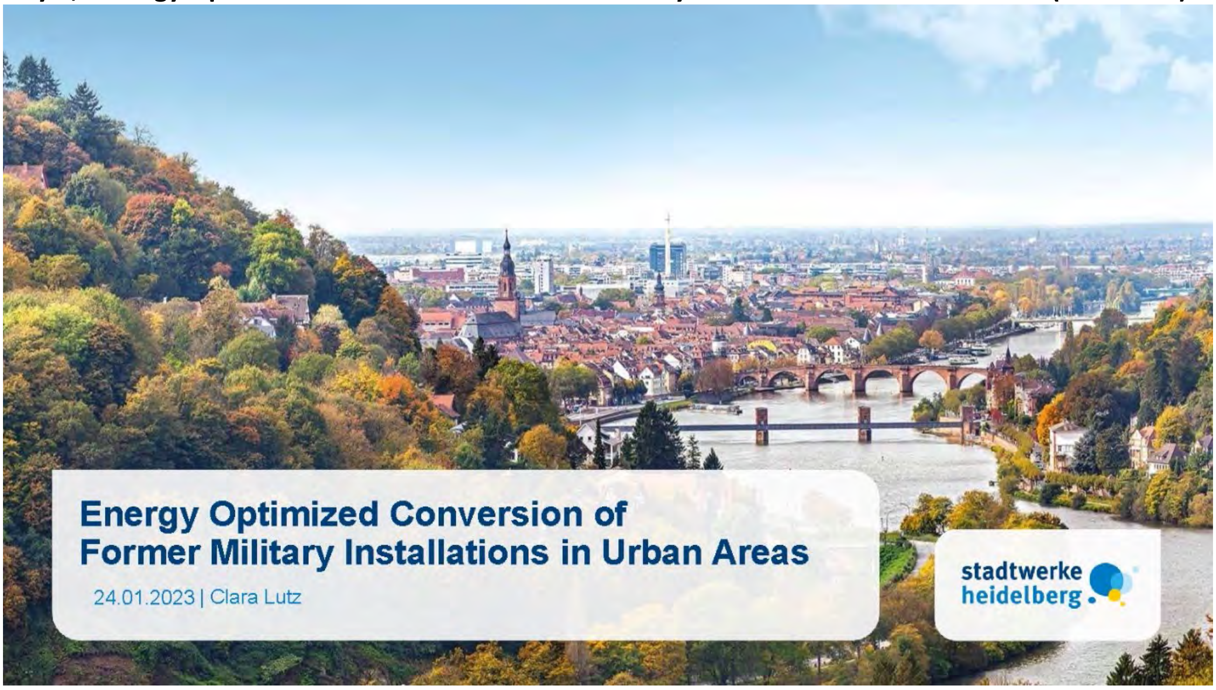
FRENGER SYSTEMEN BV

Advantages of FRENGER ceiling panels:

- ✓Energy savings of up to 50%
- ✓Rapid warming up
- ✓Maintenance free – no moving parts
- ✓Noiseless – no fans
- ✓Life expectancy > 30 years
- ✓Hygienic - no air movement
- ✓Easy to install - for new and existing buildings
- ✓Very lightweight – just 14 kg/m² including Water
- ✓No replacement of concrete floor



Day 2, "Energy Optimized Conversion of Former Military Installations in Urban Areas" (Clara Lutz)



The Patrick Henry Village (PHV) in Heidelberg – History, Development and Future Prospects

Location and dimension:

- About 6 km from the old Town of Heidelberg
- Covering an area of about 100 hectares

1954-2014:

- Residential area for members of the US-Army Europe
- Different buildings and building structures
  (Over 250 buildings with around 1,400 residential units)
- Former heating system: district heating system with coal, heating plant located in the north of the area
- Connection with the district heating system of Stadtwerke Heidelberg in the 80s, new usage of the heating plant

Energy Optimized Conversion of Former Military Installations in Urban Areas - The "Local Two-Way Heating System" 24.01.2023 2 | stadtwerke heidelberg

The Patrick Henry Village (PHV) in Heidelberg – Future Prospects

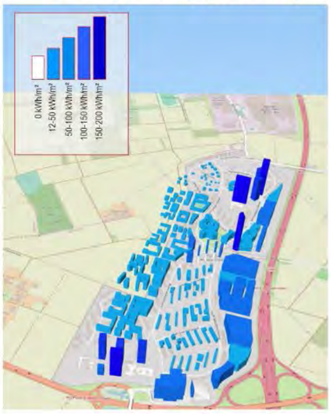
Source: www.kcap.eu/projects/8/phv-heidelberg

Energy Concept for the New City District – Simulation of Heating and Cooling Demand

stadtwerke heidelberg RWTH AACHEN UNIVERSITY ENERKO changing energy

Heating density [kWh/m²]

Cooling density [kWh/m²]



Energy Concept for the New City District – The Heating Systems

Heat distribution

Low-temperature heating System

- For the existing buildings (Cluster A1, B1, B3, B4, B5)
- Hydraulic decoupling from the long-distance heating system through the energy control center
- Flow temperature ~ 70-85°C
- Reuse of the existing heating pipeline as far as possible

'Local Two-Way Heating System' (heating + cooling)

- For new buildings with high energetic standard
- Flow temperature: for heating 10-20°C, for cooling 4-14°C
- Direct integration of lost heat from production processes or environmental heat, like heat from sewage and from geothermal probes → Temperature increase via heat pumps utilized by the consumers
- Pipelines: no thermal insulation, higher volume flow rate

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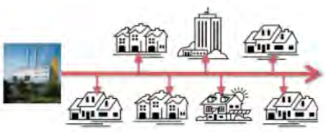
Characteristics of the Heating Systems

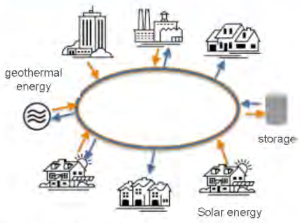
Low-Temperature Heating System



Unidirectional System:

- Central heat energy production
- Energy flow in one direction
- Two-pipe system for heating: flow and return flow

'Local Two-Way Heating System'



Bidirectional System:

- Decentral pumps on the consumer level
- Positive and negative energy flows
- One pipe for heating and one pipe for cooling

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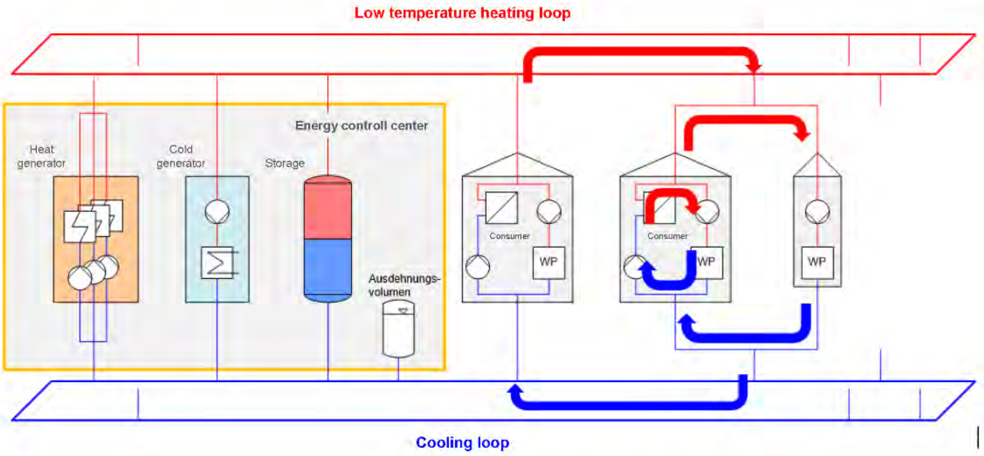
„The Local Two-Way Heating System“ – Energy Optimization



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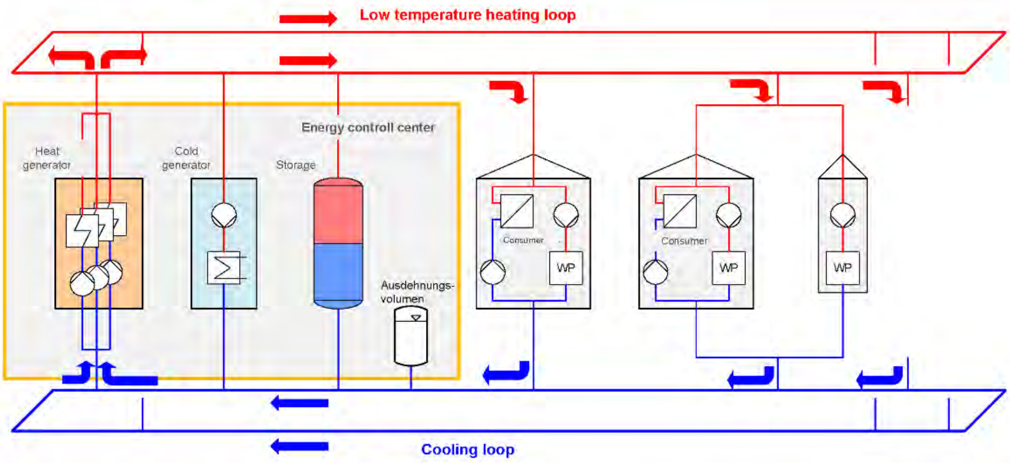
„The Local Two-Way Heating System“ – Energy Optimization



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“The Local Two-Way Heating System“ – Energy optimization for the Patrick Henry Village in Heidelberg

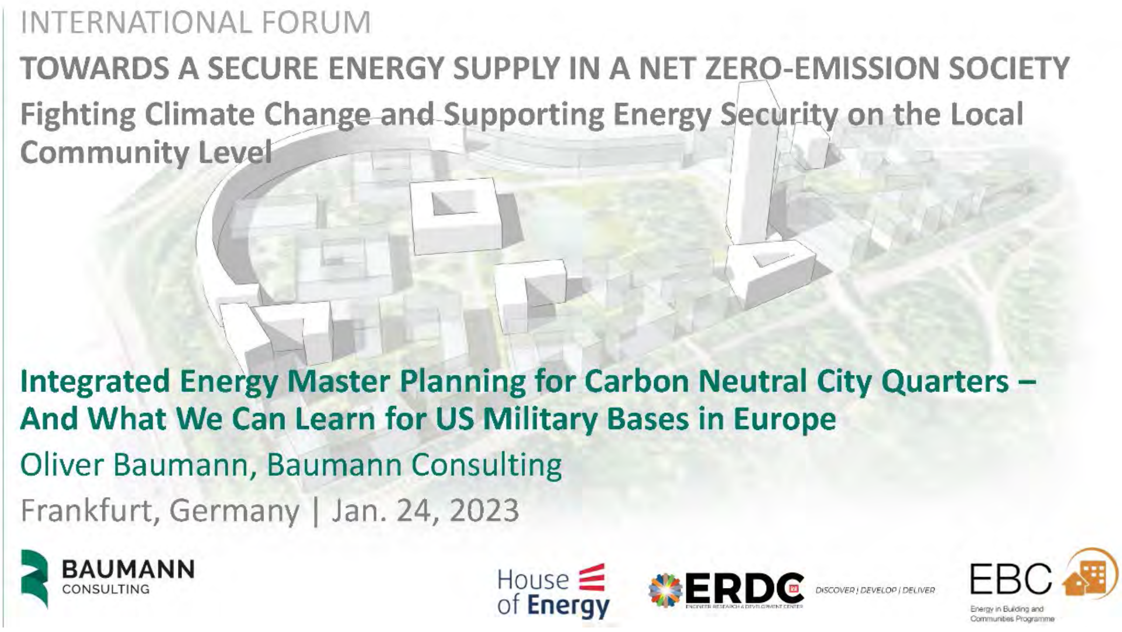
Summary

- ✓ Bidirectional heating system with one pipe for heatig and one pipe for cooling
- ✓ Low temperature (ambient temperature)
  → low energy losses
  → direct integration of local environmental heat sources
- ✓ Energy balancing on three levels: consumer, cluster and loop
  → savings in energy production
  → balancing of energy supply and demand

wechsel-warmes NETZ

Energy Optimized Conversion of Former Military Installations in Urban Areas - The "Local Two-Way Heating System" 24.01.2023 10 stadtwerke heidelberg

Day 2, "IEMP-Carbon Neutral City Quarters" (Oliver Baumann)



In 2006, German-native Oliver Baumann relocated to the United States to establish Baumann Consulting, a specialty consulting firm for energy efficiency and sustainability. As the President and CEO, he successfully developed the business from a one-man operation to a reputable international firm with a staff of over 40 located in three offices across two continents.

Oliver has more than 25 years of experience in modeling, design, commissioning, and measurement & verification for high-performance buildings. After joining the EB-Group in Munich in 1996, he went on to establish the Building Simulation Group and later served as Project Manager for integrated building design and low-energy projects and Head of the International Projects Group. Oliver earned his Diploma (Dipl.-Ing. / M.Sc.) in Mechanical Engineering / Energy & Process Engineering from the Technical University of Munich in 1997.

Building on his experiences in Germany, Oliver's expertise covers the entire lifecycle of commercial, institutional, and industrial buildings and facilities, from developing innovative energy concepts, peer review for design, quality assurance during construction, and measurement & verification of building performance and operation. As an advisory expert to building owners and project teams, Oliver advances cutting-edge best practices for high-performance buildings to maximize return on investment. Oliver also works to guide universities and communities to develop and implement campus-wide and community-wide integrated energy master plans.

One of the top engineering executives in the industry, Oliver earned the prestigious distinction of being named Consulting-Specifying Engineer Magazine's 40 Under 40 list in 2009. Under Oliver's leadership, Baumann Consulting was awarded the prestigious MERLIN Award for Outstanding Service Provider by the German American Chamber of Commerce (2014) and received the IBPSA-USA award for Outstanding Practice (2020). In 2021, Oliver was named an IBPSA-Fellow. Oliver is the author of more than 25 publications and over 100 presentations on performance simulation, commissioning, and operation of energy-efficient buildings. From 2019 through 2021, Oliver has been teaching Building Performance Verification at the Catholic University of America in Washington, DC.

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www.baumann-us.com

Vision & Mission

BAUMANN CONSULTING

As engineers, architects, planners and consultants, our team is driven to provide solutions for a carbon neutral real estate industry.

Our thoroughness and creativity combined with our depth of understanding of the entire life cycle of buildings results in tangible improvements to energy efficiency and sustainability.

IMPACT – SCALE – PERSISTENCE

Vision & Mission

BAUMANN CONSULTING

From our office locations in **Washington, D.C.** (HQ) and **Chicago**, we can conveniently reach project sites across the United States and North America

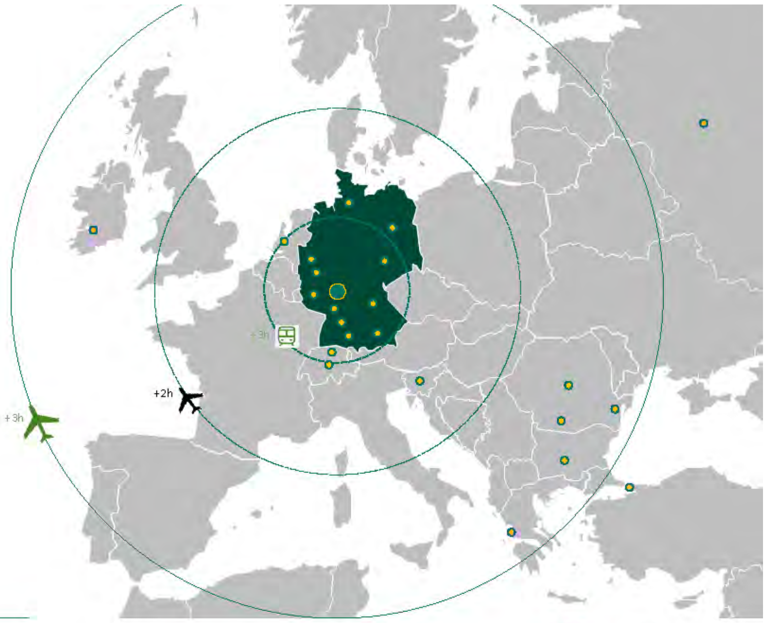
- East Coast / Mid-Atlantic & Midwest
- Eastern half of United States & Ontario
- Entire US & Canada & Central America

Offices & Projects in North America

BAUMANN CONSULTING

From our office location in Frankfurt, we can conveniently reach project sites across Germany and Europe

- Most of Germany
- Central Europe
- Entire Europe



Offices & Projects in Europe

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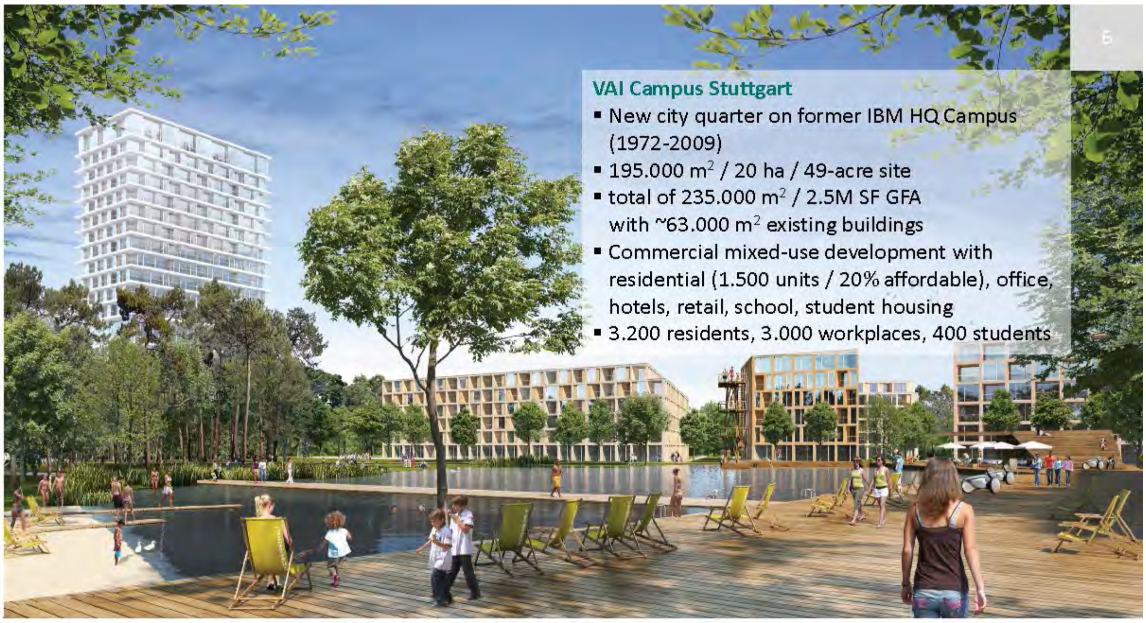

The Project

VAI CAMPUS STUTTGART

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PASSIVE STRATEGIES

OPTIMIZED SYSTEMS

SHARED RESOURCES

ON-SITE RENEWABLES

The Approach – A Word on Loading Order

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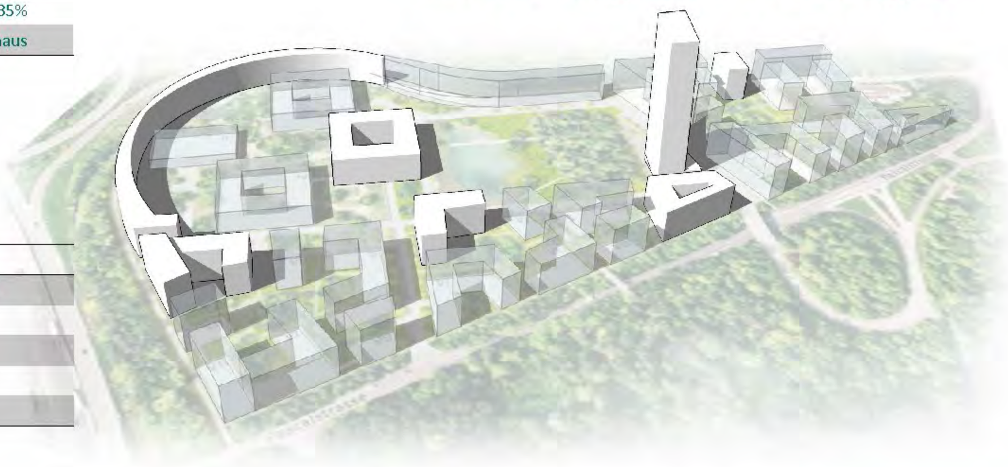
8

Efficiency Scenarios
Code
Code -35%
Passivhaus

28 Buildings……14 Prototypes



Utilization
Residential
Retail
School
Office
Hotel

The Process – Demand Analysis

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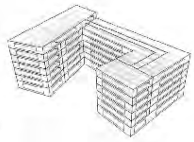
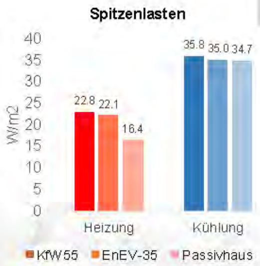
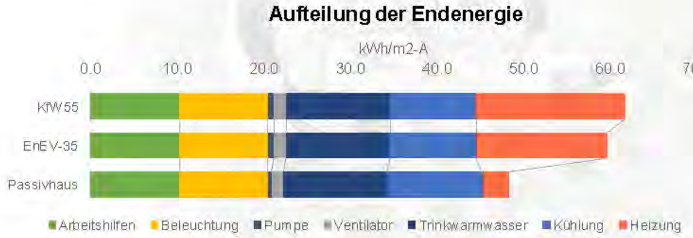
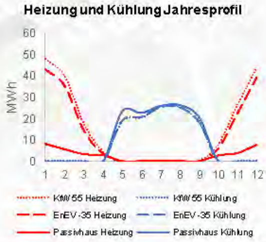
U-WOHNUNG MIT KÜHLUNG INPUTS & ERGEBNISSE

Form		**Interne Warmequellen**	
Geschosse (#)	6.5	Belegungsdichte (m2/P)	15
Geschosshöhe [m]	3	Beleuchtung (W/m2)	3.75
Dachfläche [m2]	1682	Arbeitshilfen (W/m2)	4
Geschossfläche (BGF) (m2)	10807	**Nutzung**	
Außenwandfläche [m2]	5305	Typ	Wohnung
Volumen (m3)	34103	% Belegt	65
Außenluft		Tägliche Nutzungszeit	0:00-24:00
Personbezogen [m3/h-P]	0	Jährliche Nutzungstage	365
Flächenbezogen [m3/h-m2]	10	Trinkwarmwasser [Wh/m2-d]	230









Demand Analysis – Detailed Prototype Modeling

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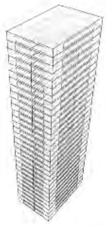
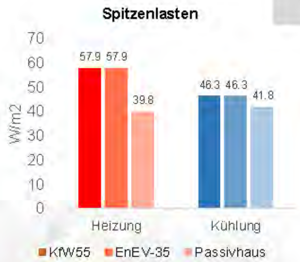
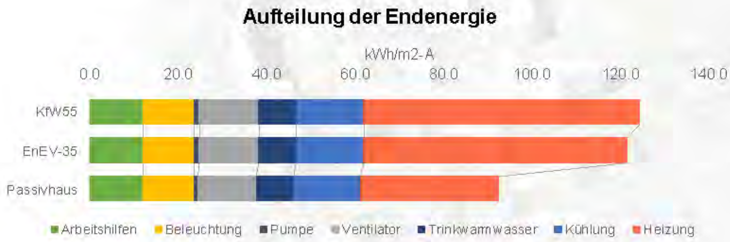
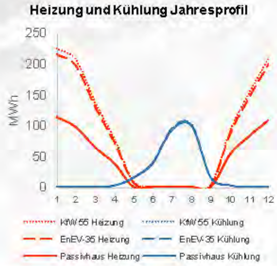
WOHNTURM MIT KÜHLUNG INPUTS & ERGEBNISSE

Form		**Interne Warmequellen**	
Geschosse (#)	31	Belegungsdichte (m2/P)	15
Geschosshöhe [m]	3	Beleuchtung (W/m2)	3.75
Dachfläche [m2]	575	Arbeitshilfen (W/m2)	4
Geschossfläche (BGF) (m2)	17829	**Nutzung**	
Außenwandfläche [m2]	5892	Typ	Wohnung
Volumen (m3)	34509	% Belegt	65
Außenluft		Tägliche Nutzungszeit	0:00-24:00
Personbezogen [m3/h-P]	0	Jährliche Nutzungstage	365
Flächenbezogen [m3/h-m2]	10	Trinkwarmwasser [Wh/m2-d]	230









Demand Analysis – Detailed Prototype Modeling

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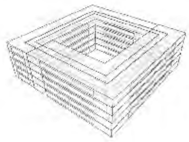
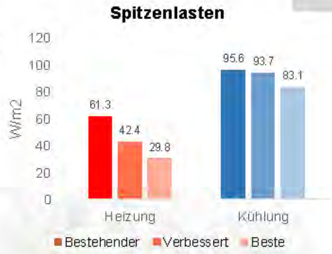
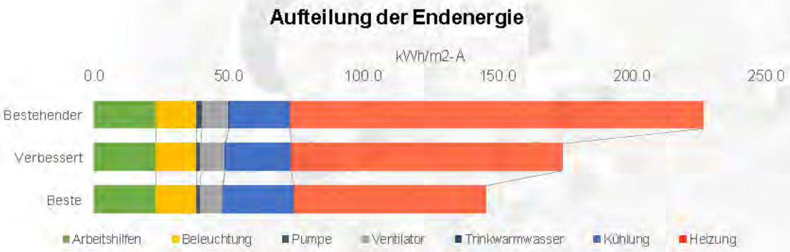
EIERMANN-BÜRO INPUTS & ERGEBNISSE

Form		**Interne Warmequellen**	
Geschosse (#)	5	Belegungsdichte (m2/P)	10
Geschosshöhe [m]	4	Beleuchtung (W/m2)	6.25
Dachfläche [m2]	2870	Arbeitshilfen (W/m2)	10
Geschossfläche (BGF) (m2)	14349	**Nutzung**	
Außenwandfläche [m2]	7552	Typ	Büro
Volumen (m3)	57395	% Belegt	75
Außenluft		Tägliche Nutzungszeit	07:00-18:00
Personbezogen [m3/h-P]	60	Jährliche Nutzungstage	250
Flächenbezogen [m3/h-m2]	6	Trinkwarmwasser [Wh/m2-d]	30







Demand Analysis – Detailed Prototype Modeling

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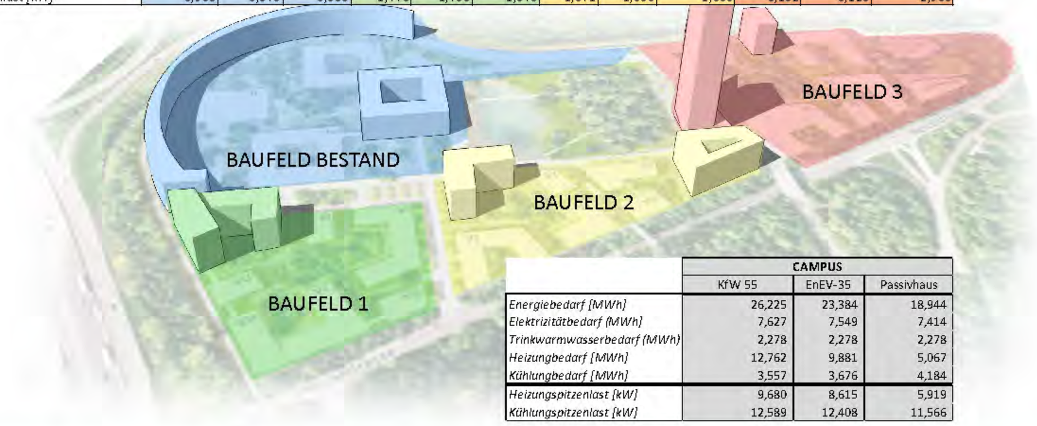
	BAUFELD BESTAND			BAUFELD 1			BAUFELD 2			BAUFELD 3		
	KfW 55 / Ist	EnEV-35*)	Passivhaus*)	KfW 55	EnEV-35	Passivhaus	KfW 55	EnEV-35	Passivhaus	KfW 55	EnEV-35	Passivhaus
Energiebedarf [MWh]	13,425	10,950	8,987	3,392	3,306	2,781	2,963	2,868	2,285	6,444	6,260	4,892
Elektrizitätbedarf (MWh]	3,140	3,071	3,020	1,168	1,165	1,134	1,159	1,156	1,138	2,161	2,157	2,122
Trinkwarmwasserbedarf (MWh)	465	465	465	637	637	637	369	369	369	807	807	807
Heizungbedarf [MWh]	8,229	5,737	3,672	985	890	234	1,041	939	278	2,507	2,315	883
Kühlungbedarf [MWh]	1,592	1,679	1,830	602	614	776	395	404	500	968	980	1,079
Heizungspitzenlast [kW]	4,248	3,330	2,368	1,161	1,121	714	1,445	1,396	939	2,827	2,768	1,897
Kühlungspitzenlast [kW]	5,983	5,876	5,338	1,773	1,750	1,676	1,671	1,656	1,568	3,162	3,125	2,983



	CAMPUS		
	KfW 55	EnEV-35	Passivhaus
Energiebedarf [MWh]	26,225	23,384	18,944
Elektrizitätbedarf (MWh]	7,627	7,549	7,414
Trinkwarmwasserbedarf (MWh)	2,278	2,278	2,278
Heizungbedarf [MWh]	12,762	9,881	5,067
Kühlungbedarf [MWh]	3,557	3,676	4,184
Heizungspitzenlast [kW]	9,680	8,615	5,919
Kühlungspitzenlast [kW]	12,589	12,408	11,566

Demand Analysis – Results

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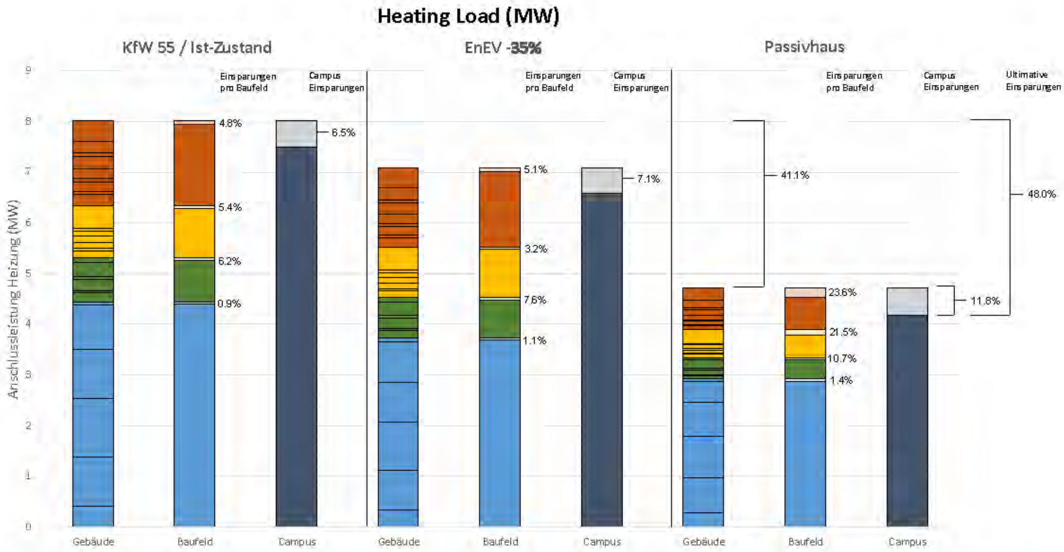

Demand Analysis – Heating Load

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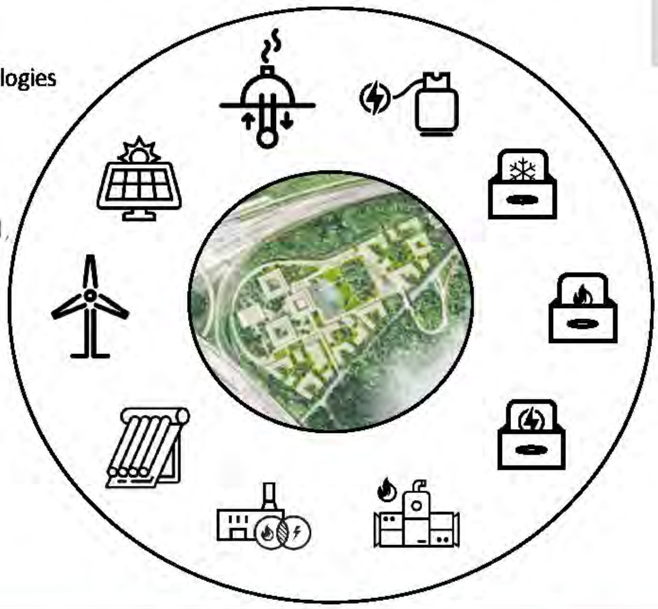
Feasibility and Potential of Supply Technologies

- Geothermal Energy (based on previous feasibility study)
- Photovoltaic (considering all useable roof and façade areas
- Solar Thermal Collectors (roof mounted, façade collectors, etc.)
- Wind Energy
- Sewage Water Heat Recovery
- CHP / Co-generation
- Absorption Chiller
- Ice Storage
- Heat Storage (e.g. "Heatcrete")
- Power2Gas
- Batteries (stationary, mobile)



Supply Technologies

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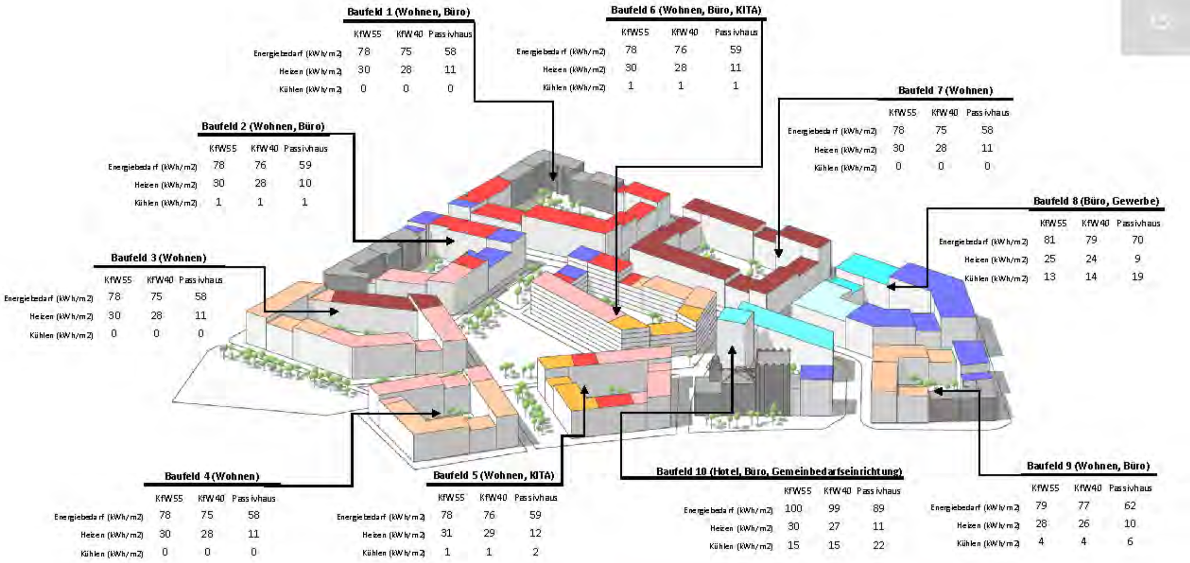

Holsten Quartier – Energy Demand

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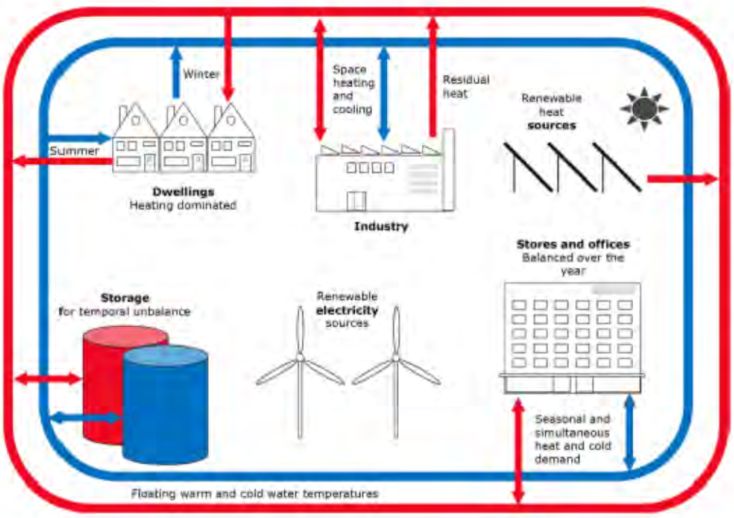

The 5th Generation of District Heating and Cooling network (5GDHC) or *cold district heating* distributes heat at **near ambient ground temperatures**, minimizing grid losses and thus, insulation needs. The main design characteristics are:

- **Bi-directional exchange of thermal energy**: supply of heat means receiving cold and vice versa
- **Thermal storage** at large and small scale, appropriately places, are integrated with the thermal system to balance the demand for heat and cold
- **Demand driven algorithm-based** control that optimizes the exergy flows using real-time data and monitoring

Source: Wikipedia

5th Generation District Energy Grid

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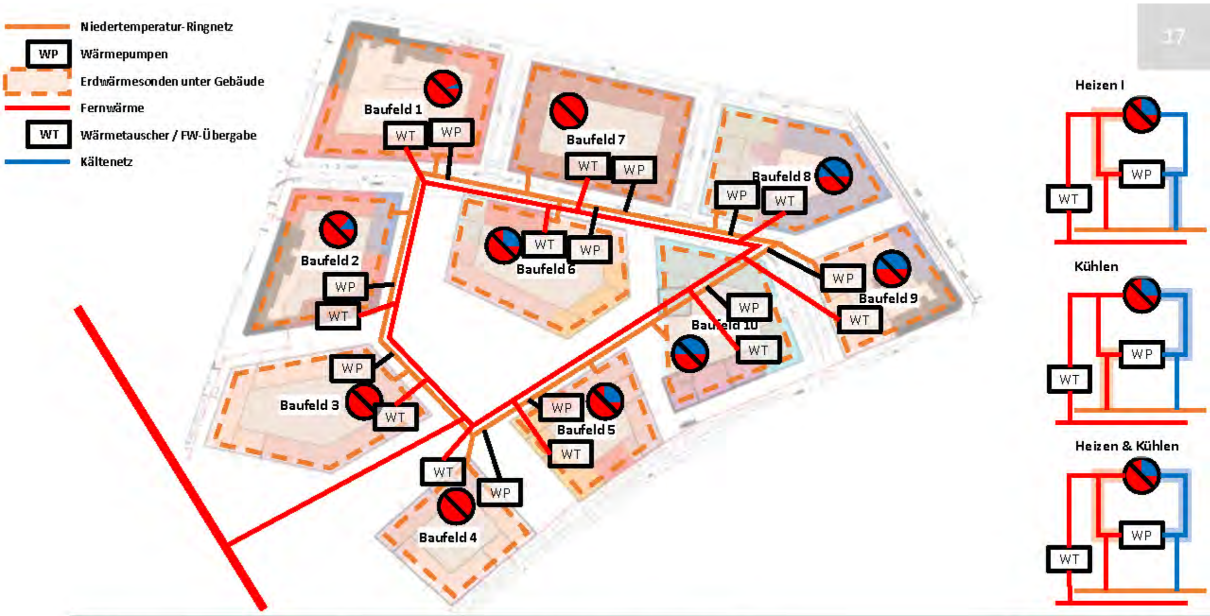

Holsten Quartier – District Energy Supply Concept

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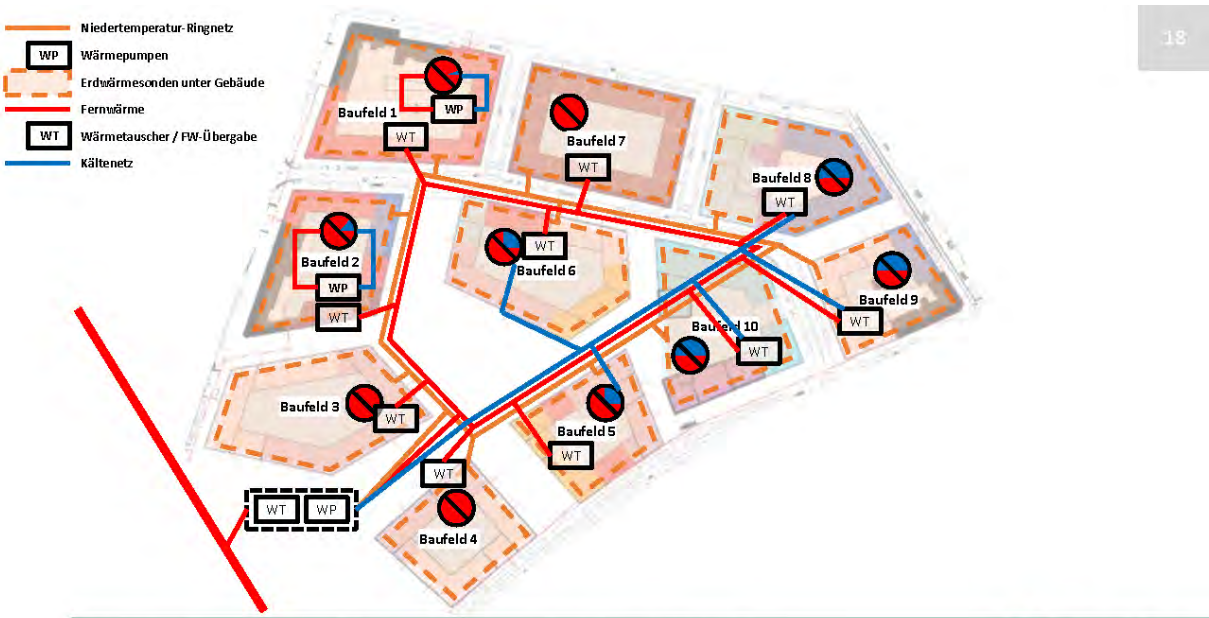

Holsten Quartier – District Energy Supply Concept

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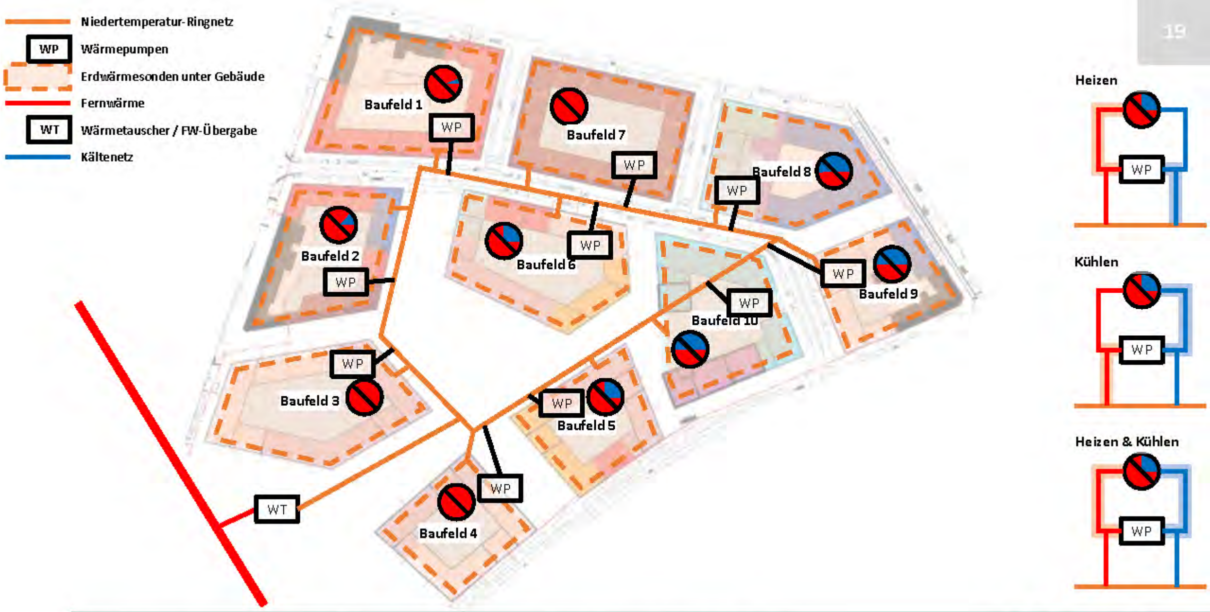

Holsten Quartier – District Energy Supply Concept

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CONCLUSIONS

1. **Energy efficiency** is key and should always be the priority for new and existing buildings – develop and implement design standards
2. **District heating and cooling networks** are crucial for resource sharing between buildings and other potential energy resources - they also provide maximum flexibility on the energy supply side
3. **Decarbonization requires electrification** – heat pumps are a viable and reliable technology
4. **Geothermal energy systems** are part of most of our energy master plans – besides other renewable energy sources
5. Many of our IEMP projects for new and existing campuses and communities have shown **carbon footprint reductions of 60-100%**

Integrated Energy Master Planning

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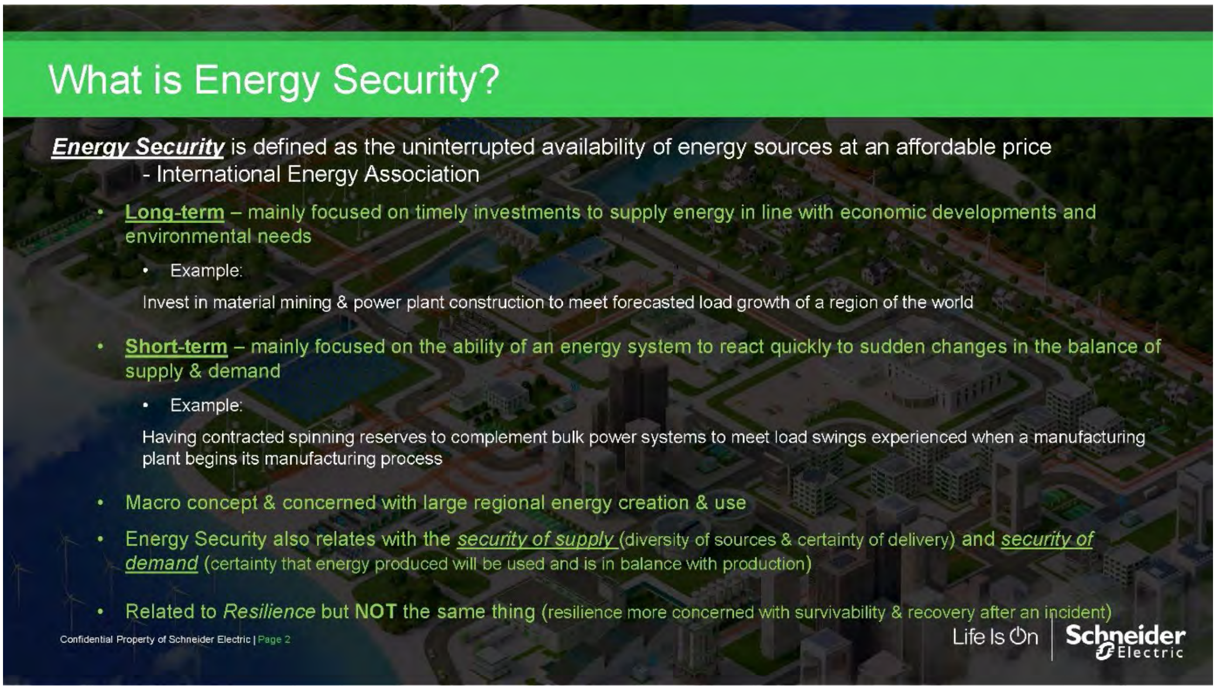
"Day 2, Energy Security in Today's Evolving Environment" (William Pfleger)

http://www.schneider-electric.us/en/work/solutions/microgrid-solutions/


What is Energy Security?
Energy Security is defined as the uninterrupted availability of energy sources at an affordable price
- International Energy Association
Long-term – mainly focused on timely investments to supply energy in line with economic developments and environmental needs
Example:
Invest in material mining & power plant construction to meet forecasted load growth of a region of the world
Short-term – mainly focused on the ability of an energy system to react quickly to sudden changes in the balance of supply & demand
Example:
Having contracted spinning reserves to complement bulk power systems to meet load swings experienced when a manufacturing plant begins its manufacturing process
Macro concept & concerned with large regional energy creation & use
Energy Security also relates with the security of supply (diversity of sources & certainty of delivery) and security of demand (certainty that energy produced will be used and is in balance with production)
Related to Resilience but NOT the same thing (resilience more concerned with survivability & recovery after an incident)
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Life Is On
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On the brink of disruption
"The electricity system that has served us well for 100 years is facing a fundamental threat to its existence."
Life Is On
Schneider Electric
Navigant Research, Liberating Microgrids (and all DER)

The Disruption is Underway….

- Demand for electrical power is on the rise – *48% energy demand increase by 2040* (compared to 2020)
  - EV's will account for 15% of market share by 2035
  - Air Conditioning globally expected to be the largest driver of demand
  - How this new demand will be met is a fundamental threat to Energy Security as its predicted that demand will out pace supply
- Climate Mitigation is a reality
  - Executive Orders 14057 & 14008 targets for 2035
- Renewable & onsite generation technology is increasingly more cost effective
- Utility costs continue to escalate while reliability continues to decline
- Technological evolution will unlock new fuel sources, generation & storage capabilities, load management possibilities & optimization on a scale never seen before (e.g., CA Rule 21 and IEEE 2030.5)
  - Better renewables & storage
  - New energy sources & fuels will become more common place
  - Convergence of IT and OT networks & increased digitization will enable more visibility & load control & optimization

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What does the future look like?

- New Fuels in sync with the natural carbon cycle (carbon neutral fuels)
- Sources (Generators & Storage Systems)
- Loads – the most cost-effective electron is the one avoided, active load shaping & load reservations
- Controls

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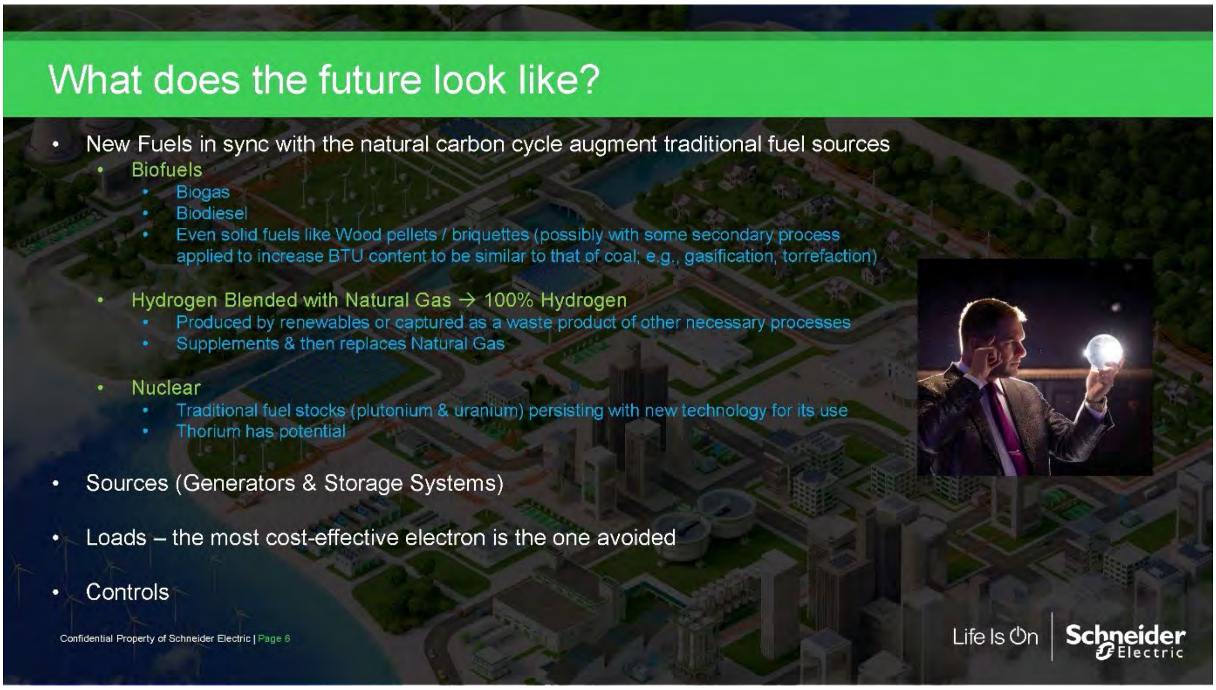
What does the future look like?
New Fuels in sync with the natural carbon cycle augment traditional fuel sources
Biofuels
Biogas
Biodiesel
Even solid fuels like Wood pellets / briquettes (possibly with some secondary process applied to increase BTU content to be similar to that of coal; e.g., gasification, torrefaction)
Hydrogen Blended with Natural Gas → 100% Hydrogen
Produced by renewables or captured as a waste product of other necessary processes
Supplements & then replaces Natural Gas
Nuclear
Traditional fuel stocks (plutonium & uranium) persisting with new technology for its use
Thorium has potential
Sources (Generators & Storage Systems)
Loads – the most cost-effective electron is the one avoided
Controls
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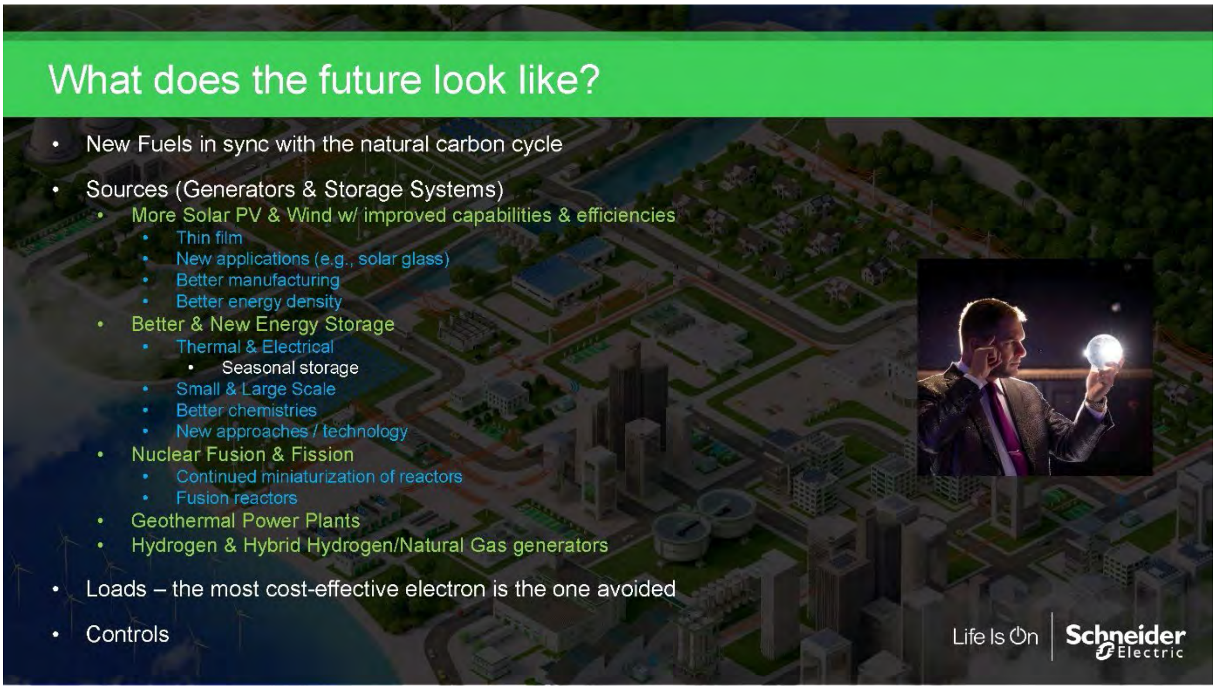
What does the future look like?
New Fuels in sync with the natural carbon cycle
Sources (Generators & Storage Systems)
More Solar PV & Wind w/ improved capabilities & efficiencies
Thin film
New applications (e.g., solar glass)
Better manufacturing
Better energy density
Better & New Energy Storage
Thermal & Electrical
Seasonal storage
Small & Large Scale
Better chemistries
New approaches / technology
Nuclear Fusion & Fission
Continued miniaturization of reactors
Fusion reactors
Geothermal Power Plants
Hydrogen & Hybrid Hydrogen/Natural Gas generators
Loads – the most cost-effective electron is the one avoided
Controls
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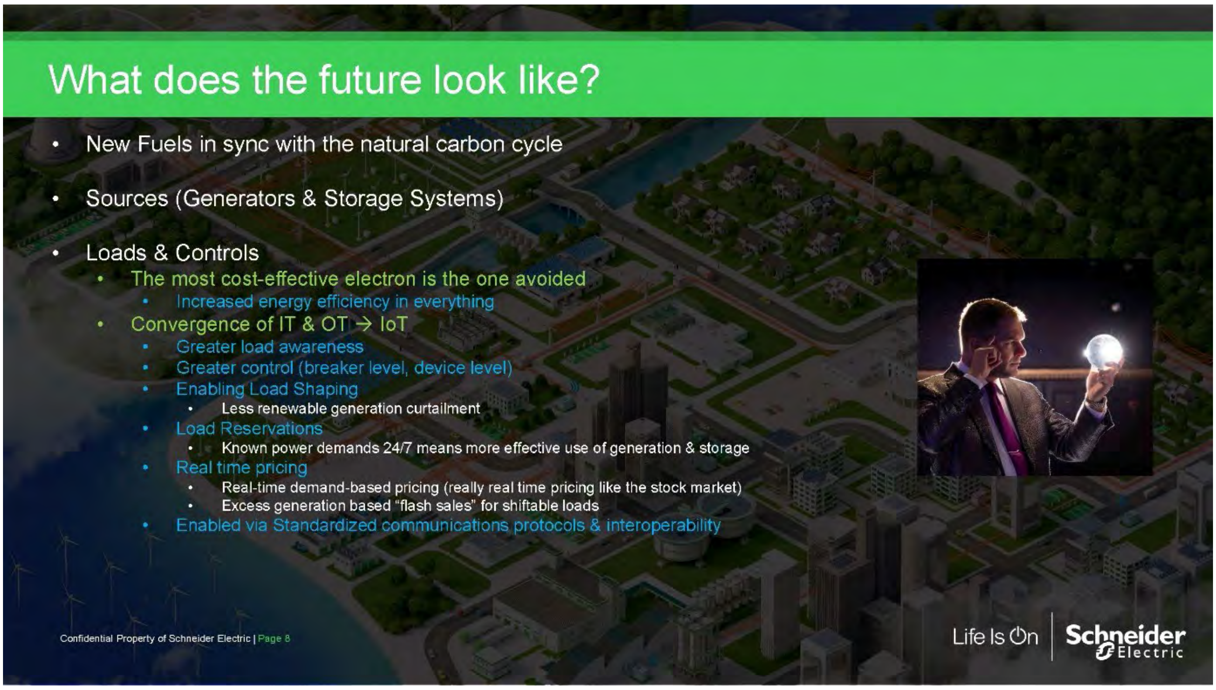
What does the future look like?
• New Fuels in sync with the natural carbon cycle
• Sources (Generators & Storage Systems)
• Loads & Controls
• The most cost-effective electron is the one avoided
• Increased energy efficiency in everything
• Convergence of IT & OT → IoT
• Greater load awareness
• Greater control (breaker level, device level)
• Enabling Load Shaping
• Less renewable generation curtailment
• Load Reservations
• Known power demands 24/7 means more effective use of generation & storage
• Real time pricing
• Real-time demand-based pricing (really real time pricing like the stock market)
• Excess generation based "flash sales" for shiftable loads
• Enabled via Standardized communications protocols & interoperability
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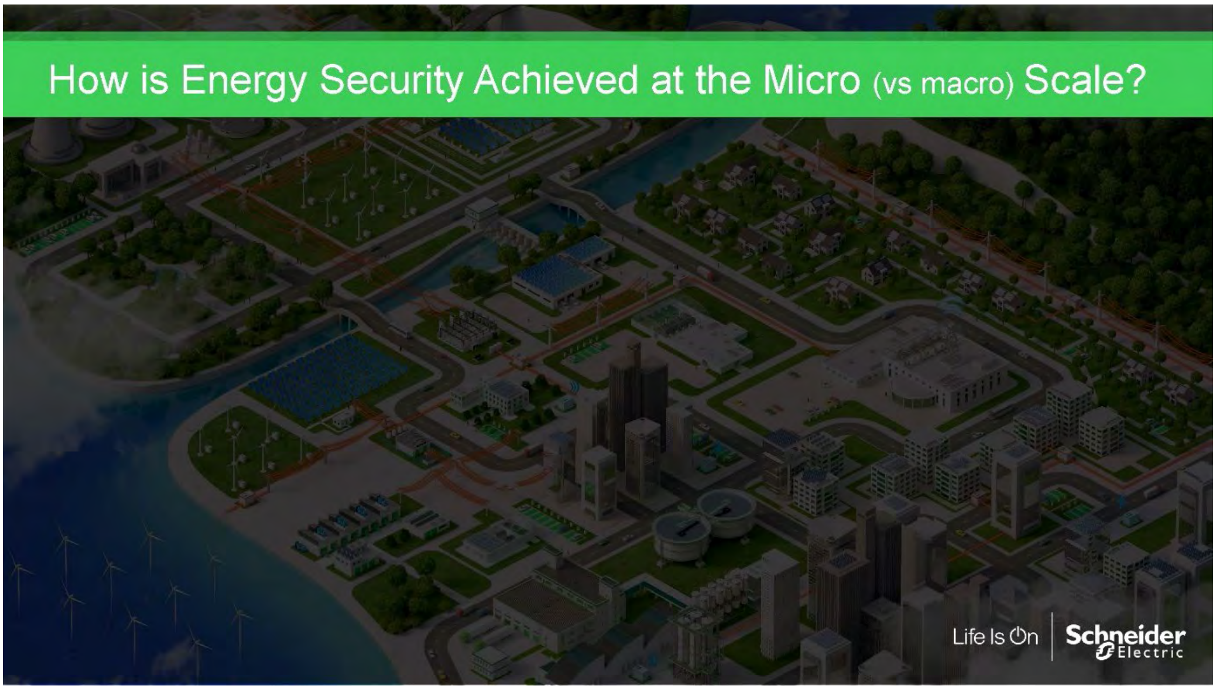
How is Energy Security Achieved at the Micro (vs macro) Scale?
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How is Energy Security Achieved at the Micro (vs macro) Scale…

…when considering E.O. 14057/14008, evolving technology, and the world transition to a zero-carbon economy?

Microgrids

- Multiple regionally specific and performance-based generation and/or storage types
  - Using industry standard, open-source communication protocols
  - Perhaps with various levels of redundancy
- Using multiple fuel sources
  - Stored and/or manufactured onsite
- With Smart Grid automation & awareness
- With significant load monitoring & control enabling load flexibility, reservation, & scheduling
  - All the way down to the end point device
  - Using industry standard, open-source communication protocols
  - *PLAN YOUR LOADS TO THE DEGREE YOU PLAN YOUR MISSIONS*
- Being as carbon neutral as possible
- Being implemented after energy efficiency upgrades
- Future proofed to the extent possible
- Operating with the intend of:
  - Carbon neutrality
  - Economic optimization
  - Ultimate reliability and resilience

What is a Microgrid?

An integrated energy system consisting of interconnected loads and distributed energy resources…

…which as an integrated system can be controlled as a single entity and operate in parallel with the grid or in an intentional *islanded* mode.

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Examples Energy Security Achieved on Base with Microgrids

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Questions?

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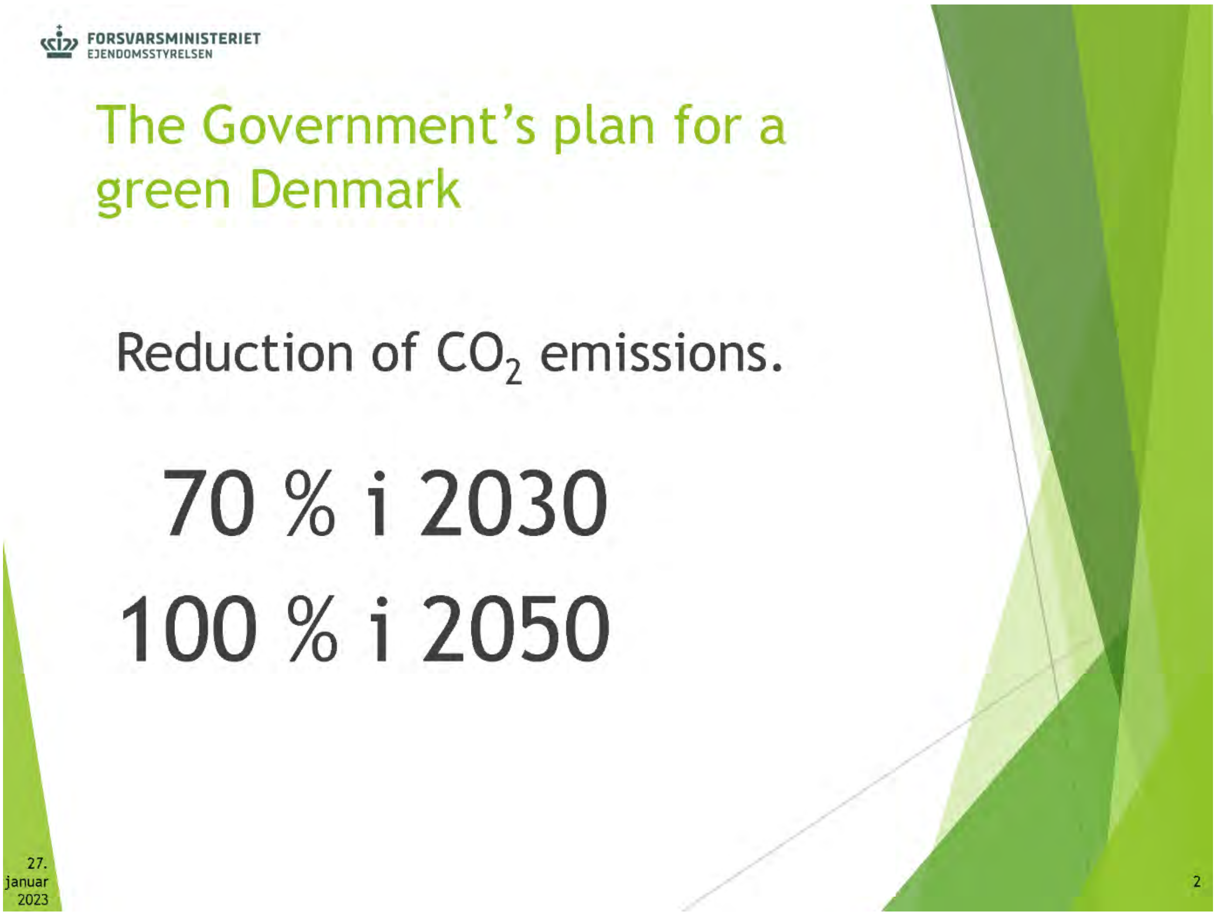
Day 2, “From Fossil Fuels to a Green Future” (Jens Peter Sandemann)



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Energy consumption in the Ministry of Defence

Field of applications	Energy consumption	Fuel	Responsible
Plane	XXX GWh	Kerosine/E-kerosine	FMI
Ships	XXX GWh	Kerosine/E-kerosine	FMI
Operational vehicles	XXX GWh	Kerosine/E-kerosine	FMI
Electricity	124 GWh	The overall power grid / micro grid	FES
Heating	215 GWh	District heating / Gas / Diesel / Heat Pumps	FES

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Facility requirements or a new dogma ☺

1. Fossil free Operation
2. Energy Efficiency
3. Material lifetime optimization
4. Resilience
5. Redundance
6. Security

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Three cases from The Danish Ministery of Defence's green Action Plan

Christiansø

Kongsøre

Kangerlussuaq (Arctic)

Common to all three cases:

Island operation – No public electricity grid or district heating

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The green actionplan

- 1.6.b. Fossil-free energy solution Christiansø

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Green Christiansø

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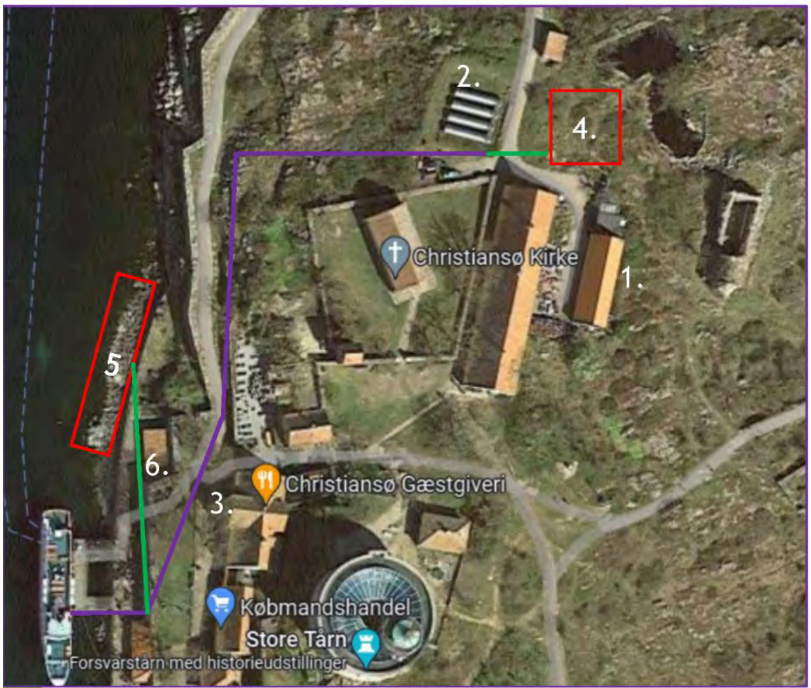

1. Existing CHP
2. Existing diesel storage
3. Existing oil pipeline
4. New CHP
5. New quay (methane storage)
6. New methane pipeline

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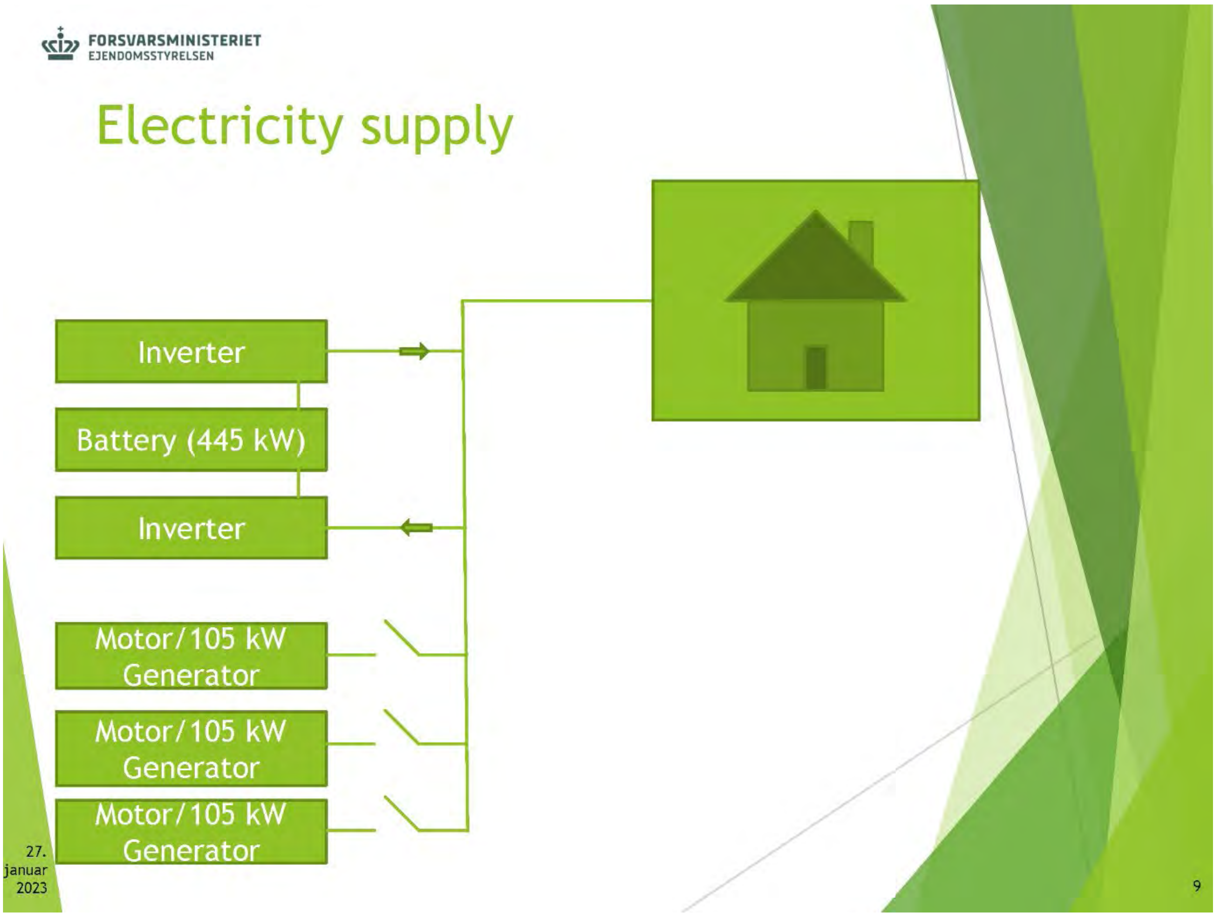
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Electricity supply
Inverter
Battery (445 kW)
Inverter
Motor/105 kW Generator
Motor/105 kW Generator
Motor/105 kW Generator
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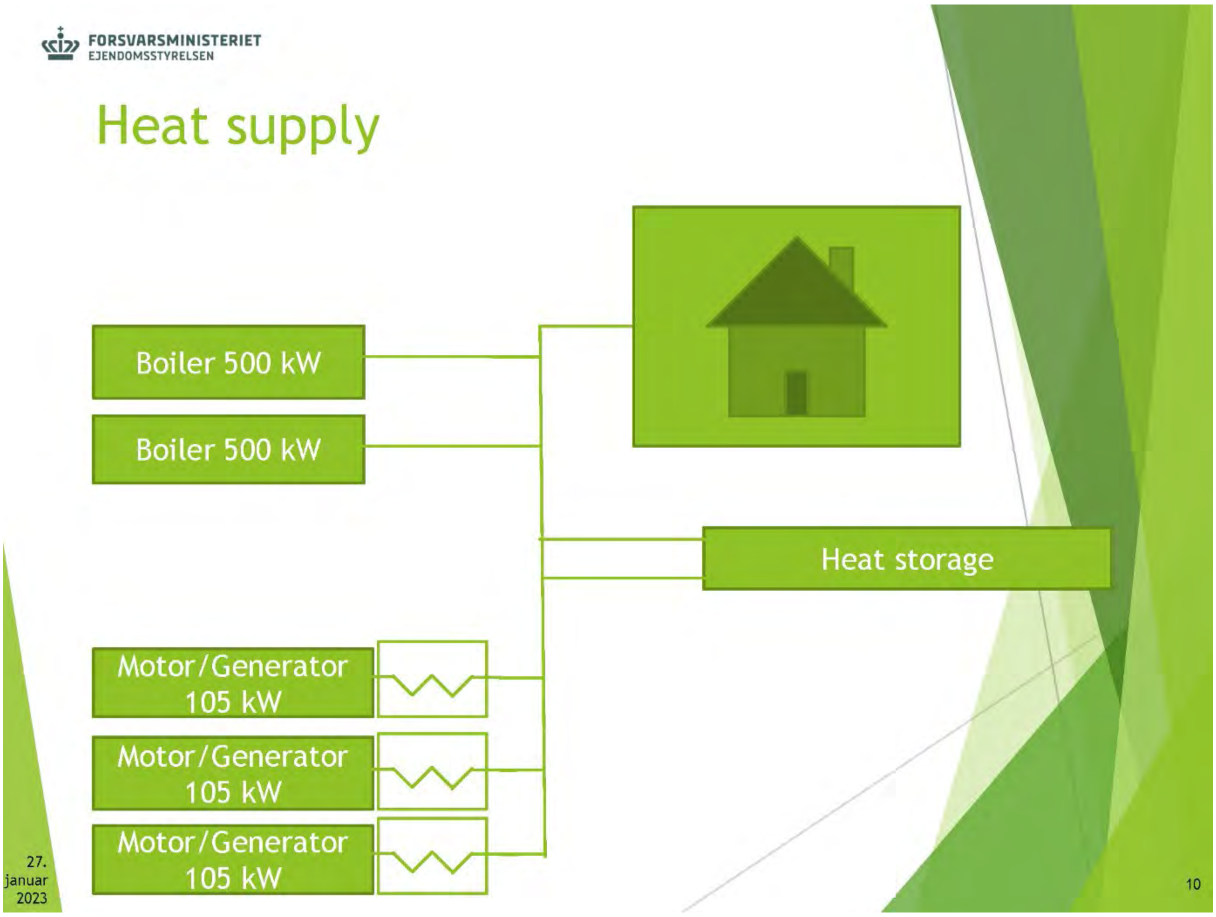
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Heat supply
Boiler 500 kW
Boiler 500 kW
Heat storage
Motor/Generator 105 kW
Motor/Generator 105 kW
Motor/Generator 105 kW
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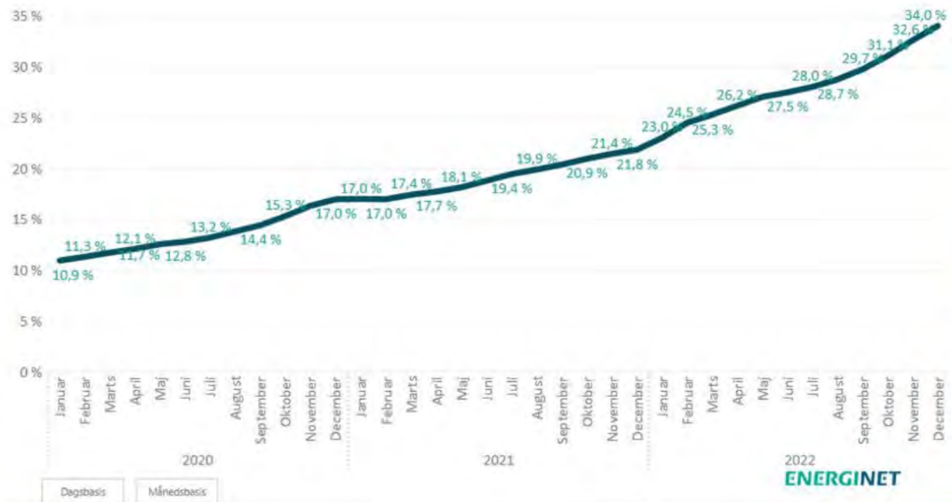
Green gas grid in Denmark

1. Amount of green gas from 2020 til 2022 (10,9 % → 34,0 %)
2. The Goverments plan i Denmark:

100 % green gas in 2035 (according to Energinet)



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Facility requirements

1. Fossil free operation
   - CHP facililty at Christiansø is based on pressurizes methan (250 bar)
2. Energy optimization
   - With battey
   - Utilization of flue gas to district heating or storage
3. Material lifetime optimization
   - 100 % operation On / Off
   - Battery made with replaceable single cells
4. Resilience
   - Salty environment
   - Large temperature difference between summer and winter
5. Redundance
   - Constant poweroutlet from CHP
6. Security
   - Stock of critical spare parts
   - Quick repair agreement
   - Ten day emergency stock

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The green actionplan

- 1.6.a. Analysis and recommendation for PTX on potential establishments

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Kongsøre

Why PTX at Kongsøre

1. Location
2. Oil consumption (128.000 l/year)

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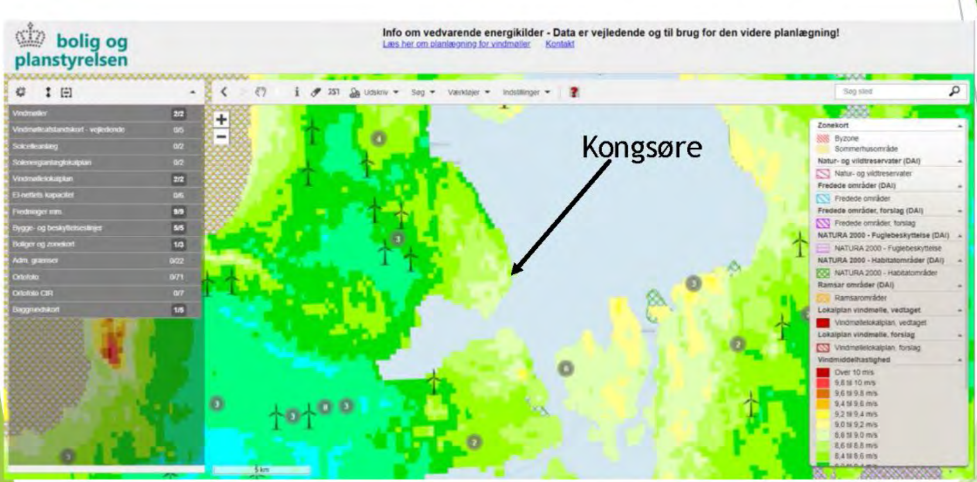
Wind energy potential



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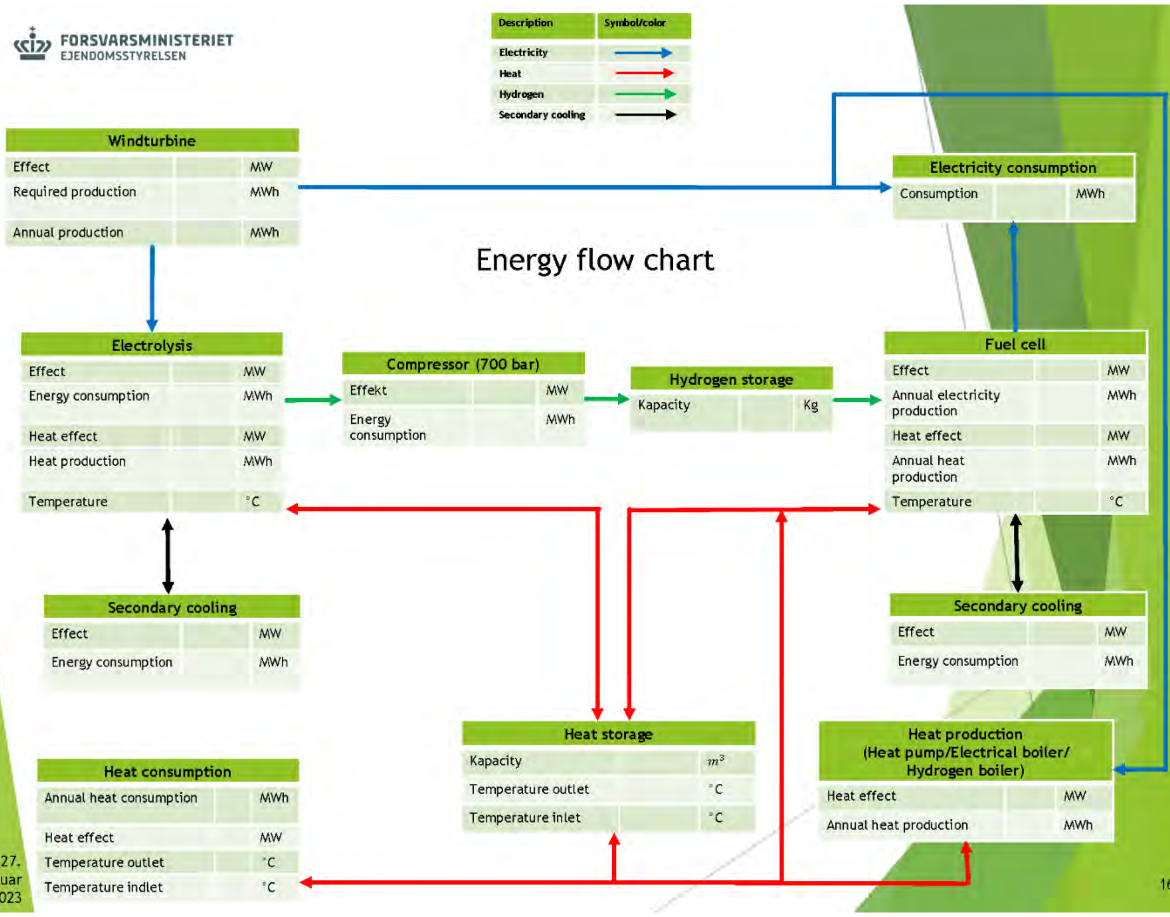
Energy flow chart



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The green actionplan

- 1.5.b Plan and study for energy production and energy optimization in the Arctic

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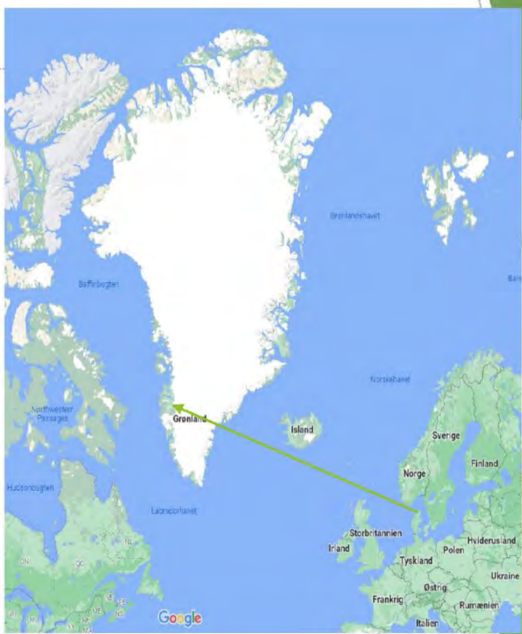
Artic



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Kangerlussuaq → Sønderstrømfjord

Why PTX in Kangerlussuaq?

1. Oil consumption(180.000 l/year)
2. Transportation 1.4 l/1 l for consumption
3. Total consumption: 432.000 l/year

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Questions

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Day 3, “Perspective of the Heating Sector in Germany” (Stephan Richter)

How We try to Figure out What's to do – in General and Next Steps

- We are on our way towards a state-directed organization
  - Federal government is engaging the municipalities to develop a heat basing energy master plan
  - Federal government is stimulating/sponsoring utility companies to develop transformation concepts as initial requirement for funding transformation of heating systems

- Primary Focus is on climate chance mitigation and climate neutrality at latest in 2045 with the option to be faster

- And the other three objectives? They should be tackled on the way towards 2045.
  - Recently climate neutrality in 2045 is in focus
  - GEF's expectation is that the greenhouse gas emission towards 2045 will become more and more relevant

- Where does this state-directed organization lead to?
  - Utility companies and the heating sector are more and more fostered to start transformation processes and changing over the existing systems – which are more or less local or regional rather than federal

3

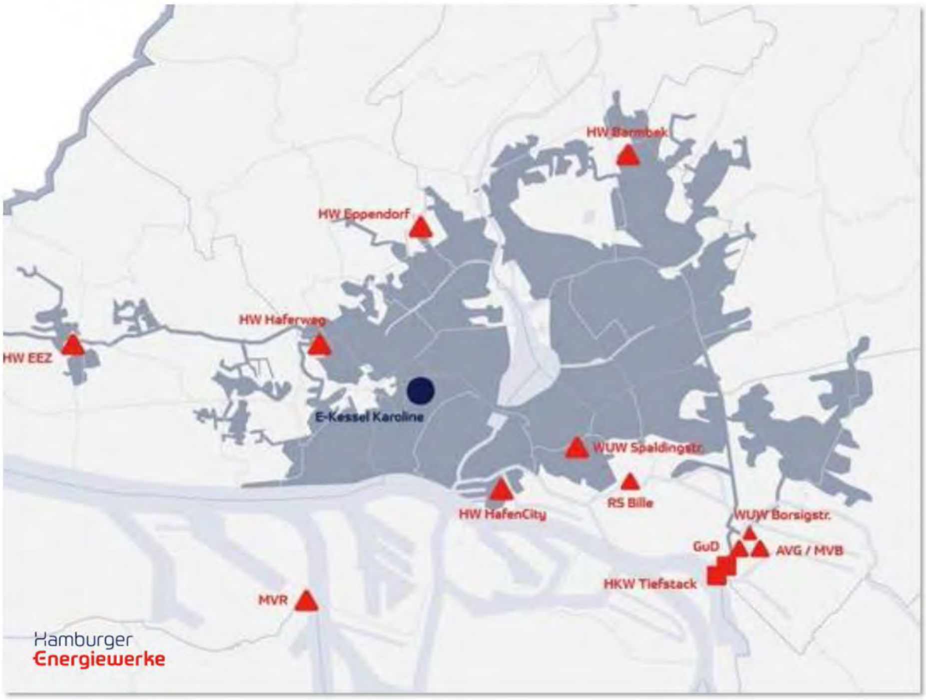
Aren't those Concepts and Match Plans Contradicting

- They have the potentials for any contradiction since
  - Master Planning is engaged by municipalities and
  - transformation concepts by utility companies
- Fortunately not, since
  - Municipalities are mostly share holder of the local utility companies
  - Master Planning and transformation concepts are not developed without any coordination at the same time
  - Both national regulations are considering that one is first and needs to be considered
- And then the war on Ukraine started and the commodity market started running riot and there's still a vital potential not to calming down
- The dilemma of the utility companies and the heating sector in Germany in general is the German answer was natural gas as the bridge
  - Out of the oil price shocks back in the 70`s and 80`s
  - Out of high carbon fossil fuels
  - Towards sustainability
  - Towards climate mitigation and climate neutrality

  Without spending tremendous amounts of CAPEX into an infrastructure mega change

4

Transformation in Hamburg – District Heating is Basing on Hard Cole and Fossile Fuels Today



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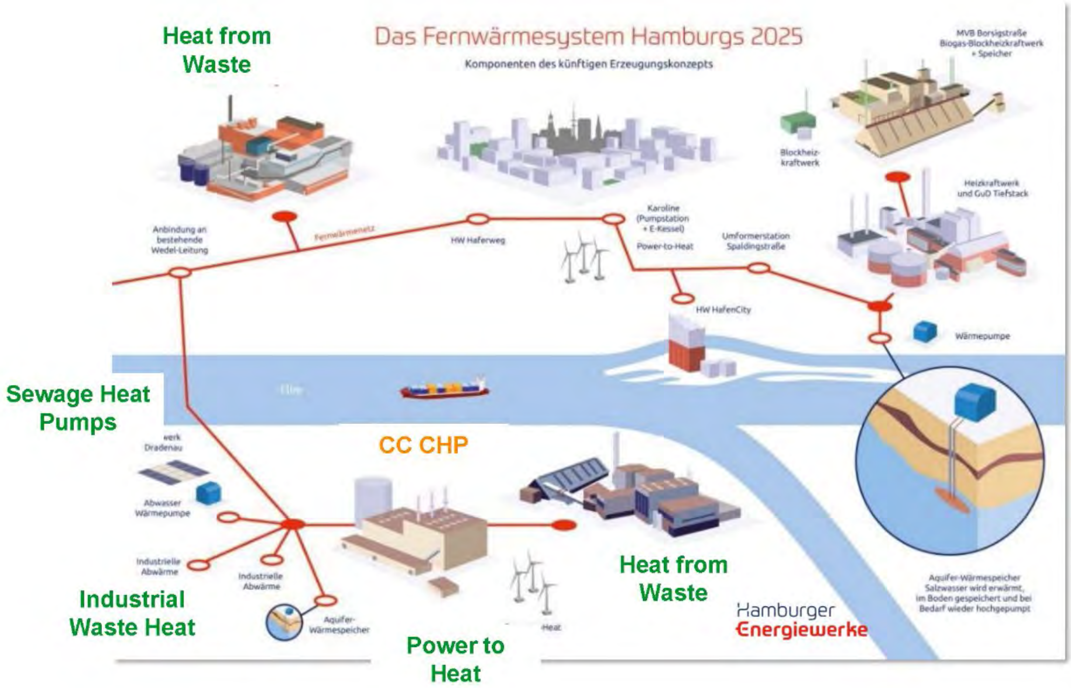
Step one: Energy Park Harbour with a Main Focus on Natural Gas



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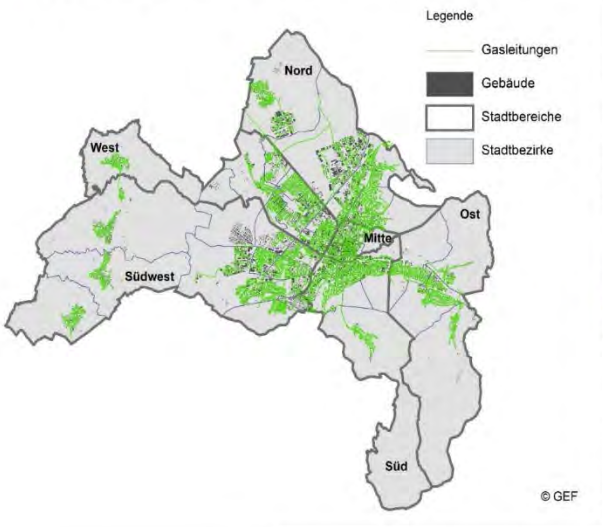
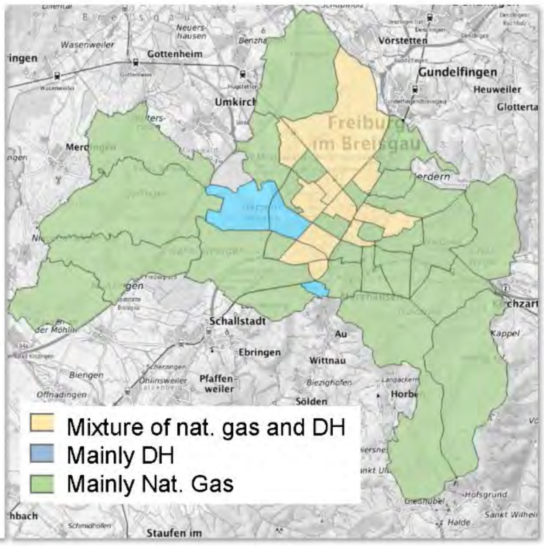
Step Two: Hard Cole Phase Out

Master Planning in Freiburg

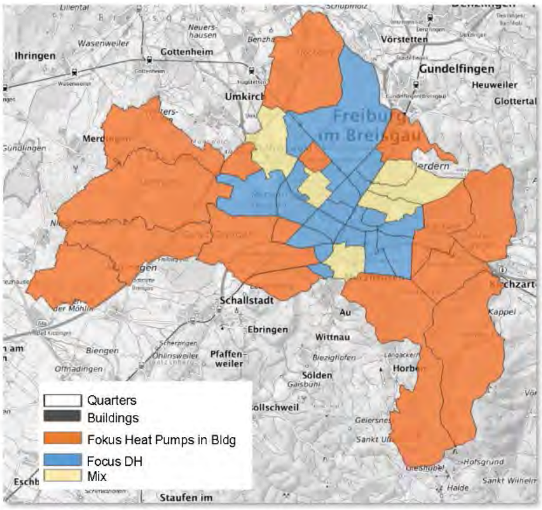
- Well maintained natural gas grid all over Freiburg
- Very heterogeneous district heating systems (36 grids operated by 11 companies)

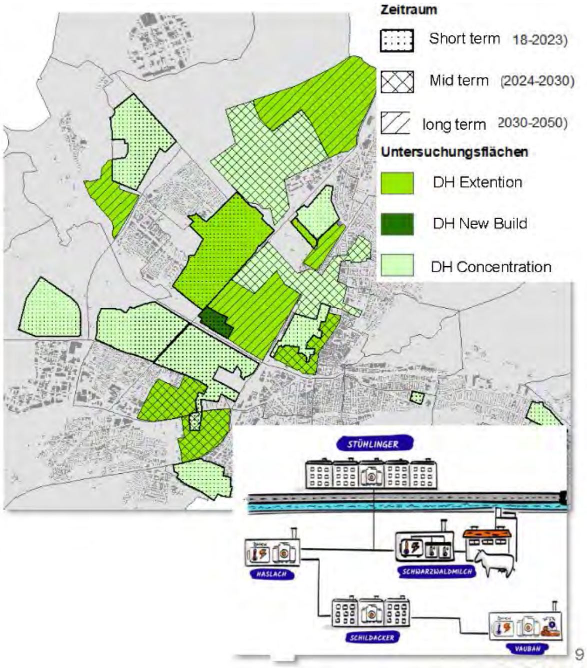




What is the Outcome of the Master Planning Process? A Mapping and tremendous Actions

GEF Ingenieur AG





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What did we Learn and See form those Two Examples

GEF Ingenieur AG

- Opening question was:

  Can We Deal with the Short-Term Issues of the Energy System without Contradicting the Long-Term Goals?

  The final answer is: **Yes, that can work, …**

  … once we consider that we need to chance the focus on the former promising bridges (what does not necessarily mean that they are wrong in general)

  … once we accept that the steps in between today towards the future goal climate neutrality will effort intermediate steps that require its own CAPEX and OPEX

  … once we will diversify the generation portfolio

  … once we are thinking out of the box

  … once we are taking use of the tools and knowledge we have

  … once we don’t lose our final goal out of our focus

  … once we start thinking in missions rather than waiting for formal instructions

10

Day 3, “Propane Air Systems for Military Installations” (Matt Swanson)

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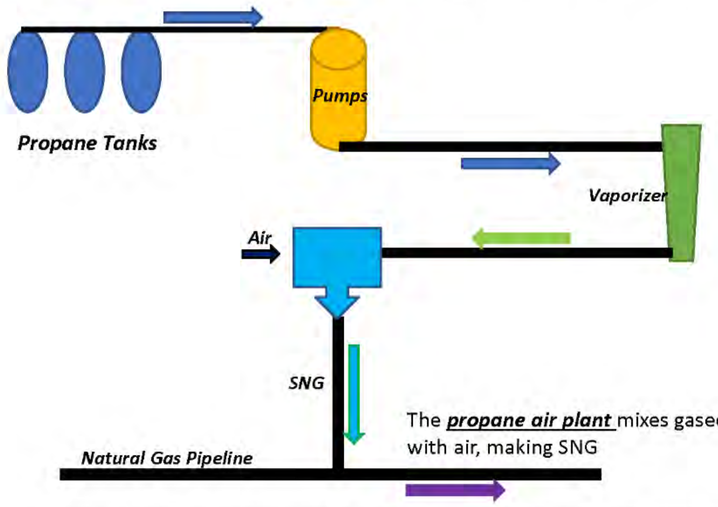
Propane-Air Injection System Overview



The ***propane air plant*** mixes gaseous propane with air, making SNG

Propane-Air Injection System Overview

- A Propane-Air Plant produces ***Synthetic Natural Gas (SNG)*** by mixing air (80% nitrogen/20% oxygen) from the atmosphere and propane to a specific ratio to replicate the properties of methane, better known as "natural gas".
- Wobbe Index is defined as Gross Heating Value divided by the square root of Specific Gravity.
- Natural gas (CH4) and propane (C3H8) have different weight and heating index properties but propane mixed with air to produce SNG in such a way that the Wobbe Index of the resulting SNG is very similar to that of natural gas.
- SNG is considered to be interchangeable with natural gas based on specific gravity and heat content properties, even though SNG is twice as heavy as natural gas and has more energy content (measured by BTU's per cubic foot.)
- The burn characteristics are very similar so the end user of natural gas sees no difference between natural gas or SNG when consuming.

Propane-Air Injection System Overview

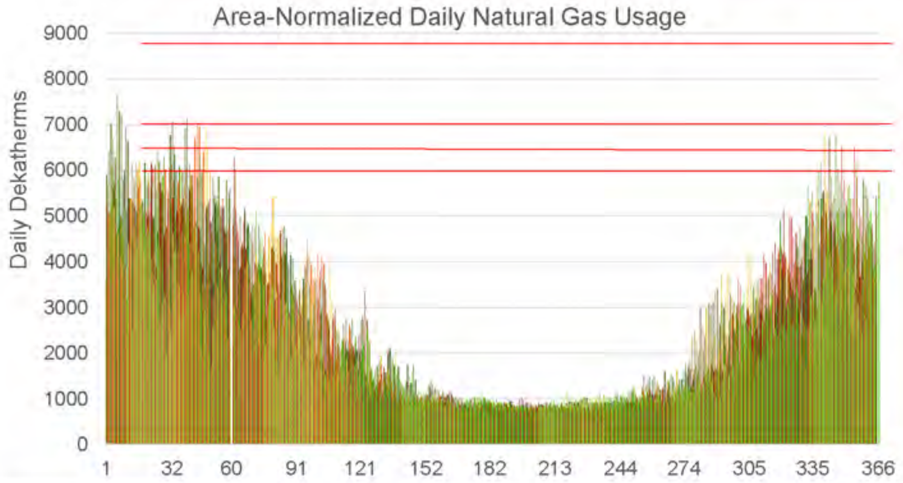
- SNG systems were first developed in the mid-twentieth century and have been implemented as ***peak shaving systems***, ***backup systems*** and ***base load systems***
- A natural gas ***Peak Shaving System*** allows natural gas users to supplement their natural gas demand during peak demand periods (cold winter days) lowering the demand from for natural gas transportation, resulting in savings to the user.
- A natural gas ***Backup System*** allows natural gas users to switch propane in the event the source of natural gas is interrupted.
- A natural gas ***Base Load System*** can be used to supply the entire installation with SNG on an ongoing basis. This could be useful in the case where the installation is currently fueled primarily with natural gas, some of which come from Russia, but new DOD requirements prohibit use of Russian natural gas.

Industrial-Scale Natural Gas Customer – Cost Breakdown

- Associated with distribution infrastructure
- Reservation fee is similar to electrical demand charge
- Natural gas peak/capacity and associated reservation fee is generally determined by the customer

Cost Component	Cost Sub-Components	Fraction of Annual Cost
Natural Gas Commodity		52%
Natural Gas Total Distribution		48%
	Onsite Distribution Charge	17%
	Intrastate - Transportation Fee	0.2%
	Intrastate – Data Collection Fee	0.2%
	Intrastate – Reservation Fee	31%

Cost Savings through Natural Gas Peak Shaving

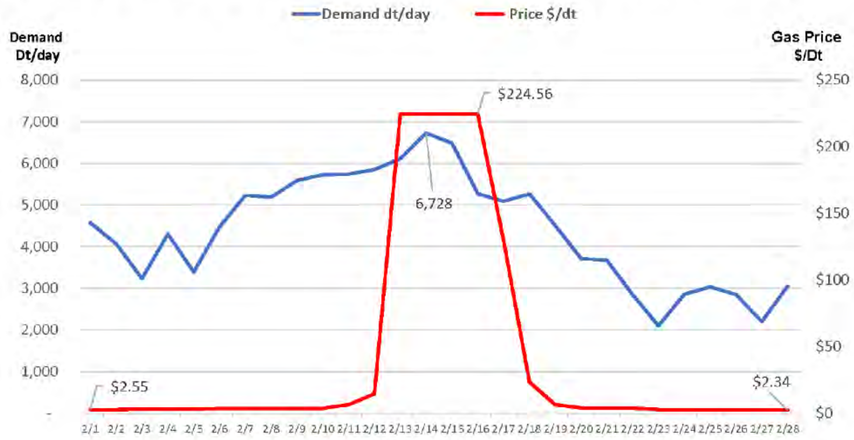


ASHRAE Article

Cost Savings through Natural Gas Peak Shaving

MDQ	4 Year Reservation Fee	Interruptible Gas Cost (@20x normal rate)	Total 4 Year Cost
8750	$9,240,000	0	$9,240,000
7000	$7,392,000	0	$7,392,000
6500	$6,864,000	0	$6,864,000
6000	$6,336,000	$9,702	$6,345,702
5500	$5,808,000	$55,017	$5,863,017

Cost Savings through Supply Redundancy/Backup



$1.2mm savings: Propane cheaper than natural gas - ran propane air plant 24x7 for 8 days

Approximate System Costs

Manufacturer's Estimates
7 MMBTU /Hr with ~3k gallon propane storage ~= $200,000

14 MMBTU /Hr with ~6k gallon propane storage ~= $250,000

42 MMBTU/Hr with ~20k gallon propane storage ~= $540,000

Actual Completed Project
~300 MMBTU/Hr with 90k gallon propane storage ~=$1,5000,000
(equivalent to 7200 Dt/Day)

** Costs include equipment and installation

Questions?

Propane-Air Injection System Overview

- ***Peak shaving*** is a process where SNG is mixed with natural gas during times of peak demand , reducing the amount of natural gas that is needed. If FLW were to utilize a propane air plant to perform "peak-shaving" during days of extreme low temperature, FLW can reduce installation's the maximum daily quantity (MDQ) of natural gas.
- There are 2 common control methods of peak shaving: ratio control and pressure control.
- With a ratio control system, a flow control valve regulates the volumetric ratio of SNG to natural gas in the pipeline. It relies on flow signals from both the natural gas line and the SNG meter. This type of control system allows the SNG flow to vary as necessary to maintain a fixed ratio of SNG to natural gas as the natural gas demand varies.
- With a pressure control system, the role of SNG is simply to maintain line pressure and flow in the natural gas pipeline, regardless of the ratio of SNG to natural gas. A pressure transmitter reduces the flow of SNG as the natural gas pressure in the pipeline approaches a fixed pressure setpoint.
- If the natural gas pressure exceeds the setpoint, SNG injection is halted.
- Conversely, if line pressure decreases, the flow of SNG will begin.

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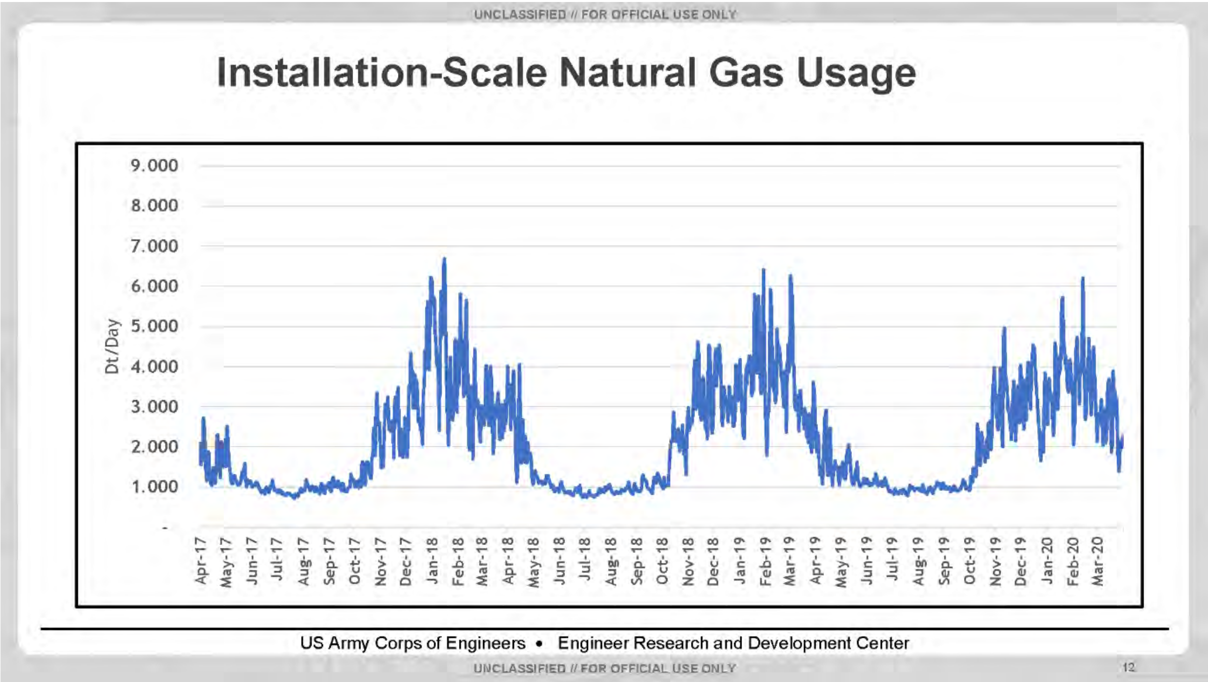


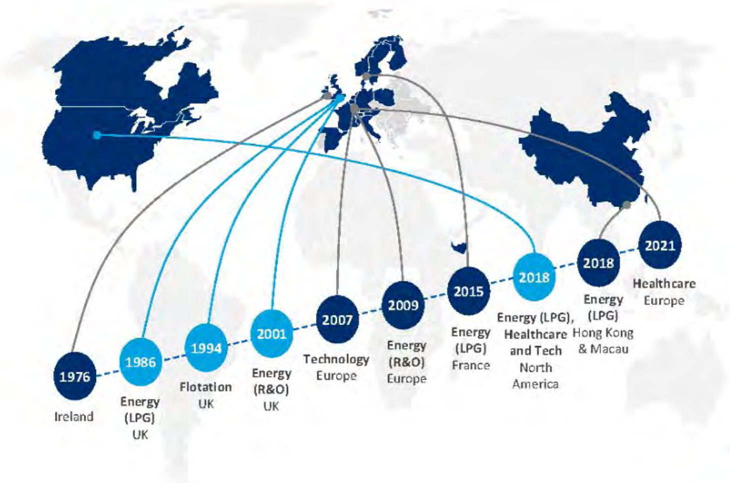
Day 3, "LPG Supply and Logistics Options for US Military in Europe" (Paul Westerman)

Presentation outline

1. Brief introduction to DCC
2. What is LPG?
3. High level trade flows of Natural Gas versus LPG (focus on Europe)
4. Simple comparison of Natural Gas and LPG futures
5. LPG Logistics to / in Western Europe
6. Future-proofing LPG; Renewable alternatives
7. Key take-aways; Questions & thoughts?

DCC

1. Brief introduction of DCC



FY22

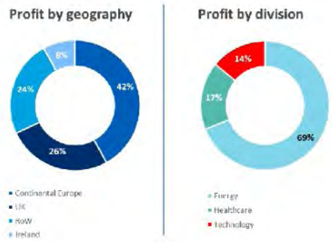
Locations	Employees	Market cap
23 countries across 4 continents	16,000	c.£5.0bn

Revenue	ROCE	Operating profit	Adjusted EPS
£17.7bn	16.5%	£589.2m	430.1p

DCC

1. Zooming in on DCC Energy - LPG

- Three divisions: Energy, Technology and Healthcare
- Within DCC Energy: LPG accounts for c. 55% of profit
- LPG operations in 22 states in the US (#6), in 8 countries in Europe (#1 or 2) and in Hong Kong & Macao
- Overall, DCC distributes c. 1.5mn tons of LPG per annum



Large Market Position: #2 France, Britain and Ireland; #1 Norway, Sweden, Netherlands

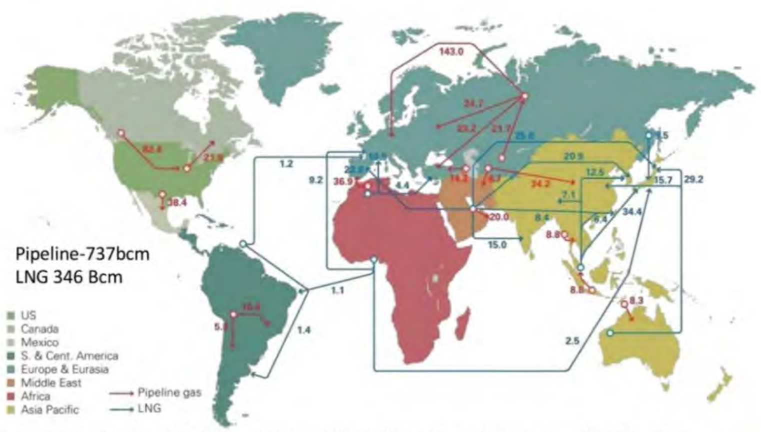
DCC

2. What is LPG?

- LPG stands for "Liquefied Petroleum Gas" and refers to Propane, Butane, or a mix of the two.
- Approx. 60% of LPG is recovered during natural gas and oil exploration. The remaining 40% comes from refining crude oil and, increasingly, from renewable sources.
- LPG is a portable, clean and efficient energy source which is readily available to consumers around the world.
- LPG emits virtually no soot, has a 20% lower carbon footprint than heating oil and 50% lower than coal.
- Renewable LPG and related products will further reduce the carbon footprint towards Net Zero.
- One liter of liquid LPG, expands to 270 liters of gaseous energy allowing a lot of energy to be transported in a compact container.
- Over 3 billion people (mostly living in rural areas, with no access to a natural gas or electricity grid) use LPG and depend on it for many different applications; in commercial business, industry, transportation, farming, power generation, cooking, heating and for recreational purposes.
- Globally, 300 million tons of LPG is used annually across all six continents.

DCC

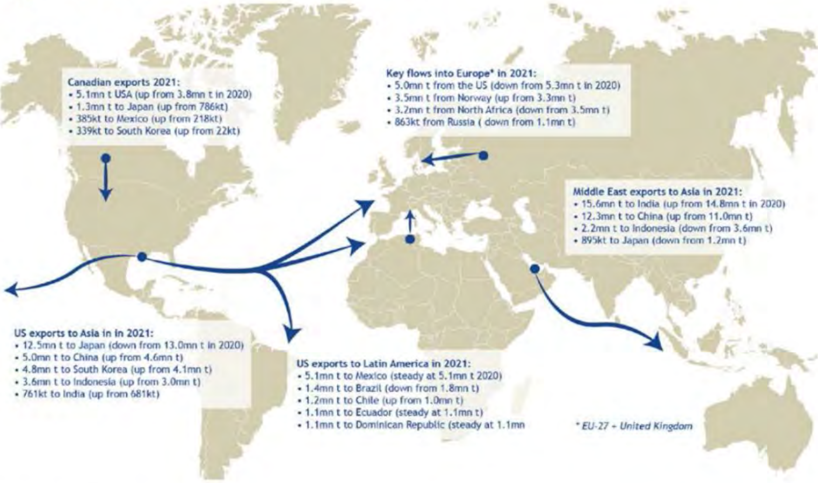
3. High level trade flows of NatGas (pre Rus-Ukr conflict; for illustration)



Source: includes data from FGE MENAgas services, GIIGNL, HIS Waterborne, PIRA Energy Group, Wood Mackenzie

DCC

3. High level trade flows of LPG



Source: WLPGA/Argus Statistical review of LPG

DCC

4. Comparison of NatGas and LPG futures

Note: while trade flow diagrams on previous slides are outdated, the key take-aways still stand:

- Europe is short NatGas, which –until recently- was imported predominantly from Russia
  - While there is enough spot LNG available, Europe lacks the import infra to replace more than 50% of its immediate needs
  - Floating storage and alternative fuels (coal, nuclear) should make up the deficit
- Europe is also short LPG, but–increasingly- this is imported from the USA (Russian exports to Europe strongly reduced back in 2020 as it commissioned a large scale Petchem facility in Tobolsk)

Aug22

	C3* ($/mt)	NG** (€/MWh)	C3 eq. ($/mt)***	diff ($/mt)***
Oct-22	649.81	212.60	**2820.44**	2170.63
Nov-22	653.78	215.00	**2852.28**	2198.50
Dec-22	654.04	215.36	**2857.05**	2203.01
Jan-23	649.49	213.78	**2836.02**	2186.53
Feb-23	641.16	211.60	**2807.17**	2166.01
Mar-23	616.91	206.80	**2743.49**	2126.58
Apr-23	593.64	195.80	**2597.56**	2003.92
May-23	579.38	190.85	**2531.89**	1952.51
Jun-23	572.61	185.80	**2464.90**	1892.29

Jan23

	C3* ($/mt)	NG** (€/MWh)	C3 eq. ($/mt)***	diff ($/mt)***
Feb-23	564	58.10	**793.23**	229.23
Mar-23	537	58.40	**797.32**	260.32
Apr-23	520	59.20	**808.25**	288.25
May-23	514	59.60	**813.71**	299.71
Jun-23	511	60.00	**819.17**	308.17
Jul-23	513	65.30	**891.53**	378.53
Aug-23	518	65.70	**896.99**	378.99
Sep-23	525	66.00	**901.08**	376.08
Oct-23	534	66.00	**901.08**	367.08

- On an energy equivalent basis the NatGas price is 1.4 – 4.4 times that of Propane.
- Differentials, again on an energy equivalent basis, range from US$ 200-2200/metric ton

Sources:
** https://www.cmegroup.com/markets/energy/petrochemicals/european-propane-cif-ara-argus-swap.html*
*** https://www.theice.com/products/27996665/Dutch-TTF-Gas-Futures/data?marketId=5419234*
**** https://www.google.com/finance/quote/EUR-USD*
***** https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html*
*Energy contents (Lower Heating Value) *****
C3 12.88 kWh/kg
NatGas 13.1 kWh/kg

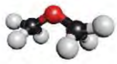
DCC

6. Future-proofing LPG; Renewable alternatives

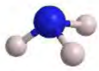
- For comparison: fossil LPG (Propane)

- Renewable LPG – from HVO co-processing / biorefining

- Renewable, recycled and e-DME – from agri/wood waste, Municipal Solid Waste and green H_2+DAC/CCU



- Renewable Ammonia – from N_2 (air separation) and green H_2 (water electrolysis)



DCC

7. Key take-aways; Questions & thoughts?

Available today, through geopolitically robust supply chains, LPG provides a 15% lower carbon footprint than gasoline and diesel and an even 20% lower carbon footprint than heating oil

Renewable LPG and LPG-like renewable drop-in alternatives pave the way to Net Zero

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Day 3, “Multimodal Energy Systems” (Georg Reithe)

What do we do?

Strategy

Current State Assessment		Benchmark progress and capabilities versus industry and technology to understand opportunity
Strategy Development		Determine short-, mid- and long-term approach and investment required for sustainable transformation across all facets of the organization and stakeholder groups
Target Setting		Data-driven target development associated with energy, water, waste and carbon
Impact Analysis		Systems model approach to understand effect of sustainability programs on people / society, environment and organization

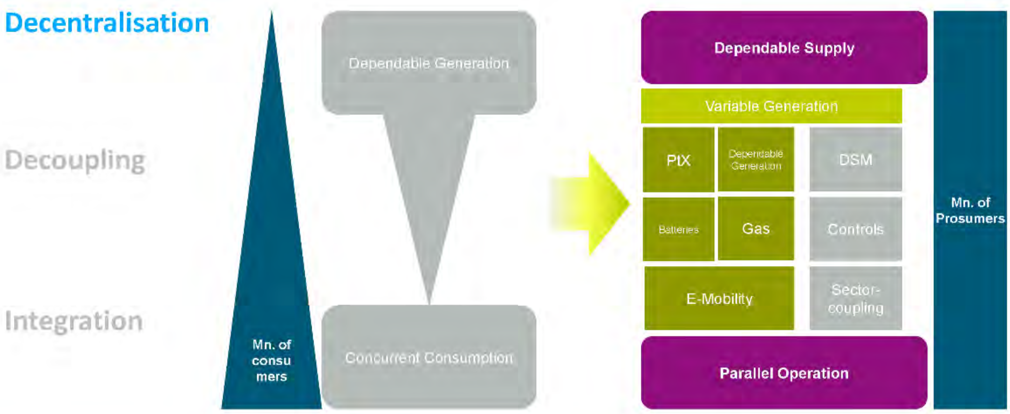
Energy System Consulting

Implementation

Engineering Solutions		Site-level technical studies and design to feasibility of available technology solutions site-level investment decisions
Procurement Management		Design and unbiased procurement events to deliver best possible value and return-on-investment for sustainability initiatives
Project Management		Holistic oversight of all vendors and solutions to ensure successful completion and performance of implemented solutions and programs

Energy systems

Trends (1/3)



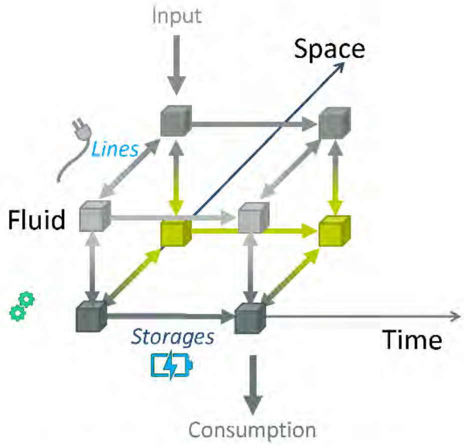
Energy systems

Trends (2/3)

Decentralisation

Decoupling

Integration



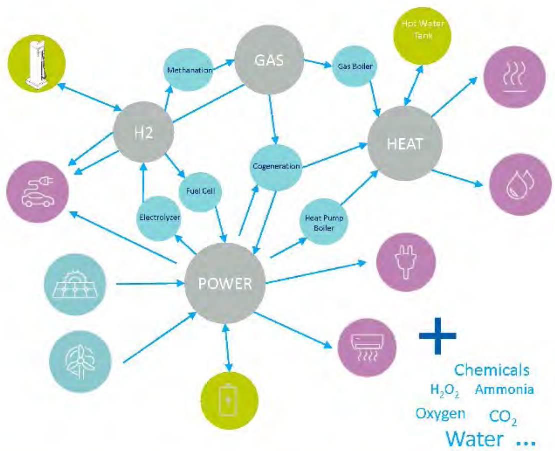
Energy systems

Trends (3/3)

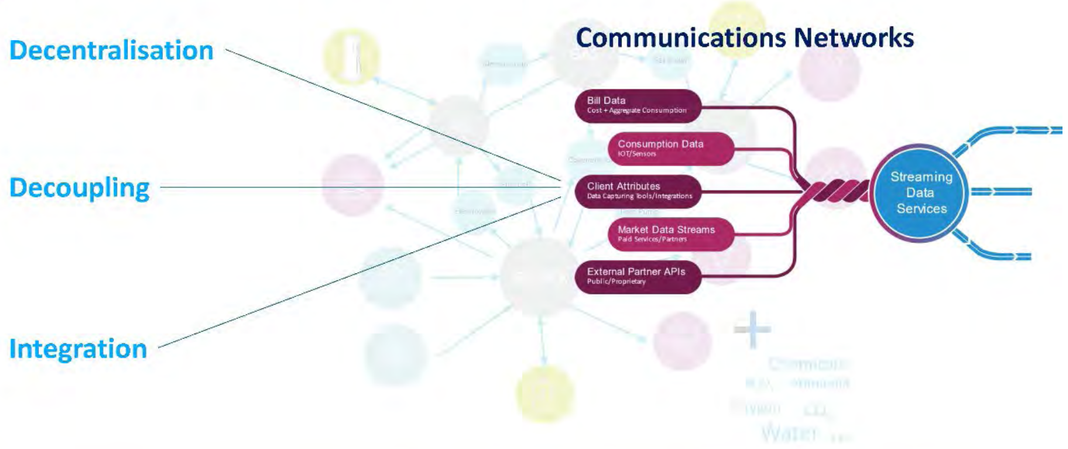
Decentralisation

Decoupling

Integration

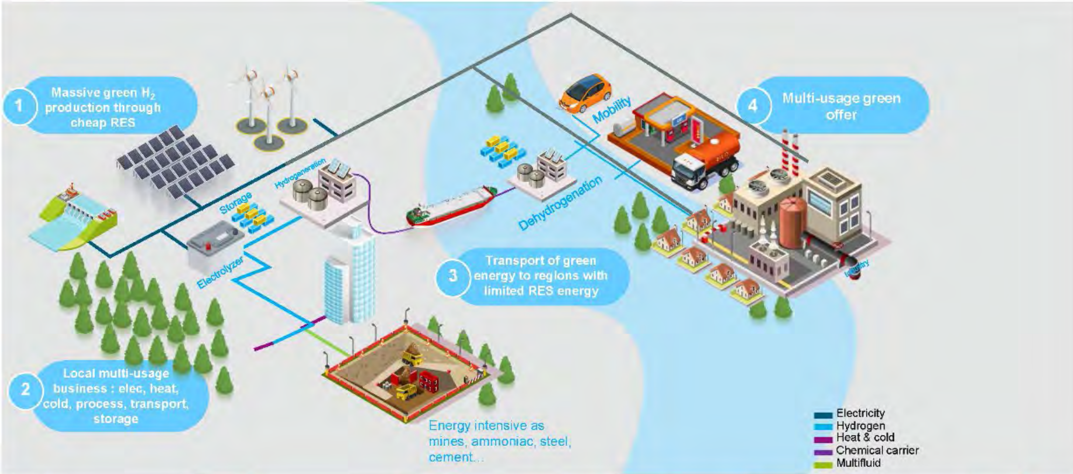


Multi-modal energy systems



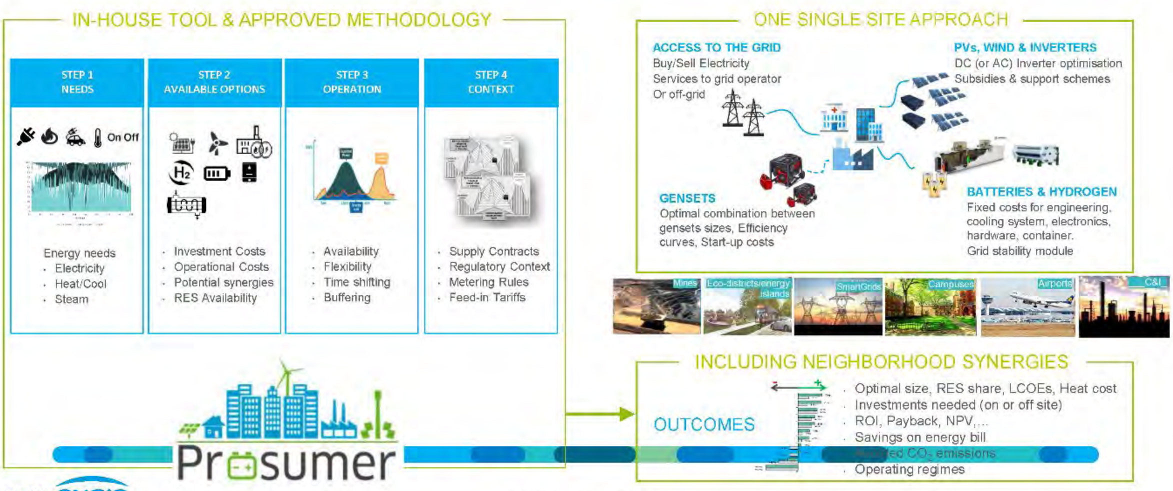
Why urban multimodal energy systems?

Our vision on regional energy systems



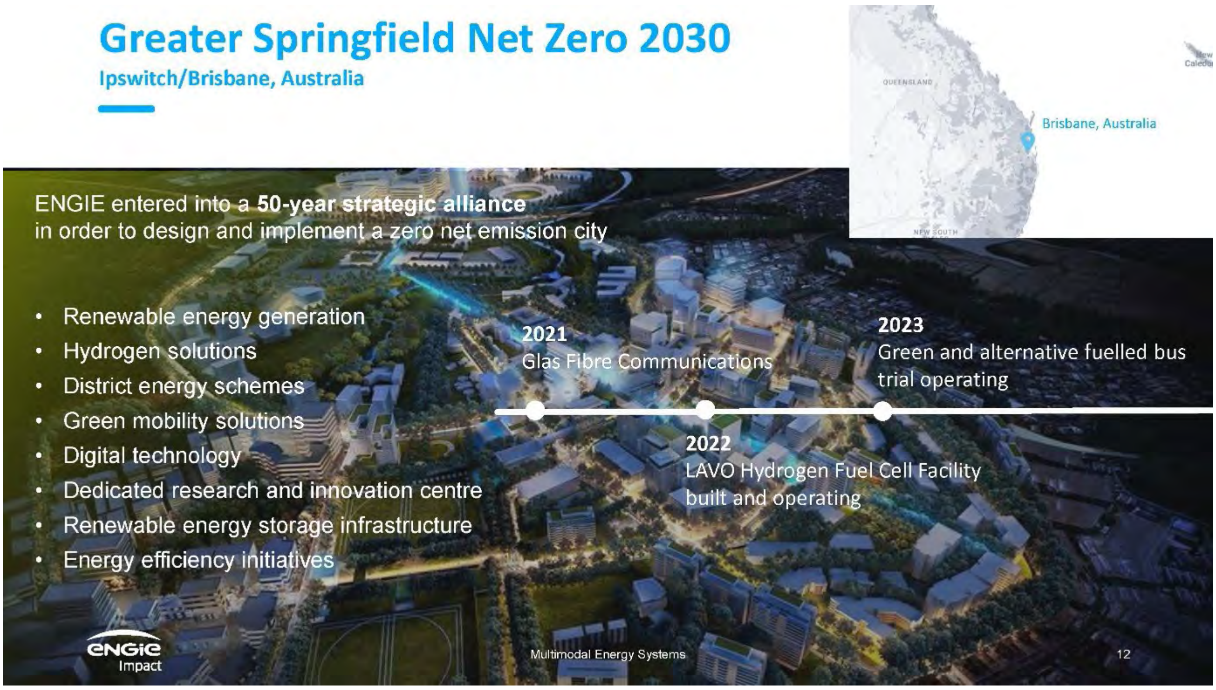
Strategy - A 360° Approach

Techno-economic assessment for multi-fluid & fleet complex energy applications



Reference Projects

Multimodal Energy Systems 11



Eco-District

Rugley/Birmingham, UK

Context

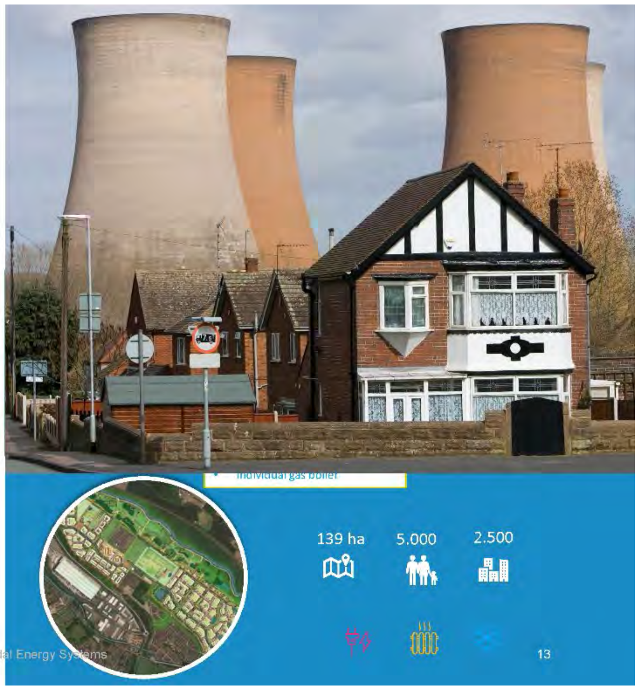
- Engie closed a 1 GW coal power plant in 2016

Proposed Solutions

- Integrated energy and mobility masterplan
- Roadmap and prioritization of project implementation initiatives
- Green H2; EV smart charging infra; heating network, local PV, heat pumps

How ENGIE differentiated

- Address the entire value chain
- Long term engagement (50 Years)
- From strategy design to implementation

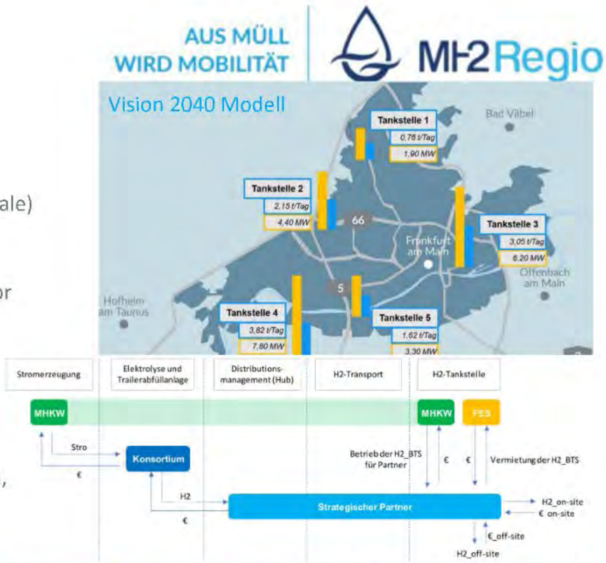


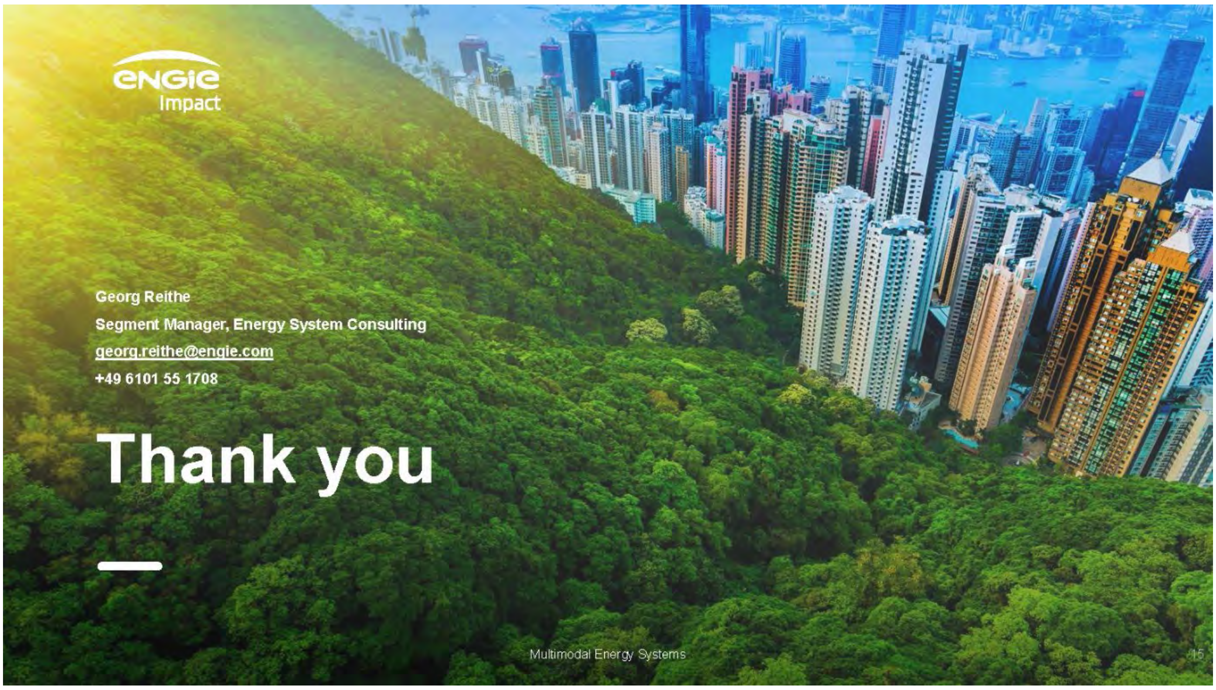
MH2 Regio

Frankfurt, Germany

Concept Study

- Conceptual design of electrolysis plant (MW-scale) on existing power plant site
- Investigation of by-product integration
- Conceptual design of refueling infrastructure for local H2 distribution
- Analysis of mobility end-user requirements
- Site selection and analysis
- CAPEX / OPEX estimation
- Techno-economic system optimization
- Business case analysis along the H2 value chain, including subsidy schemes





Day 3, “ModernMultimodalDispatchingTools” (Wolfgang Fischer)

PSI

PSI segments and vertical markets

Energy Managements | **Production Management**

Electrical grids


Gasgrids and Pipelines


Mining and Traffic


Metals Production


Energy Trading and Sales


Public Transport


Automotive and Mechanical Engineering


Logistics


Energy Management branch customers

Challenges for the future – net zero emission society

4 23-25/01/2023 PSI Software AG | Confidentiality: internal PSI & Attendees of "International Forum | Energy Security" PSI

Challenges for the future – net zero emission society

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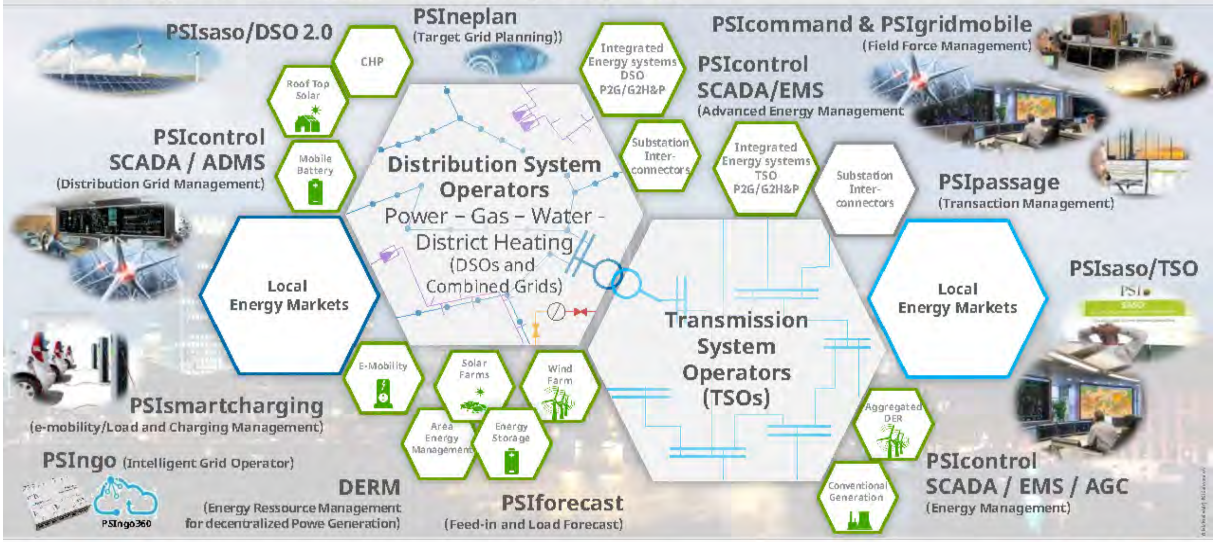
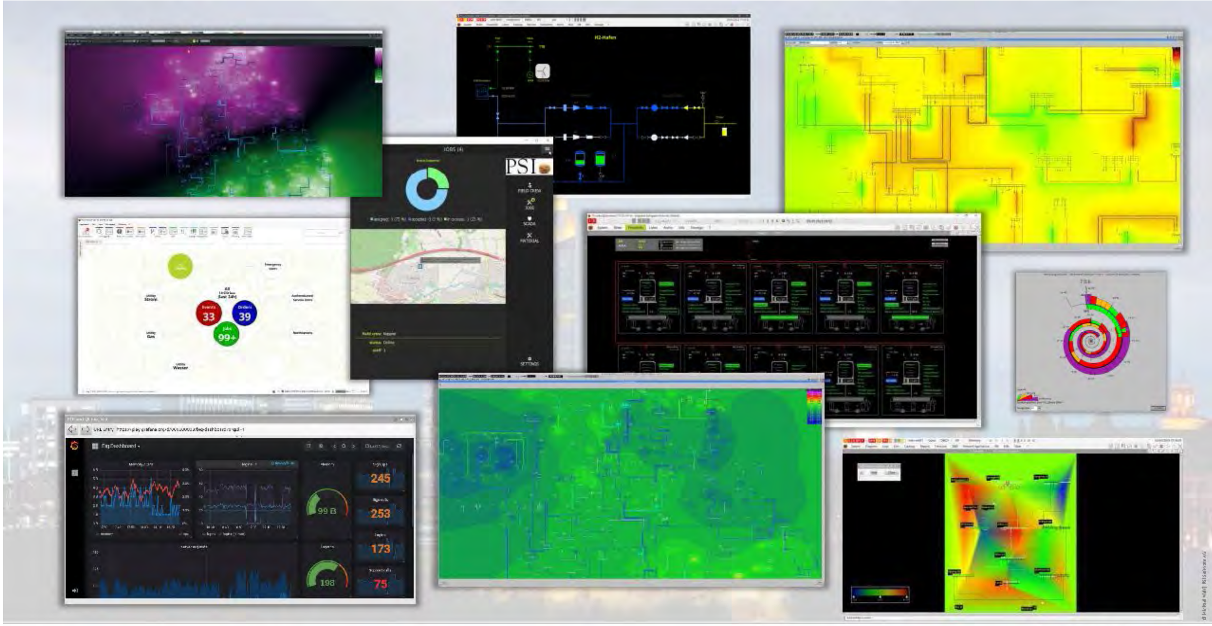
Challenges for the future – increasing complexity



Platform Design for Multimodal Dispatching Tools



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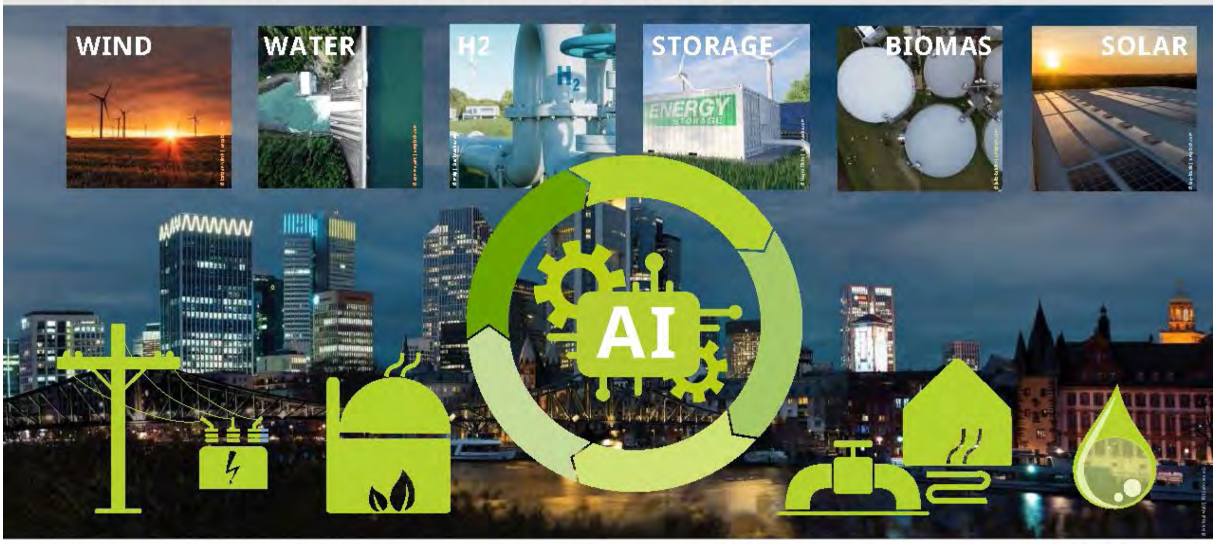
Next level – using AI for combined energies optimization



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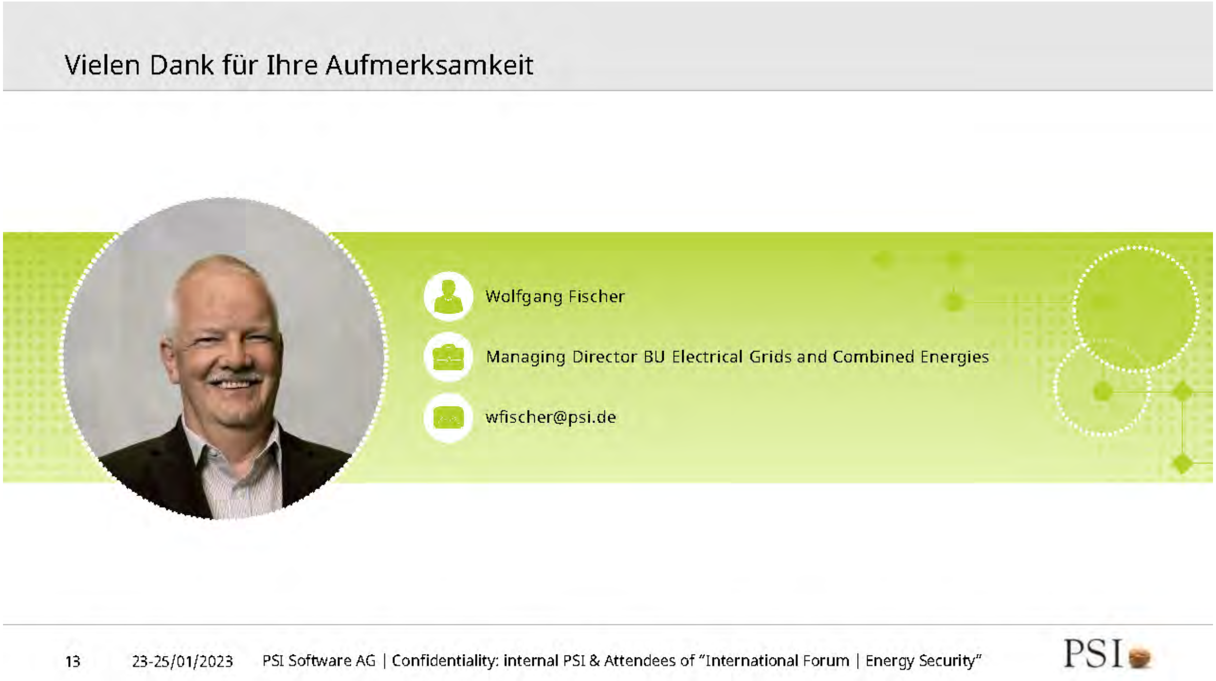
Above and beyond | Deep Qualicision ...

11 23-25/01/2023 PSI Software AG | Confidentiality: internal PSI & Attendees of "International Forum | Energy Security" PSI

12 23-25/01/2023 PSI Software AG | Confidentiality: internal PSI & Attendees of "International Forum | Energy Security" PSI



Day 3, "Implementation of Energy Infrastructure Change" (Bill Taylor)

AGENDA

- Infrastructure Approaches
- Contract Funding
- Contract Mechanisms
- Design-Build
- PPA/EUL
- ESPC/UESC
- Conclusions

Energy Infrastructure Approaches

Renewables

- Solar*
- Wind*
- Biomass
  - Renewable Natural Gas
  - Bio Diesel
  - Syn Gas
- Geothermal

*May require energy storage

Fossil Fuel Fired

- Natural Gas
- Coal
- Petroleum Based Fuels

Others

- Nuclear
- Carbon Capture

Contract Funding

- Contract funding is readily available
- Contract duration, CAPEX and technology proposed will impact financing
- Emerging technology is the largest factor in the funding
  - Emerging technology will increase the lending interest rate
  - Emerging = Risk = Higher Interest Rates
- In an ESPC, higher interest rates mean a lower contract value
  - Energy savings must pay for the ESPC
  - Less energy work can be done as the interest rates increase

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Contract Mechanisms

- Design, Build, Operate & Maintain
  - Simple & Straight forward
  - More typical in commercial/industrial opportunities
- Progressive Design Build
  - Shortest Time
  - Usually least expensive
  - Embedded in many of the solutions that follow
- Power Purchase Agreement (PPA)
- Enhanced Use Lease (EUL)
- Utility Energy Services Contract (UESC)
- Energy Services Performance Contract (ESPC)

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Technology Used is based on Risk

- Three basic parts to Project Risk (Select two of these and the third is defined):
  - Cost
  - Schedule
  - Technology
- Factors push project away from emerging Technologies
  - Cost of Money – Financiers see emerging technologies as risky
    - Results in higher interest rates and shorted loan durations
  - Schedule – Risk that the schedule will be too long
  - Technology – concerns that it will not perform as required
- Many net-zero technologies are emerging
  - Geothermal – based on Earth's thermal gradient
  - Carbon capture and related technologies

Net Zero by 2045 is Rapidly Approaching

- Consider the timeline of a Federal ESPC
  - Contract duration no longer than 25 years
    - 2 years construction
    - 23 years of guarantee
    - 2-3 years for development and release of Notice of Opportunity (NOO)
    - 6 months select a winner
    - 2 years to agree to and execute a Task Order (Audit duration)
    - Total time – 30 years from inception to the end of the contract
  - The Equipment installed under an ESPC from today will be in service in 2045
  - Latest date to issue a NOO and install new net zero equipment to meet the 2045 date is 2040-2041
  - To effectively meet the 2045 date – more technology risk and contract creativity will be needed

Design Build Contract Types

Design-Bid-Build	Design Build Operate Maintain	Progressive Design Build
– Complete the design – Bid out Construction and Operation – Longest duration to complete contract – Very common in US	– Very Common – Generally found in PPA Contracts – Often part of ESPC and UESC Contracts – Very Commo	– Typically quickest way to execute a construction contract – One entity designs and builds the project – Very collaborative approach with the customer – Duration is a function of decision making ability of the customer

UESCs and ESPCs – Common Government Entities

- Energy savings fund the infrastructure improvements
  - Energy Conservation Measures (ECMs) are designed to save energy
  - Bundle ECMs together
    - Short payback items help fund more complex ECMs
    - Resilience is usually a long payback ECM
  - Generally performed by an Energy Services Company (ESCO)
- Energy savings are typically guaranteed by the ESCO
- Term of the contract varies by government entity
- New equipment is typically operated and maintained by the ESCO
- Typical government maximum term is 25 years – typically 2 years for final design and construction, 23 year performance period

PPAs and EULs

PPAs

- Commodity (power, chilled water, steam, etc.) is provided by the owner of the facility
- Price of the commodity is negotiated – frequently held constant
- Delivery of commodity is guaranteed – usually via up-time requirement
- PPA contracted for 10 to 20 years is typical
- Commodity price will pay back the cost of building the facility plus profit

EULs

- Land is provided by the land owner via lease
    - Lease payment is often “in kind” consideration
    - Upgrades to existing facility
- Central Plant is built – typically power
- Power is sold to local utility or the land owner or both
- Economics must pay the cost of the facility and the “in kind” considerations plus profit

Energy Security Requirements

- Secure fuel sources
- Variable Fuel Sources and Types
- New technology
    - Implies Greater risk – hence higher cost (capital and interest rates)
    - Often this will be early technology adoption
- Varied Technology
    - Mixtures of new and proven technology
    - Advanced controls

Conclusions

Energy Security Requires
- Funding
- Contract Mechanism
- Secure Fuel Sources
- Mixed Technologies

Risks
- Fuel Source
- Funding
- New Technology
- Will need to mitigate risks

Energy Security is Critical but can be Accomplished
- There will be financial and technical risks
- Ultimately will Requires new Technology to be fully secure
- Will need a path to a secure future
  - Defined milestones
  - Funding for technology

Purchaser and provider must both be creative

Thank You

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Day 3, “ESPC ENABLE and AFFECT Grant Overview” (Ira Birnbaum)

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

ESPC ENABLE and AFFECT Grant Overview

Ira Birnbaum, FEMP

January 23-26, 2023 | Frankfurt, Germany

FEMP Federal Energy Management Program

Agenda

- ESPC ENABLE Overview
- Comparison of Project Funding Options
- ESPC ENABLE Process
- Program Status
- Eligible ESCOs
- FEMP Assistance
- AFFECT Grant Competition
- Discussion

Part of a 63-facility U.S. Forest Service ENABLE project across two national forests. Los Prietos Ranger Station, Santa Barbara, CA. *Photo courtesy of U.S. Forest Service (Adam Furlow).*

U.S. DEPARTMENT OF ENERGY | OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY | 2

ESPC ENABLE Overview

ESPC ENABLE is an alternative energy performance contracting program:

- Initially intended for smaller projects at federal facilities (underserved market)
  - Or where ENABLE presents the best or only option for the agency to fund a project
  - Is suitable for Federal facilities with buildings under 200,000 square feet
- Modified to include broader range of projects
  - ***No fixed minimum or maximum facility or $ size***
  - Project size range $200k - $18.5 million
- Standardized and streamlined process to quickly award projects and realize savings using the GSA Supply Schedule SIN 334512
  - Templates, IGA tool
  - No preliminary assessment
- Targets straight-forward ECMs including lighting, water fixtures, basic HVAC controls, HVAC equipment replacement including boilers and chillers, solar PV
  - Other ECMs available under "hybrid" projects
- Prescribes basic levels of measurement and verification (M&V) for each ECM
  - Primarily Option A
  - Solar PV and chillers use Option B

ESPC ENABLE: ECM Summary

ECM	Included	Outside IGA Tool
Lighting	• Lamps, Ballasts, Fixtures • Controls: Occupancy, Day lighting (on/off, dimming)	• Solar Lighting (off-grid installations allowed)
Water	• Sanitary plumbing fixtures: sinks, toilets, urinals, showers • Irrigation • Leak repair • Domestic/commercial hot water heaters • Water based appliances: dishwasher, ice machine, clothes washer, etc.	• Heating/Cooling system improvements (cooling towers, once through cooling, condensate reclaim)
HVAC Controls	Whole building control strategies including: • Time/Temperature Set-back • Demand/Night Ventilation	• Advanced Controls [1]: Energy Management Control Systems (EMCS) / Building Automation Systems (BAS)
HVAC Equipment	Basic whole building/system one-for-one replacement [2] of: • Window AC units / Electric Baseboard heat • Split AC/Furnace • Heat Pumps • Packaged Terminal Air Conditioner (PTAC) • Packaged Single Zone Air Conditioner (PSZ) • Roof Top Units (RTU) • Single building Boiler/Chiller	• Central Boiler/Chiller Plants • Retro-commissioning based activities • Non-building related heating/cooling/ventilation
Solar PV	• Ground, Roof, Parking Canopy mount • Fixed and Tracking Arrays • Grid Tied and Off-grid	• Solar Thermal (Hot Water) • Hybrid PV/Hot water systems

1. Advanced Controls may be considered; however, savings calculations within the ENABLE IGA tool are limited to time/temp set-back, demand/night ventilation
2. Current ENABLE IGA tool is presently configured to model one-for one replacement of whole system(s) across an entire building with "like" systems (ex: replace (3) RTU's with (3) higher efficiency RTU's.) IGA Tool not presently configured to model partial replacement of building HVAC systems or replacement/modification of sub-systems (ex: VFD's on select fan units).

ESPC ENABLE: Hybrid Approach

Projects may combine the ESPC ENABLE ECMs with other ECMs available under GSA Supply Schedule SIN 334512 under a hybrid approach:

- Would fall under same award; no need for different funding
- Agency and ESCO must come to agreement about how ESCO will calculate guaranteed savings outside IGA Tool for non-ENABLE ECMs; ESCO must also propose an M&V methodology for non-ENABLE ECMs
- NOO should state that ESCO must demonstrate capability to do this for your particular ECMs
- FEMP ENABLE team will review ESCO savings and cost estimates and M&V plans
- ENABLE plans to expand the IGA Tool to address some ECMs currently outside of ENABLE, such as motors; until then these ECMs would be treated under a hybrid approach
- Note that FEMP cannot provide the same level of confidence for non-ENABLE ECMs' savings as for ECMs run through IGA Tool

Comparison of Project Funding Options

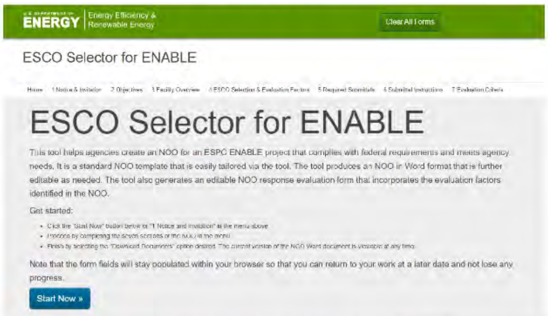
	DOE ESPCs	ESPC ENABLE	UESCs
Contract type	TOs under DOE IDIQ	GSA Supply Schedule SIN 334512	Task Order issued under a GSA Area-wide contract; Basic ordering agrmt.
Private-sector partner	ESCOs: 21 on IDIQ	ESCOs on GSA Supply Schedule SIN 334512: 25 ESCOs - 7 small business, 12 on IDIQ	Serving utility company
Eligible facilities	Federal buildings worldwide	Federal buildings worldwide	Where government pays utility bill including leased buildings; where offered/authorized
Project size	$2 million or larger	No fixed size or $ limits; suitable for smaller projects	Any
ECMs	Unlimited	Lighting, water, basic HVAC controls, HVAC equip. incl. boilers & chillers, solar PV; motors being added	Unlimited
Savings guarantees and M&V	Required	Required; simplified M&V	Performance assurance (or savings guarantees) and M&V through commissioning or retrocommissioning required for annual scoring
O & M	ESCO responsible; tasking negotiable	Government or ESCO; ESCO provides training	Negotiable
Preliminary assessment and IGA Requirement	Both PA and IGA required	Only IGA required	PA recommended; IGA required
FEMP ESPC Life of Contract Service	Included	Not included	Not applicable
Use Fee	none	$7,500 for each $1M contract value – paid by ESCO to GSA	none

ESPC ENABLE: Process Cycle

- ***Projects typically awarded in about 6 to 12 months***
- ***Energy/cost savings in 8-12 months***

Use the ESCO Selector for ENABLE Tool

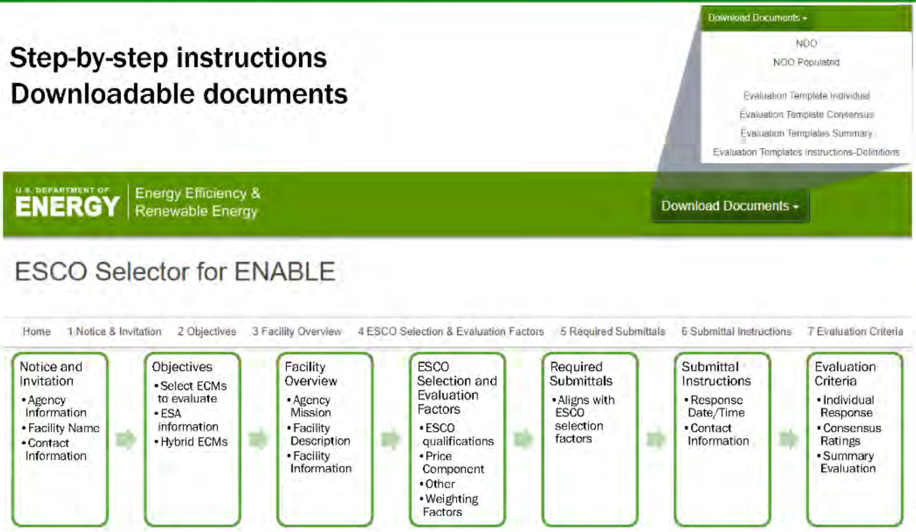
- **New web-based tool to help agencies create a Notice of Opportunity (NOO)**
  - Uses the FEMP ESPC ENABLE templates
  - Produces an editable NOO in Microsoft Word
  - Generates NOO response evaluation forms



https://esco-selector-enable.ornl.gov/

ESCO Selector for ENABLE

- Step-by-step instructions
- Downloadable documents



General Best Practices for an Effective NOO

- Use the **ESCO Selector for ENABLE tool** to quickly create a fully editable draft NOO that complies with federal requirements and meets agency needs:
  https://esco-selector-enable.ornl.gov/
- Also available for download and editing: **ENABLE Notice of Opportunity (NOO) Template:** https://www.energy.gov/eere/femp/downloads/espc-enable-request-quotenotice-opportunity-template
- Involve your FEMP Federal Project Executive in drafting NOO
- Keep NOO as broad as possible to allow ESCO to propose comprehensive, innovative solutions using standard ECMs

General Best Practices (cont.)

- Ask ESCOs to provide examples of familiarity with any non-standard (“hybrid”) ECMs you would like to consider, e.g.,:
  - Building envelope/weatherization
  - Load management/load shedding/BESS/microgrid controls
  - EMCS, BAS
  - Resilience
  - Retrocommissioning
- Identify two or three site-specific needs or wish-list items, such as renewable ECMs. ESCO responses will allow agencies to match ESCO capabilities with site needs

Evaluation Factors and Selection Criteria

- **Each ESCO response must address the ESCO’s Qualifications, Past Performance, and a Price Component, plus any other requirements the agency deems necessary**, such as experience working with local subcontractors; or, where applicable, experience with projects in coastal, maritime and/or island locations.
- **Keep evaluation factors and selection criteria to the minimum necessary**. Evaluation factors should be weighted to reflect the agency’s priorities, rather than all factors being weighted equally.
- **Weight Qualifications more heavily than Past Performance**, because ENABLE is still a relatively new program and not all ESCOs will be able to report Past Performance under ENABLE

Evaluation Factors and Selection Criteria (cont.)

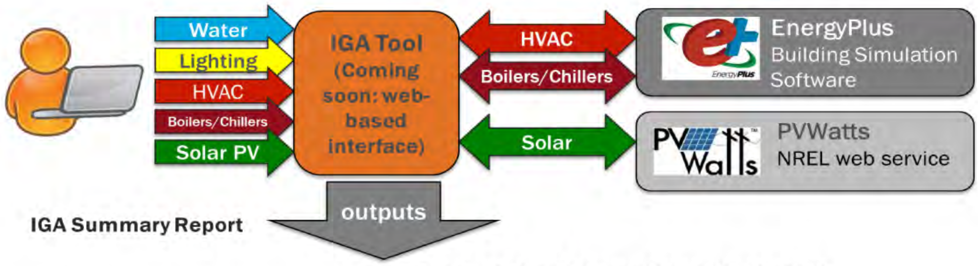
- **Weight the Price Component less heavily than ESCO Qualifications.*** ESCO has not yet walked the facility(ies) and price component won't reflect final project cost
  - EXCEPTION: single/predominant ECM bid on per-unit installed cost
- **Require ESCO to demonstrate ability to obtain low-cost financing, reflecting:**
  - Interest rate index and spread of last 3 projects, with term and size of loan
  - Whether ESCO has Master Purchase Agreement with at least one financier
  - Any credit ratings issued by Moody's, S&P, or Fitch
  - Whether ESCO is covered under a parent company guarantee
  - Extent to which work on key ECMs will be self-performed vs. subcontracted (%)
  - Who underwrites ESCO's performance/payment bond; their credit rating

**See end of next slide for exception.*

ENABLE Investment Grade Audit (IGA) Tool

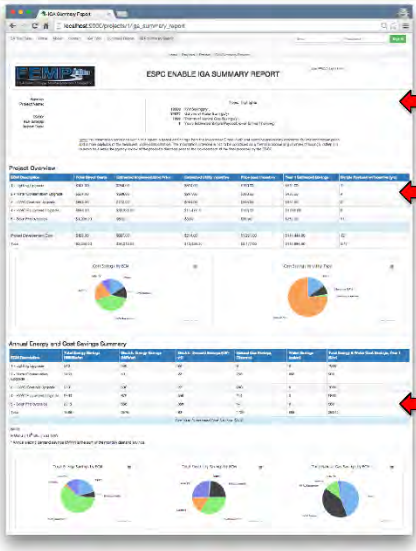
- **Intended Users:** ESCOs
- **Purpose:**
  - Standardize energy and cost savings methodology across the set of ENABLE ECMs.
  - Standardize outputs for inclusion in prescribed final proposal outline.
- **Intention:** Minimize need for customer's technical review of proposals
- **Functionality:**
  - The tool will be used to identify pre- and post-retrofit conditions and estimate energy and cost savings for the project via embedded equations, Energy Plus and PV Watts.
  - Generates a Summary Project Report
  - Generates outputs that form the basis for contract documents
    - Summary data tables by ECM for M&V Plan
    - Completed TO Schedule #4 (data needed for entry into ePB)
    - ECM equipment summaries (quantities by type)

ENABLE IGA Tool



- Energy and Cost Savings Tables (M&V Plan)
- Financial TO Schedule #4 (TO-4)
- ECM Equipment Summaries

IGA Summary Report



High Level Project Details

- **Total kwh, Gal. Water, Therms**
- **Simple Payback** (before financing)

ECM level detail on:

- Direct cost
- Estimated Implementation Price
- Incentives
- Cost Savings by Utility Type
- Simple Payback

ECM level detail on:

- Energy savings by utility type

Submitted to the agency prior to final proposal

ESPC ENABLE: Available Templates by Phase

Acquisition Planning	ESCO Selection	IGA and Award	Installation	Performance Period
• Acquisition Plan • Request for Quotation/ Notice of Opportunity (RFQ/NOO)	• ESCO Expression of Interest • Unsuccessful Offerors Letter • Notice of Intent to Award (NOITA)	• Scope of Work (SOW) • Final Proposal • Task Order award	• Commissioning • M&V Plan • Agency Acceptance	• M&V Report (Outline)

https://energy.gov/eere/femp/espc-enable-procurement-process

ESPC ENABLE: Program Status as of December 2022

ESCOs in the Program

- 24 qualified ESCOs under GSA Supply Schedule
  - Six Small Business contractors
    - Two Service-Disabled Veteran-Owned Small Business contractors
  - Twelve IDIQ contractors

Project Status

- 23 projects awarded: USAF, USN, USACE, GSA (7), USFS (4), State Dept, CBP, BoP, DOE HQ, DEA, ICE, NOAA, NIST, FAA ($0.2-$18.5m)
  - 2 solar PV projects under ESPC ESA
  - Awards have gone to 5 small business ESCOs (including 2 Disabled Veteran ESCOs), 8 ESPC IDIQ ESCOs
- Multiple projects underway (Pipeline: 8 projects, 7 agencies)
- Scopes range from one to multiple ECMs

ESPC ENABLE: Eligible ESCOs as of October 2022

ABM Facility Support Services	*	Legatus6	**
AECOM Technical Services	*	Leidos, Inc.	*
AMERESCO Federal Solutions	*	M.C. Dean	
Brewer-Garrett Co	*	METCO Engineering	**
Constellation NewEnergy	*	Orion Energy Systems	
CTI Energy Services	**	Pacific Lighting Management	**
The Efficiency Network		RealTerm Energy[1]	
Energy Systems Group	*	Siemens Industry	*[2]
ENGIE Services U.S.	*	Trane U.S.	*
Envise		Utility Systems Solutions	**
Green Generation Solutions	**	Williams Electric Co	
Honeywell International	*	Woodstone Energy	**
Johnson Controls	*		

* = DOE IDIQ ESPC ESCO
** = Small Business
[1] GSA SIN 334512 contract effective 10/15/22
[2] Same parent company as IDIQ contractor

FEMP Assistance

FEMP Resources Available to Federal Customers

- Assistance to build an ENABLE program
- Tools and guidance to train, educate, and motivate
- Project management support to guide you through the ESPC ENABLE process*
- Procurement subject matter experts to support project execution*
- ESPC ENABLE webpage resources, including training http://energy.gov/eere/femp/espc-enable

*Note: Project Facilitators are optional. Agencies may procure PFs directly or via DOE/FEMP. If via FEMP, agencies must sign an inter-agency agreement (IAA) with FEMP stipulating that the agency will either reimburse FEMP via up-front payment, or via guaranteed savings built into the project contract.

ESPC ENABLE Team

FEMP ENABLE Team

Title/Role	Contact Information
ESPC ENABLE Program Manager	Ira Birnbaum – DOE-FEMP 202-287-1869 ♦ Ira.Birnbaum@ee.doe.gov
Federal Project Executives	Doug Culbreth – ORNL 919-610-8259 ♦ culbrethcd@ornl.gov Tom Hattery – ORNL 202-256-5986 ♦ Thomas.Hattery@ee.doe.gov Scott Wolf – ORNL 360-866-9163 ♦ wolfsc@ornl.gov
Audit Tool, Energy/Water Savings, Finance	Christine Walker – ORNL 865-241-4896 ♦ walkerce@ornl.gov
Acquisition Process and Contract Documents	Sam Espinosa – BGS 505-463-0942 ♦ samespinosa@comcast.net
Support Contractor	Matt Roney – BGS 603-828-7512 ♦ mroney@bgs-llc.com

GSA Schedule Team

Title/Role	Contact Information
Business Development Specialist	Kris Ann Nieswiadomy – GSA 817-850-8165 ♦ kris.nieswiadomy@gsa.gov
Supervisory Marketing Specialist	Stephen Bartley – GSA 817-850-8245 ♦ stephen.bartley@gsa.gov
Contract Specialist	Michael Brown – GSA 817-850-8340 ♦ michael.s.brown@gsa.gov
Supervisory Contract Specialist	Daniel Stafford – GSA daniel.stafford@gsa.gov

AFFECT Grant 2022 Appropriations FAC Key Dates

- **FAC Issue Date:** 12/02/2022
- **Informational Webinar:** 12/15/2022
- **Submission Deadline for Applications:** 2/28/2023
- **Expected Date for Selection Notifications:** 05/2023
- **Expected Timeframe for Award Negotiations:** 05/2023 – 07/2023

AFFECT Grant 2022 Appropriations FAC Priorities

Federal leadership in clean energy, climate, environmental justice and equity

- **E.O. 14057, Catalyzing America's Clean Energy Economy Through Federal Sustainability**
- **E.O. 14008, Tackling the Climate Crisis at Home and Abroad**
- **Energy Act of 2020**

AFFECT Grant Eligibility and Funding

- Available Funding: $13M
  - FEMP does not intend to award individual grants under this FAC in excess of $2 million (Historical average ~$700,000 per grant)

- **Only U.S. federal agencies (including sub-agencies) are eligible to apply for funding under this FAC. Only facilities that are owned by the U.S. federal government are eligible for funding under this FAC**

- **Eligible Project Costs: AFFECT grant funding may be spent on any of the equipment and/or technical assistance and other services related to the planning, development, or implementation of an eligible project**

- Coming in 2023: AFFECT/BIL Funding: $250 million

AFFECT 2022 Appropriations FAC Topic Areas

- Topic Area 1: Projects Under Development Facing Reductions in Scope Due to Adverse Changes in Fiscal/Economic Conditions
  - Projects that the applicant has not yet awarded to its ESCO/utility, or modifications to existing awards that are:
    - Under development or capable of modification as of the date the FAC is issued
    - At risk of not being implemented as initially scoped in the PA or IGA because of changing monetary conditions (I.e., increased interest rates) and/or economic conditions (e.g., increased equipment costs related to inflation or supply chain problems
    - Must include ECMs that align with programmatic priorities of EO 14057 such as clean energy supply; load management; storage and resilience; energy efficiency; and/or adaptation to effects of climate change

AFFECT FY22 Appropriations FAC Topic Areas (cont'd)

Topic Area 2: Load Management (Energy Performance Contracts)

- Carbon pollution-free electricity (CFE)/Grid interactive efficient buildings (GEB): Supporting early adoption of load management technologies
- Projects that utilize energy performance contracts and will reduce peak demand, shift demand load or provide energy storage that leads to energy savings, cost savings, and/or GHG emission reductions
  - Load management devices, BESS, EVSE, Thermal storage, micro-grid components, GEB, etc.
    - EVSE with managed charging solutions (controls when vehicles are charged or allows for bidirectional charging)
  - Other measures and practices that implement load management, load shifting, and/or peak load reduction that enable the use of utility bill savings through tariff structures and demand response incentives

Topic Area 3: Load Management (Other Procurement Mechanisms)

- Projects that do not utilize energy performance contracts and will reduce peak demand, shift demand load or provide energy storage that leads to energy savings, cost savings, and/or GHG emission reductions (see ECMs under Topic Area 2)
- FEMP intends to allocate <= 10% of the AFFECT 2022 grants to Topic Area 3 projects

Technical Review Criteria

- Criterion 1: The Viability and Cost Effectiveness of the Project (20%)
- Criterion 2: The amount of energy and cost savings anticipated to the federal Government (35%)
- Criterion 3: Leverage (15%)
- Criterion 4: Programmatic Priorities and Policy Considerations (30%)

Demonstrating Replicability

- **Applications must actively demonstrate how the proposed project results are conducive to, and how they will be used by the applicant, to promote broader adoption at other federal facilities**
  - Specific requirement (to be negotiated prior to grant award), will include commitment to develop a Government Use Case publication with key project information:
    - general location (City and State)
    - short project description addressing key issue(s) being addressed by the project;\
    - technology(ies) used
    - project costs
    - energy savings and GHG reduction
    - lessons learned
    - other notable features that can help persuade other agencies to undertake similar projects

Program Policy Factors

- In addition to the above criteria, the Selection Official may consider the following Program Policy Factors (PPFs) in determining which agencies to select for award negotiations:
  - The diversity of technologies and approaches (including the degree to which the proposed project would be complementary to and support the existing portfolio of projects to achieve the overall goals and objectives of FEMP)
  - The geographic distribution of projects
  - The diversity of agencies or sub-agencies in the project portfolio
  - The previous history of Agencies or sub-Agencies receiving AFFECT award
  - The extent to which the project results in positive environmental benefits in economically and/or environmentally disadvantaged communities (To the extent applicable, consideration will be based on the information provided in response to questions 5.1 – 5.2 in Section 5 of the AFFECT Application Form)
    - For each facility encompassed by the proposed AFFECT project, use the Department of Energy's Disadvantaged Communities Reporter Mapping Tool (https://energyjustice.egs.anl.gov/) to determine whether the facility's location has been categorized as a disadvantaged community (DAC). Provide facility address(es) requesting AFFECT funding and provide DAC Status. (Use table provided)
    - Describe the extent to which the project results in positive environmental benefits in economically and/or environmentally disadvantaged communities. (250 words or less)
  - The extent to which the project supports American-made products and a diversified workforce within the clean energy economy in construction, skilled trades, and engineering to enhance American infrastructure (To the extent applicable, consideration will be based on the information requested in question 5.3 in Section 5 of the AFFECT Application Form)

AFFECT Grant Links

- **Announcement**
  - https://www.energy.gov/eere/femp/articles/department-energy-boosts-climate-change-mitigation-federal-facilities-through#:~:text=As%20indicated%20in%20the%20AFFECT%202022%20Appropriations%20FAC%E2%80%99s,of%20any%20applicant%20submissions.%20Register%20for%20the%20webinar
- **FAC**
  - https://eere-exchange.energy.gov
  - Financial Opportunities: Funding Opportunity Exchange (energy.gov)
  - https://eere-exchange.energy.gov/Default.aspx#FoaIdf565c25e-de3e-4ff4-bda5-6f6b4c3dad08
- **Webinar**
  - https://youtu.be/paEVOEJECks

Questions/Additional Information

- **FEMP personnel are prohibited from communicating (in writing or otherwise) with agencies regarding the FAC except through the established question and answer process as described below**
- Questions regarding the content of this FAC must be submitted to: AFFECT2022Approp@hq.doe.gov. Questions must be submitted by 3 business days prior to the application due date and time. Feedback on individual applications will not be provided through Q&A
- All questions and answers related to this FAC will be posted on EERE Exchange at: https://eere-exchange.energy.gov. Please note that you must first select this specific FOA/FAC Number in order to view the questions and answers specific to this FAC. FEMP will attempt to respond to a question within 3 business days, unless a similar question and answer has already been posted on the website

Questions?

An ESPC ENABLE LED lighting retrofit project at the James Forrestal Building, DOE's headquarters in Washington, DC, resulted in a 50% reduction in lighting energy use and more than $250,000 in annual energy cost savings. *Photo courtesy of DOE.*

More information on ENABLE:

- Contact your Federal Project Executive
- ENABLE Homepage
- Project Development Process
- Eligible ESCOs
- Awarded Projects

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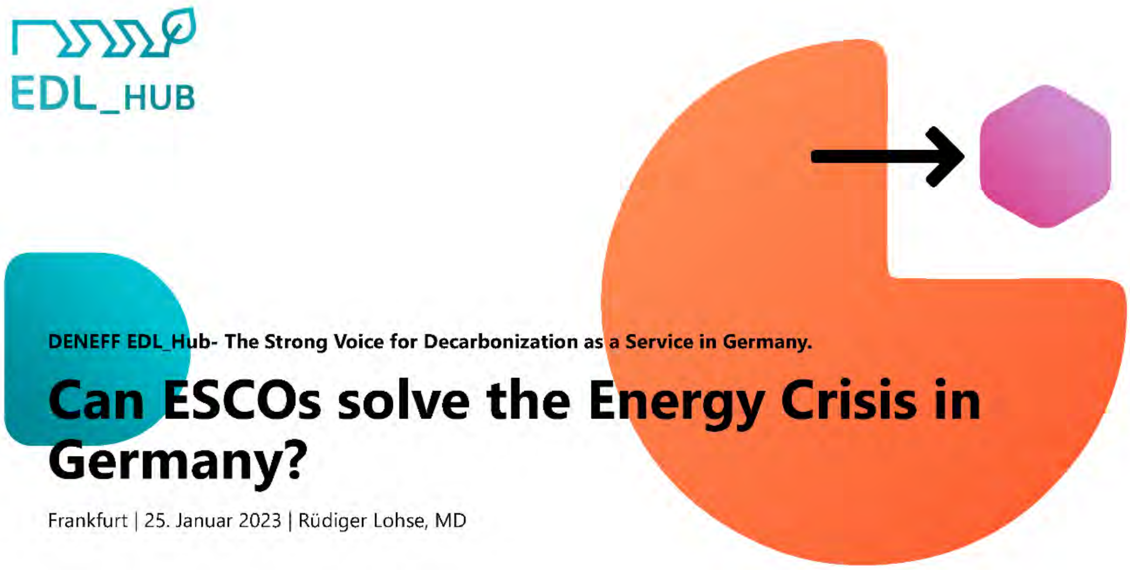
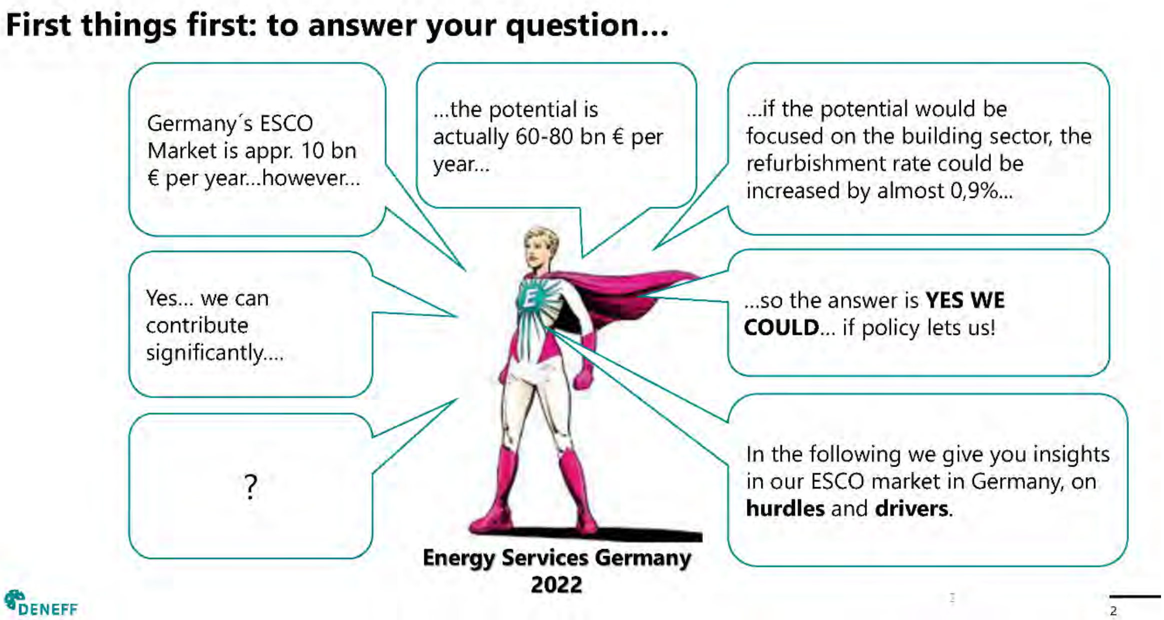
Day 3, “ESCO” (Rüdiger Lohse)





Dramatic policy failures in the past 20 years have to be corrected in short time now! ESCOs have started to adapt to new demands.

Major Policy Events	Impact on Energy Services in Germany
• **EnergyEfficiency Act** to create robust framework for energy efficiency and energy services in DE	• Level Playing field still not existing for energy services in the housing sector.
• **Energy in Buildings Act**: thriving for binding energy targets for newly built and building stock refurbishments and priorization of worst performing buildings- from 2024 on fossile heating systems will have to be replaced by heating systems based on 65% RE.	• Instead of gas based CHP ESCOs have started 2022 to dive into the electrification of the heating sector. The technical scope in these projects includes HVAC and building insulation measures which has not been the case in energy supply contracting before. This increases also the demand for finance by factor 2-5.
• **Heating Design Act**: Setting up structures for the decarbonization of the heating system (50% by 2030, 100% by 2045)	• ESCOs have started to increase consulting business in their portfolio. In the past this has been mostly cost-free acquisition effort.

Disruptive Changes in the German Energy Market challenge traditional business models. ESCOs only have the option of adapting the new rules of the game or dissappearing form the market in rapidly shrinking niches

DENEFF EDL_HUB Supports ESCOs in the Disruptive Change Process which started 2022 with the Russian Attack on Ukraine

DENEFF EDL_HUB: Innovation Plattform and Association with major German and EU ESCOs on Board- making the ESCO case since 2020

GETEC · e.on · kofler energies · steag new energies · ove Contracting mit Energie · 2G · ENGIE · GASAG · TENAG · e.on · thermorent · eins · WILLBEE ENERGY · Stadtwerke Düsseldorf · tado° · M&P · mpw · Buderus · Hausbank · EFFIZIENZPIONIERE · 42watt · instaGreen OHNE UMWEG GRÜN

DENEFF Begleitkreistreffen: DENEFF EDL_HUB - Politische Stimme und Innovationshub der EDL-Branche 5

DENEFF EDL_HUB: Mission and Vision

Policy HUB

Contribute Strongly to Create Level-Playing Field for ESCOs in Germany:

- **Policy Agenda Settings in EU and DE**
- **Access** to funding and subsidies
- **Policy** regulations to create a framework which enables ESCOs to put in place significant investments

Stakeholder HUB

Creating Interaction Between Stakeholders

- **Connecting** ESCOs, Service and Component Suppliers and Stakeholders
- **Enhancing** interaction between ESCOs, Suppliers and Energy Consumers

Innovation HUB

- **Inkubation and Fertilization of innovative Business and Finance**

- **Market Development** in Disfunctional Market Settings
- This is done within in third party Finance Research Projects on EU and national level

EDL_HUB Begleitkreistreffen: DENEFF EDL_HUB · Politische Stimme und Innovationshub der EDL-Branche 6

Lessons Learnt:

Disruptive Changes in the Energy Market provide Exceptional Opportunities for ESCOs- if ESCOs are Willing to Adopt User Demands

Stakeholder- and User-Workshops provide a clear picture: User Demands are Changing, and innovative ESCOs and Start-Ups are on their way to provide adequate and new solutions

EDL_HUB

The Political Agenda, New User Demands have Sparked Disruptive Changes and Frictions in the ESCO market since 2021

Challenges: Policy & Society

- Climate Protection has become Main Stream
- Decarbonization Target 2045 for Buildings and Industry
- Fed. Regulation: 65% Renewable Energy in the Heating Market
- Energy Security and Independance
- Building Sector: MEPS

....changing User Demands

- Reduction of Coordinative Effort: One-Stop-Shops instead of complex multi tasking of dozens of partners
- Longterm Partnerships instead of Project approaches
- Simple Front End Solutions-moving complex structures into the back end

...require innovative Responses !

- ESCO Scope: handling, coordinating holistic approaches
- The Deployment of Combined Approaches for the Electrification of Heating in Buildings and Pprocess Steam and Heating Processes in Industry have been increased dramatically since Summer 2022

EDL_HUB DENEFF EDL_HUB- Politische Stimme und Innovationshub der EDL-Branche

Evolution of ESCo Tec-Bundles in 2022: Electrification of Heating Market, Reduction of Dependency from Russian Gas by > 75%

Standard Solutions before 2021

- Housing Sector: Gas CHP + Gas Peak Boiler, Building-/Heating Grid with 70/50 °C System temperature making >80% of the ESCo Heating Market in Housing Sector
- Industry Steam: CHP (engine/turbine)+Gas Peak Boiler more than 60%
- Renewable: <10%

....changing Legal and Market Framework, and User Demands

- Gas and Power Prices exploding August 2022 (>+200%)
- Housing: 65% RE by 2024 in New or Replaced Heating Systems
- Housing/Industry: Federal Support Gas-/PowerPrice Cuts from January 23

...catalize innovative Responses

- Housing: Heat Pump+PV+P-Storage+Peak Gas Boilers/Large Thermic Boilers+Heating Grids
- Industry: HT-Heat Pumps+Gas-CHP+Storage+ PPAs
- CHP used in the context of grid stablization

EDL_HUB DENEFF EDL_HUB- Politische Stimme und Innovationshub der EDL-Branche

...ESCO provide Tremendous Services-to help Germany´s Energy System to Move out of Gas Based Heating in Housing and Industry Processes

Contact

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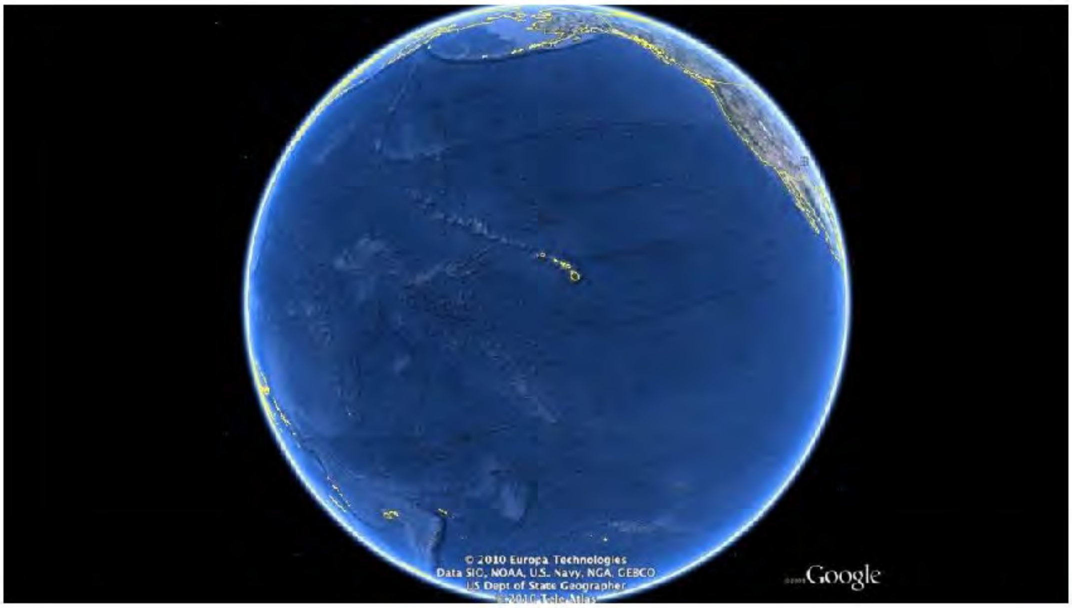
E-Mail: ruediger.lohse@edlhub.org

Day 3, "Schofield Generating Station_Micro Grid" (Keith Yamanaka)

U.S. ARMY

Why Worry?



U.S. ARMY

Because

Risk

- Natural Hazards as identified in the 2018 State of Hawaii Hazard Mitigation Plan
- Malicious activity – cyber-attack, shipping disruption
- Condition of infrastructure

Ranking	2018 Hazard Ranking Order	Mission Risk
1	Climate Change/Sea Lever Rise	Loss of Generation
2	Hurricane	Loss of Generation & Lines
3	Tsunami	Loss of Generation
4	Earthquake	Loss of Generation & Lines
5	Volcanic (lava or vog)	Loss of Solar
6	Wildfire/Landslide	Loss of Lines

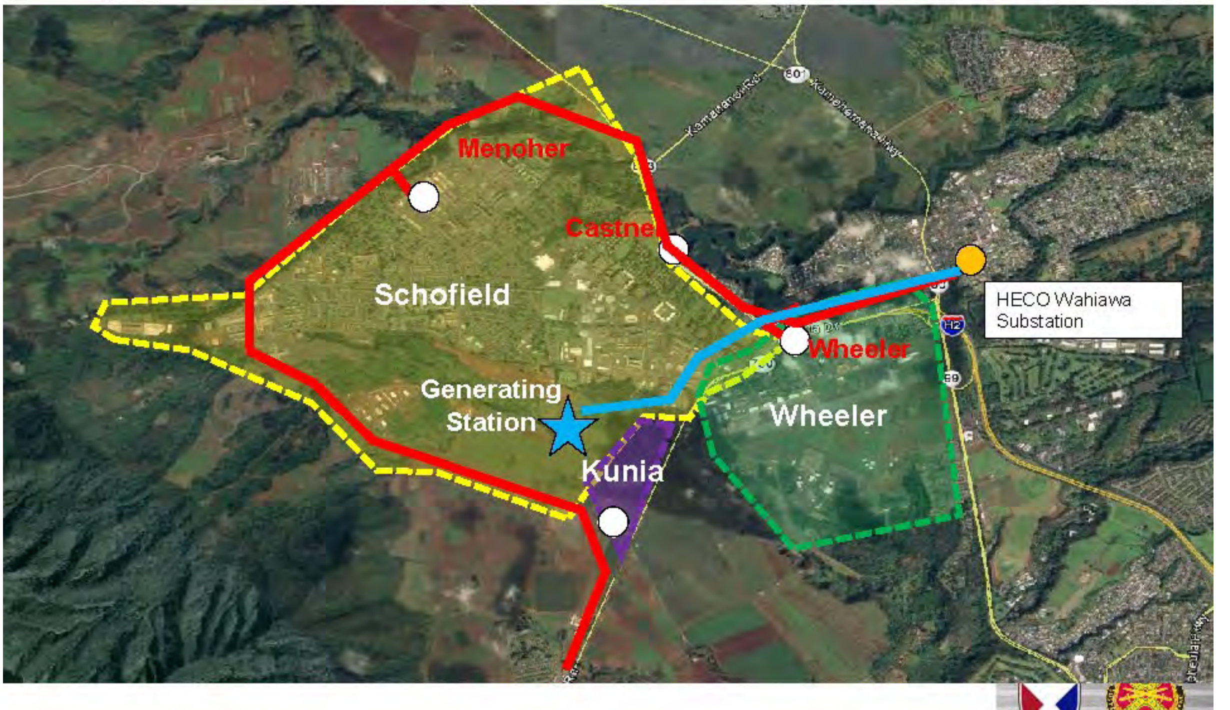
SGS Microgrid

✓ **The SGS Micro-grid is owned and operated by the Hawaiian Electric Company (HECO)**

- Construction started 2016 and placed into full service 2018
- Located on Schofield Barracks Army installation
- Executed through an Enhanced Use lease – HECO provides Army exclusive islanding service in lieu of lease rent for 50 years
- $148 M capital and $9.2 M annual O&M)

✓ **Provides 100% back-up power to SB, WAAF, Field Station Kunia NSA and South Range service at no cost**

- Duration: 7 days of onsite fuel at all times, 13 days of fuel storage capacity, 30 days of on-island fuel
- Capacity: 50 MW (Army load is 32 MW)
- Redundancy: Six 8.3 MW multi-fuel Wartsila marine diesel generators (2 spare units)
- Response: 2 hour from Army request by contract (each generator can ramp from blackout to 100% in 6 minutes)



SGS Microgrid

Features	HECO/Public Benefit	Army Benefit
Six 8.3 MW Wartsila marine units	Flexibility - 3 MW to 50 MW operating range	Increased reliability and resilience - 4 units meet 100% of load. 2 spare units. Meets full range of Mission power requirements.
Quick starting - 0 to 100% in 6 minutes	Serves as non-spinning reserve lowering costs and emissions	Decreases duration to restore
Efficient - improvement over previous technology (gas turbine)	Lowers costs and emissions	Increased duration of resilience
Black start capable	Provides other power stations black start power	Blackout recovery
Firm renewable - frequency deviation better than industry standard during islanding	Mitigates frequency deviation from wind and solar variability	Clean power/allows interconnection of unfirm renewable into the microgrid to extend duration
Proven and time tested technology	Reliability	Mission assurance
Multi-fuel (bio and conventional diesel)	Resilience and economic flexibility	Resilience
Grid connected	Ratepayer asset	No cost resilience, utilized daily to insure reliability
Located above the tsunami inundation zone	Energy Resilience	Energy Resilience
Located on military installation	Security	Energy Resilience - onsite resource
Services only airstrip above the tsunami inundation zone	Food and Relief Resilience	Mission resilience
Located near transmission substation (5.5 kM)	Energy Resilience for local community and lower cost	Provides resilience to supporting community functions (Hospital and vendors)

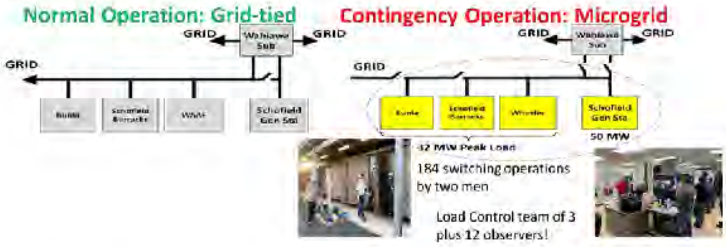
SGS Microgrid

✓**Provides 50 MW of reserve generation for Oahu**

- Offsets intermittent output of renewable energy sources – a renewable that allows more wind and solar onto the grid!
- Oahu's only generation not in ocean inundation zone
- Black start unit for other power plants
- More efficient use of biofuel and water (emission control) – lowering costs to all ratepayers
- Exercised regularly (daily) to verify availability

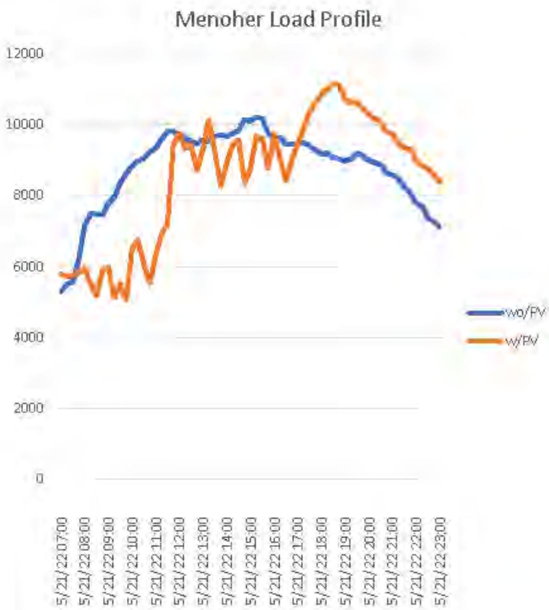
SGS Microgrid Black Start Test

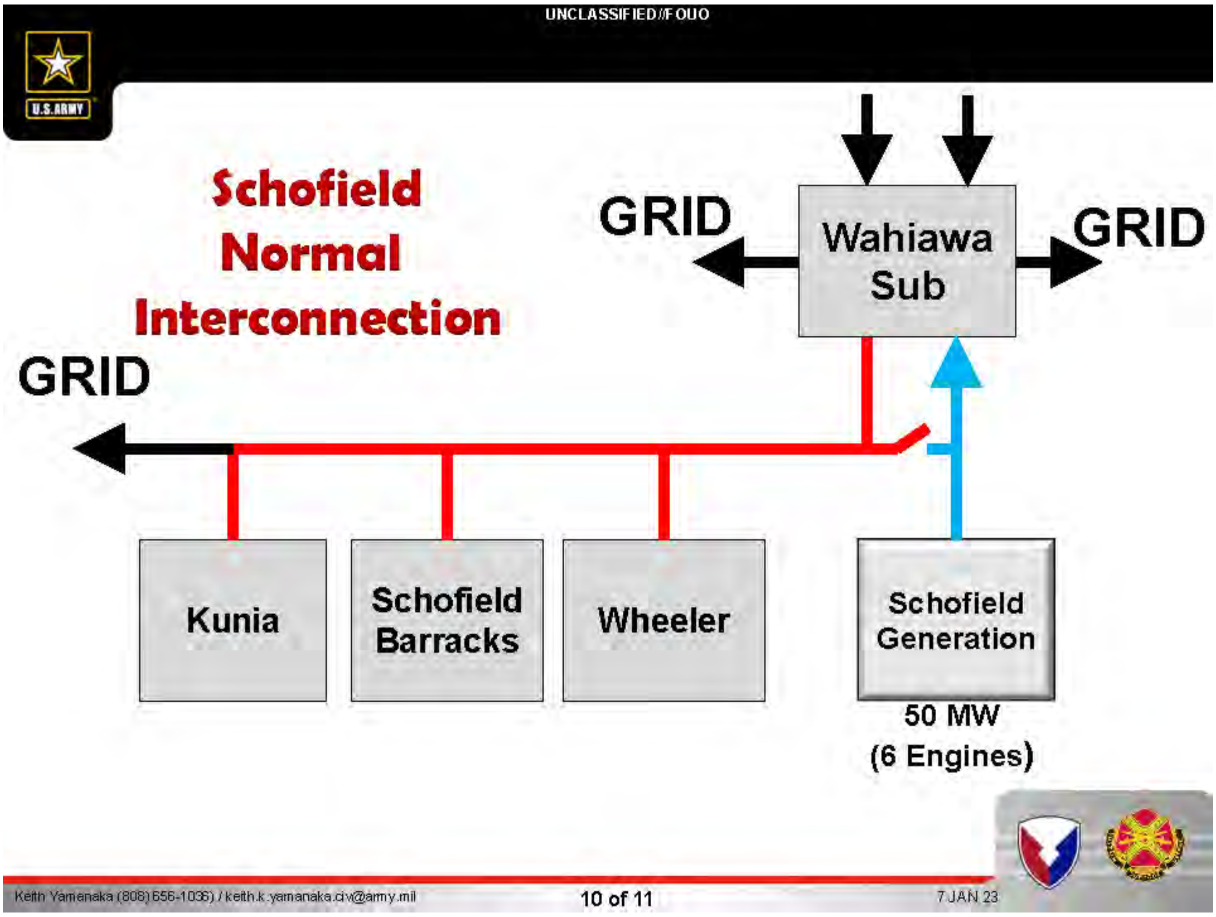
- ✓ On 22-23 May 2021 a black start test of the SGS Microgrid demonstrated its ability to restore power to SSA within 2 hours, sustain all power requirements for 24 hours on SGS only and interconnect an additional 1 MW of PV for an additional 9 daylight hours. For a total of 33 hours the three military installations were restored and sustained with 100% on site renewable energy with no deviation in power quality or equipment failure.
- ✓ **Critical key events**
  - Isolate micro-grid from main grid
  - Forecast load profile and cold load pick-up
  - Sequencing of 92 breaker operations total among 4 substation locations
  - Coordinate loading with number of generating units
    - each unit must have 2.5 MW within 30 minutes of start for clean air permit
    - Maintain adequate up and down reserve
  - Manage distributed inverter based and rotating energy resources
  - Manage large loads – HVAC central plants, water plant, wastewater plant, Kunia Diesel Reciprocating UPS (DRUPS)
  - Sequencing of 92 breaker operations total among 4 substation locations
  - Transfer back to grid



SGS Microgrid – the Future

- ✓ **Loop the 46 kV line to create omni-directional capability**
- ✓ **Create 12 kV critical bus/feeder with direct SGS feed in**
- ✓ **SCADA to shorten recovery and provide fidelity to cold load pick-up estimates**
- ✓ **Determine PV tolerance test and develop mitigation measures to allow maximum amount (11 MW) of interconnect in islanded mode**
- ✓ **Black start enabler for a 100% inverter based resource macrogrid**

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Barracks
Wheeler
Schofield
Generation
50 MW
(6 Engines)
Keith Yamenaka (808) 656-1036) / keith.k.yamanaka.civ@army.mil
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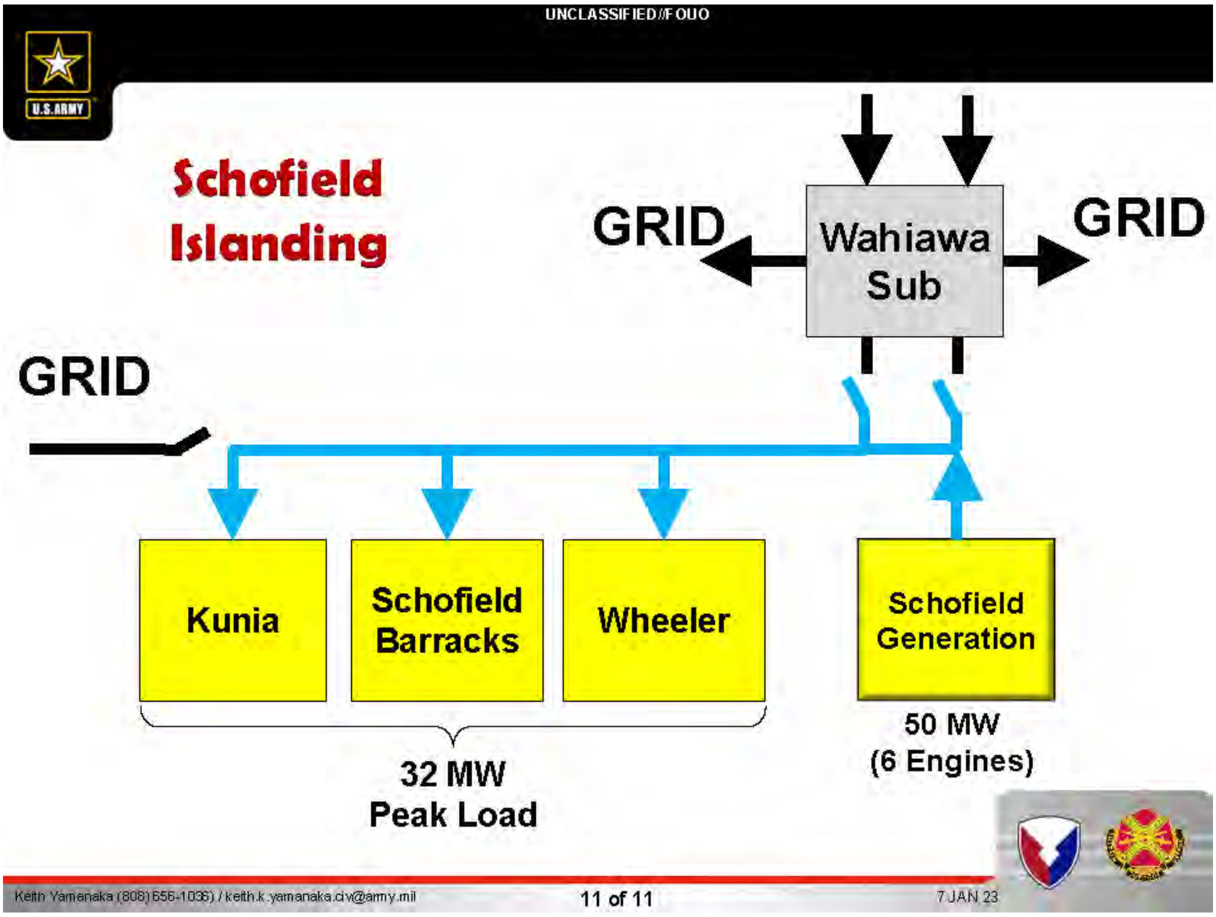
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Kunia
Schofield
Barracks
Wheeler
Schofield
Generation
50 MW
(6 Engines)
32 MW
Peak Load
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7 JAN 23

UNCLASSIFIED

Basic Legal Aspects of DoD Energy Projects in Germany and other European Host Nations

Stronger Together! UNCLASSIFIED

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UNCLASSIFIED

Legal Framework Overseas

- International Law
  - ✓ Customary International Law
    - Territorial Sovereignty
    - Sovereign Immunity
  - ✓ International Agreements
    - NATO SOFA
    - Supplementary Agreements
    - Implementing Agreements (e.g. ABG1975)

Stronger Together! UNCLASSIFIED

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Legal Framework Overseas

- **Host Nation Law**
  - ✓ Includes EU Law
  - ✓ Zoning and Building Codes
  - ✓ Environmental Law
  - ✓ Energy Supply Legislation
  - ✓ Renewable Energy Legislation
  - ✓ Tax Laws

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Legal Guardrails (Germany)

- **Art. 49, Supplementary Agreement (SA)**
  - ✓ All US Forces Construction IAW ABG1975
  - ✓ Normally indirect by German authorities for the US
  - ✓ Direct construction = exception (threshold $1.2M)
- **HN Permit Requirements**
  - ✓ Art. 53, 53A, SA
  - ✓ FRG Nominal Party
  - ✓ Notification vs. State Building Law
  - ✓ Environmental law (e.g. emission control, nature preservation, water, etc.)
  - ✓ Renewable Energy Law, Cogeneration Law
  - ✓ Power Grid Connection Regulation
  - ✓ Industrial Safety

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Legal Guardrails (Germany)

- Taxation (Art. 67, SA)

✓ Sending State Forces exempt from taxation
✓ No Participation in German Trade (see also PoS re Art. 53, SA)
✓ Conflicts with statutory requirement to market renewable energy from facilities w 5capacity of ≥ 100kW
✓ Producer = Entrepreneur = Participation in Trade
✓ Taxable with VAT and Business Tax
✓ US will not subject itself to HN taxation

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Concepts and COAs

- Use of Small and Non-Stationary Facilities

✓ No construction permit may be necessary
✓ No emission control permit for certain small facilities

- Direct construction (up to $1.2M)

✓ May not be available for projects requiring complex public permitting

- Special Contracting Models

✓ third-party construction, facility operation, etc.
✓ Relief to military construction process
✓ Pro: Saving US, HN capacities, no taxation issues
✓ Contra: No legal privileges, construction permit vs. notification

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Day 3, Introduction, Session 6 "Energy Master Planning" (Alexander Zhivov)

ENERGY MASTER PLANNING TOWARDS NET ZERO ENERGY RESILIENT PUBLIC COMMUNITIES

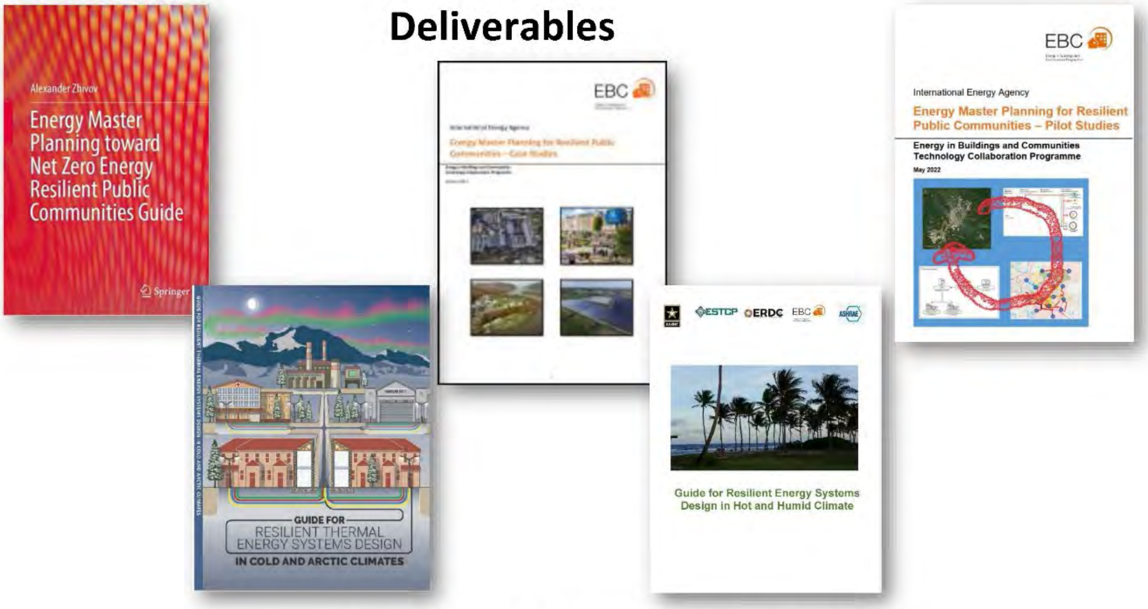
Dr. Alexander Zhivov
IEA EBC Annex 73 Co-operating agent
Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)

January 25, 2023

Project Participants:
8 countries and 36 organizations

Leveraged with projects co-funded by the Office of the Deputy Assistant Secretary of the Army, U.S. Army Program 633734T1500 and the International Energy Agency Energy in Buildings and Communities Program Annex 73.

Deliverables



https://annex73.iea-ebc.org/publications

3

Case Studies of Energy Master Plans

32 Case studies of energy master plans for military installations, University campuses, Medical centers and public housing from Australia (2), Austria (2), Denmark (10), Finland (6), Germany 4), Canada (1), Norway (1) and the USA (7)

Fort Bliss, USA

Guam, USA

Fort Bragg, USA

University of Texas, Austin

Nymindegab military campus, Denmark

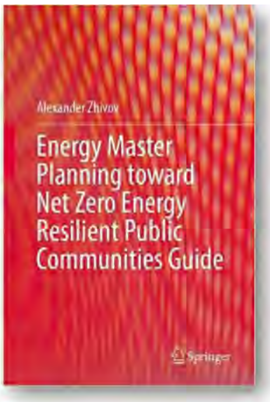
"Ford Plant" area development Minneapolis, MN

Town of Gram, Denmark

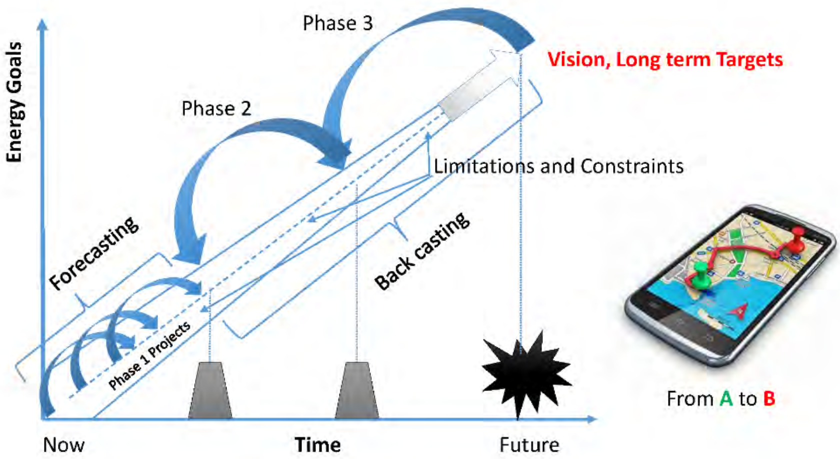
The Univ. of British Columbia, Canada

Volkswohnung
Karlsruhe, Germany

Guide Content



Energy Master Planning = Establishing a Roadmap



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Concept

- The objective of the community/installation Energy Plan is to produce a **holistic roadmap** that enables to work constructively towards **various framing energy goals** within **defined community boundaries** and **specific constraints**
- Energy master planning is a complex process that includes cultural, organizational, technical, legal, and financial aspects. We will be focusing primarily on **technical and financial aspects** of this process.
- The process of building efficient, sustainable, and resilient communities requires careful coordination between a number of stakeholders, including **master planners**, **energy planners**, **building owners/tenants** and **building designers.**
- Three levels of stakeholders can readily be identified**.**
  - **Highest level**: master planners think in terms of long-term sustainability goals, including community layout, transportation, and street design. To address sustainability, master planners have to extend the length of their view to 25 or more years.
  - **Middle tier**: Energy managers focus may vary between longer-term energy infrastructure projects, such as district energy systems, to medium- or near-term projects, such as building retrofits designed to meet community energy goals.
  - **Detailed level**: The building (or infrastructure) designer must create designs for a specific project that can be shown to be effective, buildable, biddable, and cost effective.

Framing Goals: Consistent EMP Terminology Is Important

- Goals, Objectives, and Targets - may be desired/optional
- Requirements & constraints - must be met

EXAMPLES:

State Building Code* – meet ANSI/ASHRAE/IESNA Standard 90.1 (requirement)

EU-EPBD** - New buildings nearly zero-energy by 2020 (Dir. 2018/884/EU) (goal)

U.S. 10CFR433 - Federal facilities designed to meet ASHRAE 90.1-2019 (regulation)

Campus be 100% renewable energy (target)

* State of Florida
**European Union – Energy Performance of Buildings Directive

Identify and Classify Project Objectives -
This Step Clearly Identifies Your Overarching Design Boundaries

	Classification of Objective			
Energy Master Planning Objective	**Goal (Y/N)**	**Requirement (Y/N)**	**Value**	**Value (units)**
Environmental impact (% reduction in GHG)				%
Reduce source energy use (% reduction)				%
Reduce site energy use (% reduction)				%
Renewable energy generation (% of electricity use)				%
Backup/redundant systems for electric generation				
Grid-independent capability- mission critical				
System availability for mission-critical (uptime)				%
Water use limit				kgal/day
Particulate emissions limit				ppm
Maximum project cost				$k
Return on investment (ROI)				%
Ease of maintenance (simple, low cost, serviceable)				

Scope of Energy Master Plan

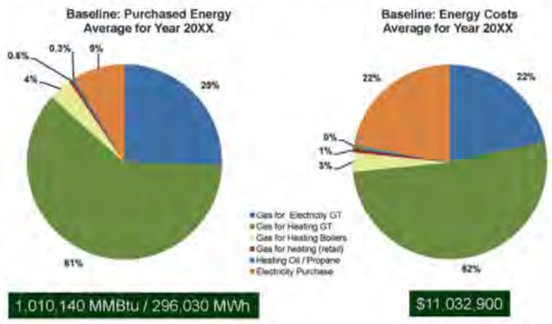
- The scope of energy master planning effort can include residential, commercial, and public buildings; community-based infrastructure; industrial energy users; community-owned and transit transportation and other energy-consuming users; or any combination of those. Also, it can be limited to include only mission-critical facilities. When defining the scope, it is important to understand the energy users that the community can control.
- A community can have fixed boundaries defined either by physical limitations (e.g., an island-based community) or political or administrative boundaries. For example, a military installation or university campus may be a contiguous area or may be comprised of separate areas

Selected Terminology

- Baseline
- Base Case
- Alternatives
- Resilience
- Blue-sky scenario
- Black-sky scenario

Baseline

The baseline is defined as the current energy consumption profile (site and source), energy cost profile and associated greenhouse gas (GHG) emissions, and resilience of existing energy systems. It is essential that the baseline capture the quantity and type of energy used (transformed) by the community/installation



Example of energy use and cost for a nominal community

Total Community-wide Energy Use

The total energy use in the community can be grouped by different users, losses in generation, conversion, and transmission using the following categories:

End uses

- a. Building Functions
- b. Industrial Processes
- c. Central Services – Compressed Air/Water/Sewer

Distribution losses

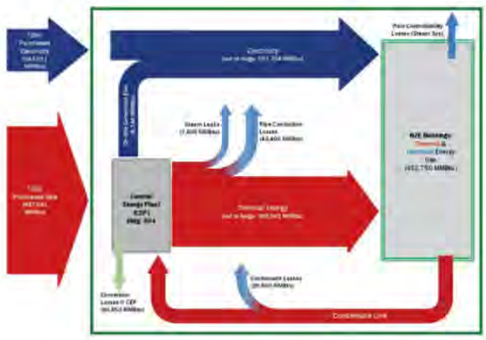
- d. Hot water, chilled water, and steam network
- e. Onsite electrical

Onsite Conversion Losses

- f. Turbines
- g. Boilers
- h. Engines

Offsite Conversion and Distribution Losses

- i. Purchased natural gas
- j. Purchased electricity.



Schematic of baseline energy uses and wastes for a campus areas

Base Case

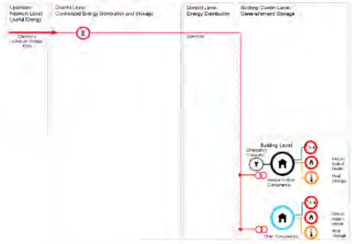
- The baseline data can be used to project a base case scenario for energy use given the availability of information on an increase or decrease of energy use due to: new construction; consolidation and demolishing processes; building repurposing and change of mission or new requirements to thermal comfort and indoor air quality; use of new and existing utility contracts; and the dates when known contracts will expire.
- The base case is defined as a future “business as usual” alternative that includes all existing and already planned facilities. Facilities marked for demolition in the baseline are not included. The baseline models of buildings and energy systems shall be adjusted to reflect all planned modifications. The base case shall include the data on site and primary energy use and energy cost with categories similar to ones used for the baseline. It is important to present the data showing the cost of implementation of the base case as well as changes in site, and source energy use, energy cost, and GHG compared to the baseline.
- During this step, team compares the base case analysis results against the installation’s vision and goals. The analysis should assess implementation costs and quantify gaps for energy systems including their resilience against community framing goals. The base case will serve as a benchmark for life cycle cost analysis (LCCA) of alternative systems.

Establishing energy system alternatives

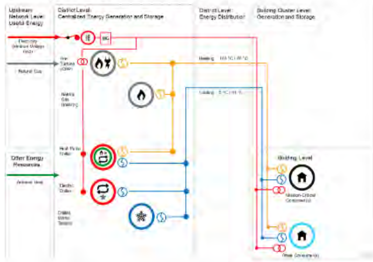
- Once the baseline and base case have been established, energy planners can start exploring options or alternatives. A handful of alternatives shall be selected that will be analyzed in depth. Electric and thermal energy systems consist of four major elements: energy generation, energy distribution, energy storage, and energy demand. The goal is to find the optimum balance of these elements for the entire energy system, where each element is considered in the calculation of the amount of energy delivered and lost, in various forms, by the energy systems as well as its impact on energy system resilience.
- Alternatives can explore different levels and scopes of building stock renovation and energy supply strategies
- Supply strategies can include, but not be limited to, decentralized energy supply, steam to hot water district systems conversion, energy supply using only renewable energy sources, short-term and seasonal thermal energy storages, batteries, etc.
- For each alternative, it is important to present the data showing the cost of its implementation as well as changes in site, and source energy use, energy cost, GHG compared to the baseline and the base case as well as systems’ energy resilience compared to the base case.

Examples of Thermal System Architectures

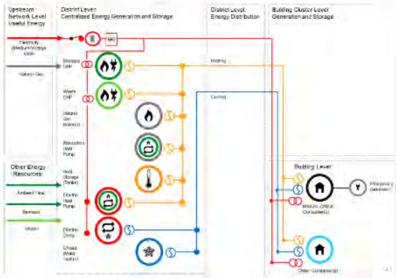
Example of generic power only system with buildings heating and cooling using electric boilers and chillers



Example of District heating, cooling and power systems (Case Study from UT Austin Medical Center)



Example of generic power, heating and cooling systems with CHP base load generation seasonal storage, waste heat use, etc..



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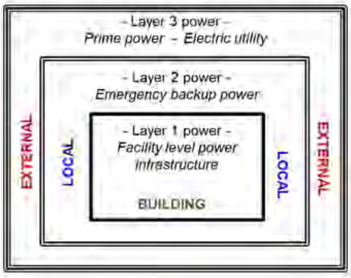
Structure of Technology Database

Quantifying energy system resilience

The proposed quantitative approach includes (but not limited to) the following metrics:

- **Energy System Robustness (ER)**
- **Energy System Recovery time**
- **Energy Availability (EA)**
- **Energy Quality (EQ).**

The first three parameters are critical for the selection of the Layer 2 and Layer 3 energy supply system architecture and technologies they are comprised of to satisfy requirements related to energy system resilience.



Most of the mission-specific energy quality requirements (both electric and thermal), including the level of tolerance to short-term interruptions, can be handled by the Layer 1 energy systems (electric nano-grids), or building thermal systems (that include the building envelope, thermal storage and HVAC system), which are designed based on class or tier of such requirements.

Energy Availability & Max Single Event Downtime

Evaluate → Criticality + Remoteness + Redundancy

- Then determine -

↓

Resilience Phase
= Availability + Recovery

Resilience Metric	Facility Level	Resilience Sub-Metric	Category	Degraded State Availability	Acceptable Average Weekly Downtime (Minutes)	Maximum Single Event Downtime (Minutes)
Low	Primary	Low	LP/1	0.92	806.4	2,419
		Moderate	LP/1+	0.95	504	1,500
	Secondary	Low	LS/0	0.9	1008	3,024
		Moderate	LS/0+	0.92	806.4	2,419
Moderate	Primary	Low	MP/2	0.99	100.8	302
		Moderate	MP/2+	0.995	50.4	150
	Secondary	Low	MS/1	0.95	504	1,500
		Moderate	MS/1+	0.99	100.8	302
Significant	Primary	Moderate	SP/3	0.999	10.08	30
		Significant	SP/3+	0.9995	5.04	15
	Secondary	Moderate	MS/2	0.95	504	1,500
		Significant	MS/2+	0.99	100.8	302
High	Primary	Significant	HP/4	0.9999	1.008	3
		High	HP/4+	0.99999	0.1008	0.3
	Secondary	Significant	HS/3	0.9995	5.04	15
		High	HS/3+	0.9999	1.008	3

Parametric Analysis of Maximum Time for an Office Building Thermal Energy System Repair

Building Parameters	Temp ODB	Mass Building			Frame Building		
		Typical/Post 1980	Low Efficiency	High Efficiency	Typical/Post 1980	Low Efficiency	High Efficiency
Walls R-value, °F·ft²·hr/Btu ([m2·K]/W)		20.5 (3.6)	40 (7.0)	50 (8.8)	20.5 (3.6)	40 (7.0)	50 (8.8)
Roof R-value, °F·ft²·hr/Btu, ([m2·K]/W)		31.5 (5.5)	45 (7.9)	60 (10.6)	31.5 (5.5)	45 (7.9)	60 (10.6)
Air Leakage, cfm/ft2 at 0.3 in. w.g. (L/s.m2 @75Pa)		0.4 (2)	0.25 (1.25)	0.15 (0.75)	0.4 (2)	0.25 (1.25)	0.15 (0.75)
Window (R-value, °F ft²·hr/Btu, U value, W/(m2·K)		Double Pane; R = 1.78 / U = 0.56	Double Pane; R= 3.34 / U=0.3	Triple Pane; R= 5.25 / U=.19	Double Pane; R = 1.78 / U = 0.56	Double Pane; R= 3.34 / U=0.3	Triple Pane; R= 5.25 / U=0.19
MaxSEDT Hab. (60°F/15.6°C)	-60 °F -51.1 °C	< 1 hours	2 hours	5 hours	<< 1 hour	1 hours	2 hours
MaxSEDT Sust. (40°F/4.4°C)		9 hours	28 hours	41 hours	4 hours	14 hours	21 hours
MaxSEDT Hab. (60°F/15.6°C)	-40 °F -40 °C	1 hours	3 hours	10 hours	< 1 hour	2 hours	4 hours
MaxSEDT Sust. (40°F/4.4°C)		20 hours	36 hours	51 hours	10 hours	18 hours	24 hours
MaxSEDT Hab. (60°F/15.6°C)	-20 °F -28.9°C	2 hours	6 hours	15 hours	1 hour	3 hours	6 hours
MaxSEDT Sust. (40°F/4.4°C)		31 hours	46 hours	60 hours	15 hours	22 hours	28 hours
MaxSEDT Hab. (60°F/15.6°C)	0 °F -17.8°C	3 hours	13 hours	29 hours	2 hours	5 hours	9 hours
MaxSEDT Sust. (40°F/4.4°C)		43 hours	59 hours	90 hours	21 hours	28 hours	33 hours
MaxSEDT Hab. (60°F/15.6°C)	20 °F -6.7°C	10 hours	28 hours	45 hours	3 hours	8 hours	15 hours
MaxSEDT Sust. (40°F/4.4°C)		60 hours	78 hours	95 hours	28 hours	35 hours	40 hours
MaxSEDT Hab. (60°F/15.6°C)	40 °F 4.4°C	29 hours	54 hours	72 hours	8 hours	17 hours	23 hours
MaxSEDT Sust. (40°F/4.4°C)		93 hours	112 hours	123 hours	41 hours	47 hours	50 hours

Blue-sky Vs Black-sky System Operation

- Blue sky system operation is operation under normal conditions, when system reliability is solely a function of the inherent design characteristics of the system.
- Black Sky system operation is operation under any man-made or natural events, that disrupt the normal functioning of the system for extended periods of time. This can include extreme weather, mega earthquakes, cyber terrorism, and high-altitude electromagnetic pulse.

Requirements for Building Thermal under and Emergency Operations

Maintaining thermal parameters is necessary to achieve one or several purposes:

- Perform the required work in a building safely and efficiently,
- Support processes housed in the building, and
- Provide conditions required for the long-term integrity of the building and its materials.

Data and Electronic Equipment Centers

Conditions	ClassA1/ClassA2 (ASHRAE 2019a)		NEBS (ASHRAE 2005)	
	Allowable level	Recommended level	Allowable level	Recommended level
Temperature control range				
A1	51 °F - 89 °F (11 °C – 32 °C)	64 °F-80 °F (18 °C–27 °C)	41 °F-104 °F (5 °C–40 °C)	65 °F-80 °F (18 °C–27 °C)
A2	51 °F - 91 °F (11 °C - 33 °C)			
Maximum temperature rate of change	9 °F/hr (31 °F/hr)[1] (5 °C/hr [2 °C/hr])		2.9 °F/hr (1.6 °C/hr)	
RH control range				
A1	10 °F (-12 °C) dewpoint and 8% RH to 62 °F (17 °C) dewpoint and 80%RH	15 °F - 51 °F dewpoint (-9 °C - 11 °C) dewpoint and 60% RH	5%-85% 82 °F (28 °C) Max dewpoint	Max 55%
A2	10 °F (-11 °C) dewpoint and 8% RH to 69 °F(21 °C) dewpoint and 80%RH			

[1] 9 °F/hr (5 °C/hr) for tape storage, 31 °F/hr (2 °C/hr) for all other IT equipment and not more than 9 °F (5 °C) in any 15 min period.

Recommended thermal conditions for buildings located in hot humid climates – Normal (blue-sky) operations.

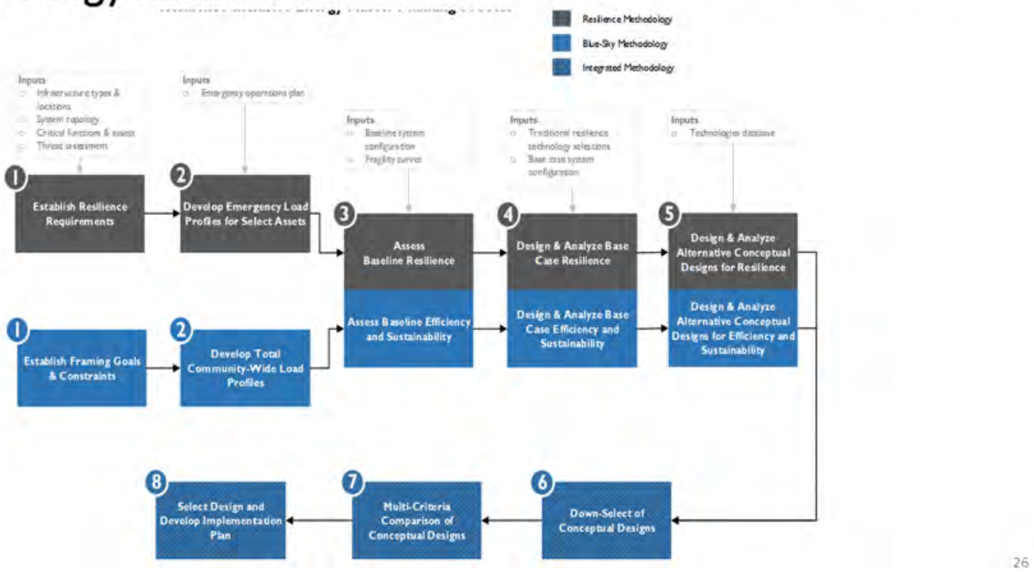
Type of Requirement	Space Occupancy						
	Normal Operations (Regular Business Hours)			**Unoccupied for a Short Period (e.g., Few Days)**		**Unoccupied for an Extended period (e.g., Weeks)**	
	Humidity Not to Exceed	**Maximum Dry Bulb Temp**	**Minimum Dry Bulb Temp**	**Humidity Not to Exceed**	**Maximum Dry Bulb Temp**	**DP Not to Exceed**	**Maximum Dry Bulb Temp**
Human Comfort	60%[1]	82 °F (27.7 °C)[1]	68 °F (20 °C)[1]	70%[4]	85 °F (29 °C)[4]	N/A	
Process Driven	Process specific			Process specific)		N/A	
	DP		RH	Humidity not to exceed	DP	DP	RH
Building Sustainment	≤60 °F (15.6 °C)[3,6]		< 70%[3]	<70%[3]	<60 °F (15.6 °C)[3,6]	≤60 °F (15.6 °C)[3,6]	<70%[3]

Recommended thermal conditions for buildings located in hot climates – Emergency (black sky) operations

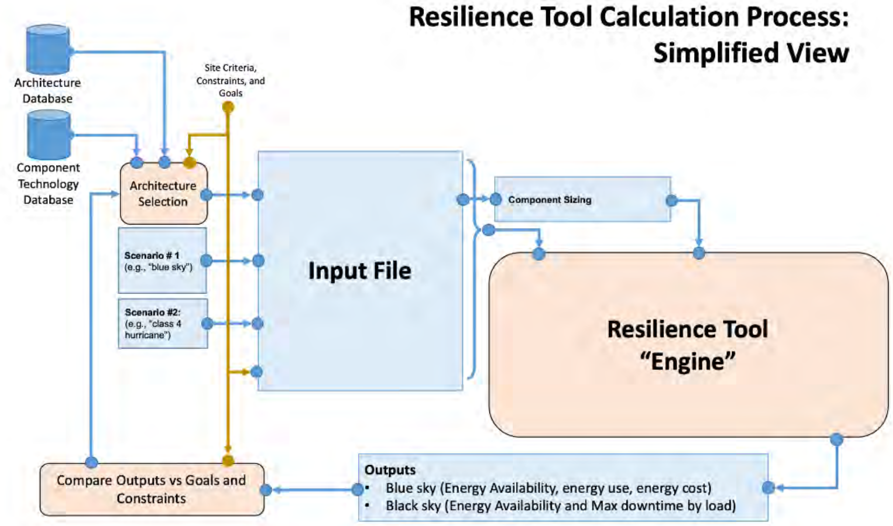
Type of Requirement	Space Occupancy					
	Mission-Critical		**Tertiary Space around Mission-Critical**		**Hibernated Can Be Unoccupied for Extended period (from Days to Weeks)**	
	WBGT		**WBGT**		**WBGT**	
Human Activity Broad Range	< 85°F (29°C)[5]		NA		N/A	
Process Driven	Process specific		N/A (unless specified otherwise)		N/A	
	DP	RH	DP	RH	DP	RH
Building Sustainment	≤60 °F (15.6 °C)[3,6]	< 70%[3]	≤60 °F (15.6 °C)[3,6]	< 70%[3]	≤60 °F (15.6 °C)[3,6]	<70%[3]

[1]ASHRAE Standard 55 (2017), [2]To prevent water pipe rupture, with a factor of safety, [3]To prevent interior surface mold growth, with no factor of safety, [4]To prevent long time recovery and significant energy losses
[5] ACGIH TLV, Thermal stress recommendations, [6]ASHRAE Standard 62.1

Integration of Energy Systems Resilience Analysis into Energy Master Plan



Resilience Tool Calculation Process: Simplified View

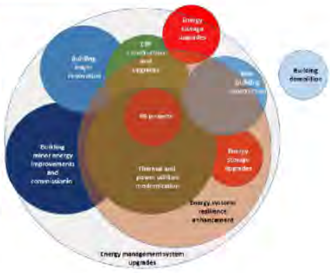


Economics of Energy Master Plan Implementation

Selection of alternatives for an EMP shall be based on cost effectiveness of the entire EMP instead of individual projects that comprise the EMP.

Most common business models used for communities EMP implementation

- Appropriated Funding
- Fixed Payment Model and Utility Fixed Repayment Model
- Energy (Saving) Performance Contracting-Model (ESPC)
- UESC
- Blended funding (public and private combined funding)
- ESPC Energy Sales Agreements
- Power Purchase Agreements
- Enhanced Use Lease



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Comparison of EMP business models.

Business Model	Description	Pros	Cons
Appropriated Funds	Funds appropriated by the governing agency as part of the yearly budgetary process, execution supervised by agency and subcontracting parties	- Straight forward - follows the normal processes for capital improvement program - Can be done incrementally for several years - Manage resource to highest priority areas	- Subject to normal budget priorities - Must be managed internally - Follows normal design-build processes - no extended guarantees - No energy performance guarantees - No budget limitation guarantee
Fixed Payment	Funded by a utility. Paid back via fixed payments on the utility bill or on the property tax bill	- Easily implemented - Usually low interest rates - Payment stays with the property in case property is sold	- No energy guarantee - Usually limited to small projects - EMP implemented in pieces
ESPC	Energy Savings Performance Contact	- Budget Neutral - Energy/Operations savings pay for the upgraded systems Third Party manages the contract - Energy savings are guaranteed - resulting in lowered financing rates - Multiple technical updates can be built in	- Not readily understood by many municipal officials - Typically need a 3rd party expert to advocate for the customer - Long approval cycles on final project/financing by customer - Concerns by some decision makers on long term debt
UESC	Utility Energy Savings Contract	- Budget Neutral - Energy/Operations savings pay for the upgraded systems Third Party manages the contract - Customer contracts with their utility - people they know - Customer decides level of energy guarantee	- Not readily understood by many municipal officials - Typically need a 3rd party expert to advocate for the customer - Long approval cycles on final project/financing - Concerns by some decision makes on long term debt - Not all utilities offer this service
Blended Funding	Combing appropriated funding with ESPC/UESC	- Same as ESPC/UESC - Shorten financing term by injecting one time or multiple cash payments - Can get more ECM's in the project	- Same as ESPC/UESC - Ensuring that the cash payments are available in the budget
PPA	Power Purchase Agreement - buy power from a non-utility partner or developer	- Developer pays all costs - Customer buys power at a price - At the end of the contract period, customer can buy the equipment for fair market value or have it removed - Developer may pay a lease payment to use customer land - Consistency of long-term budget planning	- Long term procurement contract for customer - typically 20 years - Energy prices may be fixed or escalated - Locked in prices result in not being able to take advantage of potential future lower pricing
EUL	Enhanced Use Lease - customer leases underutilized land to a 3rd party in exchange for resiliency	- Developer pays all costs - Lease payment is often "In Kind Consideration" which is often required or needed customer infrastructure updates - If utility power is lost, the power being produced on the leased land is sent to the customer	- Lease is 30-40 years - Power from the leased land is sold to the utility grid or may be bought by the customer - Land is unavailable for future customer expansion

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Multi-Criteria Analysis of Alternatives: Integrating Economic, Energy and Resiliency Targets

- Analysis of the base case and alternatives produces quantitative results that allows to determine how close the users were able to come to achieving their goals and objectives and compare the baseline, base case, and alternatives using defined criteria.
- There might be additional conflicting qualitative and quantitative criteria (e.g., risk, safety, comfort, fuel availability, etc.) which can support decisions in defining the roadmap to achieving ultimate framing goals
- MCDA allows selecting a reduced set of good non-dominating alternatives to be presented to decision makers for the final choice.

Questions and Discussion

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Day 3, "Danish District Heating System" (Anders N. Andersen)

Planning resilience and sustainability in the energy system modelling tool energyPRO

A case of a Danish district heating system having become fossil free with only wind and solar energy

Presentation at International Forum of Energy Security, Frankfurt 23-25. January 2023

made by PhD Anders N. Andersen, ana@emd.dk

energyPRO

Agenda for this 12 minutes presentation

- Scope of the presentation
- Components at Hvide Sande district heating, which has made it fossil free with only wind and solar energy
- The resilience and sustainability of Hvide Sande have been planned in the energy system modelling tool energyPRO
- Hvide Sande improving resilience by also participating in the balancing markets

25-01-2023 International Forum of Energy Security 2

Scope of the presentation

- Hvide Sande, at the west coast of Jutland in Denmark, in recent years has become more resilient.
- From being a natural gas fired district heating plant providing 1637 consumers,
- It has invested in:
- 9 MW wind turbines
- 5 MW heat pump
- 10 MW electrical boiler
- 9500 m2 solar collector
- 3200 m3 hot water storages
- Making their district heating independent of natural gas.

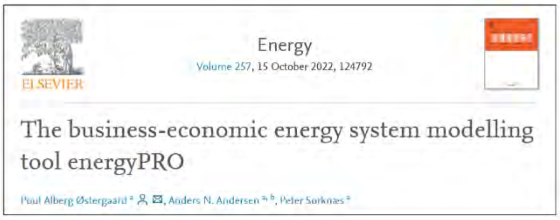
Hvide Sande Case

Components at Hvide Sande district heating, *https://www.youtube.com/watch?v=GSSqEieV56c*

Two thermal storages increasing flexibility and resilence, 2000 m3 + 1200 m3

ELSEVIER

- The resilience and sustainability of Hvide Sande have been planned in the energy system modelling tool energyPRO
- *https://www.sciencedirect.com/science/article/pii/S0360544222016954*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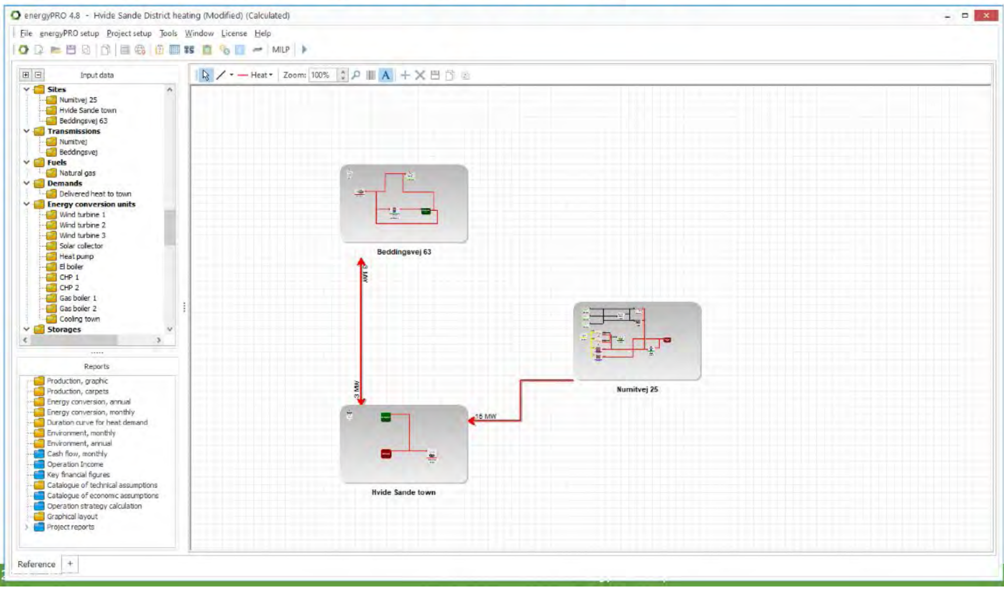
Energy
Volume 257, 15 October 2022, 124792

The business-economic energy system modelling tool energyPRO

Poul Alberg Østergaard [a], Anders N. Andersen [a, b], Peter Sorknæs [a]

An energyPRO analysis - is about finding the right balance between investments in production units, storages and grid infrastructures



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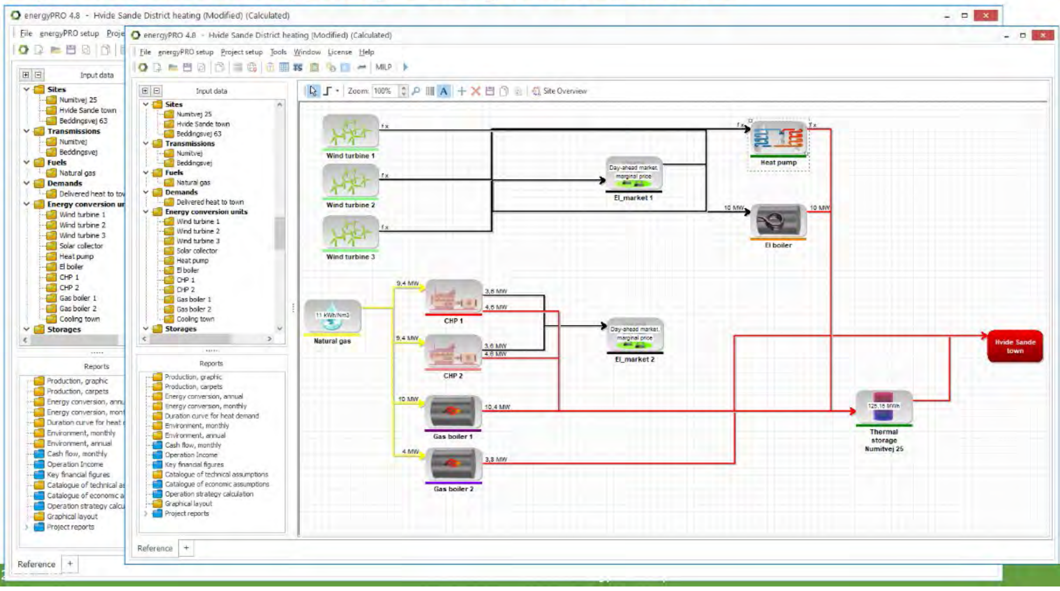
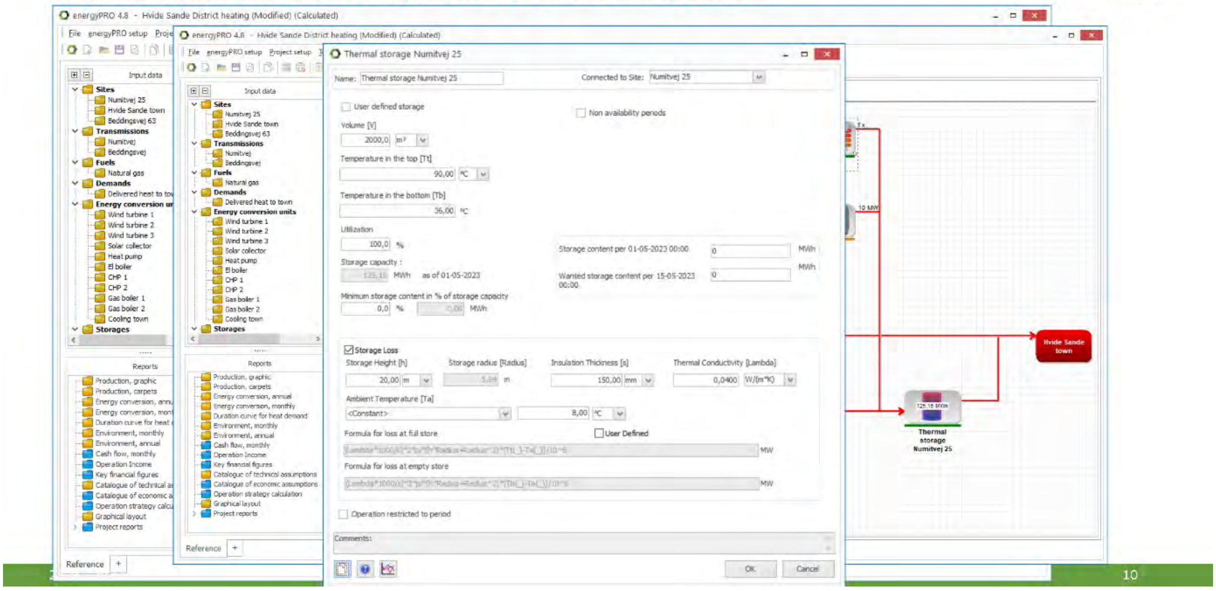


An energyPRO analysis - is about finding the right balance between investments in production units, storages and grid infrastructures



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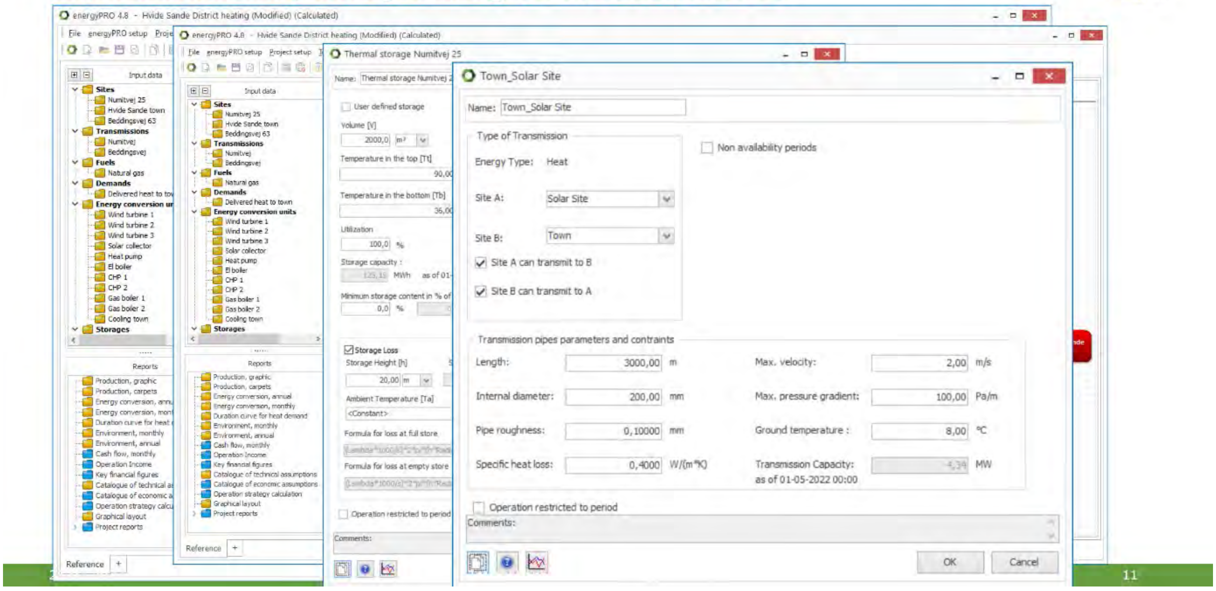
An energyPRO analysis - is about finding the right balance between investments in production units, storages and grid infrastructures



11

Resilience is tested in daily Production, graphic

Hvide Sande is improving resilience by also participating in the balancing markets (primarily in the yellow balancing markets):

- **FCR**, Frequence Containment Reserves
- **aFRR**, automatic Frequence Restoration Reserves
- **mFRR**, manual Frequence Restoration Reserves
- **mFRR EAM, Upward** , Energy Activation Market in mFRR, Upward
- **mFRR EAM, Downward**, Energy Activation Market in mFRR, Downward

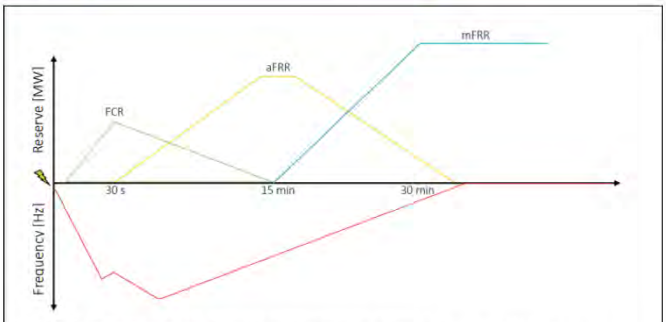


Figure 6: *Illustration of FCR, aFRR and mFRR maximum activation times (presently for DK1)*

The conditions at these balancing markets – to be visited after my presentation.

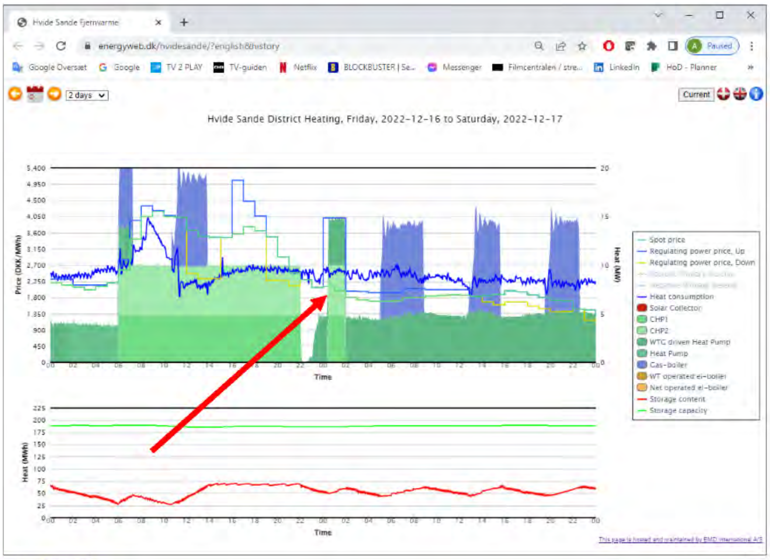
DK1	FCR	aFRR	mFRR
Purpose	Automatically contain and stabilize the frequency when incidents occur	Automatically restore frequency and balance in a specific geographic area (bidding zone)	Manually restore frequency and balance in a specific geographic area (bidding zone)
Technical specifications			
Reaction time, see Figure 6	Maximum 30 seconds	Maximum 15 minutes (5 minutes from 2024)	Maximum 15 minutes (10 minutes from 2024)
Minimum endurance	Approx. 20 minutes	Continuously in the contracted period	Continuously in the contracted period
Characteristics	The provider measures frequency and provision is required when frequency deviates outside given thresholds.	Energinet continuously forwards an activation signal based on requested activation.	Energinet activates providers per market time unit (MTU), currently per hour, but per quarter in ultimo 2023.
"Load factor"[7]	Net ~0 % ~1 % both down and up	Net ~12 % ~38 % down and ~26 % up (as mFRR in 2024[8])	100 % as the reserve is either activated or not. Activation is performed via the separate energy activation market.
Market specifications			
Minimum bid size	1 MW	1 MW	5 MW
Maximum bid size	N/A	50 MW	50 MW
Procured as	Symmetric product	Symmetric product (asymmetric for both up- and downwards regulation in 2024)	Asymmetric for upwards regulation only, seen from the power system perspective.
Market time unit (MTU)	4 hour block (6 blocks a day)	1 month (as mFRR in 2024, GCT 7.30 a.m.)	1 hour
Gate closure time (GCT)	8 a.m. the day before operation (before day-ahead)	2nd last working day before the coming month	9.30 a.m. the day before operation (before day-ahead)
Danish demand procured	+/- 20 MW	+/- 100 MW	+ 284 MW (up to 584 MW when sharing with DK2 is not possible)
Capacity market	Yes	Yes	Yes
Market size	Common central European market, with limited exchange possibility for DK1 due to grid constraints.	National (will be common Nordic in 2024)	National (will be common Nordic ultimo 2022)
Energy activation market	No	No (expected in 2024)	Yes (the regulating power market)
Pricing mechanism for capacity market	Marginal pricing	Pay-as-bid (marginal pricing in 2024)	Marginal pricing
Pricing mechanism for energy activation	Settled as imbalances (as the net energy activation is insignificant)	Day-ahead price +/. 100 DKK/MWh (as mFRR in 2024)	The balancing price (marginal price on the regulating power market)
Balancing responsibility	No	Yes	Yes

***Table 1**: Main technical and market specifications for reserves in DK1 (with coming changes).*

At EMD we show online the participation in the balancing markets of more plants, here Hvide Sande

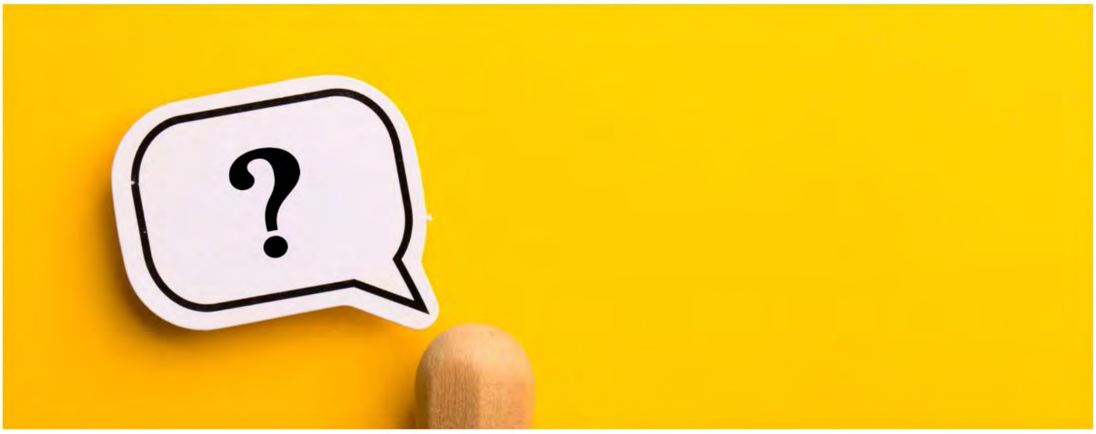
www.emd-international.com/livedata

Here Hvide Sande win an upward regulation of the two CHPs



www.emd-international.com/livedata

Thanks for your attention !



Day 3, "Energy Master Planning" (Michael Case)

Energy Master Planning and Resilience Analysis using the System Master Planning (SMPL) and the Energy Resilience of Interacting Networks (ERIN) Tools

Dr. Michael Case U.S. Army
U.S. Army ERDC/CERL

US Army Corps of Engineers®

1

Purpose of the SMPL Tool

Provide installation planners and energy managers with a parametric and predictive tool to develop energy and resilience master plans for defense installations

2

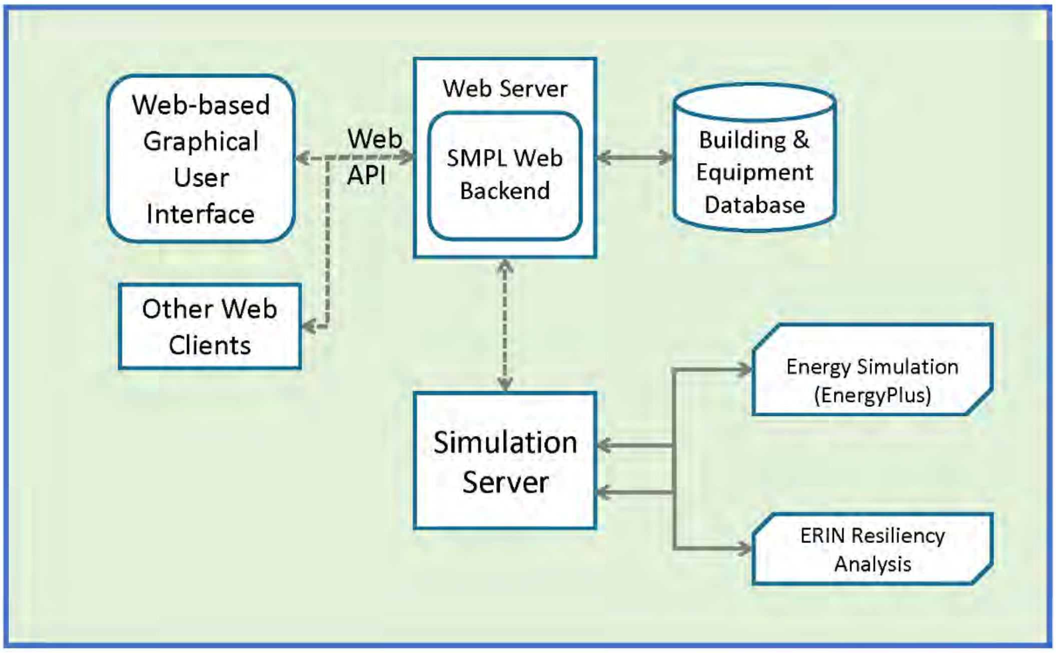
SMPL TOOL

Online system that enables energy and resilience analysis of a portfolio of facilities over their lifecycles (past, present, and future). Users can create studies to explore alternative energy efficiency and resilience courses of action to support creation of Master Plans and Energy Master Plans.

Developed with Big Ladder Software LLC, Denver, CO, USA

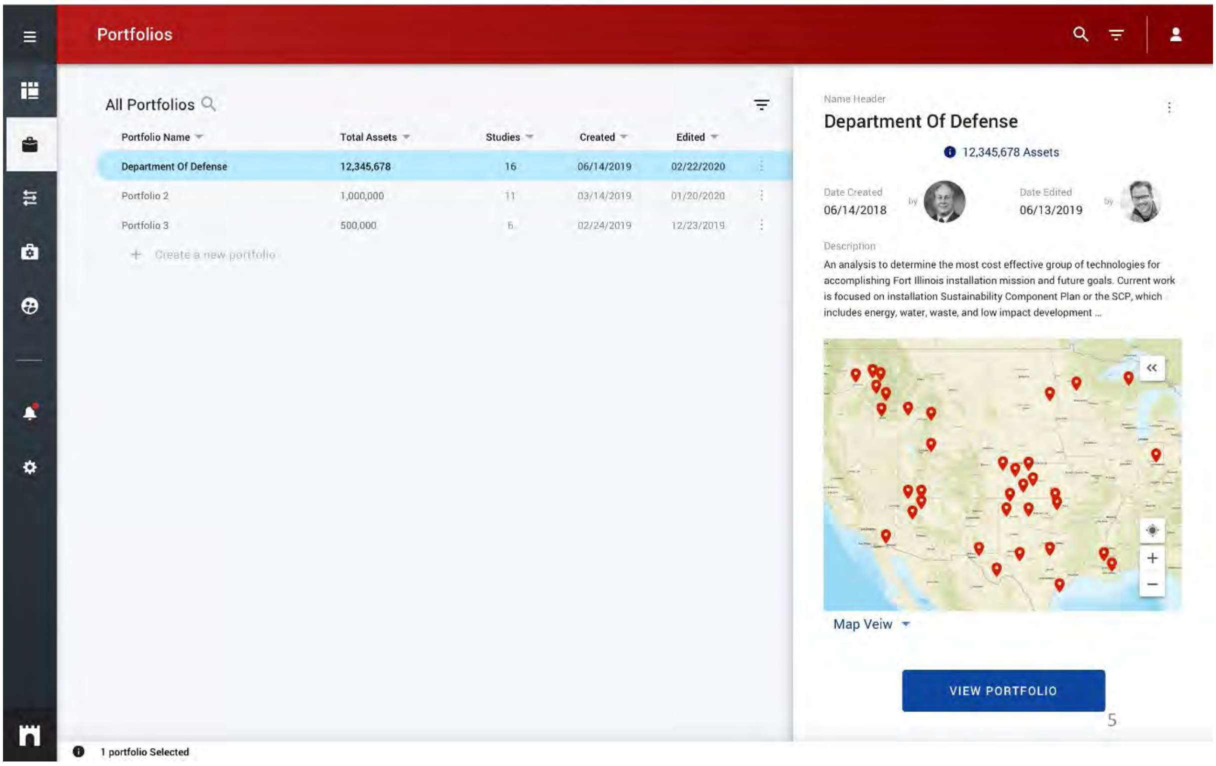
3

SMPL/ERIN Functional Diagram

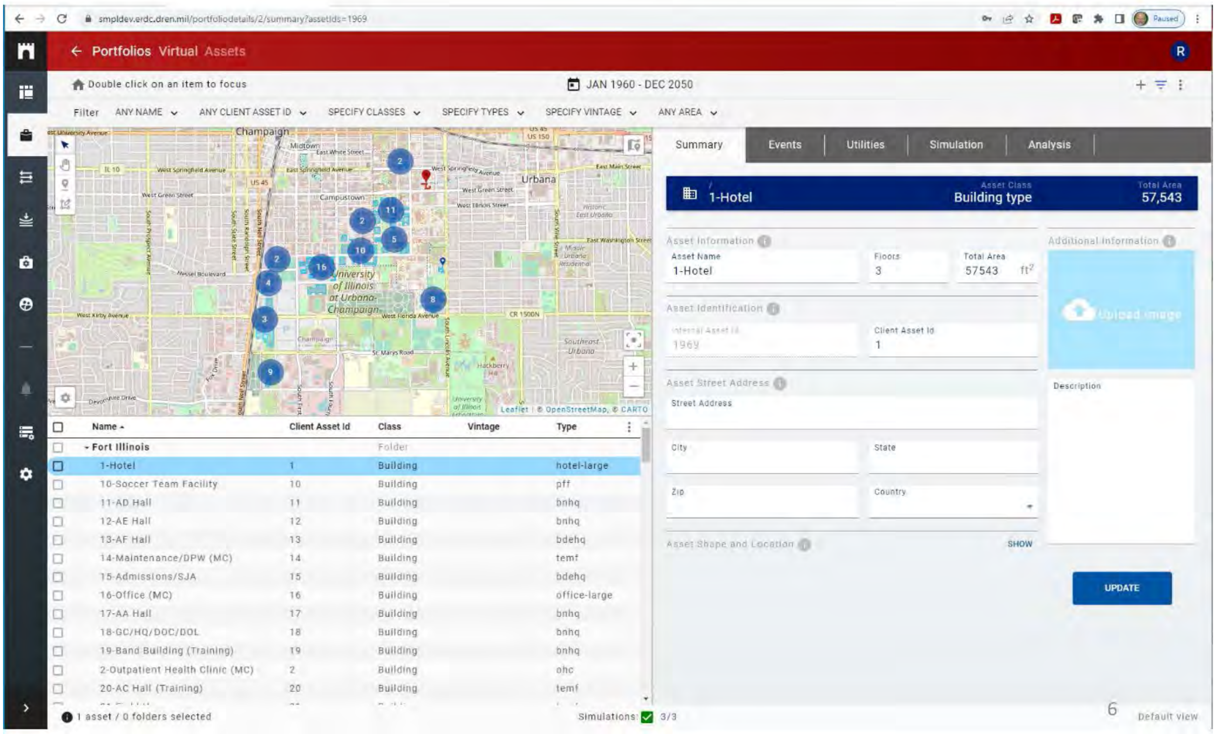


4

Portfolios: Contain and Organize Assets

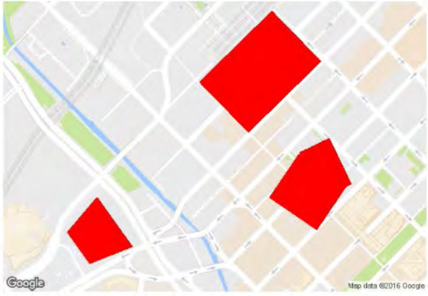


Portfolios: Contain and Organize Assets

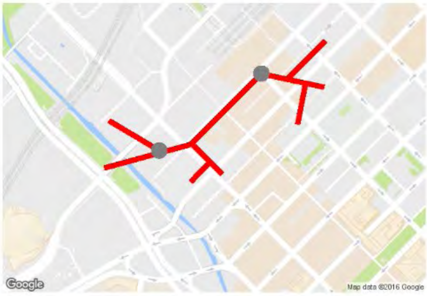


Portfolios: Types of Assets

Building



Site

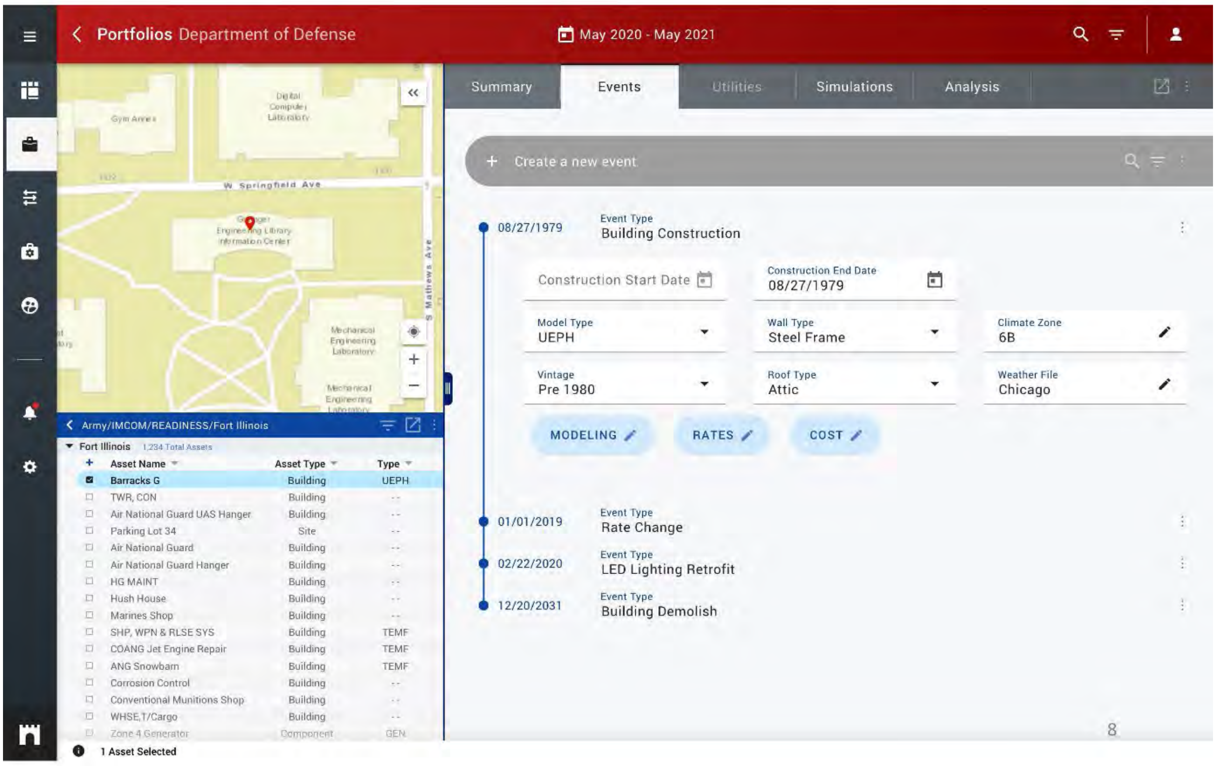


Network

Equipment

7

Simulate: Projects and Other Changes are Events



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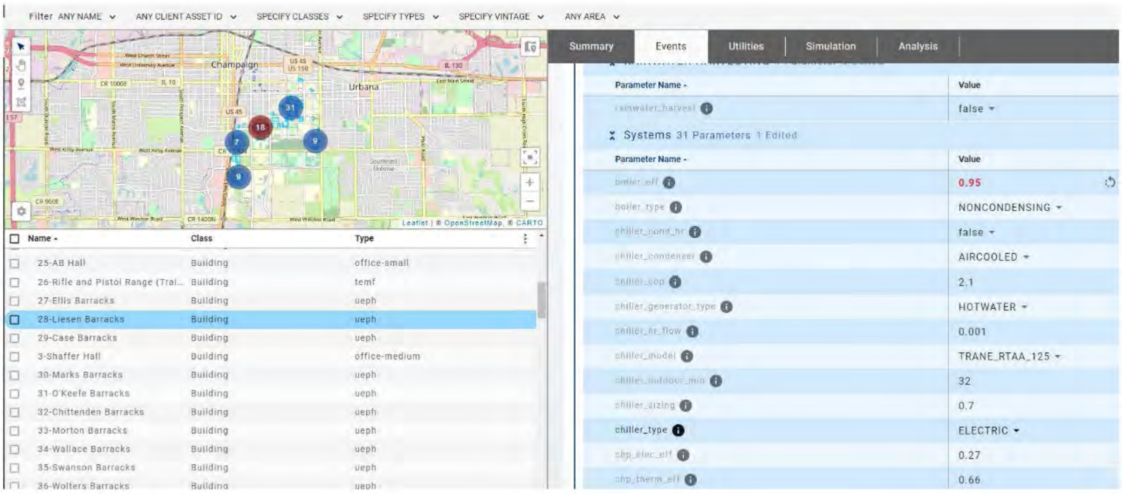
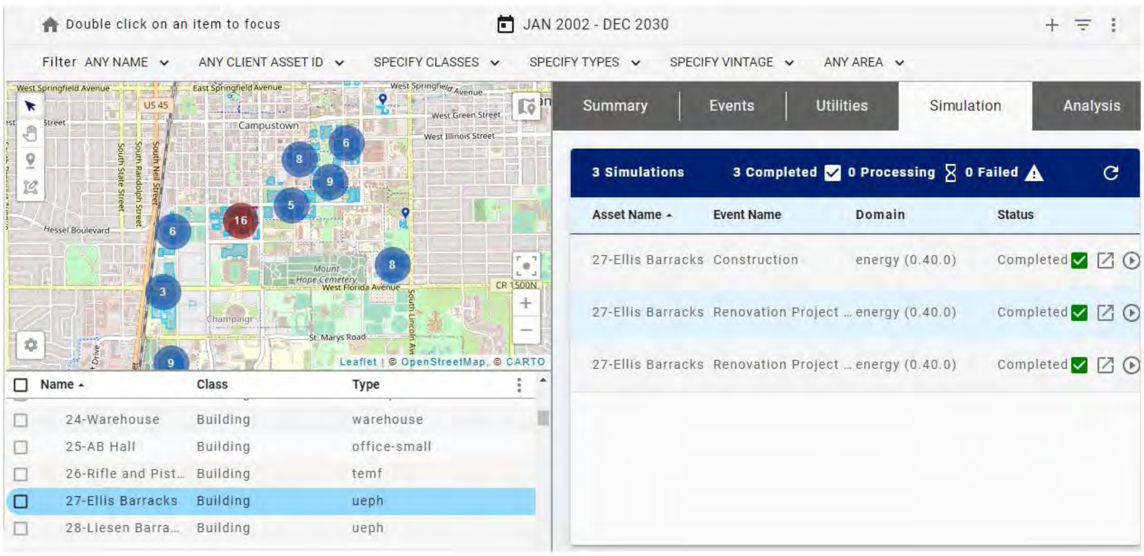
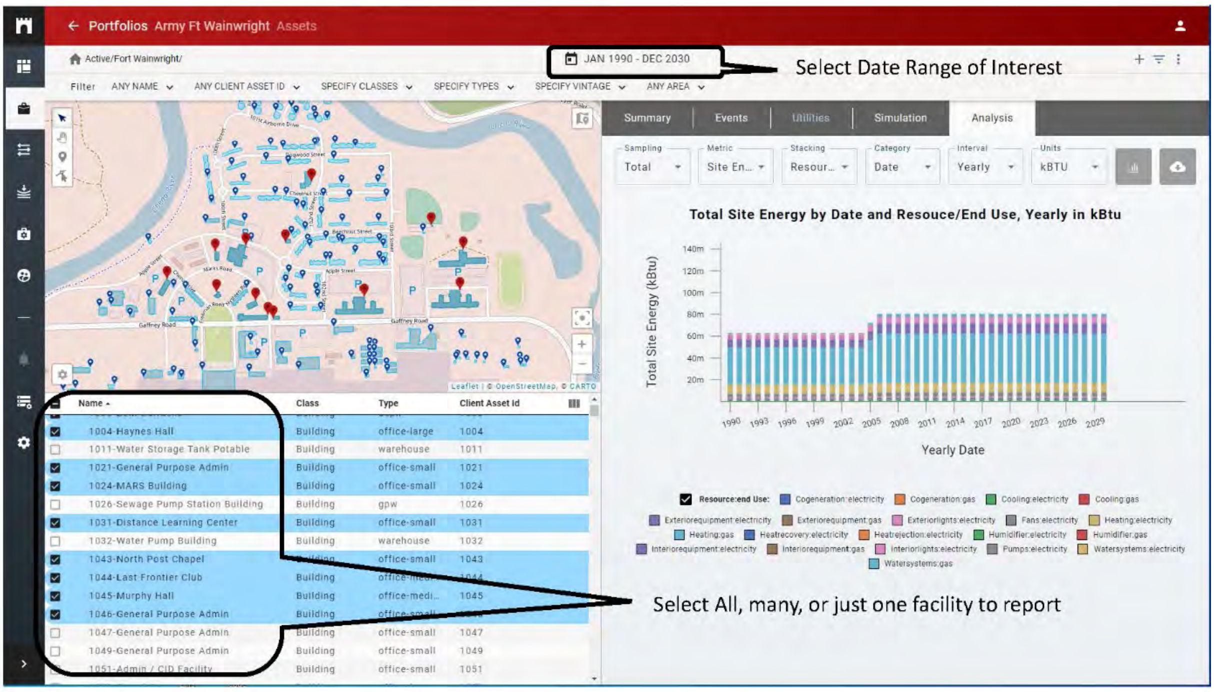
Simulate: Customized or Default Parameters



Simulate: Parametric EnergyPlus Runs



Analysis: Data Analytics



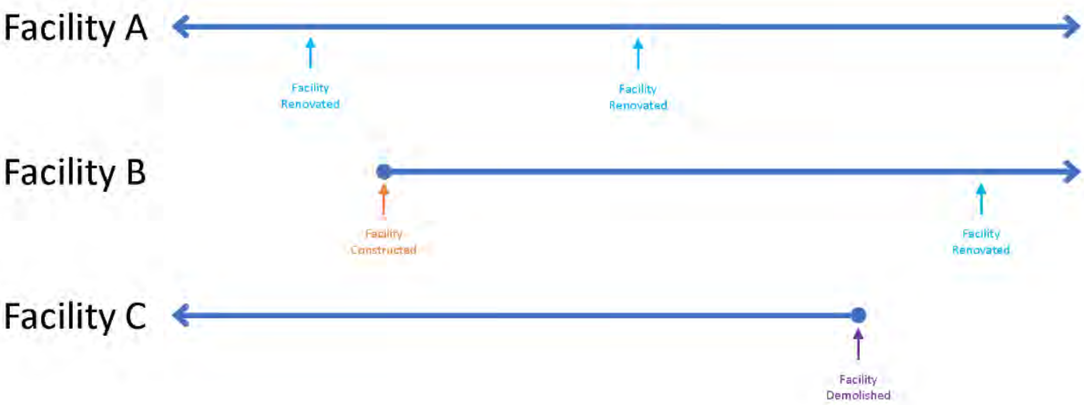
11

Asset Timelines

- Each Asset has a timeline

12

Asset Timelines



- Changes to each facility are tracked (e.g., construction, renovation, demolition)
- Plan is the aggregate of all the facilities and their changes over time

13

Portfolio Timeline: "Master Plan"

- Plan extends forward (and backward) as a timeline
- Changes to the installation are tracked (e.g., facility construction, renovation, demolition)
- Reports can be generated for any desired points on the timeline

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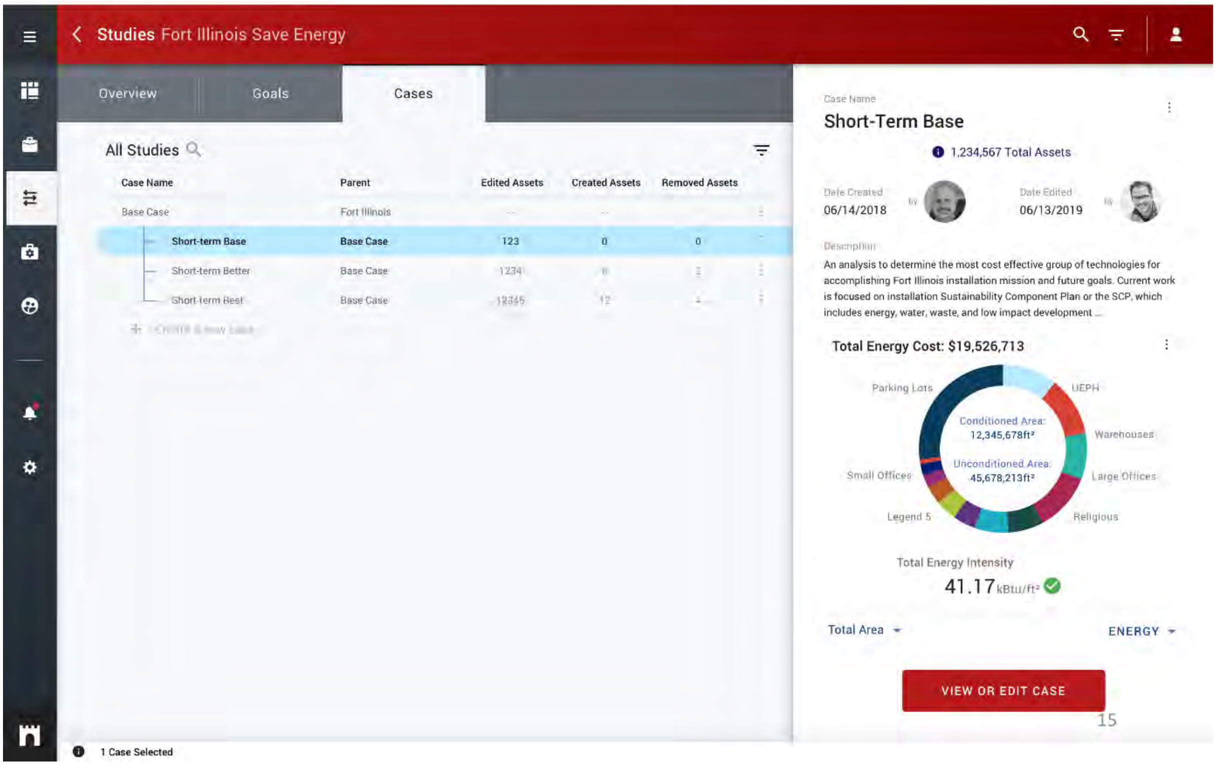
Studies: Cases/Alternatives



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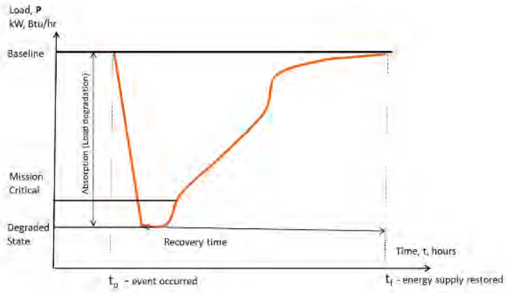
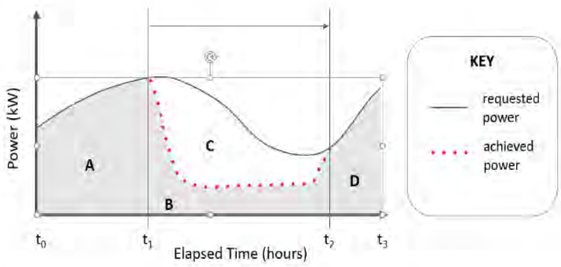
Resilience Metrics

- Model network of missions and supporting infrastructure
- Apply models of reliability and fragility under multiple threat scenarios
- Develop new quantitative metrics, published in ASHRAE and IEA Guide
  - EA – Energy Availability - % of time missions served
  - ER – Energy Robustness - % of mission energy load served
  - MaxSEDT – Maximum Single Event Downtime
- Calculate baseline and mitigation strategy metrics to compare potential courses of action.





Energy Availability (%) = $[((t_1 - t_0) + (t_3 - t_2)) \times 100\%] / (t_3 - t_0)$

Energy Robustness (%) = $[(A + B + D) \times 100\%] / (A + B + C + D)$

Max Downtime (hours) = $t_2 - t_1$

Load Not Served (kWh) = C

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Common Threats for Assessment -

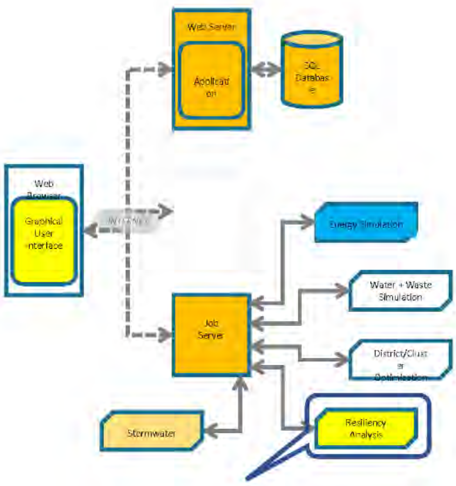
Source: Data from Annex 73, Energy Master Planning for Resilient Public Communities Guide, 2021

Natural	Unintentional and Technological	Manmade
Hurricane and tropical storms	Unintentional spill of hazardous materials	Conventional bomb/IED
Landslides and debris flow	Nuclear power plant failure	Biological agent
Thunderstorms and lighting	Failure of supervisory control and data acquisition system	Chemical agent
Tornados	Explosion	Nuclear bomb
Tsunami	Workplace fire	Radiological agent
Wildfire	Industrial accident	Arson/ incendiary attack
Water and ice storms		Armed attack
Sinkholes		Cyber terrorism
Earthquakes		Hazardous material release (intentional)
Extreme heat		
Floods and flash floods		
Hail		
Damaging winds		
Droughts		

Evaluating Resilience In SMPL

using ERIN (Energy Resilience in Networks)

- **The process of Resilience analysis in SMPL V2 using ERIN takes place through four steps:**
  - Step 1: Run Baseline analysis. Results are compared to the required resilience and reliability metrics for facilities. Show if the requirements are met or deficiencies need to be addressed.
  - Step 2: Determine the necessary remediations to meet the reliability metrics and Run Reliability Analysis until required metrics are satisfied for baseline analysis.
  - Step 3: Run the Black-Sky analysis for a minimum of 14 days energy disruption, unless otherwise prescribed by the military department or other departmental guidance.
  - Step 4: Model threat scenarios on selected infrastructure (electric, heating, etc.) and compare to required metrics. Repeat analysis as necessary with remediations until required metrics are satisfied.



ERIN module integration into SMPL V2

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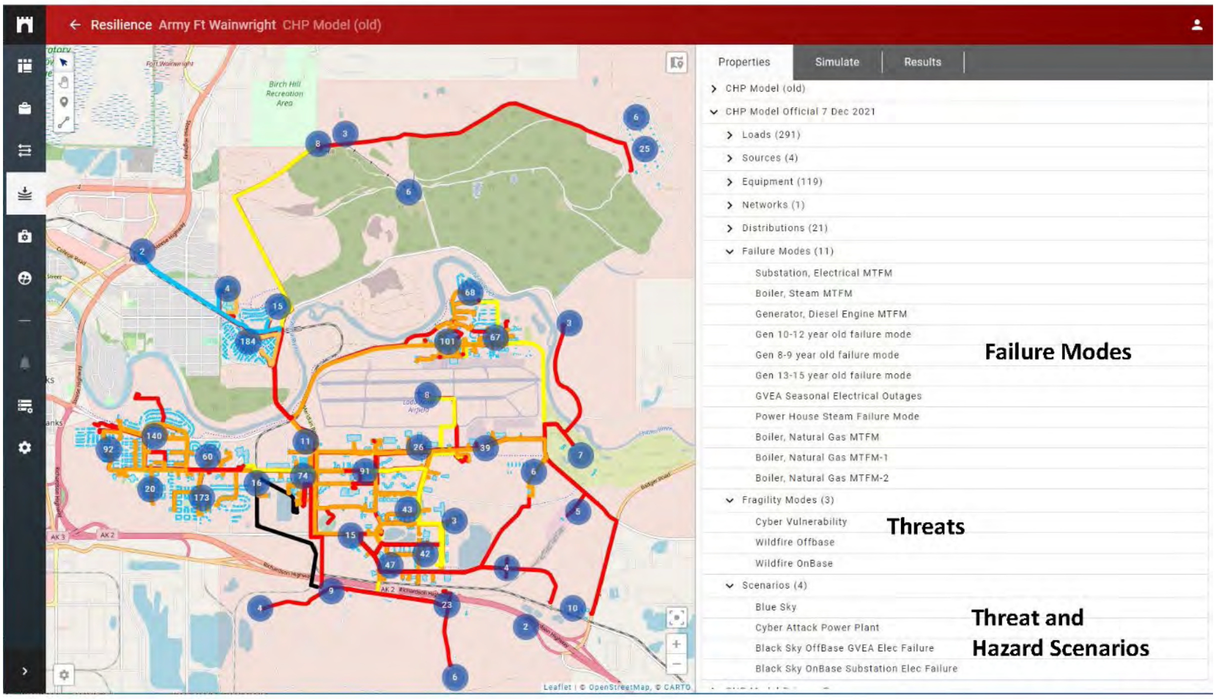
Model Construction: Graphical Layout of Resilience Model



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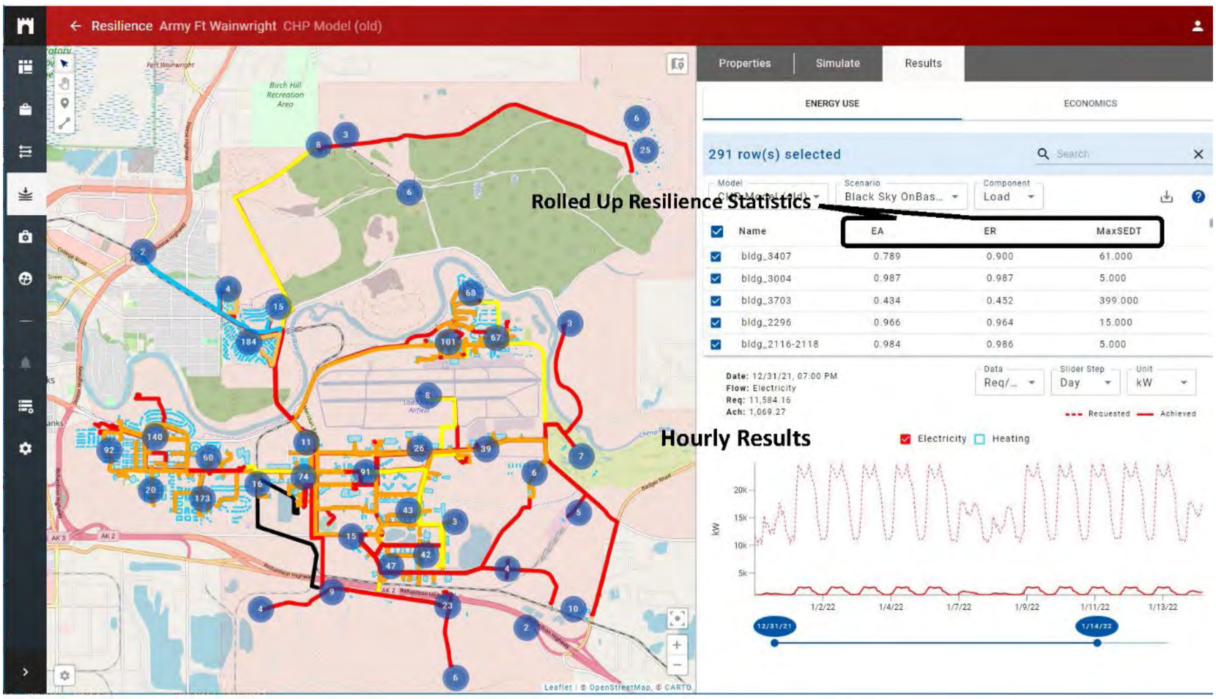
Analysis: Resilience Metrics



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Conclusion

- The SMPL Tool with ERIN provides installation planners and energy managers with a parametric and predictive tool to develop energy and resilience master plans for defense Installations.
- More detailed information is available in the Annex 73 Guide.
- SMPL access is available though U.S. Army ERDC to the U.S. Department of Defense.
- A commercial version of SMPL is available from Big Ladder Software, LLC.

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Points of Contact

- SMPL – Dr. Richard Liesen, Richard.J.Liesen@usace.army.mil or Dr. Mike Case, Michael.P.Case@usace.army.mil
- Big Ladder Software, LLC. Peter Ellis, peter.ellis@bigladdersoftware.com

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Day 3, “Conclusions and Recommendations”

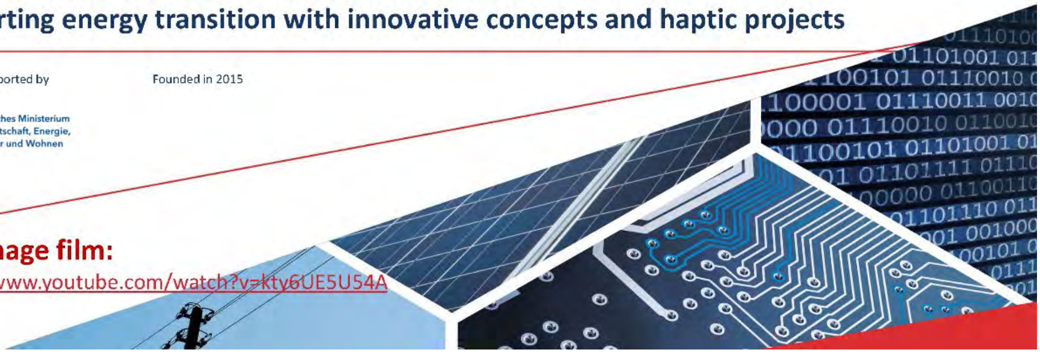
House of Energy

House of Energy e.V.

Innovation cluster and think tank
supporting energy transition with innovative concepts and haptic projects

Financially supported by
HESSEN
Hessisches Ministerium für Wirtschaft, Energie, Verkehr und Wohnen

Founded in 2015



Our Image film:
https://www.youtube.com/watch?v=kty6UE5U54A

27.01.2023

Manifesto

Lessons learned (since Monday)
- Great people
- Excellent competences
- Complementary competences
- Willingness to cooperate
- Engagement and commitment
- Highly complex system

Conclusions
- USP of the people gathered in Frankfurt: international, transdisciplinary and openminded experts
- Excellent base for the way forward
- Many subjects discussed – Many subjects still open – Forum as a kind of appetizer
- Create and maintain a network
- Take bilateral or common actions
- Structure cooperation in a manifesto (“manifestus” – making something tangible) and implement it

27.01.2023 2

Manifesto

1st International Forum
TOWARDS A SECURE AND RESILIENT ENERGY SUPPLY IN A NET ZERO-EMISSION SOCIETY

Proposal for a common Manifesto on the way forward

I – Introduction – Where we come from and what we want to achieve

II – Features of the energy system of the future with a global perspective

III – Targets of the international and transdisciplinary network – Expectations and outcome

IV – Identified challenges – High transdisciplinary complexity

1. Security of the energy system
2. Resilience of energy systems
3. Climate change mitigation
4. Cost of energy limitation

Manifesto

V – Elements contributing to a solution – Challenges to be described – Measures to be taken

1. Energy sources and demand
2. Transitional and future fuels (final energies)
3. System stability
4. Standards, metrics, definitions
5. Implementation strategies
6. Legal challenges and barriers
7. Financial aspects and business cases
8. Digitalization and data
9. ...

VI – The international perspective – Targets and expectations

VII – Activities to foster international and transdisciplinary cooperation

Who, where, what, when, why

Manifesto

Proposed next steps

- Compiling and sharing information of the 1st International Forum
- Starting bilateral activities
- Setting up a core team to
  - Coordinate manifesto
  - Coordinate network
  - Initiate and coordinate network activities, e.g. 2nd International Forum to discuss general progress, follow-up activities from 1st International Forum, enlarge network, identify new options and challenges
- ...

Contact persons: Dr. Alexander Zhivov – Alexander.M.Zhivov@usace.army.mil
Prof. Dr. Peter Birkner – p.birkner@house-of-energy.org

27.01.2023 5

Contact us

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https://twitter.com/HoE_Hessen

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Ministry for Economic Affairs, Energy, Transport and Housing
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27.01.2023 6

Day 3, “Closing Remarks” (Gary Russ)

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EUCOM Notes

- EUCOM Role
  - Security Cooperation
  - CCDR Responsibilities per DoDD 4180.01, DoD Energy Policy:
    - Incorporate guidance and analyses in CCMD planning to address energy risks and opportunities across the full range of military operations, from security cooperation to major operations and campaigns
    - Assess energy-related operational risks and identify associated capability gaps
    - Ensure that joint training and exercises improve the Joint Force’s tactics, techniques, and procedures for the delivery and use of energy
- Nest Operational & Installational Energy (NOT make new mtg/include into existing WGs)
  - CCWG > JPWG (J5)
    - 7 min drill update w/mandatory attendance by Service Components & Installation Cmds.
  - Installation energy – JFUB > JLB (J4)
  - Operational energy – JLWG > JLB (J4)
- Defense Innovation Unit (DIU) Projects – need POCs
- Climate Change funding
  - FY23 EUCOM $3M
  - (U) 2023 NDAA replaced DEIC with the *Defense Operational Resilience International Cooperation* (DORIC) pilot program
  - (U) Wargaming Incentive Fund (WIF) increased

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Mr. Gary Russ, J4 ES, +49(0) 7117-080-4216
Gary.r.russ.civ@mail.mil

1

Day 3, Closing Remarks (Judah Bradley)

Collaboration

- Where do we go from here
  - Requirements are coming quickly: Energy Security, Climate, Economic Drivers
  - Multiple Energy Options Discussed to meet Security and Climate Requirements
    - Electric (Wind, Solar), Geothermal, H2, Ammonia, SNG, Hybrid
  - Numerous Political and Technical drivers need to be understood
  - The DOD is a guest of the HNs; however, we have requirements, constraints too
- Collaborate essential to avoid waste and inefficiency
  - Political, Government (EU, HN, US)
  - Industry
  - Education, R&D
  - NATO, DoD, DOS
- How do we ensure collaboration moving forward
  - Political, Intergovernmental, Industry, Military etc.
  - Multiple WGs exist today; how do we communicate between groups and work toward a consensus, common direction
  - Ideas, suggestions welcome

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International Forum Frankfurt

House of Energy

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With the support of

ERDC EBC

Report - Points to take away

Monday, 23. January 2023

Dr. Andreas Meissauer
Head of Division: Energy Policy, Renewable Energy, Energy Technology, Hessian Ministry for Economic Affairs, Energy, Transport, GER

Energy Strategies of Germany and the Federal State of Hesse

- Building up a decentralized energy system based on renewables and enhancement of energy efficiency are among the essential preconditions for the achievement of climate targets, security of supply and economic independence.
- Appropriate legal and financial frameworks for theenergy transition process are established on EU and federal level.
- In addition, the Federal Land provides significant financial subsidies and non-financial support for the transformation of the energy system

Werner Lutsch
Managing Director of Energy Efficiency Association for Heating, Cooling and CHP (AGFW), GER

Expansion of district heating in Germany

- 75 % of the global pollutants are emitted in cities (predominantly major cities and metropolitan areas)*
- Cities which have developed DH in favor of individual heating (oil, natural gas, coal) were able to significantly lower their air pollutants (CO_2, CO, SO_2, NOx, particulate matter)
- The DHC sector in Germany has always been advocating an efficient, environmentally friendly and secure heating supply at fair market conditions
- Around 56 % of the space heat in German residential and administrative buildings is suitable for district heating supply
- Investments in these future-proof technologies have to be realized today in order to be effective in the following 60 years and provide security of supply for our citizens

Prof. Christian Held
Partner of Becker Büttner Held, Berlin, GER

The Impact of Legal Framework in the Process of Energy System Transformation with a focus on hydrogen networks

H_2 market ramp-up faces big challenges.
The essential course could be set by:
- Adjustment of the EU gas package through less stringent unbundling requirements
- Guarantee of origin for green hydrogen with less stringent requirements and a broader scope of application (e.g. in relation to energy supply)
- A binding integral Municipal Heating Plan including a transformation strategy

Olaf Beyme
Head of Renewables & Power at ING, ING Bank, GER

Financing the Future Renewables Based Energy System

The challenges of the Energy Transition are enormous, and so are the CAPEX requirement.
The Finance industry is accepting the challenge, and is on the way to be a key facilitator of change.

Tuesday, 24. January 2023

Ander Dyrelund
Senior Market Manager, Ramboll, DEN

Energy Security and Cost Effectiveness – A Cornerstone of 50 years of Danish Energy Policy

The energy crisis in 1973 kick-started a strong Danish national energy policy with the objective to establish a resilient, cost effective and later also carbon neutral energy system. The Heat Supply Act has since 1979 been the legal framework for developing the heat supply in urban areas in accordance with the objectives. District heating has been the key technology in this development, as this infrastructure has appeared to be a precondition for a cost effective and resilient energy system, which can utilize surplus heat and low carbon fluctuating renewable energy sources in urban areas.
Campuses, cities and countries who consider how to meet the same objectives guided by the UN sustainability goals and the EU directives can be inspired by the Danish planning methodology and many of the cases, which are implemented in Denmark. Please look for further details in the EU JRC reports and in the IEA Annex73.

Dr. Andy Walker
Senior Research Fellow; Energy Systems Integration, National Renewable Energy Laboratory, USA

Considerations in Development of Roadmap toward Resilient and Net-zero Energy Supply

Consider a sequence of steps toward a resilient and net-zero energy supply: occupant behavior and conservation; advanced controls; efficient equipment; electrification of thermal loads; energy storage; grid integration; energy security and resilience; financing; and long-term performance issues.

Dr. Anna Maria Fulterer
Scientific Project Manager, AEE - Institute for Sustainable Technologies, AT

Austrian Strategy for Energy Security and Transition To Climate Change Mitigation key strategy of Austria:

- electrification (heating, mobility, industry)
- energy communities: enable communities to organize their energy supply
- transition to renewable sources by F&E and grants to industry, building owners, transport, cultural institutions, educational institutions
- energy strategy for critical infrastructure
- campaigns to inform people about supplies for blackout resilience (water, food,...)

Prof. Dr. Stephan Reimelt
Head of Commercial Partnerships and Development, Bloom Energy, USA and GER

Fuel cell as an important energy source for critical infrastructure and resilient powersupply

Fuel Cell as SOFC technology is the most advance power supply to day.
Data center, Hospitals and other are using our technology.
High temperature soild oxide is very reliable;
- efficency of over 60%
- integrated heatrecovery brings additional efficency
- reduces with more than 50% the CO2 compared to gasengines
- no NOx emmisions

Bloomenergy has over 15000 modulars in commercal operation with an availibility of + 99%. Bloom has 2 giga factories in operation. We drive decarbonisation

David Petermann
Head of Research and Development, E-Netz Südhessen, GER

The Utility Perspective on the Future Energy System

The energy transition accelerates the expansion of renewable energies, the ramp-up of electromobility and the electrification of heat supply. This poses new challenges for the power grids and also causes the complexity of mid and low-voltage grid management to increase massively. In oder to meet these challenges, you need innovations towards flexible and smart Grids.

Prof. Dr. Hannes Utikal
Head of the Center for Industry and Sustainability Infraserv / Provadis Hochschule, GER

The Future Energy Infrastructure in the Chemical Industry

The European Green Deal and the national CO_2-reduction targets call for a profound transition of the chemical industry in Europe.
The transition of the European energy system is a condito sine qua non for the defossilisation of the chemical industry.
New infrastructures and updated regulatory frameworks for green electricity, green hydrogen, CCUS are urgently needed.
The transition of the European chemical industry requires an unknown level of cooperation between business, academia, policy and civil society: The different stakeholders need to co-own the transition pathway and do their respective tasks in a coordinated manner.

Andrew Knox
Director Installation Energy, Office of the Deputy Assistant Secretary of Defense (Environment & Energy Resilience), USA

The Imperative for Resilient and Sustainable DOD Installations

The US Department of Defense (DOD)'s goals for Installation Energy resilience align with the government's sustainability and climate change goals. DOD intends to deploy microgrids as an effective resilience tool.

Kirk Philips
Director Air Force Office of Energy Assurance, AFCEC, USA

Net-Zero and Energy Supply for USAF Buildings

The Air Force Office of Energy Assurance is focused on finding solutions to separate European-based Air Force installations from Russian energy and mitigating the threats of climate change to Air Force installations and infrastructure.

Julian Bischof
Researcher, Institute for Housing and Environment IWU), GER

Future Proof Energy Standards for New and Existing Buildings - A German Perspective

Building energy standards need to consider the entire life-cycle of buildings to achieve future proof buildings.
Future proof buildings have to comply with a greenhouse gas emission limit that supports a stable and sustainable climate.
The required knowledge and technology for constructing these future proof buildings already exist.

Barry Cope
Managing Director Building Compliance Testers' Association, UK

Reduce Demand to Reduce Supply – Using Air Leakage Testing to Reduce Energy Demand from Buildings

For 20 Euro per home, plus 200 Euro per home in materials and labour, we could reduce the peak demand on the grid by a substantial amount during a typical winter period, which would mean the energy we create from sustainable sources goes further and reducing, if not eradicating, the need to import or create energy.

Steven Tratt
National Sales Manager, Tremco-Canarm Building Envelope Specialists, CA

Does Your Building Suck?

- Identify requirements for a continuous air barrier and what that means
- Understand how to diagnosis and remediate Air Barrier issues
- Understand from the title of this session why buildings suck, which is a play with words, Stack, Wind, mechanical effects on the building envelop.

Oddgeir Gudmundsson
Director, Danfoss, DEN

Building Technical Measures to Ensure Sustainable Thermal Supply

- Simple technical measures are available to significantly reduce energy consumption in buildings.
- Taking control of your heating installation is both a non-regret option and is fully compatible with any future building envelope energy improvements.
- Optimal results are achieved by looking on the whole heat supply system, from energy source to the end user.

Jay Tulley and Chris Battisti
Research Engineers, ERDC-CERL, USA

A Retro-commissioning methodology for assessing Army installations for natural gas savings

We will review set of processes to assess Army garrisons for energy savings opportunities from three major perspectives: the macro level through a real property building portfolio analysis; the energy systems level through utility meter analysis and system diagramming; and controls strategies.
We will also review how to use these strategies to develop contractual requirements and deliverables that the government should include in an energy savings project RFP.

Edward Borer
Director, Energy Plant, Princeton University, USA

A Time of Energy Transition At Princeton University

Carbon neutrality is achievable on a community scale, using existing technologies, with good financial stewardship.
Princeton University is implementing an all-of-the-above strategy to: reduce campus energy demands; produce and deliver heating, cooling, and power more efficiently; store and retrieve thermal energy rather than wasting it; and provide input energy from on-campus and off-campus renewable sources.

Clara Lutz
Project Managing Director, Stadtwerke Heidelberg, GER

Energy Optimized Conversion of Former Military Installations in Urban Areas

The Patrick Henry Village in Heidelberg - a former residential area for members of the US-Military - will be transformed into the "knowledge city of tomorrow". The heat supply for the new district will be based on a cold district heating system or "Local Two-Way Heating System". That means the heat-energy can be transported on a lower temperature (ambient temperature) than in conventional district heating systems because it uses synergies within or between heat consumers. The lower temperature also allows it to easily integrate lost heat from production processes or environmental heat.

Oliver Baumann
President, Baumann Consulting, USA

Integrated Energy Master Planning for Carbon-Neutral City Quarters in Germany

The redevelopment of the Holsten Quartier, the former site of the Holsten Brewery in Hamburg and the VAI Campus, the former IBM headquarters in Stuttgart-Vaihingen into large mixed use city quarters present the opportunity and the challenge of creating carbon neutral large scale developments. The presentation goes through the steps of developing integrated energy master plans for these two community-scale projects and state-of-the-art technologies used to make them carbon neutral. The presentation will further discuss how the lessons learned can be applied to existing campuses and communities to turn them into energy independent and carbon neutral assets.

Wednesday, 25. January 2023

Dr. Stephan Richter
CEO, GEF, GER

Can We Deal with the Short-Term Issues of the Energy System without Contradicting the Long-Term Goals? – A Perspective of the Heating Sector in Germany

What are the short-term challenges, tasks and options regarding the current energy supply - focus on Heating in Germany? What are the long-term challenges, tasks, and options regarding the current energy supply? Which long term strategies are reasonable and what are the strategies on the short term? Can we avoid contradictions of the long-term goals while tackling the short-term issues.

Dr. Matt Swanson, Senior Researcher
Propane-Air Injection Systems for Military Installations

Propane-Air injection systems provide cost effective redundancy to the installation's natural gas supply. Depending on the natural gas rate structure, these systems can pay for themselves over a relatively short period of time, while providing "free" redundancy to the installation.

Paul Westerman
Global Supply Director LPG & Renewables, DCC Energy, USA

LPG Supply & Logistics Options for US Military in Europe

LPG is a versatile, portable, clean burning energy source with well-developed assets and infrastructure to supply the (US) military's energy needs.
LPG is readily available from (local) refineries and from oil & gas fields. Europe is a net importer where the majority of the balance is imported from the USA. Renewable LPG and alternative renewable liquid gases (like renewable & recycled DME) are provide customers with drop-in renewable alternatives both today as well as in the future.

Georg Reithe
Project Manager, Engie Impact GmbH, GER

Planning of Multimodal Energy Systems

Our economies see a clear push towards a low carbon society fuelled by the Nationally Determined Contributions (NDC) under the UNFCCC's Paris Agreement but also an reorganizing energy supply situation. Connecting energy vectors and adopting new technologies is not only fighting climate change but is increasing resilience of our cities and indutries. Such multimodal energy supply networks will consist of a increased combination and interaction of different energy sources and technologies.
This will not only necessitate a more flexible and strenghtened energy infrastructure to allow for a physical supply of electricty, gas, hydrogen, heat and colling but also new partnerships between organsations to set-up and operate such multimodel energy systems.

Wolfgang Fischer
Head of Sales, PSI, GER

Modern Multimodal Dispatching Tools

There need to be efficient tools to cope with the challenges towards a Carbon Neutral and Renewable Energy System which

- supports to provide stability of the grid
- enables multimodal optimization from UHV to LV and/or high pressure to low pressure (e.g. power and gas, district heating, water, ...)
- provides high quality look ahead congestion forcasts and congestion correction(s) not only for today.

What are the technological options already available.

William Taylor
Director Engineering, ESG, USA

Implementation of Energy Infrastructure Change

- Define the requirements and the solution then decide on how to finance it
- Multiple contract options are available
- Manage risk, but no solution/contract paring is risk free
- Be flexible and creative

Ira Birnbaum
Program Manager, US DOE FEMP, USA

Overview FEMP ENABLE Streamlined ESPC Mechanism, and Available AFFECT Grant Competition

ENABLE provides an expedited, streamlined vehicle for developing, procuring, and implementing energy saving performance contracts, compatible for combining with available AFFECT grants and ERCIP funds. FEMP can help unfamiliar energy/ sustainability, facility, and contracting officers through the ENABLE process to quickly develop and implement projects without requiring up-front funding from appropriations. The annual energy cost savings are guaranteed to exceed the project costs by the implementing energy services company (ESCO). These features make ENABLE a key tool to meet the challenges facing DoD European facilities in terms of increased utility costs, energy security, reslience, and climate change mitigation.

Ruediger Lohse, Managing
Director, DENEFF EDL_HUB, GER

German ESCOs Facing Energy Crisis- First Success Stories

German policy have started to pull back from misled energy policies of the recent 20 years. Instead of relying on natural gas, DOE is conducting a not before seen effort to create new energy policy framework. RL is providing insights in major energy policies in DE and how ESCos have started to adopt their business model and contribute to the energy transition

Keith Yamanaka
Energy Manager, Schofield Barracks, USA

Schofield Generating Station (SGS) Micro-Grid

Partnering with the utility company can increase energy resilience and security for both the military and utility.

Felix Rosenberger
SeniorHost Nation Attorney International Law Branch HQ USAREUR-AF OSJA

Legal Aspects of US Forces Energy Supply Projects in Europe

As a foreign visiting force, the U.S. Forces are subject to host nation law as determined by the applicable international agreements. DoD energy supply concepts commonly used in the continental United States, therefore, have to be adjusted to the applicable legal framework of each host nation. Challenges that result from these legal frameworks may require special approaches during planning and execution.

Dr. Anders N. Andersen
Ext. Ass. Professor at AAU, R&D projects re-sponsible at EMD, DEN

Planning resilience and sustainability in the energy system modelling tool energyPRO

Documented through simulations in the energy system analysis tool energyPRO it will be demonstrated how a small fishing town at the west coast of Jutland in Denmark in recent years has become more resilient. From being a natural gas fired district heating plant providing 1600 consumers, they have invested in 9 MW wind turbines, 5 MW heat pump, 10 MW electrical boiler, 9500 m2 solar collector and 3200 m3 hot water storages, making their district heating independent of gas.

Dr. Michael Case
Senior Research Engineer, ERDC-CERL, USA

Energy Master Planning and Resilience Analysis using the System Master Planning (SMPL) and the Energy Resilience of Interacting Networks (ERIN) Tools

- Use energy and resilience analysis tools to quantify key metrics of alternatives when determining courses of action.
- Reduce energy and other resource loads before sizing supply and distribution. Lower loads make it easier to develop resilient alternatives.
- There are quantifiable metrics for resilience, including % of time energy is available (Energy