

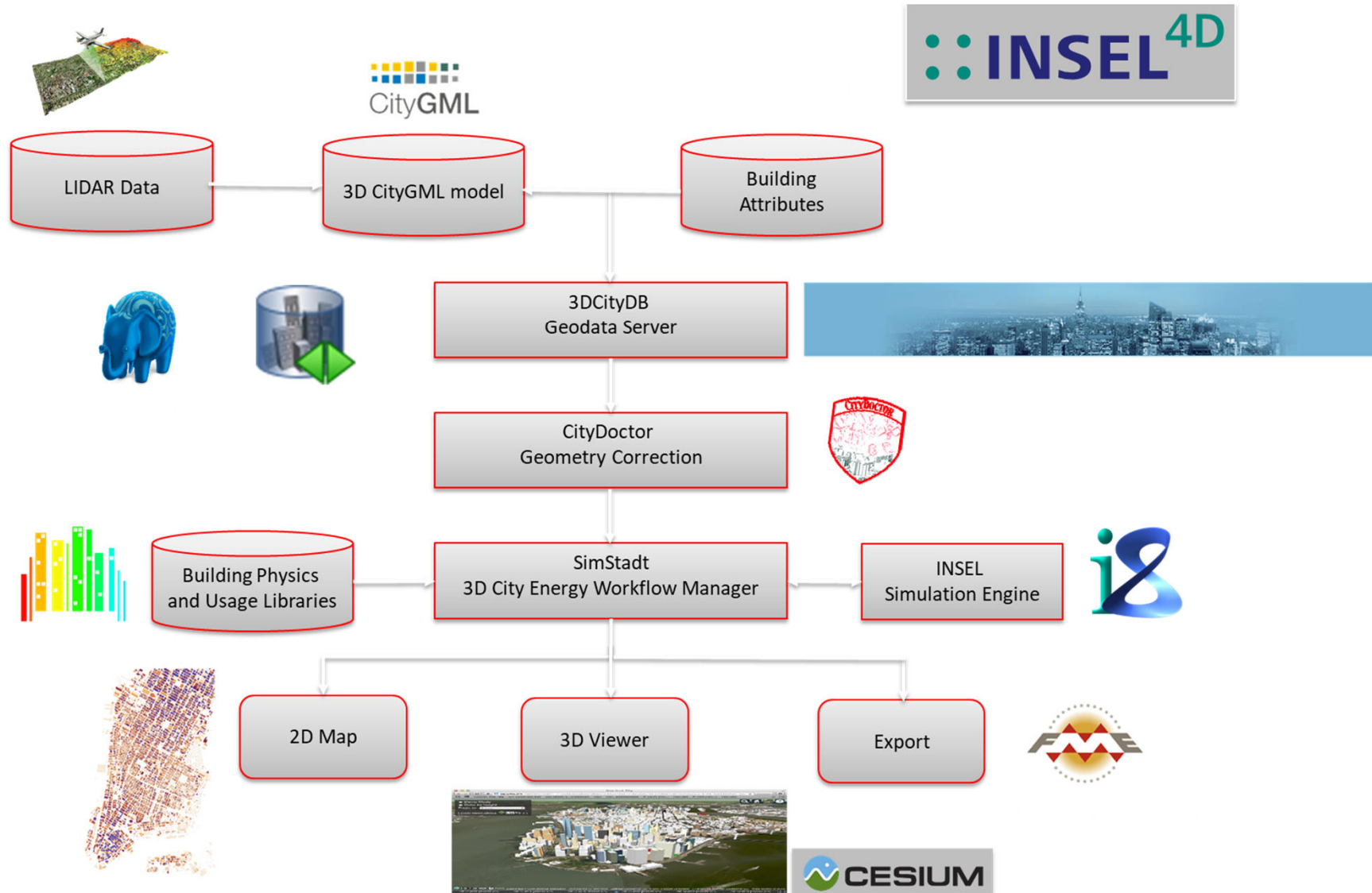
Scenarios for a zero- carbon inner city university campus using 3D modeling

An inner city campus case study

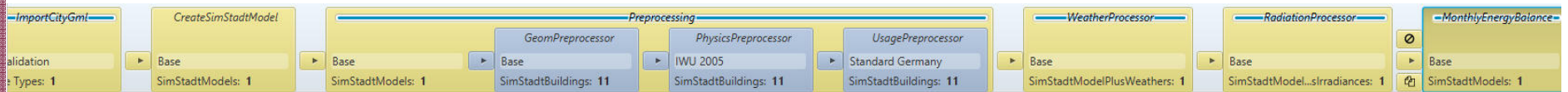


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Urban Platform



SimStadt workflow



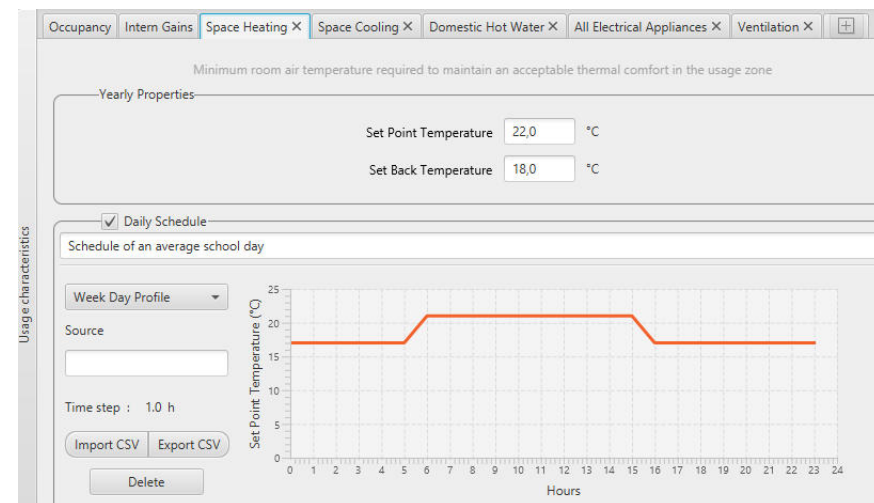
Building Physics Library

- Different refurbishment scenarios available
- Material properties of buildings can be adjusted

Variant ID	Description
MediumRefurbishment	Medium full refurbishment recommended by Institut
AdvancedRefurbishment	Advanced full refurbishment recommended by Institut
EnEV2016	EnEV2016 - Minimum requirements of German Energiee
EffizienzHaus70	Energy label KfW EffizienzHaus 70 - German Energiee
EffizienzHaus55	Energy label KfW EffizienzHaus 55 - German Energiee
EffizienzHaus40	Energy label KfW EffizienzHaus 40 - German Energiee

Usage Library

- Internal gains, heating and cooling etc., can be adjusted
- Schedules can be adjusted

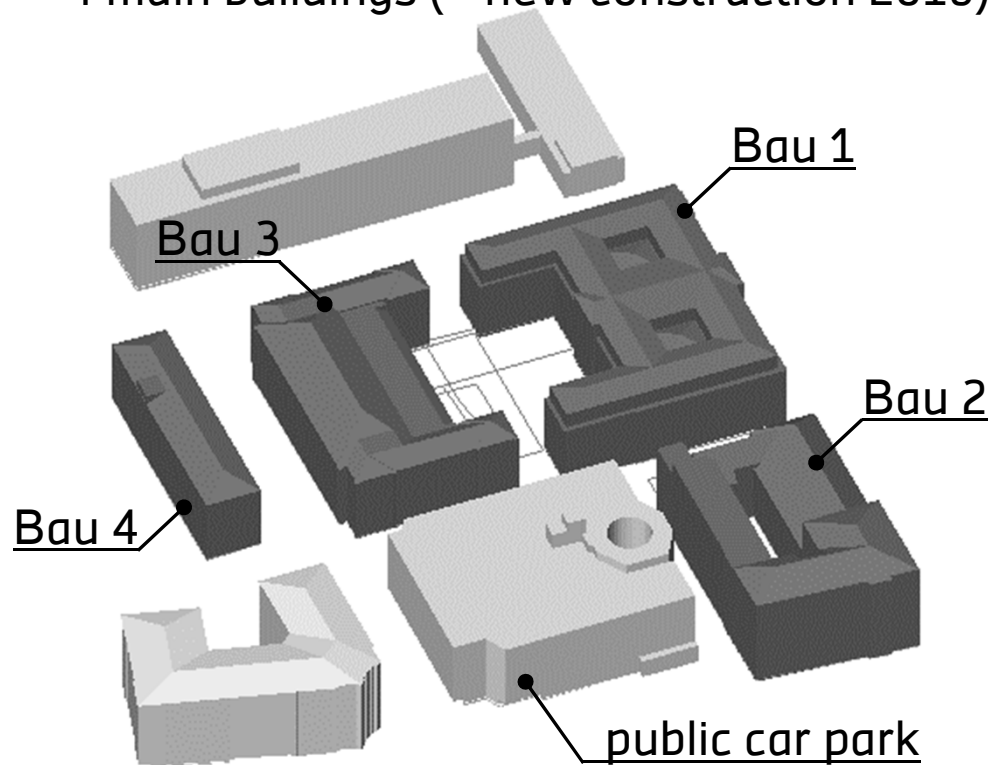


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Overview HFT-Campus / Buildings and Energy

Key Facts HFT-Campus


- 4.000 Students & 350 staff members
- 28.850 m² heated area (Bau 1 bis 4)
- 4 main buildings (+ new construction 2016)



Key Facts Energy Consumption

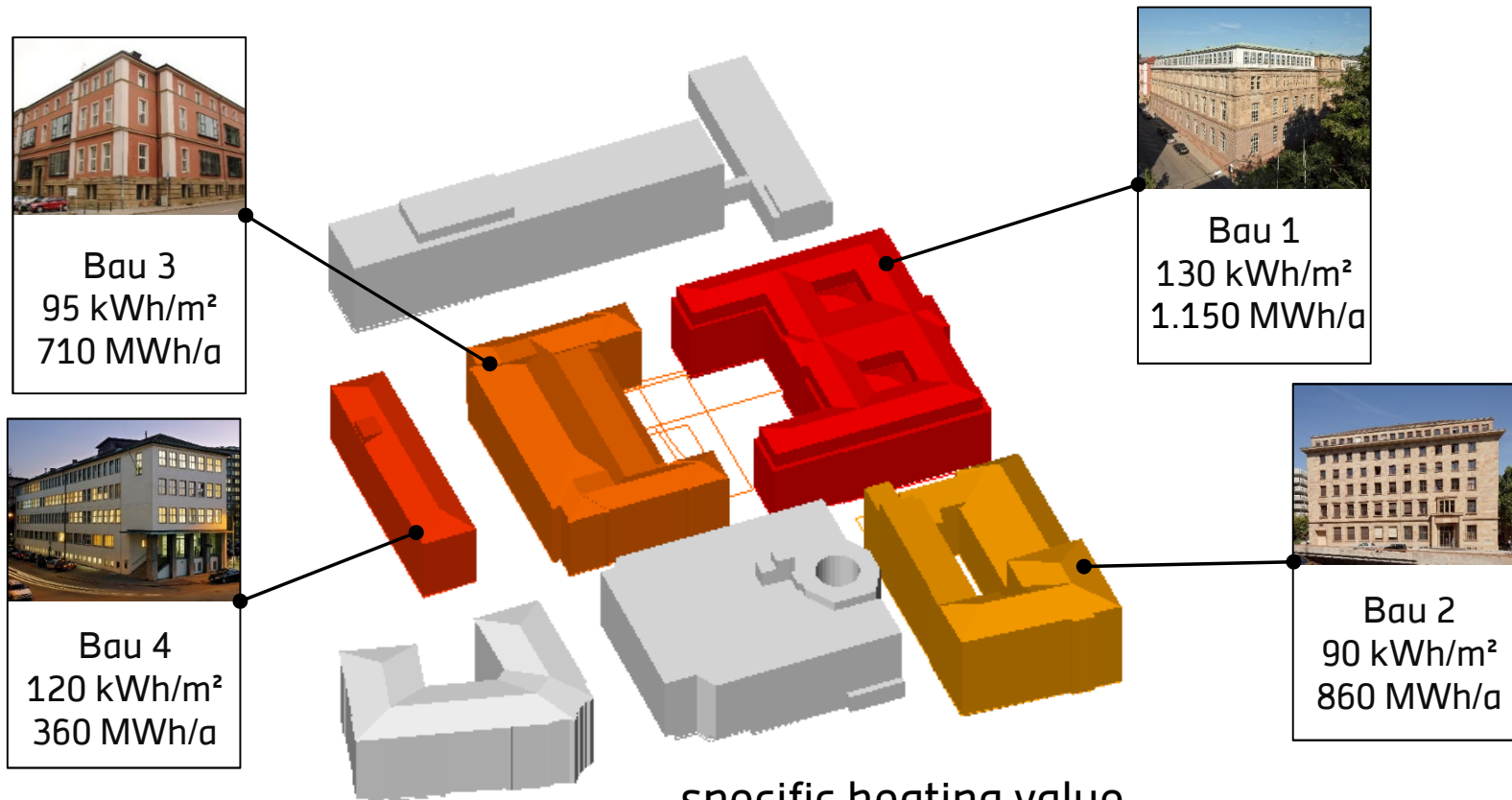
 **electricity consumption**
~ 1.600 MWh/a

 **heat consumption**
~ 2.700 MWh/a

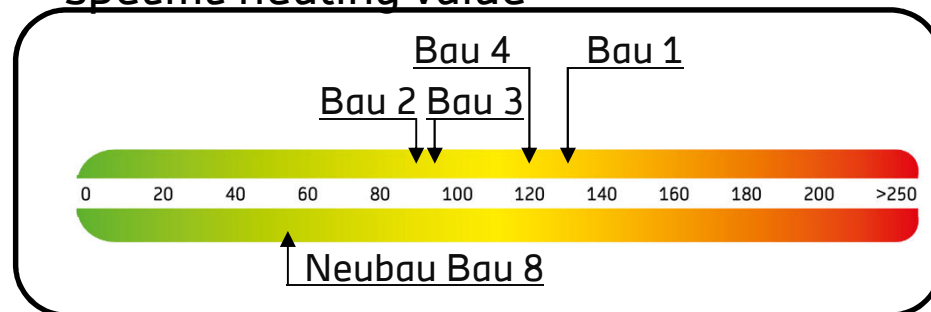
 **emissions**
~ 525 t CO₂/a

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Simulation Results – Campus HFT Stuttgart

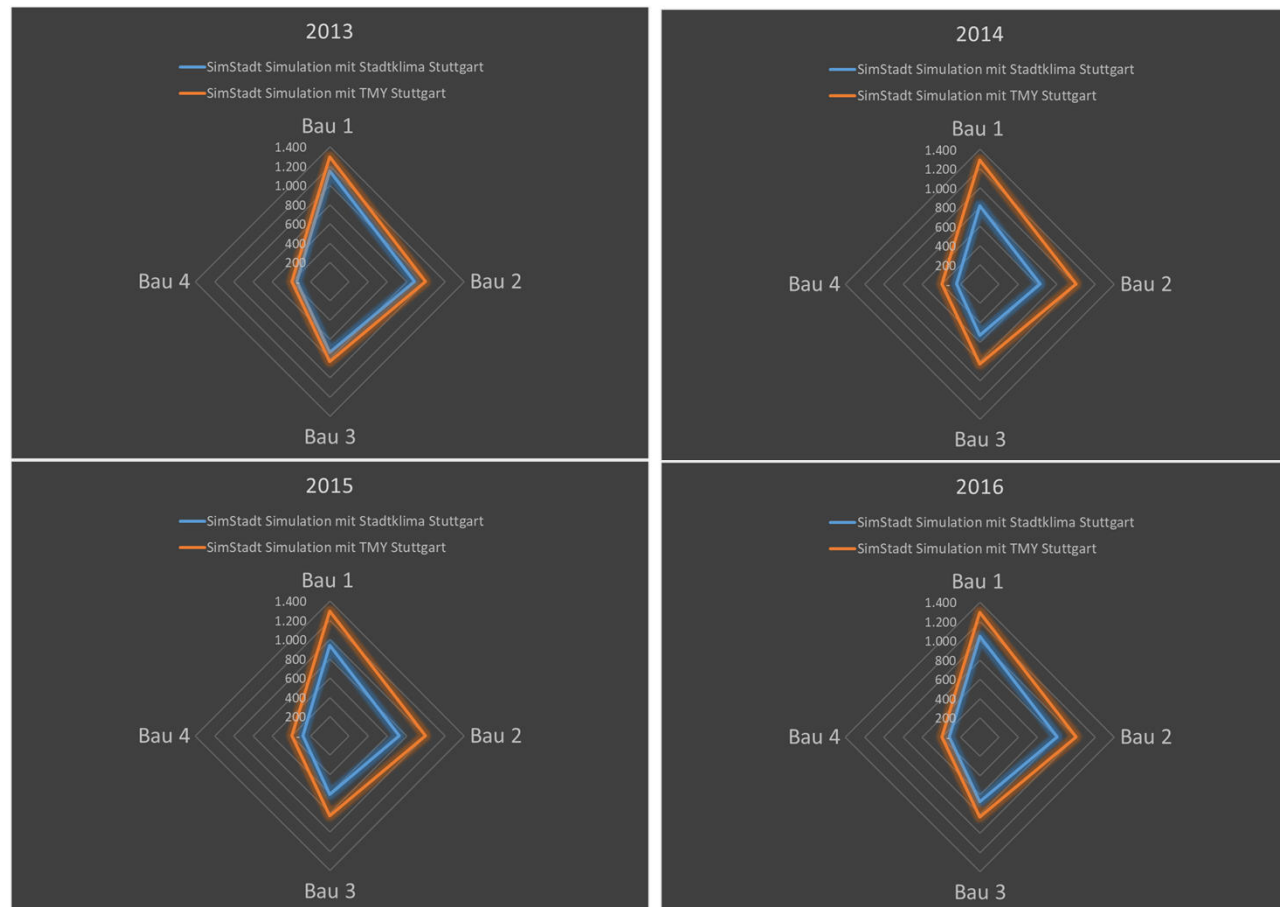


specific heating value



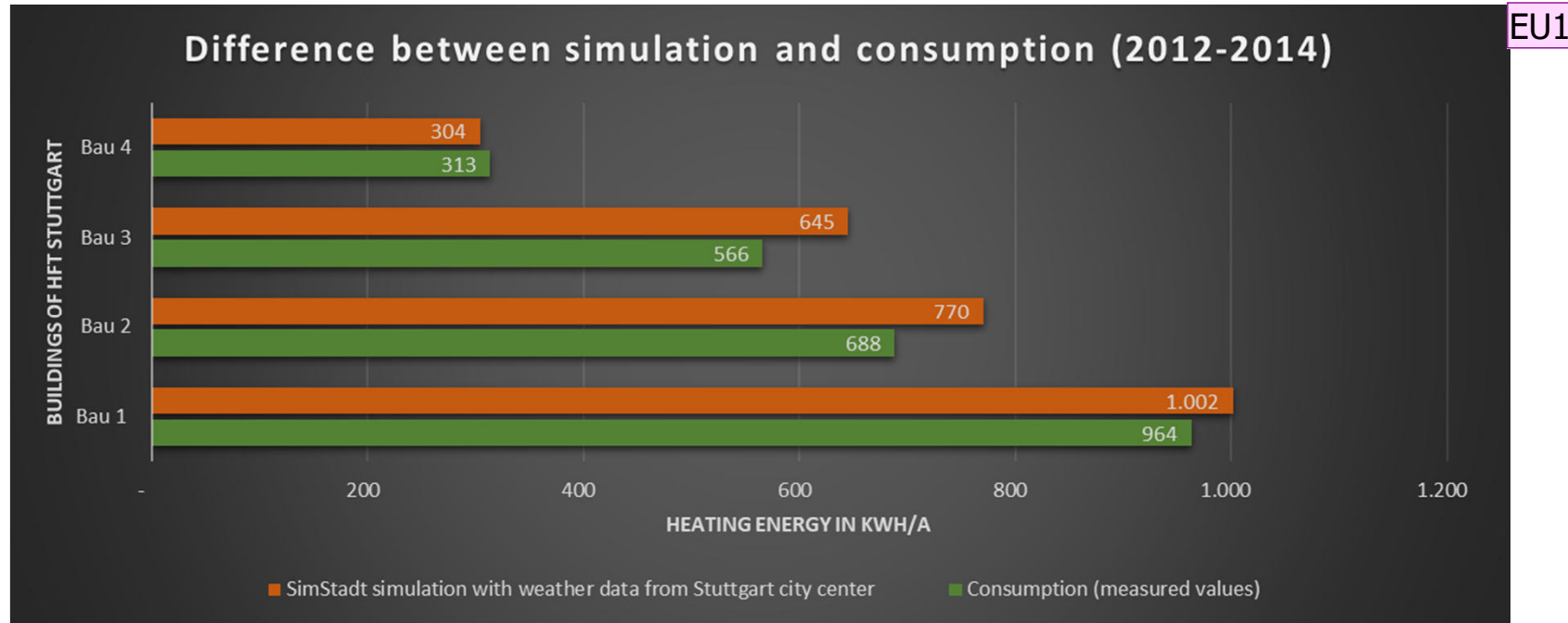
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Weather analysis



Differences between simulation up to 37% in 2014

Reason: TMY Stuttgart is the longterm average at the Stuttgart airport in Echterdingen, 10km from the city center, with a significantly different climate from the annual measured values at the city center of Stuttgart



Simulation with the actual weather data (monthly mean values for each year) of a station in the Stuttgart city center results in very low differences of -3% to 12% from the measured consumption.

These differences can be attributed to changes in user behaviour.

Folie 8

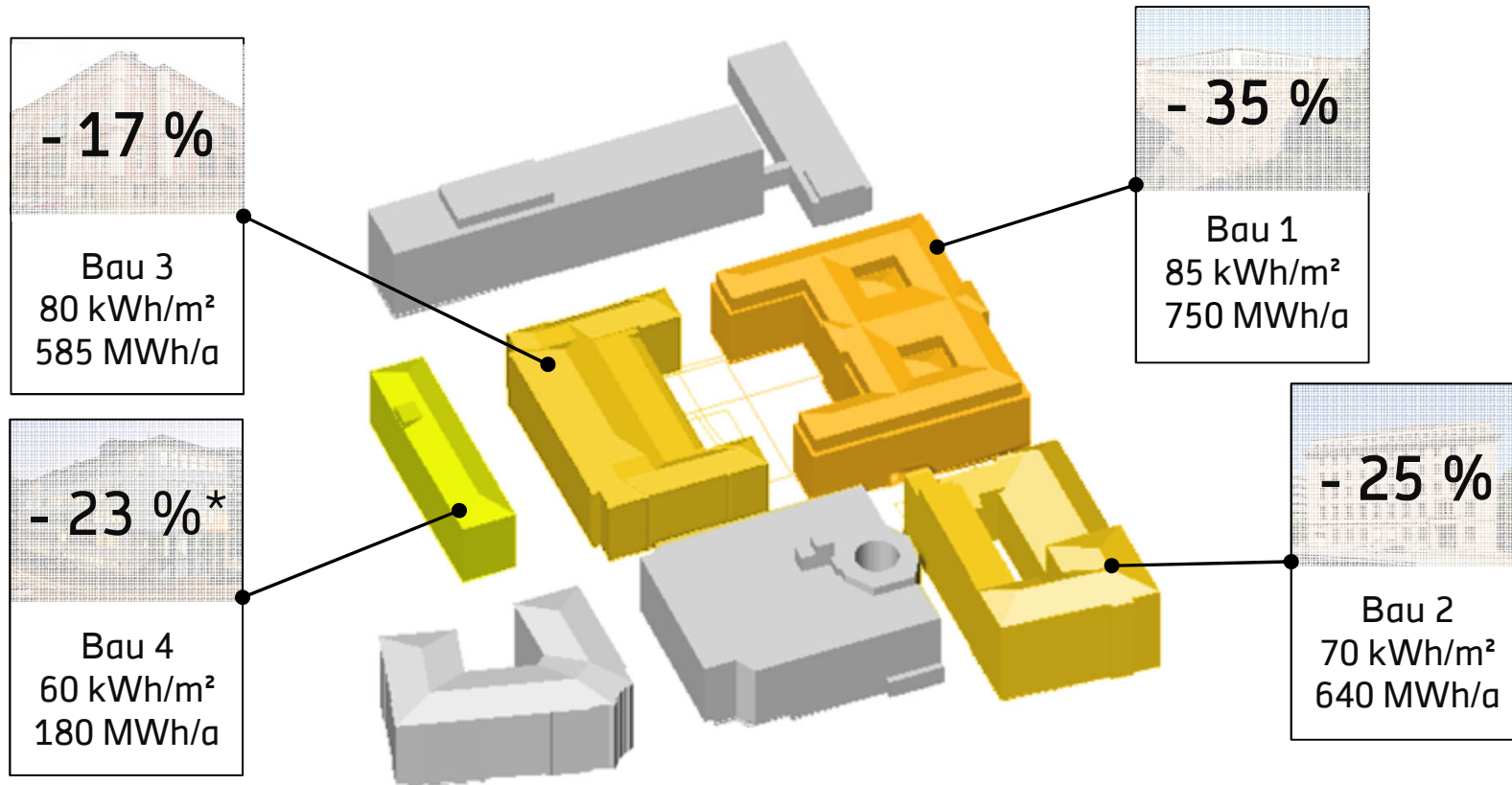
EU1

2012 - 2016

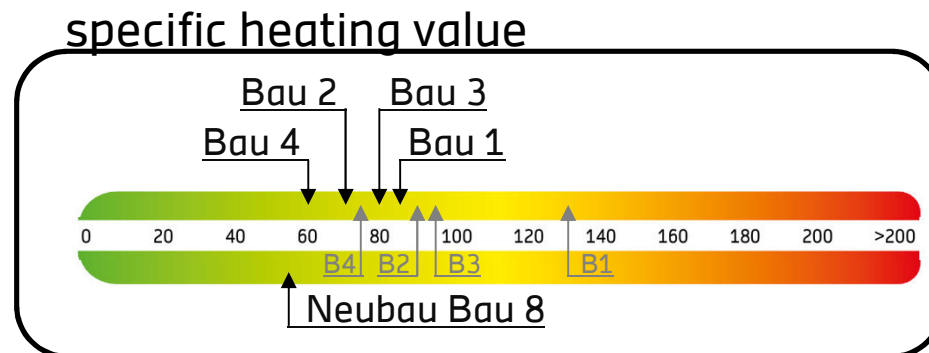
Eicker, Ursula; 23.03.2018

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Refurbishment scenarios – Campus HFT Stuttgart

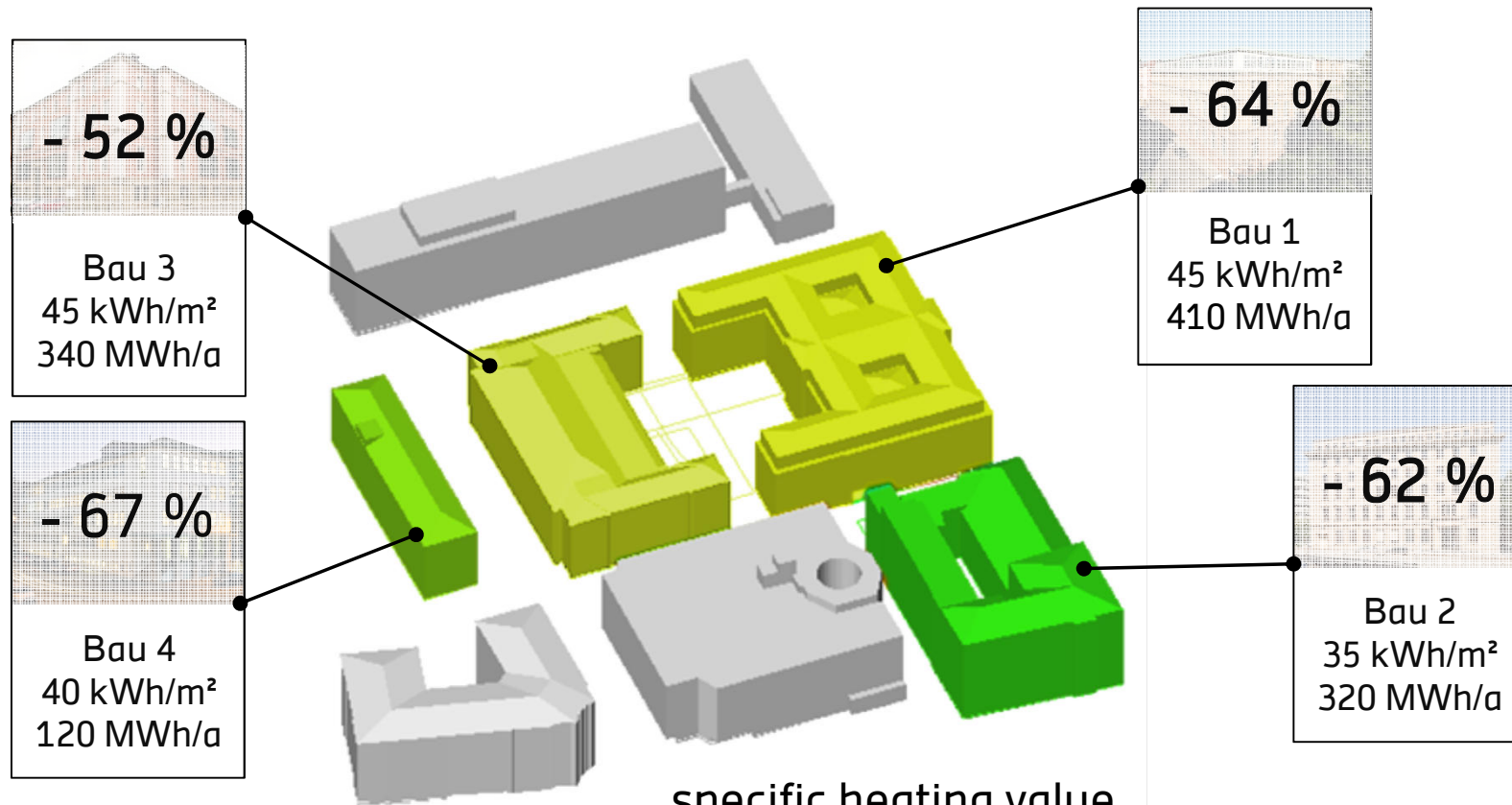


„Standard“
- 27 %

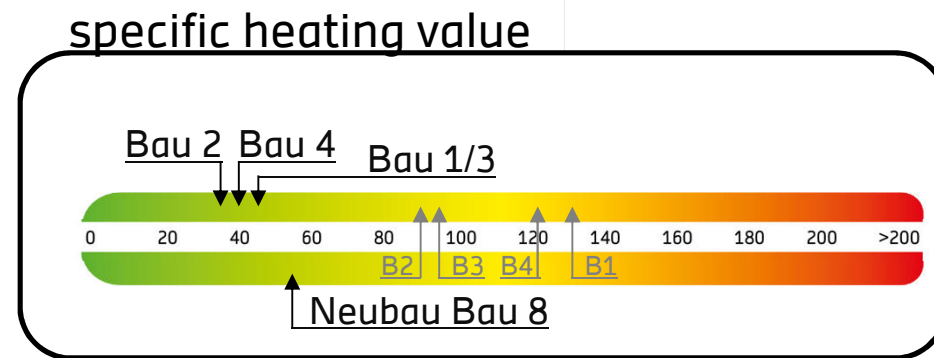


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Refurbishment scenarios – Campus HFT Stuttgart

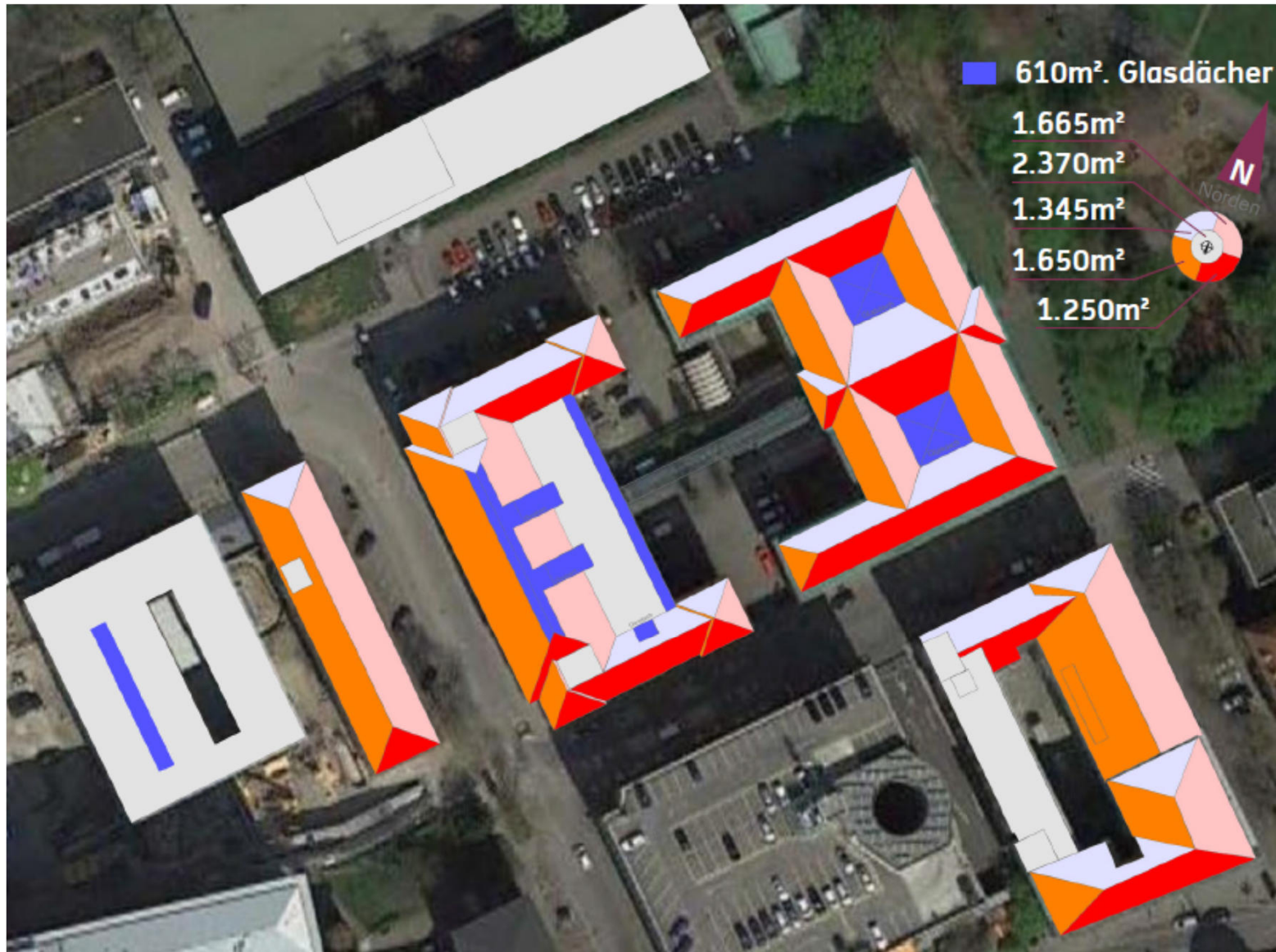


„Pilot“
- 59 %



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PV-Potential analysis – roof surface shares

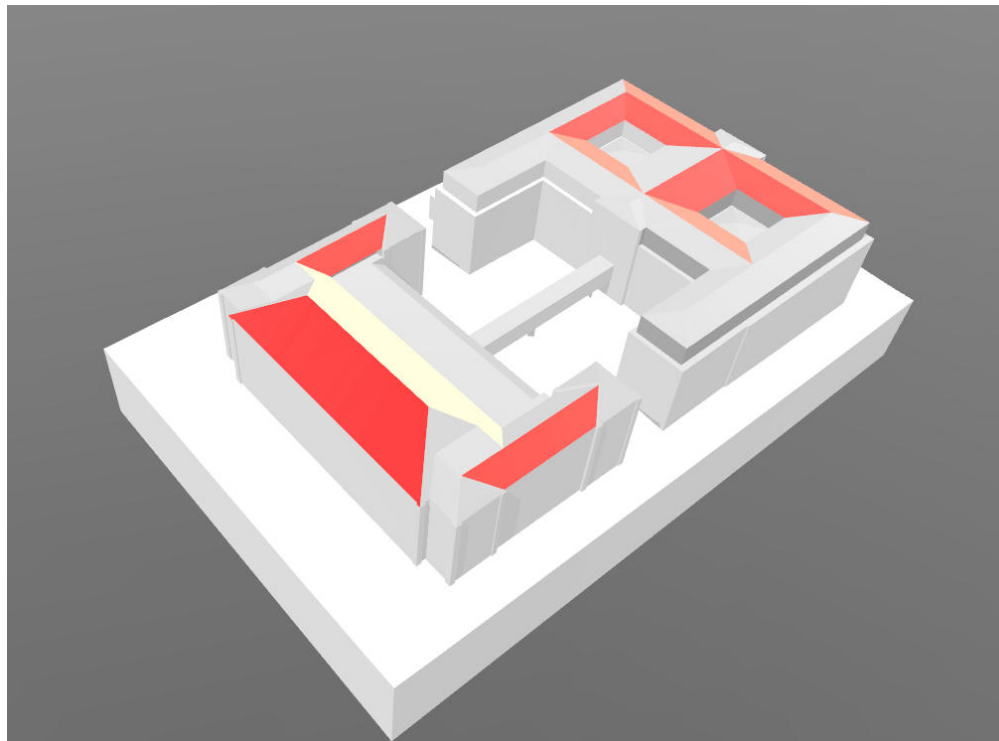


Step 1 - SimStadt:

- automated analysis of solar radiation for all roof areas
- usable surface ratio parameter → PV capacity (kWp) & yearly PV yield (kWh/a)

Step 2 - INSEL:

- manual selection of suitable roof areas for more detailed analysis
→ hourly Simulation of PV yield



	kWh/kWp
Bau 1 - SW	1070
Bau 1 - SO	1060
Bau 1 - NO	830
Bau 3 - SW	1240
Bau 3 - SO	1050
Bau 3 - NO	640

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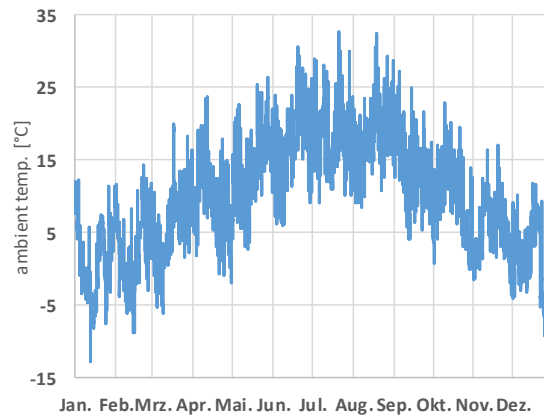
Generating a hourly annual load profile for the heating demand

INPUT



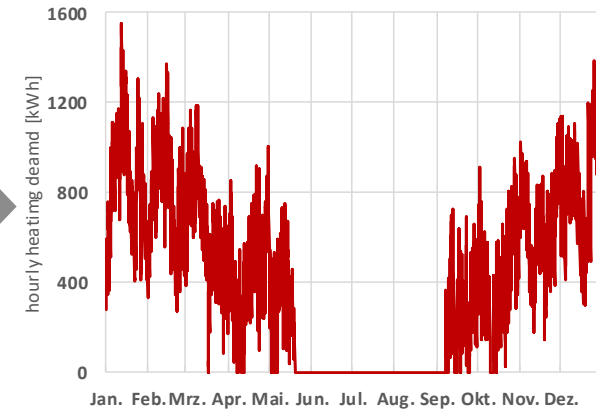
heating demand
(Simstadt)

&



ambient temp.
(local weather data)

OUTPUT



hourly heating
demand

Heating degree days method

Parameters:

- Heating limit temperature 15 °C
- Heating setpoint temperature 20 °C

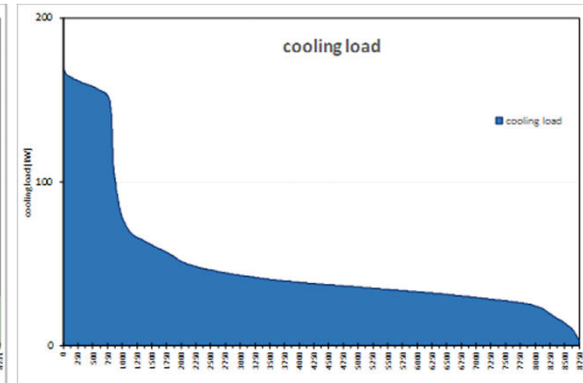
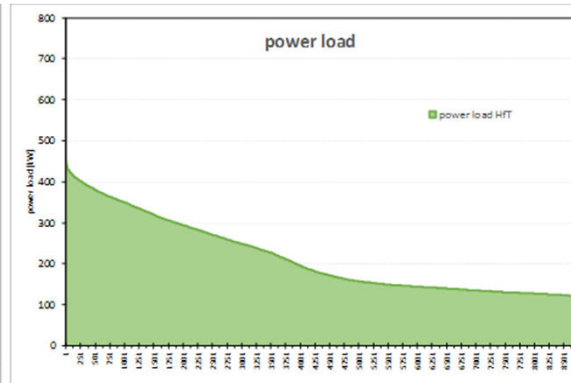
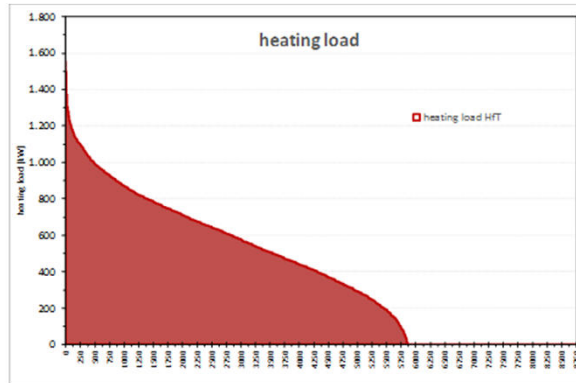
Optional:

- heating season Sep - Mai
- night set-back 24:00 – 06:00

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Parametrization of energy supply concepts

Using the annual load duration curves for the dimensioning process

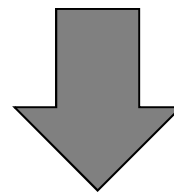


heat demand

electricity demand
From monitored load profiles

cooling demand
Only cooling of computer center
and library, combination with
monitored data

Guided parametrization of
various energy supply systems



CHP



heat pump



vapor-
compression
refrigeration



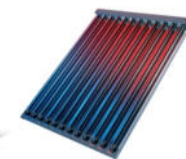
absorption
refrigerator



heat & cold
storage



PV(T)
modules



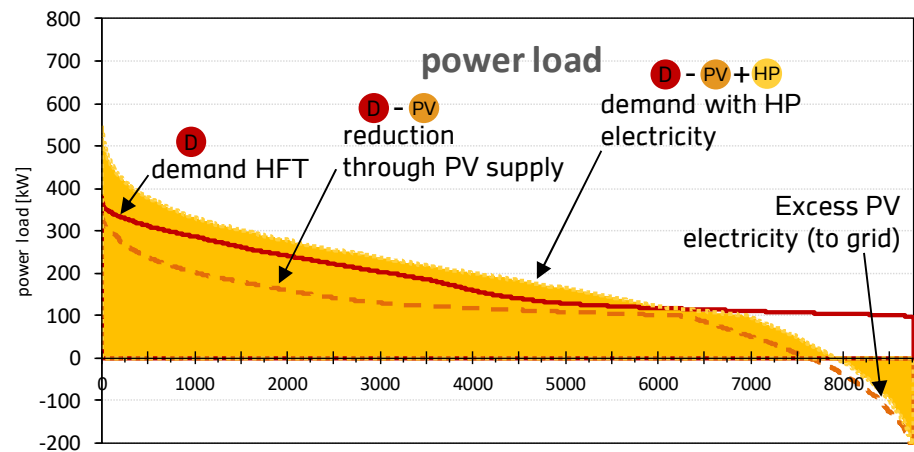
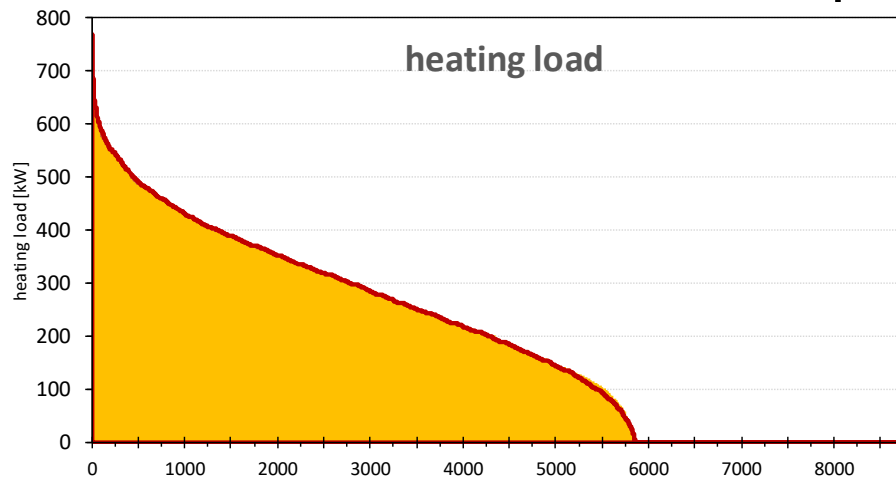
solar thermal
collectors

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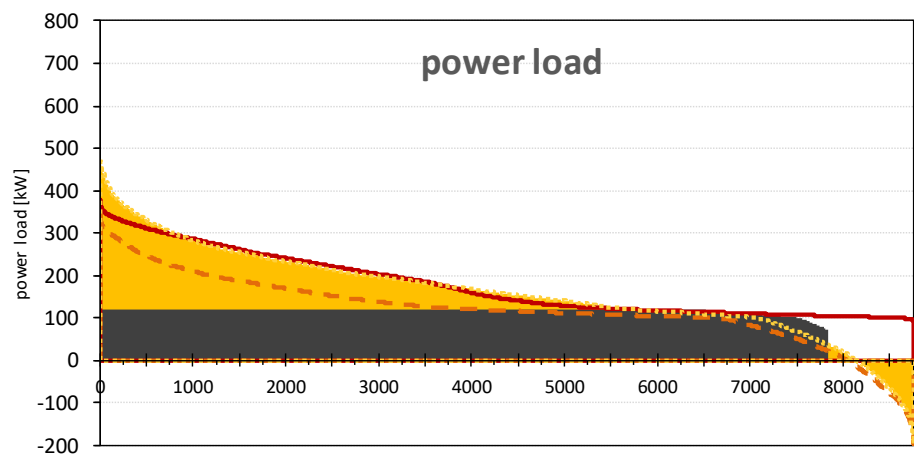
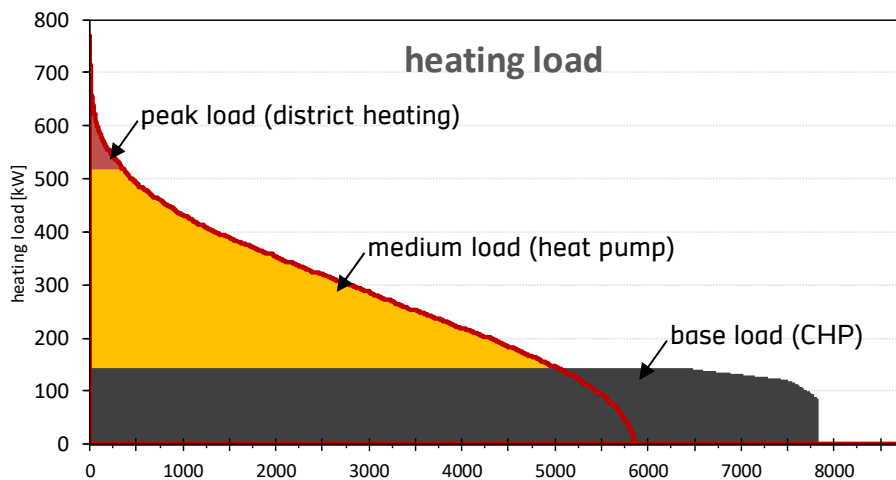
Campus HFT Stuttgart - energy supply concepts

Scenario modeling of energy supply concepts for renovation scenario „Pilot“:

Heat pump (monovalent) + PV



CHP (base load) + heat pump (medium load) + district heating (peak load) + PV



■ demand HFT

■ HP share

■ CHP share

■ PV reduction

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Results of various concepts



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Roadmap Zero-Emissions - RealLabor Campus

Recommendations:

2018  renovation Bau 4 (approved)

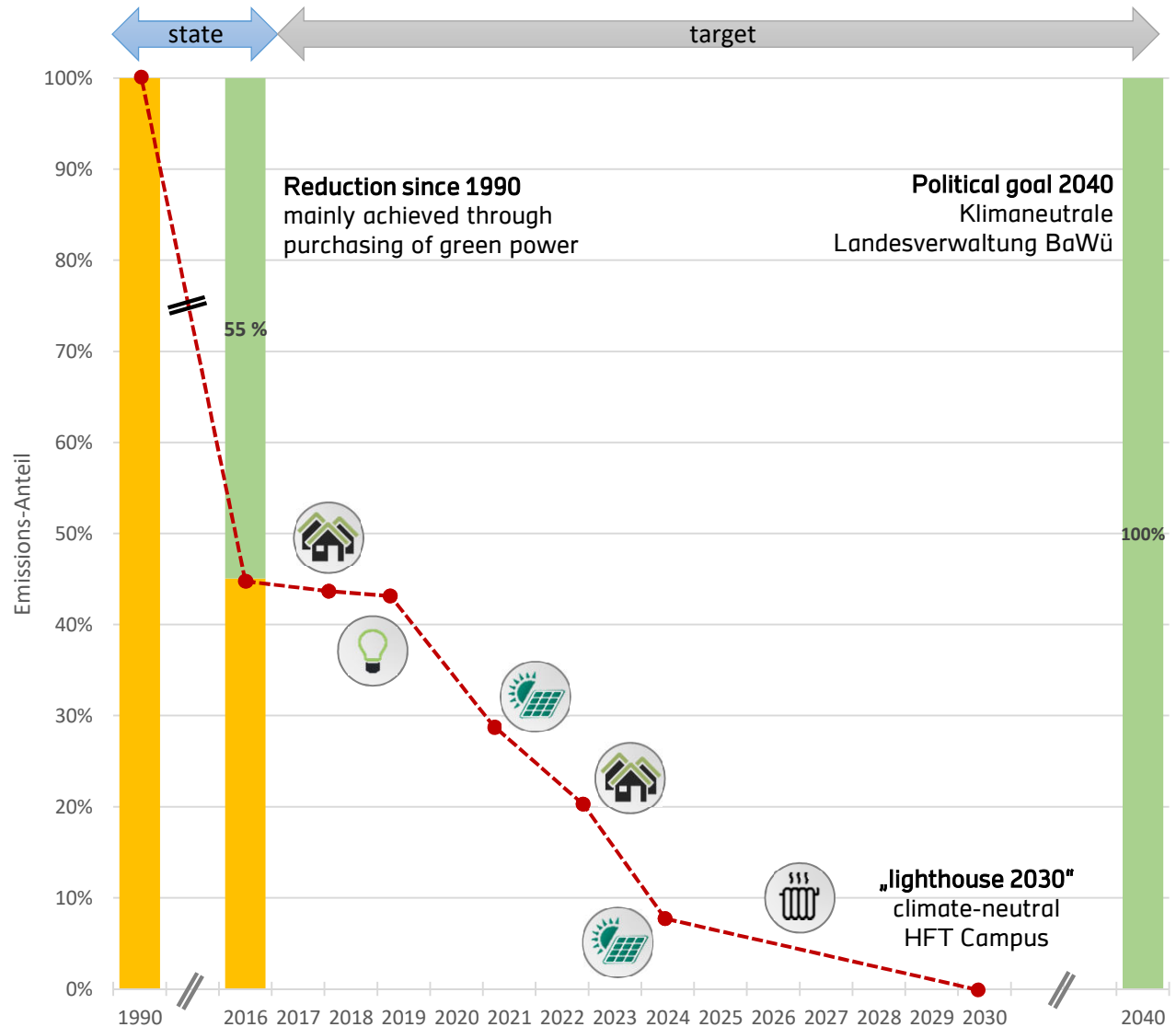
2019  LED installation

2020  PV Hofdiener Garage

2022  standard renovation Bau 1-4

2023  PV Bau 1-4

bis 2030  heat pump



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Automated energy concept derivation from 3D urban district modelling



Thank you for your attention!

[www.hft-stuttgart.de
/Forschung/Reallabor](http://www.hft-stuttgart.de/Forschung/Reallabor)



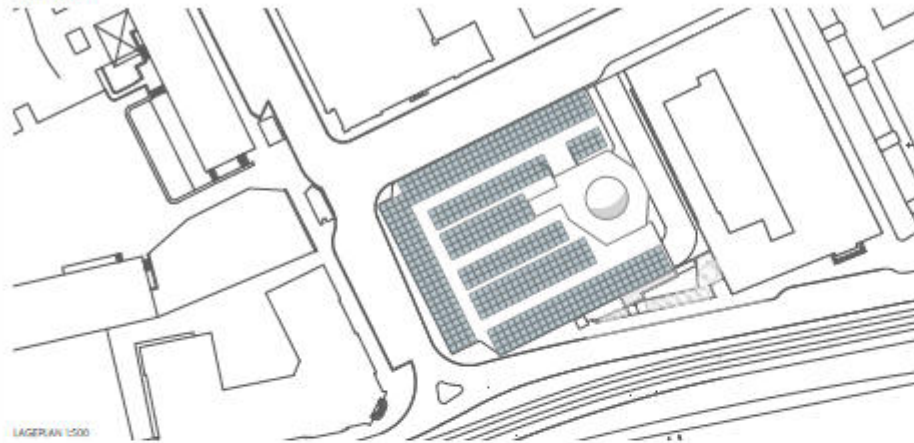
BackUp

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Campus HFT Stuttgart - Energieversorgungskonzepte

PV Potential Ermittlung HFT

ENERGIEFASSADE HOFDIENERGARAGE STUTTGART



An die Süd-Ost und Süd-West Fassade des Gebäudes werden PV Module installiert die aus multifunktionalen Baustoffen gefertigt werden, die Solarenergie erzeugen. Die verwendeten Materialien erfüllen nicht nur die Anforderungen des nachhaltigen Bauens, sondern ermöglichen auch eine ausgezeichnete Umweltleistung und Energieeffizienz des Gebäudes. Die gleichen Module befinden sich auch auf den Überdachungen der Pkw Stellplätze, welche gleichzeitig als Verschattung dienen.



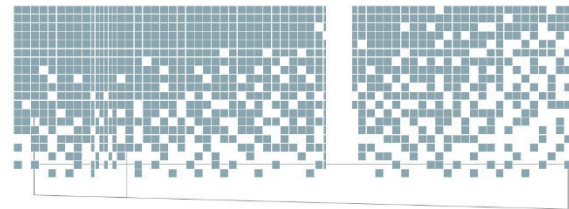
Die vorgehängte Fassade wird optimal ausgenutzt. Die Sommerstrahlung erzeugt Energie, des Weiteren dienen die Photovoltaikmodule als Sonnenschutz. Die Nordost und Nordwestfassaden bleiben in ihrem ursprünglichen Zustand und bringen somit Nordlicht in das Gebäude.

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RealLabor Campus – Darstellung Fassaden-PV Hofdiener Garage



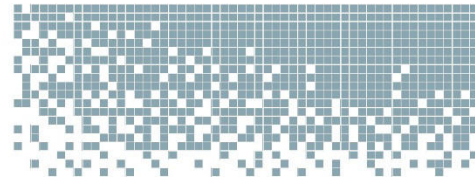
Südost Fassade
620m²



Aufzug ca. 150m²



Südwest Fassade
560m²



Dachfläche 1300m²
bei 5° Grad Neigung
Modulgröße = 1,60*1,60m

GESAMTFLÄCHE = 2625m²

Photovoltaikmodule haben zum jetzigen Stand des Entwurfs eine Größe von ca. 0,80*0,80m.



Verschattungs- & Ertragssimulation mit PVSol für vereinfachten Entwurf