Building Simulation and Control

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Building Simulation

- Thermal model of the building
- Coupled electric and thermal simulation of the energy systems
  - Heating, ventilation, air condition
  - Lighting
  - Heat pump, solar thermal, photovoltaics
- Simulation of internal loads
  - Occupancy
  - Computers, white goods etc.
- Outside climate
  - Temperature, humidity, solar radiation

- Create a complete multi-domain simulation of building and environment

Goals

- Optimization
  - Energy Efficiency
  - Use of self-produced energy
  - Grid-friendliness
  - Costs
- Failure Detection
  - Comparison of real values with simulation
- Virtual Plant
  - Participation in energy stock exchange

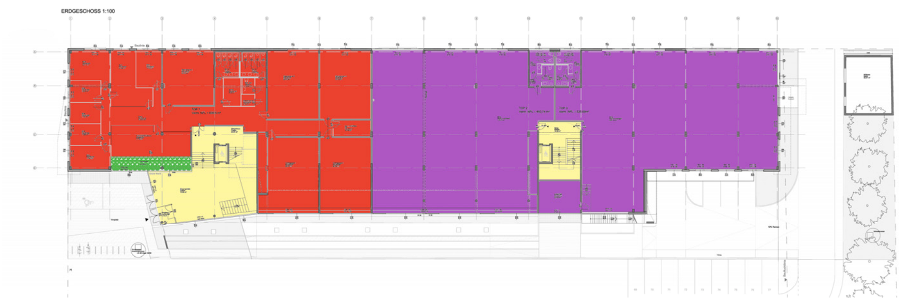
ENERGYbase

ENERGYbase: Office Building – Passive House Standard

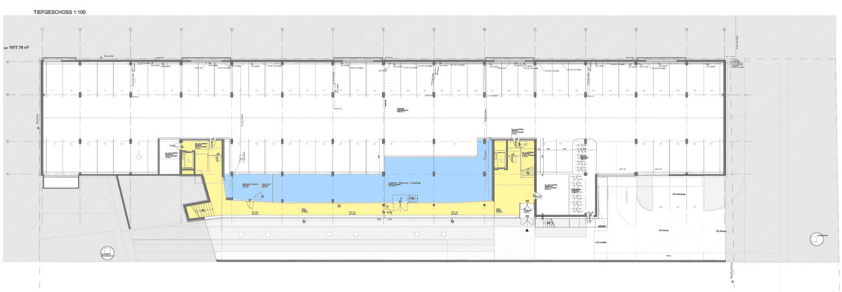
South View

North View

ENERGYbase: Usage



Erdgeschoss

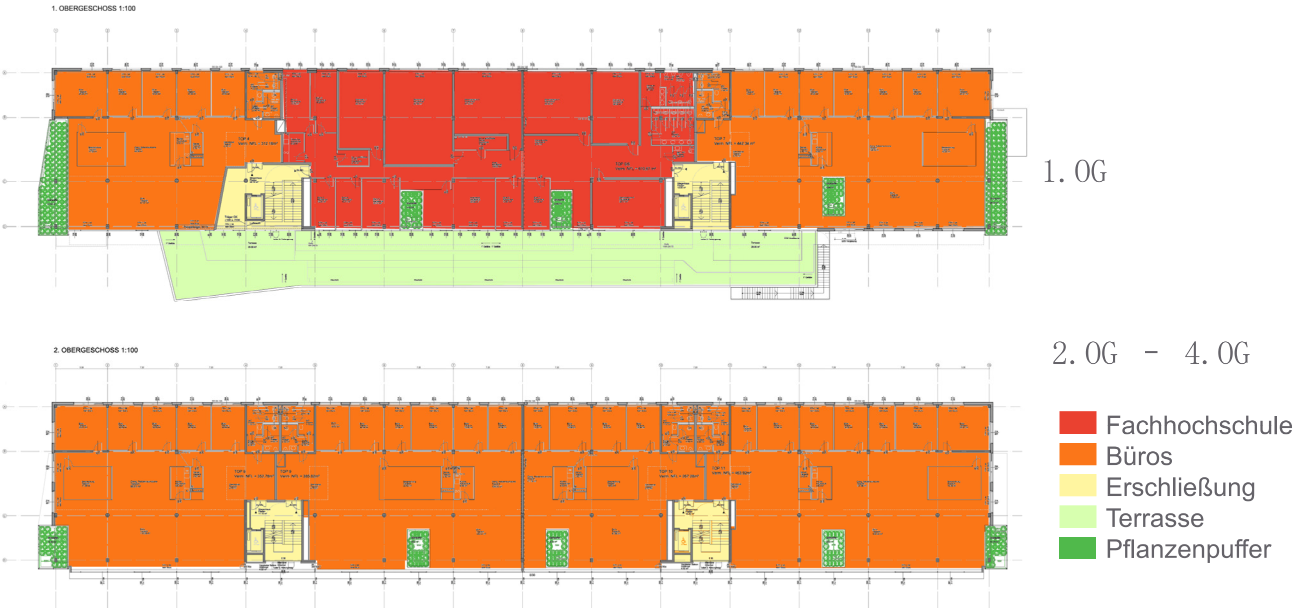


Keller

- Fachhochschule
- Labore
- Erschließung
- Haustechnik
- Pflanzenpuffer

Quelle: pos-architekten

ENERGYbase: Usage



Quelle: pos-architekten

ENERGYbase: Facts & Figures

- Passivhouse Standard
- 400m² photovoltaic systems
- 300m² solar thermal collectors
- Plant buffers for air conditioning
- Heating: Heat pump / concrete core activation
- Cooling: Free Cooling (groundwater pump)/ concrete core activation, supported by solar cooling

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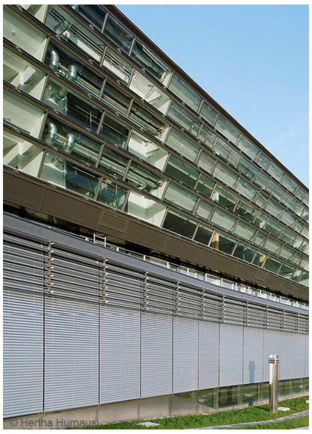
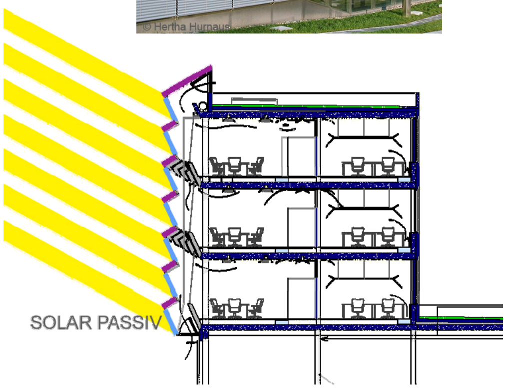
Photovoltaic Systems

- PV modules integrated into faccade
- Act as blinds for south offices by reducing direct solar radiation
- Orientation and tilting optimized for maximum electric yield
- Comparison of different technologies in long term tests





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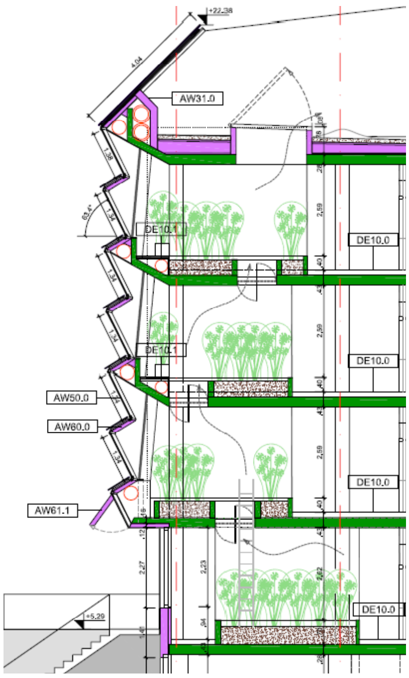
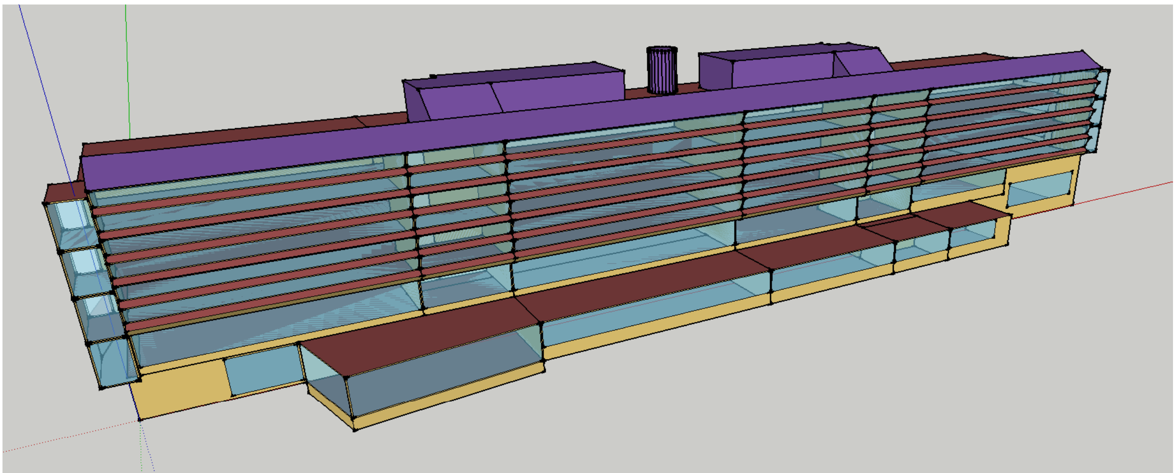
Plant Buffers

- Ecological humidification and revitalization of air
- Comparison of air qualitiy when using inside or outside plant buffers
- Researching the possibilities with plant buffers

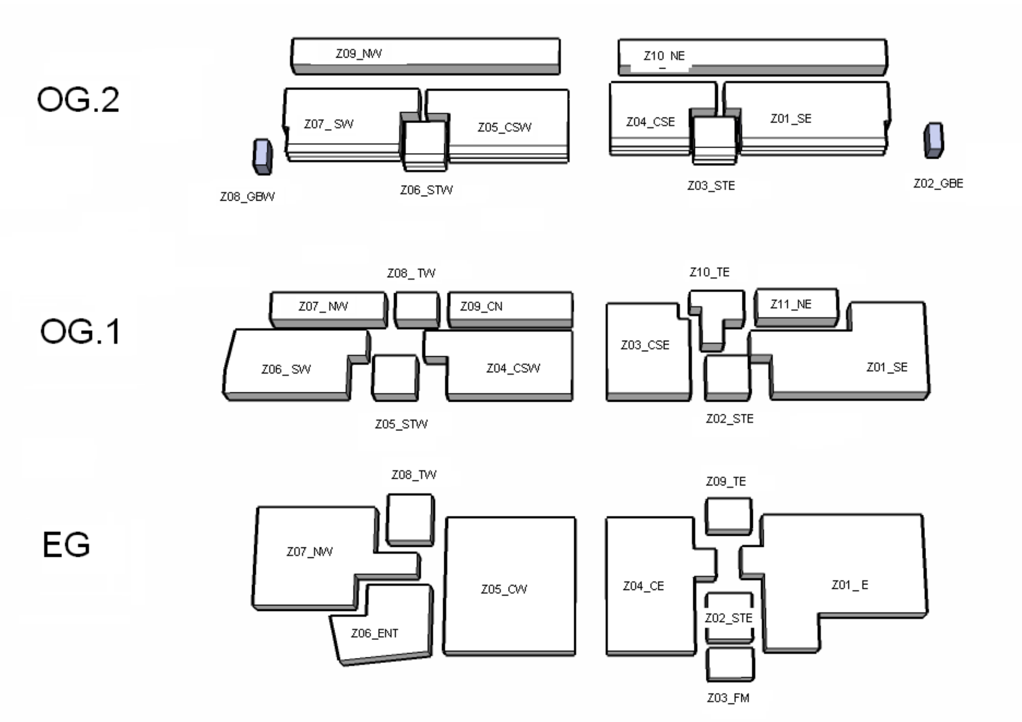


Quelle: pos-architekten

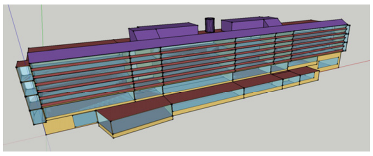
Modelling

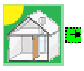


ENERGYBase in SketchUp & TRNsys



EnergyBase in SketchUp & TRNsys





ENERGYbase

68 Zones
758 walls, ceilings and floors
59 different wall structures
66 different layers
146 windows
8 different window structures

ENERGYbase - Simulation

Goal

- Identification of thermal dependencies of ENERGYbase from outside radiation and temperature

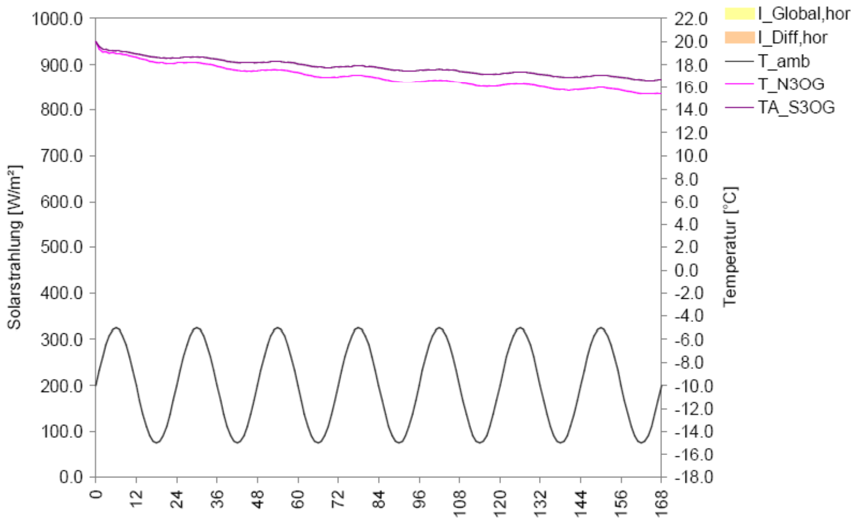
Method

- Using datasets for weather in representative weeks
- Simulating representative room air temperatures in northern and southern office on the third floor

Scenarios

- Typical winter, summer and season changes with idealized outside air temperature and solar radiation

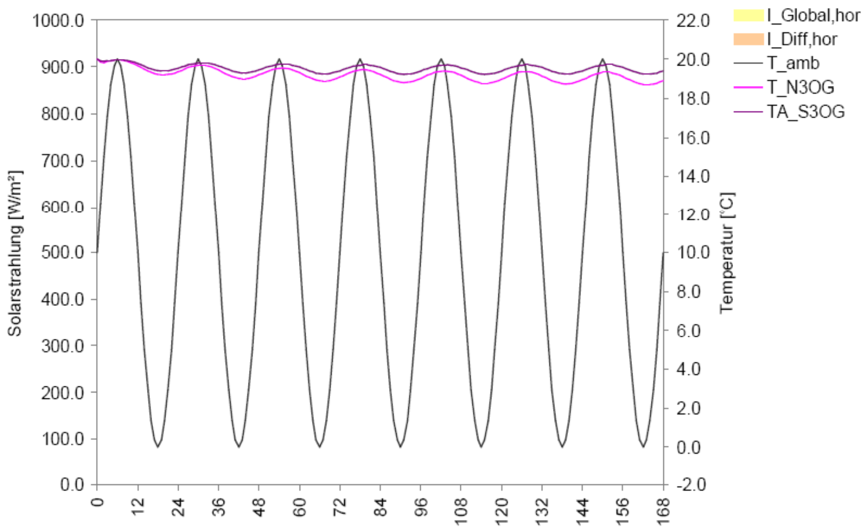
Szenario S2



Winterfall

- Umgebungstemperatur sinusförming um T_Umg = - 10° C schwingend
- Keine solare Strahlung

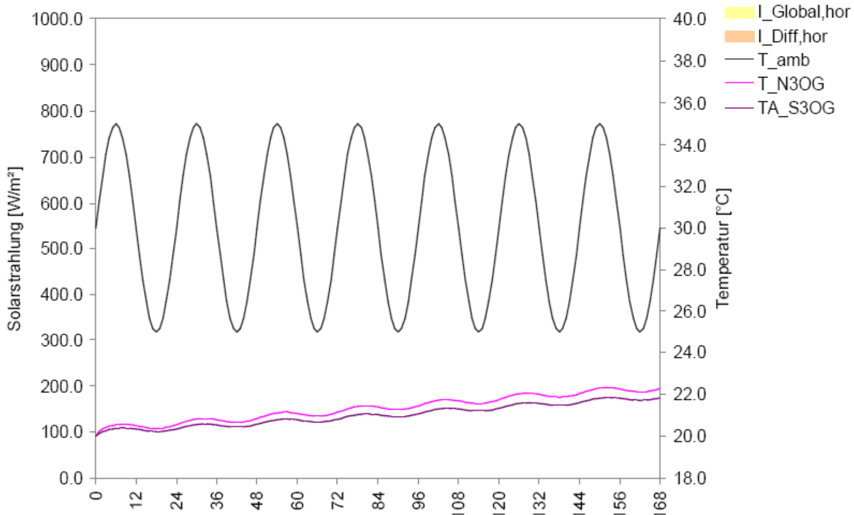
Szenario S3



Übergangszeit

- Umgebungstemperatur sinusförming um T_Umg = 10° C schwingend
- Keine solare Strahlung

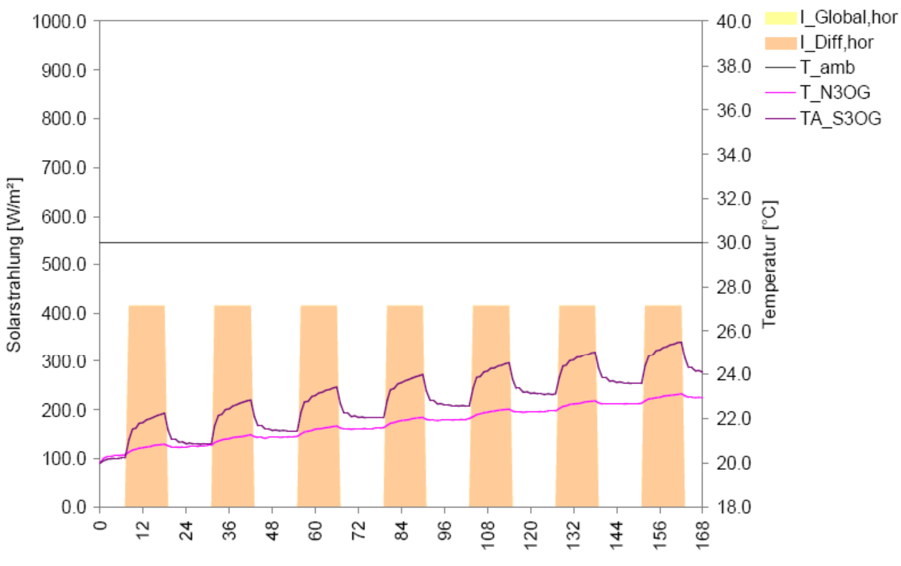
Szenario S4



Sommerfall

- Umgebungstemperatur sinusförming um T_Umg = 30° C schwingend
- Keine solare Strahlung

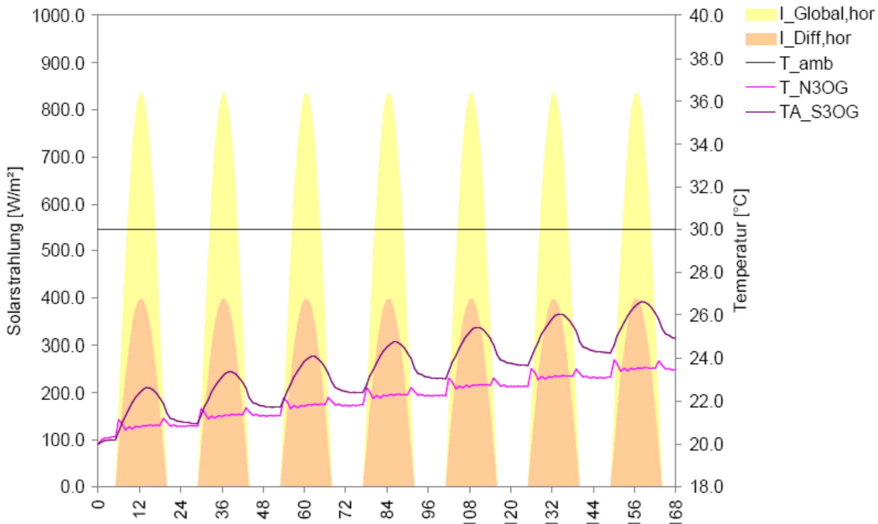
Szenario S6



Sommerfall

- Umgebungstemperatur konstant mit T_Umg = 30° C
- Konstante Diffuse Solarstrahlung um Idiff = 400 W/m²

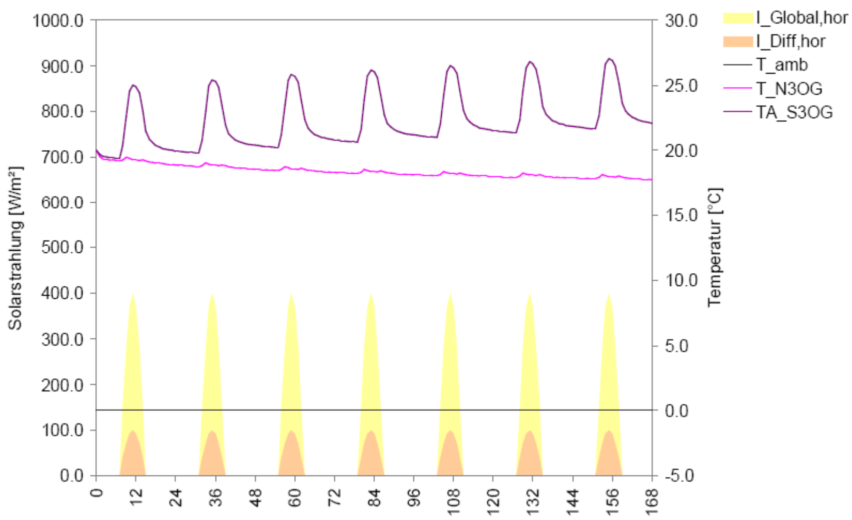
Szenario S7



Sommerfall

- Umgebungstemperatur konstant mit T_Umg = 30° C
- Sinusförmig schwingende Solarstrahlung Iglob_max = 800 W/m²

Szenario S8



Winterfall

- Umgebungstemperatur konstant mit T_Umg = 0° C
- Sinusförmig schwingende Solarstrahlung Iglob_max = 400 W/m²

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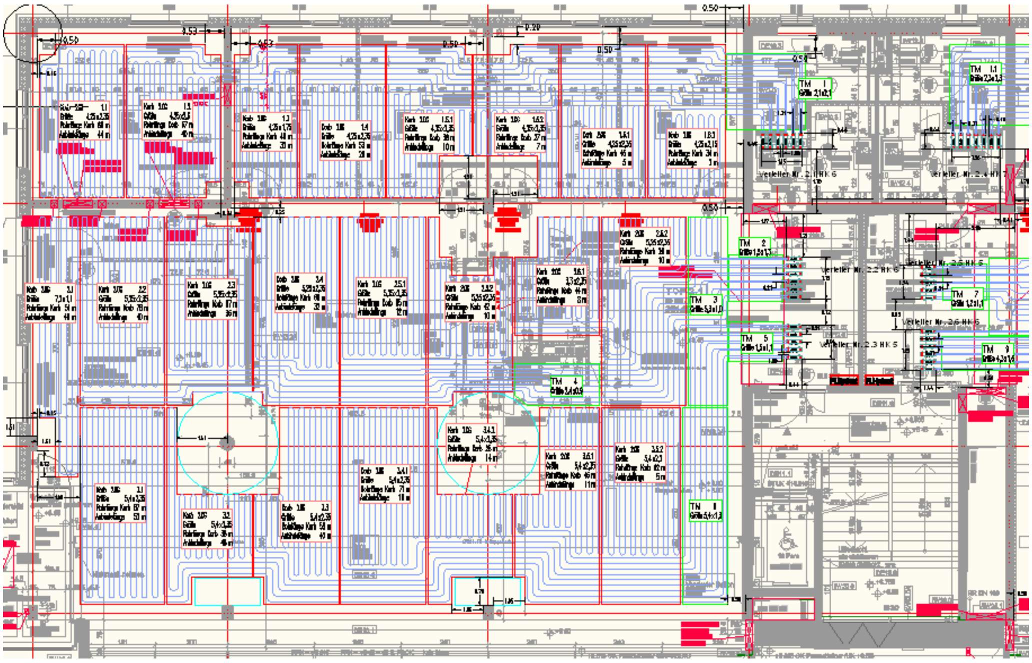
Concrete Core Activation



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NCM – schedules (National Calculation Method)

Energy Performance of Buildings Directive (*EPBD*)

2926	2927	2938	2940	2935	2936	124	125	1423	1424	1420	1421
Office_OpenOff_Occ_ Wkdy	Office_OpenOff_Occ_ Wknd	Office_OpenOff_Light_ Wkdy	Office_OpenOff_Light_ Hol	Office_OpenOff_Equip_ Wkdy	Office_OpenOff_Equip_ Wknd	Uni_Lecture_Occ_ Wkdy	Uni_Lecture_Occ_ Wknd	Uni_Lecture_Light_ Wkdy	Uni_Lecture_Light_ Wknd	Uni_Lecture_Equip_ Wkdy	Uni_Lecture_Equip_ Wknd
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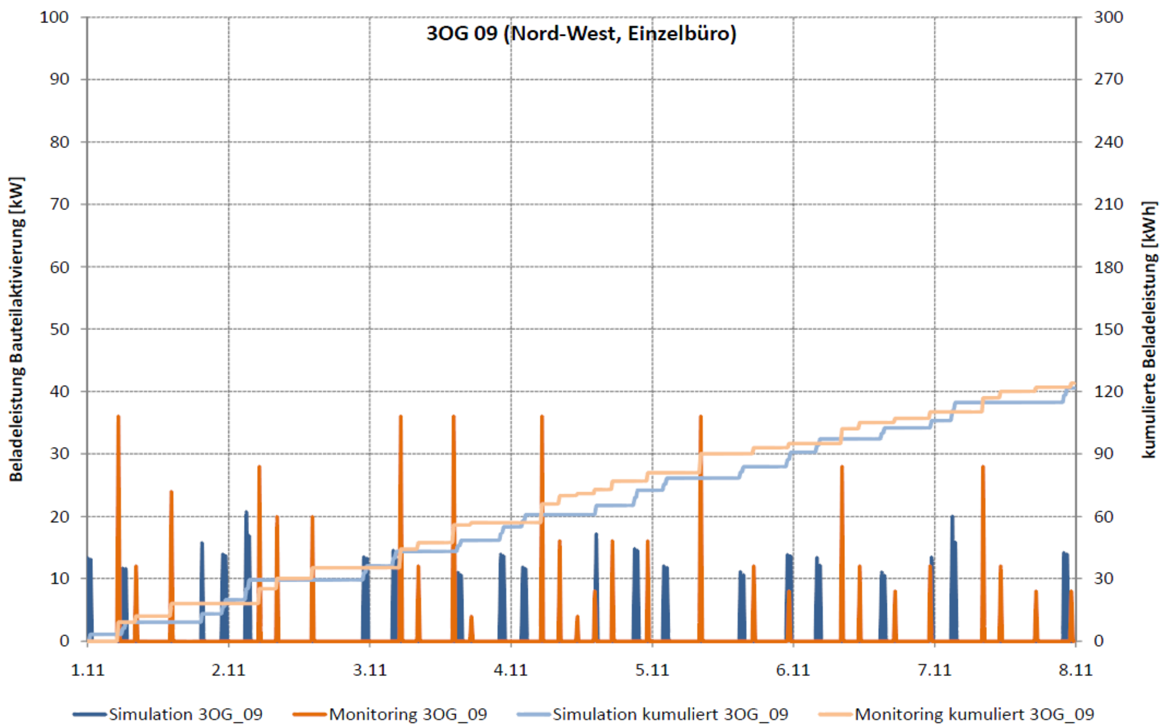
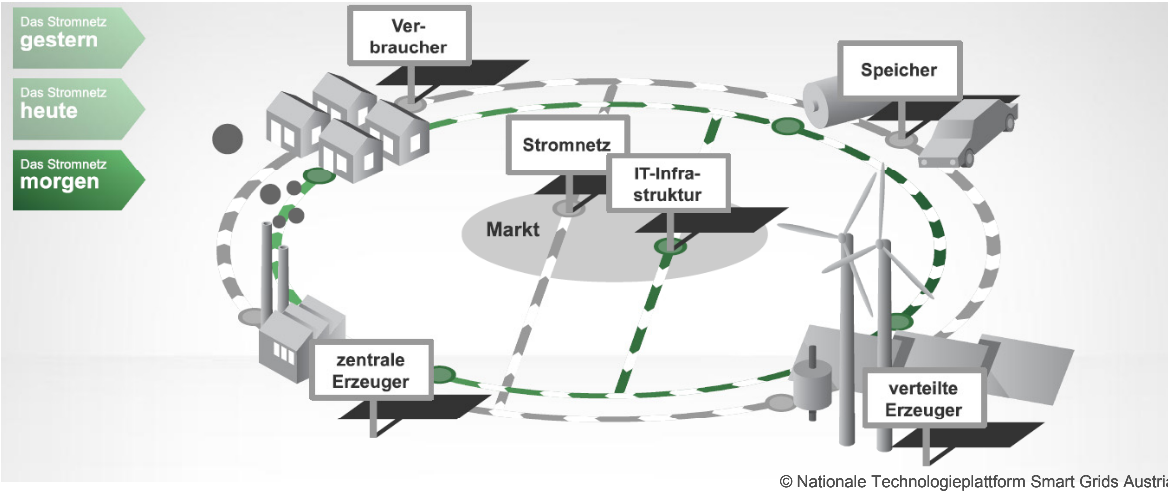


B2G – Building to Grid

Dr. Peter Palensky | Head Sustainable Building Technologies

Power Grid of the Near Future



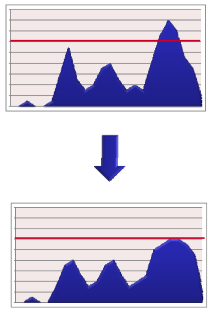
- Many decentralized producers
- Buildings: from consumer to producer & consumer -> prosumer
- Customers adapt their behavior: Smart Meters
- Power Grid combined with IT network
- New decentralized storage to compensate consumption and production (e-mobility)

B2G – Building to Grid

- The challenge
  - High load peaks in the grid
  - Improvement of buildings with no regard to the grid
- The target
  - Intelligent building services enabling cooperative integration into the grid
  - Optimal mains operation by utilising buildings' degrees of freedom
- The method
  - Building simulation to predict status and capacity
  - Equipment and operation of 10 test buildings over one year
- The result
  - Improved load models of buildings
  - Buildings in the role of storage and active participants in a smart grid

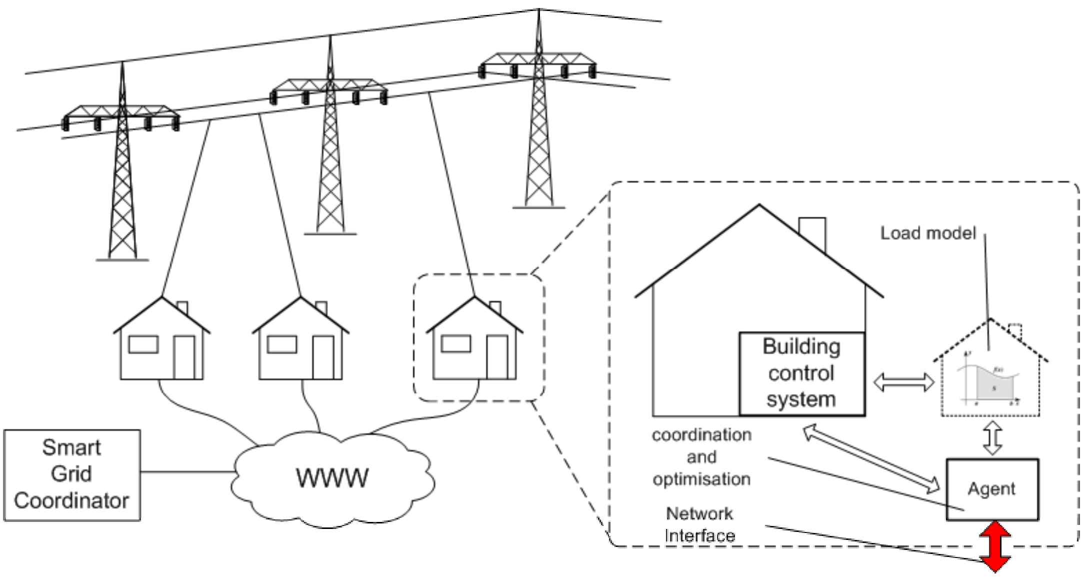
B2G – Building to Grid

- Investigation
  - Selection of appropriate demonstration buildings in Salzburg, Austria
  - Occupancy and use, thermal mass and existing IT infrastructure
- Simplified load model
  - Simplified generic load model for electric-thermal coupling
  - Anticipatory application of storage potential
- Load Shifting
  - Determine maximum time for shifting
  - Avoid heating during grid peak loads



B2G – Building to Grid

- Interaction between the remote action, building control and the smart grid



B2G Outlook

- Find maximum time for switching off loads
  - Minimum of two hours expected
- Determine potential of electric-thermal coupling
- Simplify thermal model
  - Required for online optimization

Next steps:

- Include weather prediction

TOMORROW TODAY

Thank You!