Ingenieure für Energieeffizienz und Komfort
Österreich
teamgmi

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

VITALITY

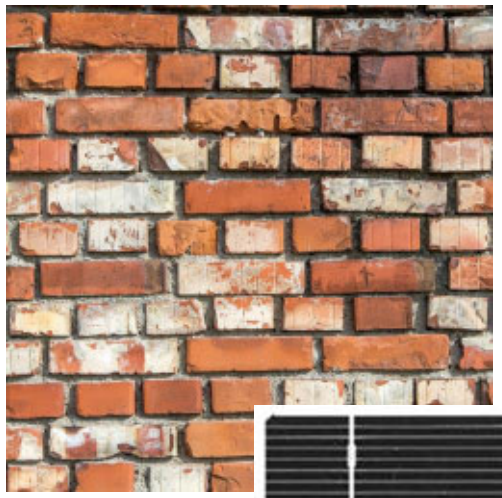
"Design rules for Building integrated photovoltaics in the early planning phase"

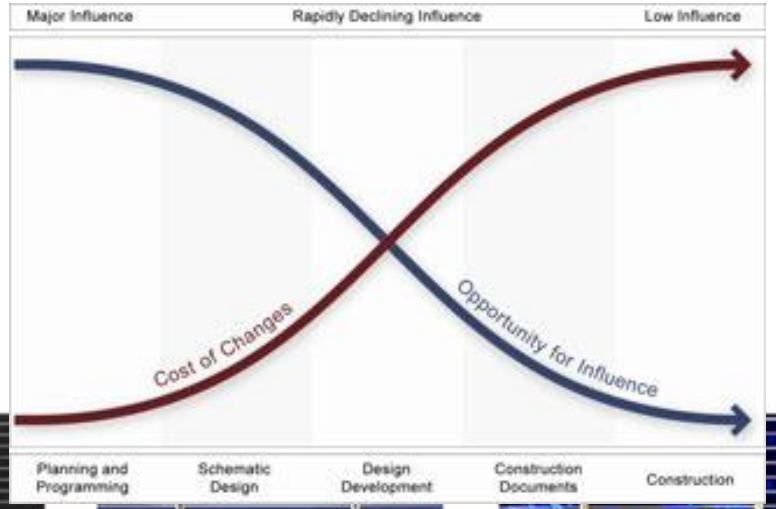
This project is funded by the Austrian Ministry of Transport, Innovation and Technology within the programme ‚*Stadt der Zukunft'* 3rd Call 2015

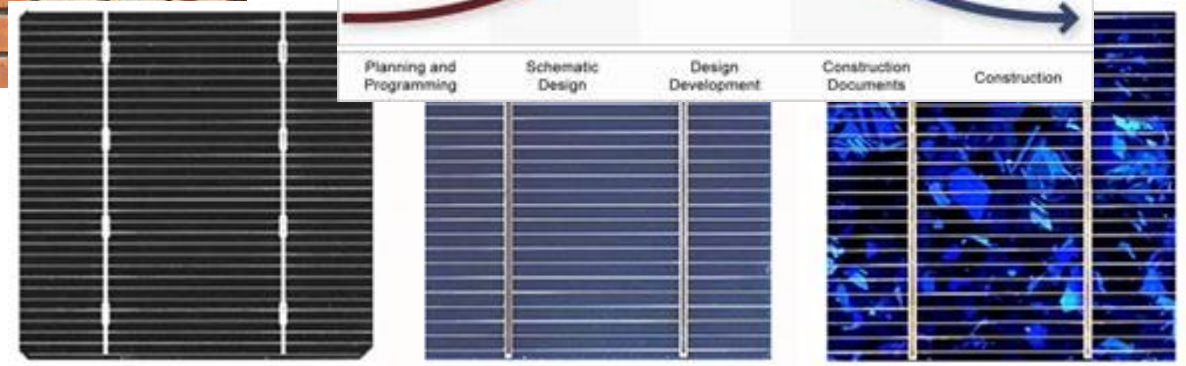
Tim Selke, AIT and Anita Preisler, teamgmi

INTERNATIONAL SUSTAINABLE ENERGY CONFERENCE 2018
3 – 5 October 2018, Congress Graz, Austria

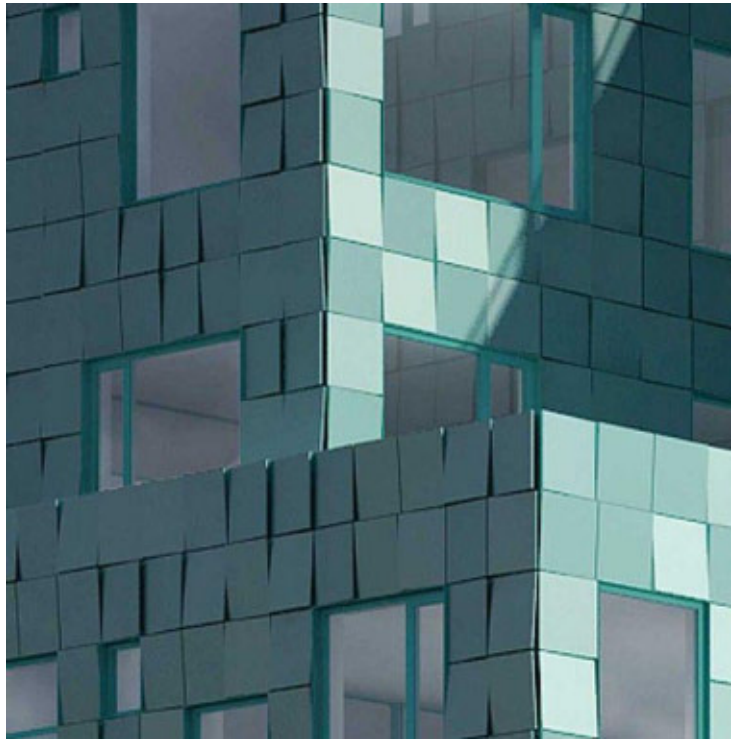
BUILDING INTEGRATED PHOTOVOLTAICS
EARLY DESIGN PHASE HIGHEST OPPORTUNITY OF IMPACT



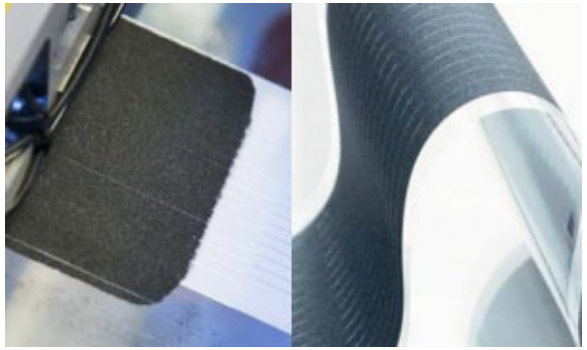




LATEST R&D TECHNOLOGIES

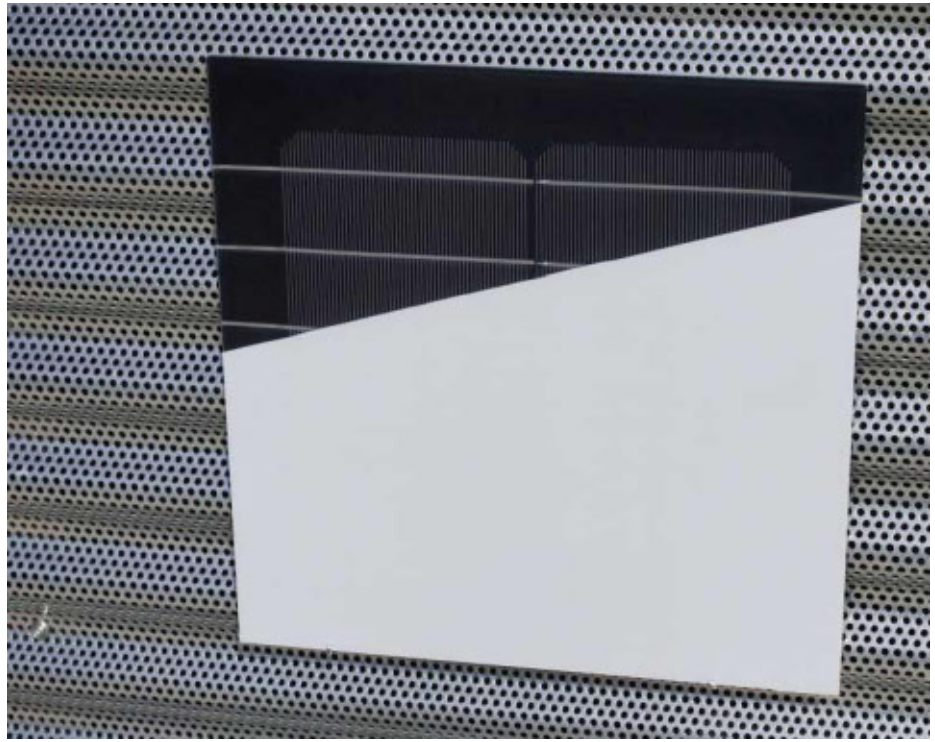


KromatixTM technology https://www.pinterest.at



Crystalsol - Printed Solar Modules

https://www.csem.ch/ CSEM entwickelt ziegelrote Solarmodule



https://www.csem.ch/ das Weisse Modul

VITALITY PROJECT

FOCUS / EMPHASIS

- We focus on urban BIPV projects
- We provide and show-up convincing, high quality data & information & picture in the very early development phase of a building project

Products

- Vitality tool for assessing the BIPV potential in the early design phase
- Design rules for BIPV according to the energy concept
- CASE STUDIES

Expected Impact:

- Decision makers, architects and investors get the information needed to take the decision for BIPV

VITALITY PROJECT

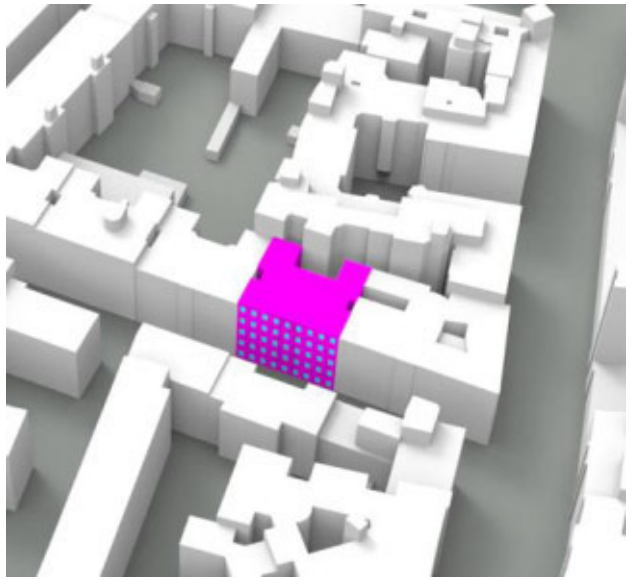
PARTNERS

- AIT Austrian Institute of Technology GmbH
- Technische Universität Graz,
  Institut für Gebäude und Energie - IGE, Österreich
- EURAC European Academy of Bozen, Institute for Renewable Energy, Italien
- teamgmi Ingenieurbüro GmbH, Österreich
- Lund University, LTH, Architecture and Built Environment, Energy and Building Design (LTH-EBD), Schweden
- ATB-Becker e.U., Österreich

URBAN SOLAR POTENTIAL
TYPICAL 5 STOREY RESIDENTIAL BUILDING IN VIENNA

Parametric study

- 100% PV yield from PV modules oriented (Azimuth/ Slope) South / 30°
- 3 different distances – street width: facade to facade 15, 20 and 30 meter
- 5 Orientation: East, South-East: South, South-West, West,



15 m

Floor	East	South-East	South	South-West	West
5th	42%	56%	61%	57%	43%
4th	35%	49%	53%	50%	37%
3th	29%	41%	46%	43%	31%
2nd	24%	32%	39%	34%	25%
1st	20%	25%	34%	28%	21%

20 m

Floor	East	South-East	South	South-West	West
5th	42%	58%	63%	60%	43%
4th	35%	53%	57%	54%	37%
3th	29%	47%	51%	47%	31%
2nd	24%	40%	46%	41%	25%
1st	20%	34%	40%	34%	21%

30 m

Floor	East	South-East	South	South-West	West
5th	47%	62%	66%	63%	49%
4th	44%	58%	63%	59%	45%
3th	39%	55%	58%	55%	41%
2nd	35%	48%	52%	46%	38%
1st	32%	29%	48%	30%	33%

> 50 %

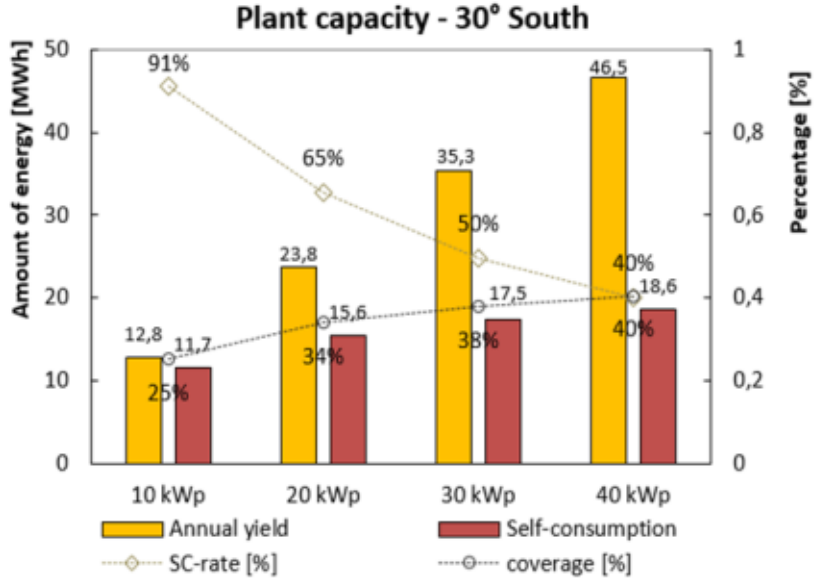
35-50 %

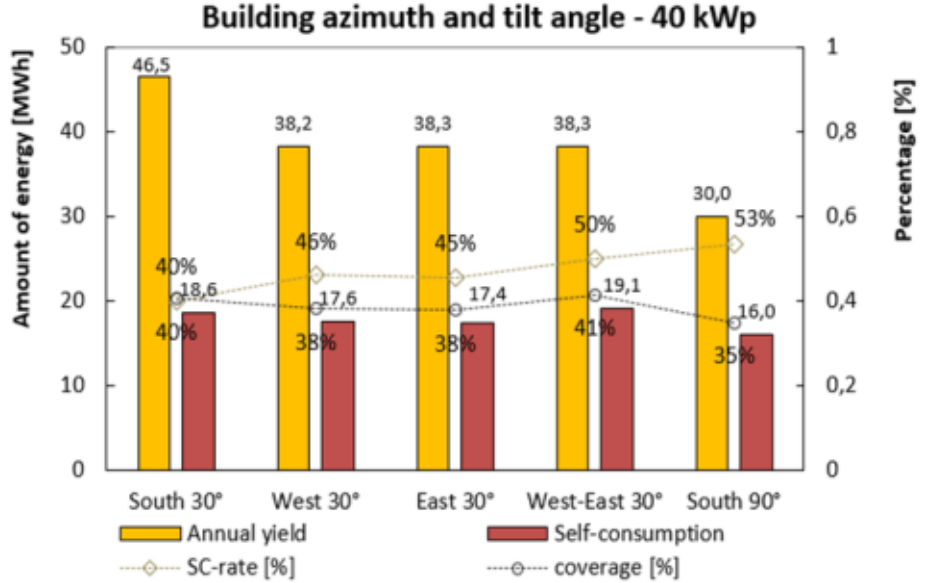
< 35 %

URBAN PV YIELD, SELF-CONSUMPTION AND PAY BACK TIME TYPICAL 5 STOREY RESIDENTIAL BUILDING IN VIENNA

Parametric study

- (left) different PV system capacities rooftop mounted (south/ 30°) and
- (right) different module position (rooftop, façade) of a 40 kWp capacity (Source: Wenin)

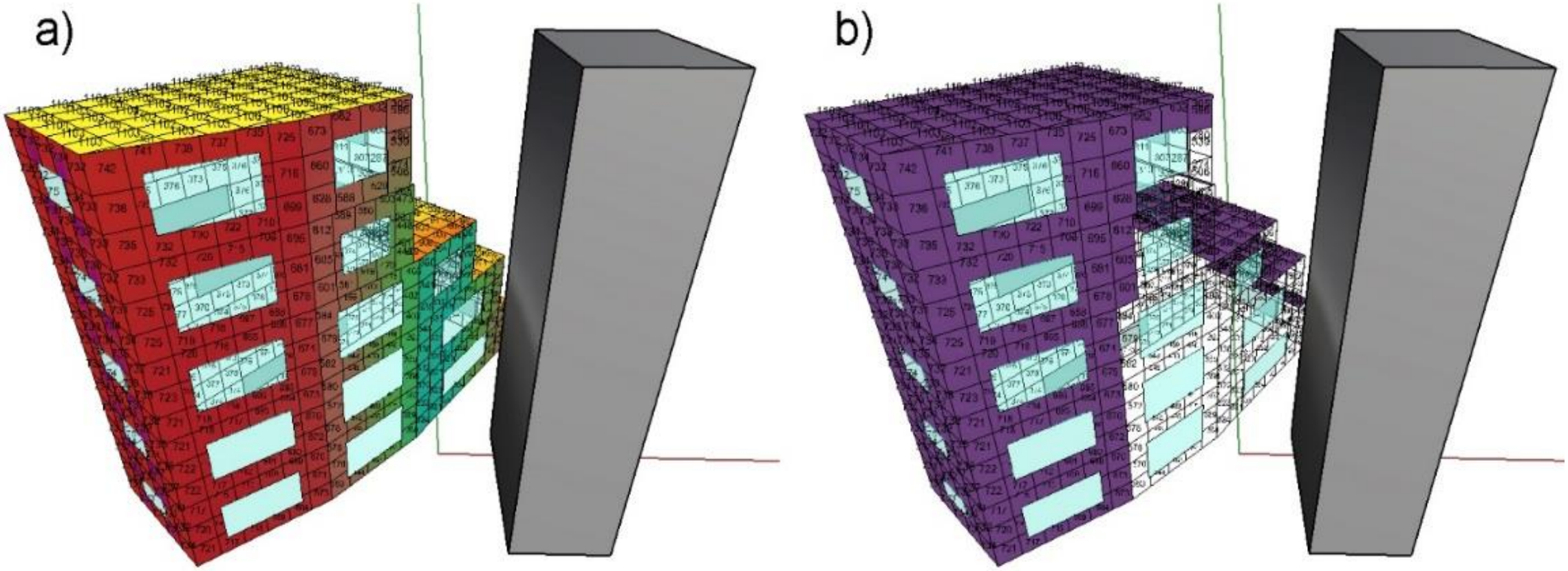




	10 kWp	20 kWp	30 kWp	40 kWp
LCOE [Cent/kWh]	6,7	6,3	5,9	5,6
Payback period [a]	5	6,1	6,9	7,6

South 30°	West 30°	East 30°	West-East 30°	South 90°
5,6	6,8	6,8	6,8	8,7
7,6	8,4	8,5	8	9,7

VITALITY – PV MODULE PLACEMENT



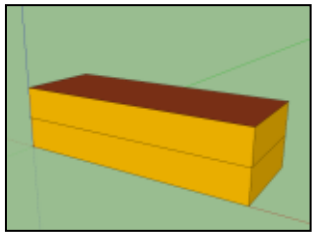
a) solar radiation grid, b) PV effective distribution > 600 kWh/year Load file is adapted

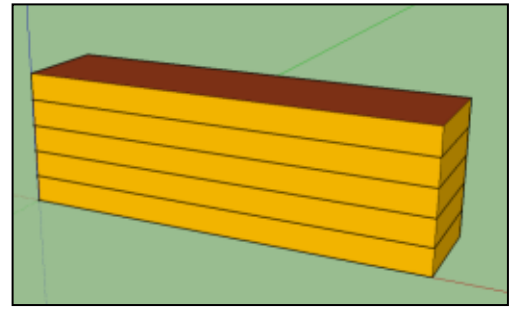
VITALITY – ENERGY CONCEPT MATRIX

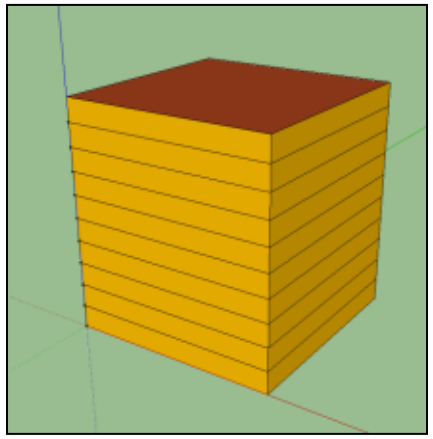
	Strategy 1	Strategy 2	Strategy 3
Heating/ DHW supply	Thermal source (District heating, Biomass, Gas)	water-water-heat pump with a ground water well	air-water-heat pump
Cooling supply	Compression Cooling with dry heat rejection	Free-cooling by ground water well / Rev. heat pump Peak load: Compression Cooling with dry heat rejection	Rev. heat pump Peak load: Compression Cooling with dry heat rejection
Central mechanical ventilation for fresh air supply	35 m³/hP	35 m³/hP	35 m³/hP

VITALITY – EXAMPLE BUILDINGS

- Small size:
  - 2 floors/ 432m²$_{BGF}$
  - Lc = 1,28 m
  - Average u-Value = 0,40 W/m²K
  - Window area: 50%
- Medium size:
  - 5 floors/ 3.000m²$_{BGF}$
  - Lc = 2,38 m
  - Average u-Value = 0,44 W/m²K
  - Window area: 50%
- Large size:
  - 10 floors/9.000m²$_{BGF}$
  - Lc = 4,03 m
  - Average u-Value = 0,46 W/m²K
  - Window area: 50%
- Location: Vienna

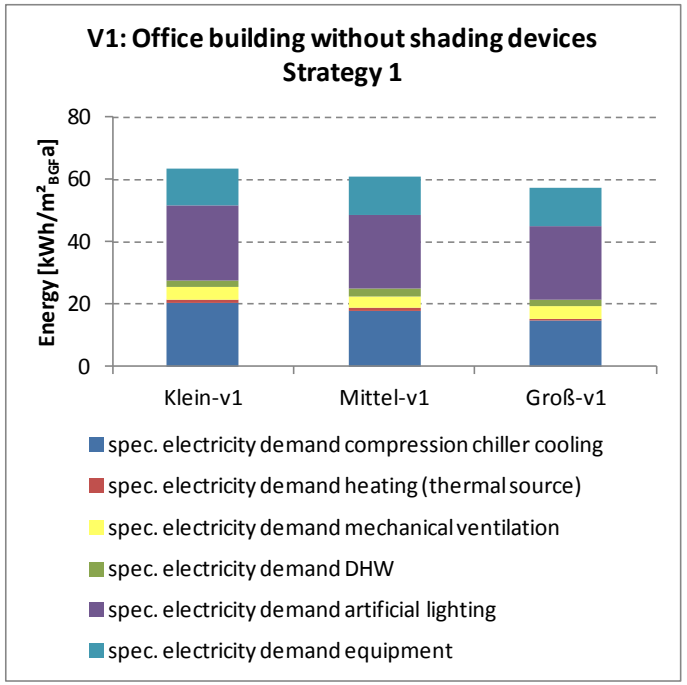


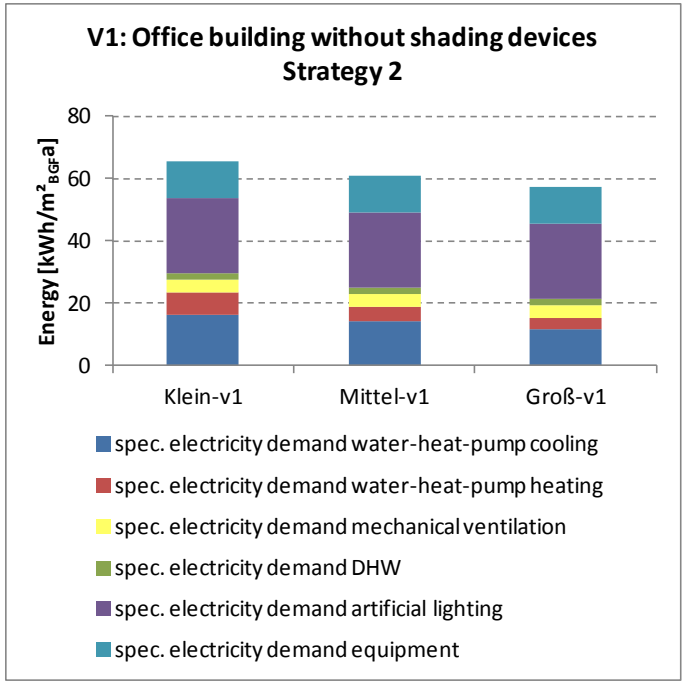


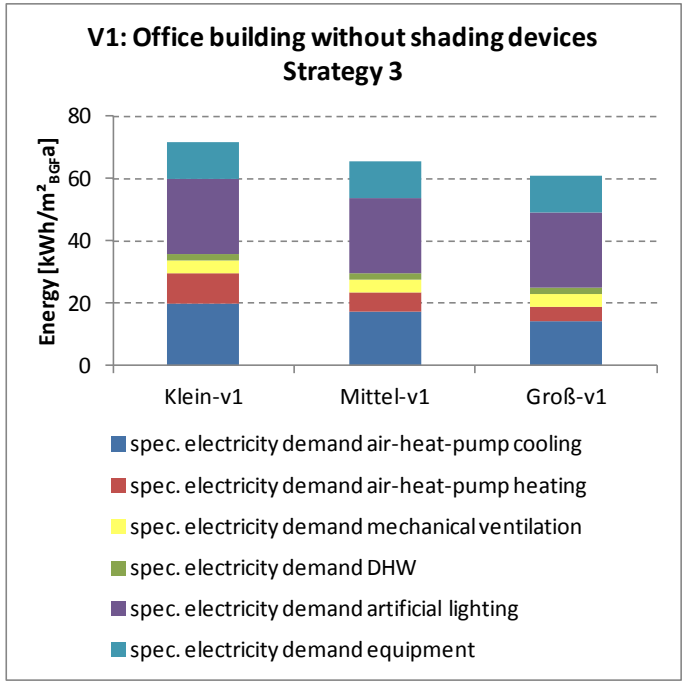


VITALITY – ELECTRICAL LOAD PROFILES

Results V1: Office building without shading devices

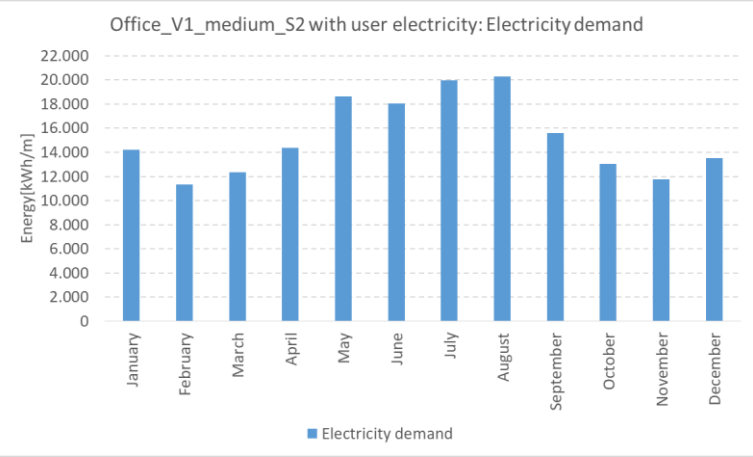


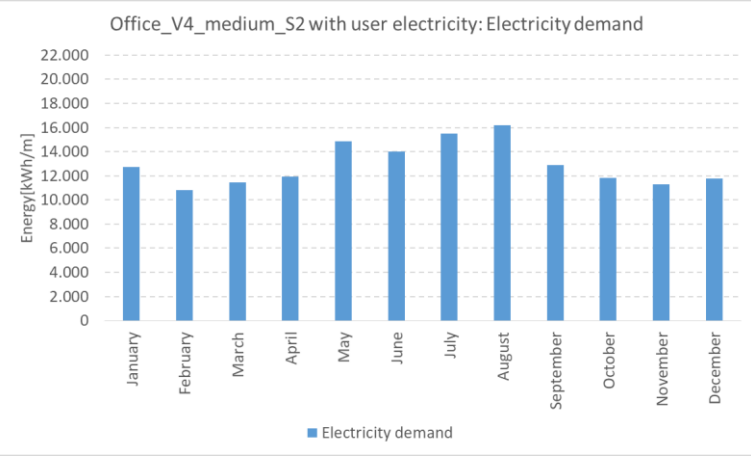


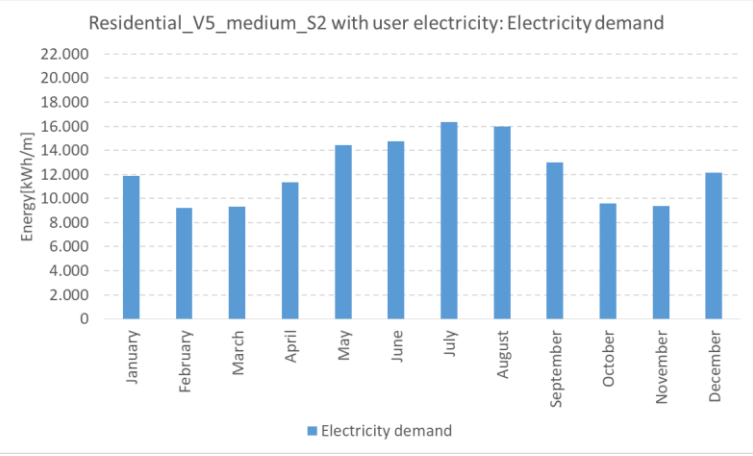


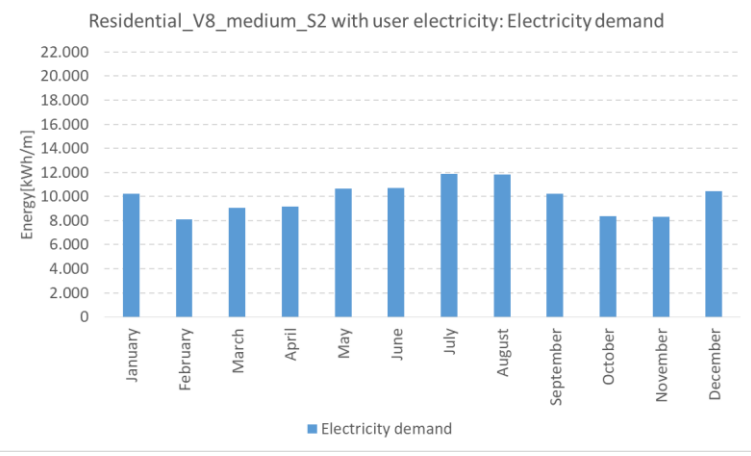
VITALITY – ELECTRICAL LOAD PROFILES

Electrical load profiles for offices and residential with user electricity



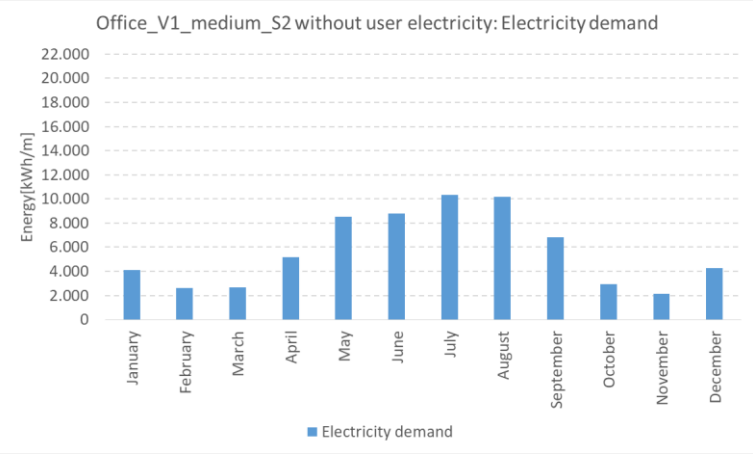


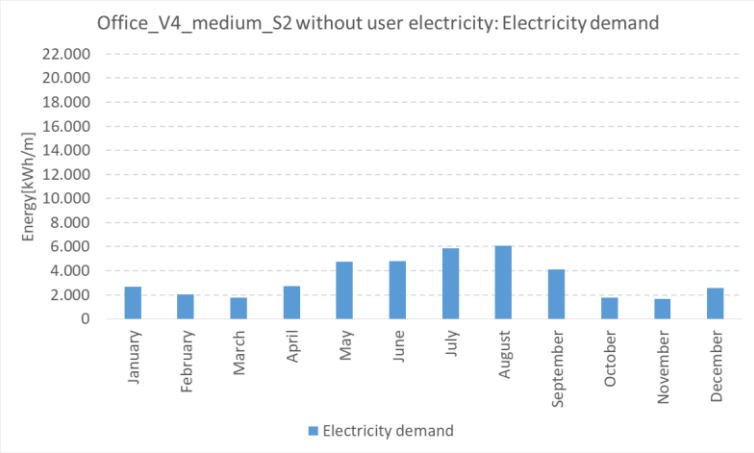


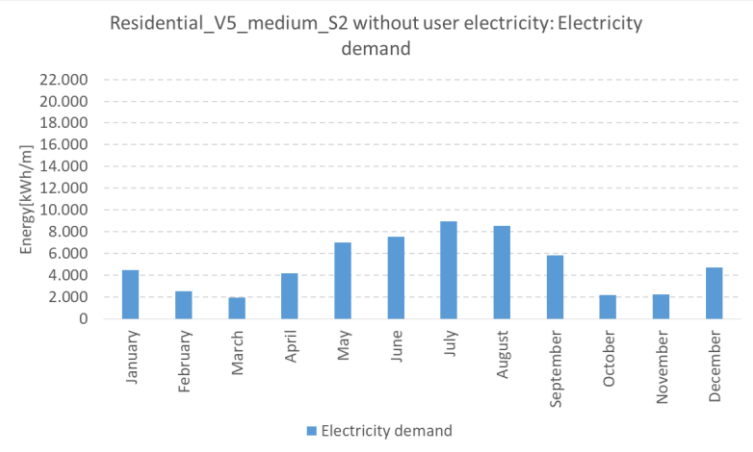


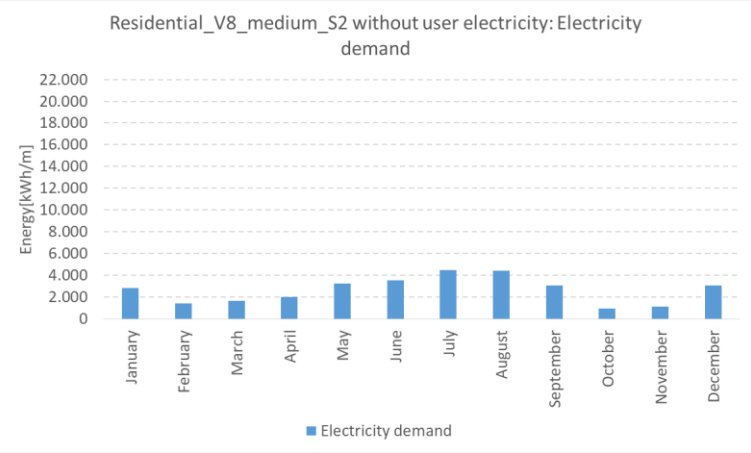
VITALITY – ELECTRICAL LOAD PROFILES

Electrical load profiles for offices and residential without user electricity







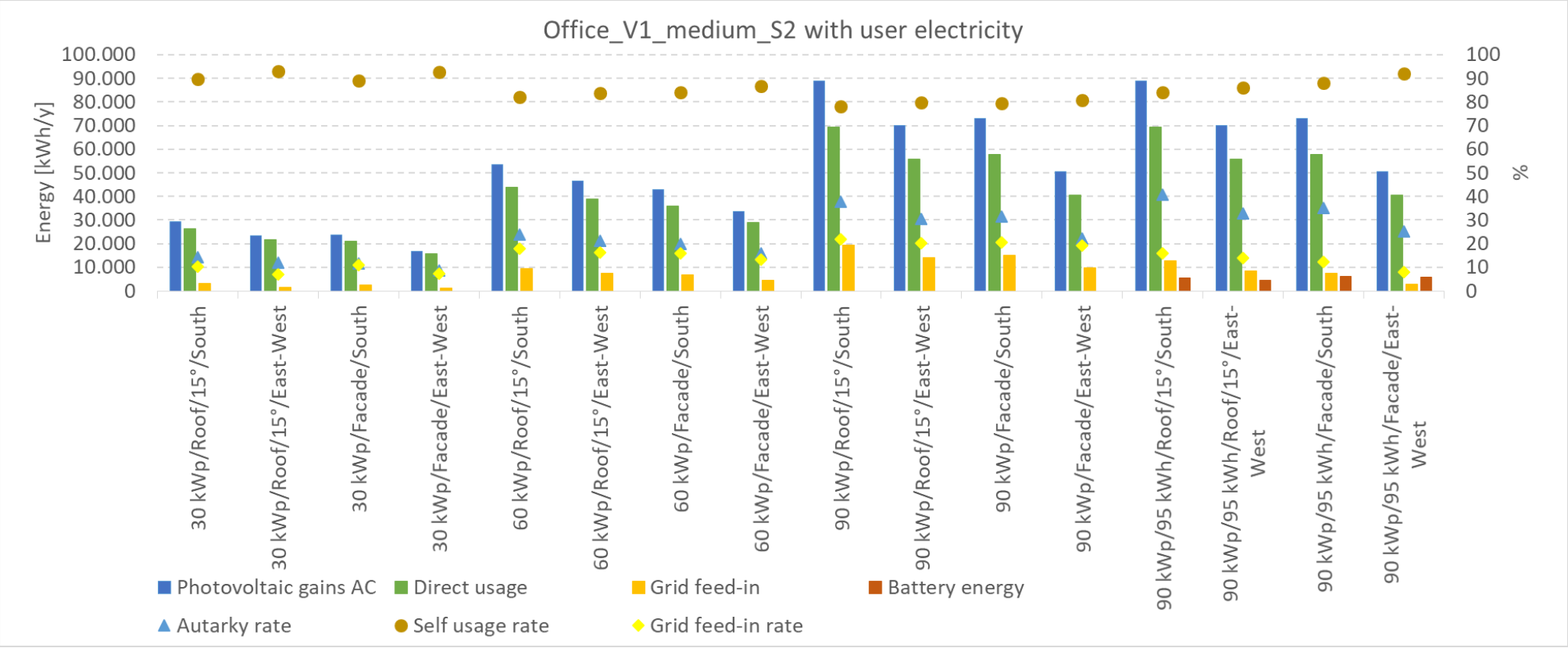


VITALITY – SELF CONSUMPTION STUDY

- Solar coverage by PV-systems: Polysun Professional
  - 4 building types:
    - Office building, medium size, standard (V1)
    - Office building, medium size, passive house (V4)
    - Residential building, medium size, standard (V5)
    - Residential building, medium size, passive house (V8)
  - 2 types of electricity load profiles:
    - With user electricity
    - Without user electricity
  - 2 Angles of PV modules
    - Roof 15°
    - Façade 90°
  - 2 Orientations of PV modules
    - All modules south oriented (15° roof, 90° façade)
    - 50% modules east oriented/ 50% modules west oriented (15° roof, 90° façade)
  - 4 sizes of PV systems
    - 30 kWp → 1 kWp/100 m^2_{GA} (according to Vienna building regulation for commercial buildings)
    - 60 kWp
    - 90 kWp
    - 90 kWp with 95 kWh battery
  - → 128 Simulation variants (4 building types x 32 variants)

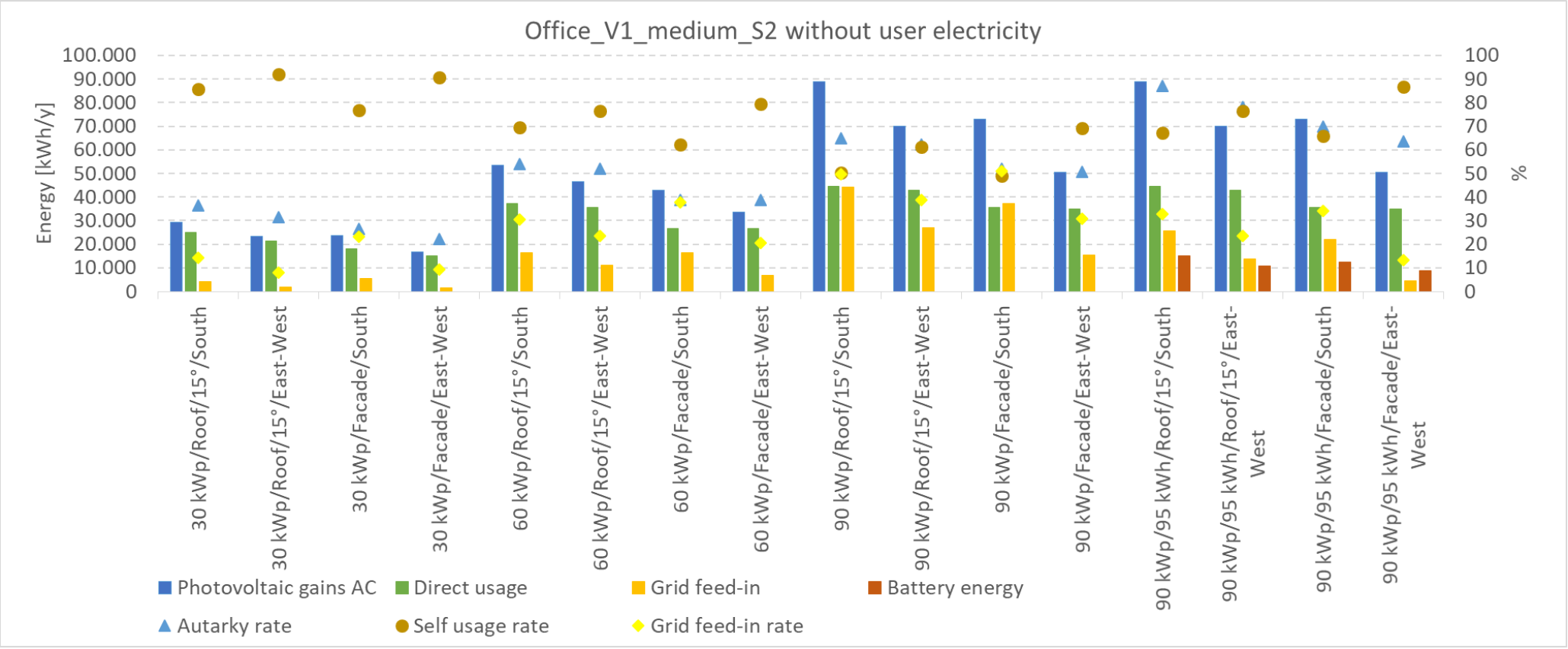
VITALITY – SELF CONSUMPTION STUDY

Results of standard office building with user electricity



VITALITY – SELF CONSUMPTION STUDY

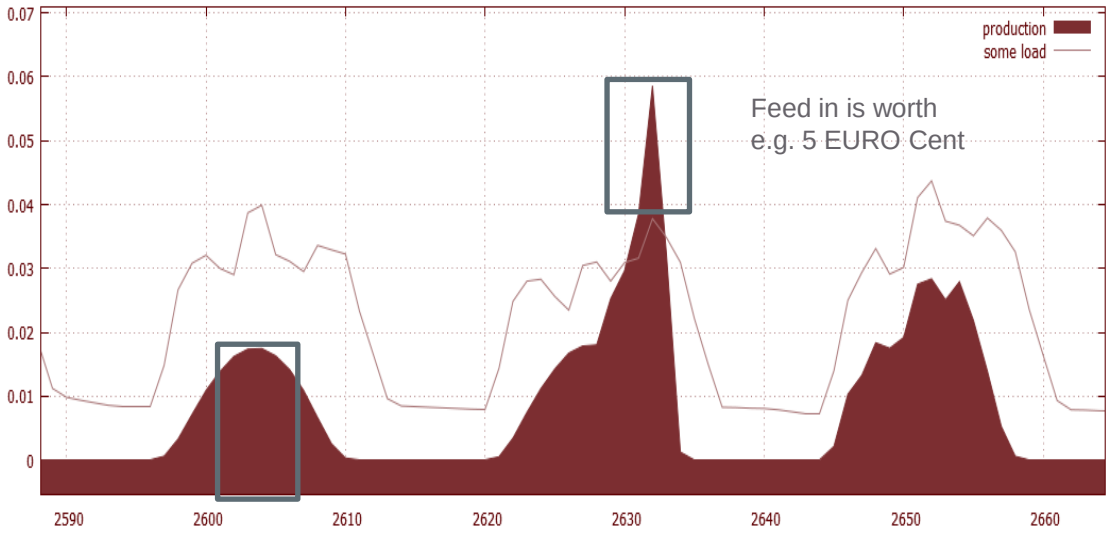
Results of standard office building without user electricity



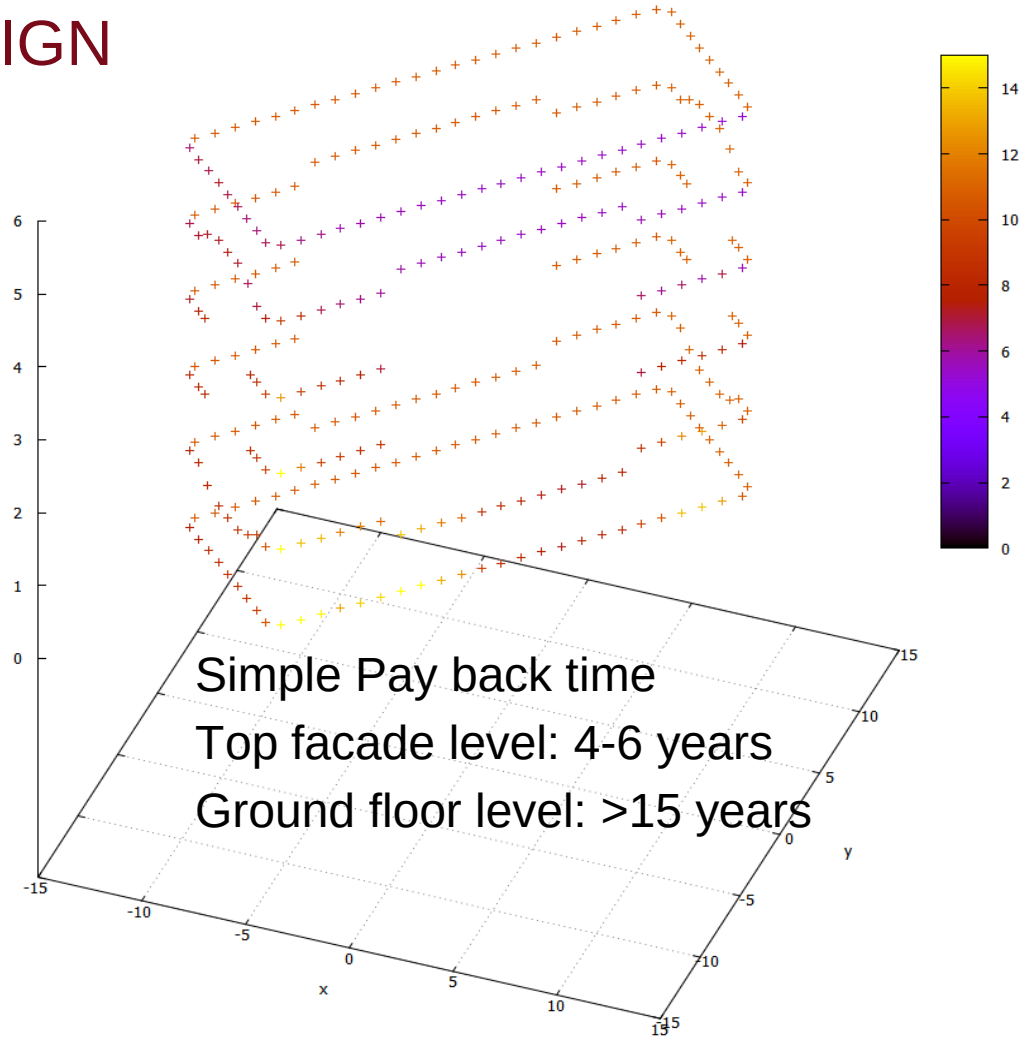
VITALITY OPTIMIZATION APPROACH TO IDENTIFY BEST ECONOMIC OF BIPV MODULE DESIGN

Approach

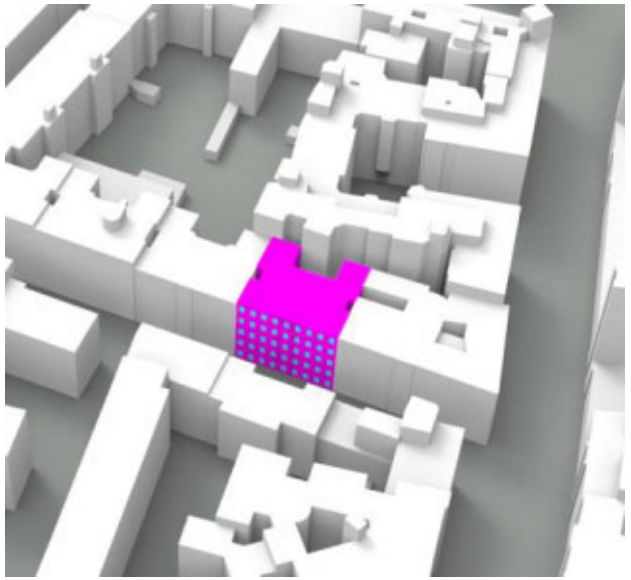
- Order of modules with the highest yield
- Load file is adapted
- Identification of the next module with best economics



Self consumption is worth e.g. 20 EURO Cent



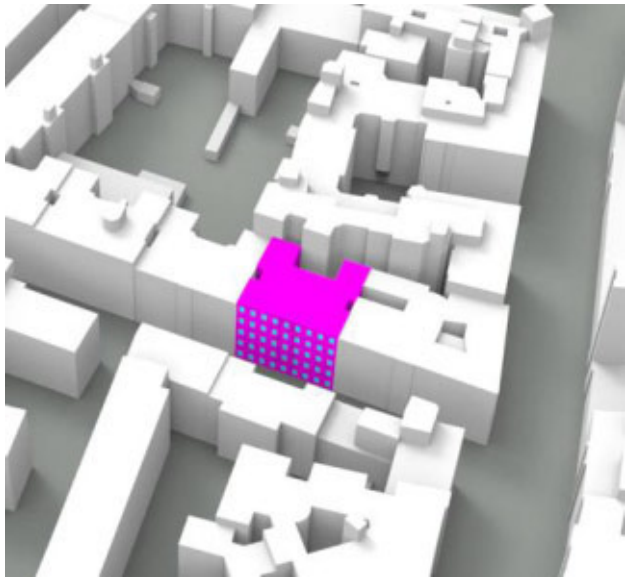
VITALITY DESIGN RULES FOR BIPV
TYPICAL 5 STOREY RESIDENTIAL BUILDING IN VIENNA



Key Findings

- 40/40/40 : In case of a multi-family house with 48 MWh electricity demand per year; a 40 kW_{peak} PV system (South / 30°) covers 40% of the overall electricity demand and 40% of the PV electricity production is directly consumed
- All investigated PV system designs lead to payback periods less than 10 year. The LCOE is in a range of 5.6 and 8.7 EUR Cent per kWh, where Austrian PV funding schemes are considered.
- The impact of the orientation of a 40 kWp rooftop PV system on the coverage of solar electricity is not significant, all orientation causes a coverage of almost 40%
- Design rule for e-Battery is identified for typical residential multi-family house in Vienna, Battery capacity [kWh] = 1,5 times PV capacity [kWp] achieves around 70%, higher battery capacities doesn't improve significantly the self-consumed PV electricity

VITALITY DESIGN RULES FOR BIPV
TYPICAL 5 STOREY RESIDENTIAL BUILDING IN VIENNA



OUTLOOK

- Development and completion of a comprehensive simulation environment with an optimizing algorithm for best BIPV placement on the building envelope
- Testing of the developed simulation environment by architect students from TU Graz
- Investigation by applying the simulation environment of typical USE CASES of typical urban buildings
- Extraction of DESIGN RULES based on both partner experience and results of the comprehensive investigation
- Final Vitality report will be available in Summer 2019