



# Simulation of Solar Cooling Systems

## Polysun

- Combination solar thermal + heat pump + PV
- Component database
- World-wide presence, multi-language
- 12'000 active licenses (3'000 in teaching)

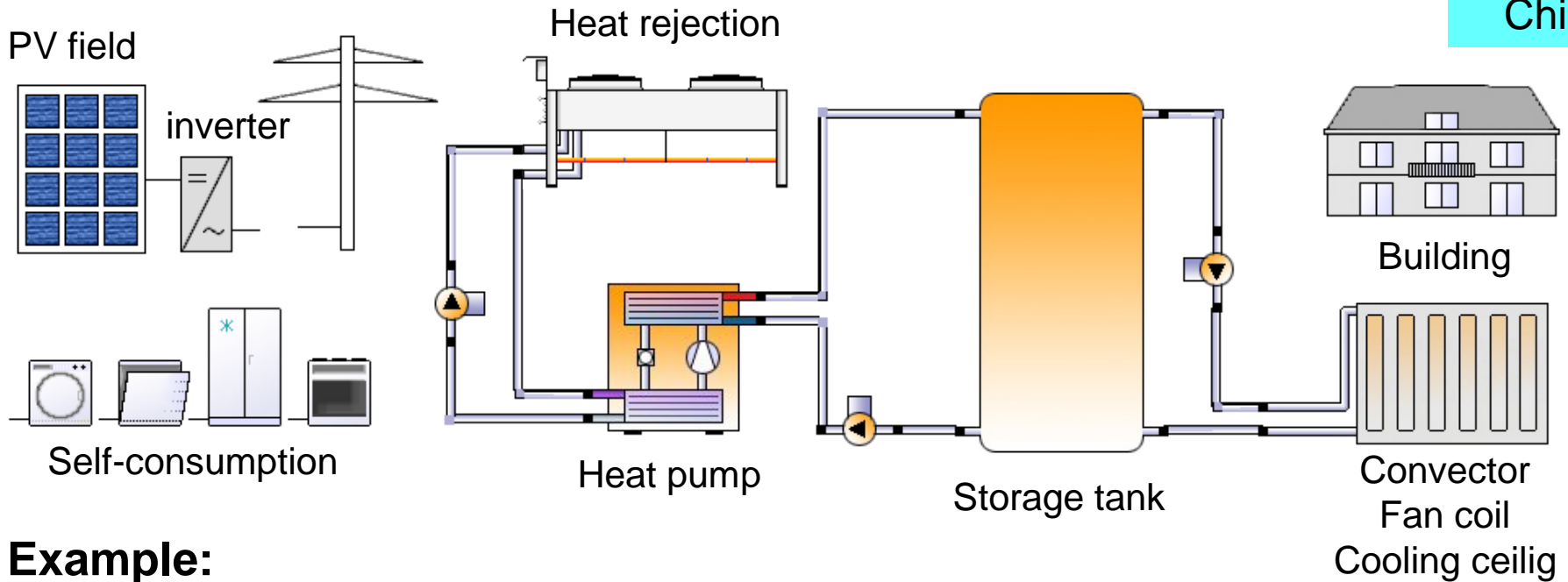
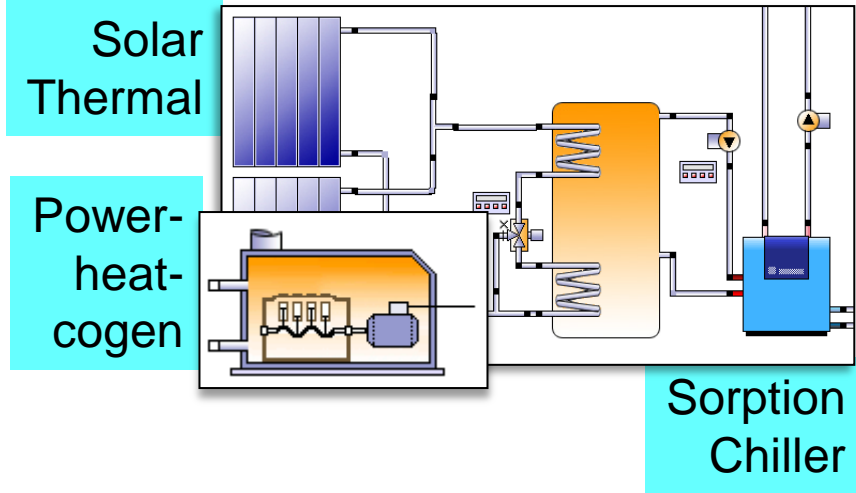


## Andreas Witzig

- Electrical Engineer, PhD in Optoelectronics at ETH Zurich
- Solar Institute SPF in Rapperswil (2001)
- Spin-Off Vela Solaris (2003)
- Institute for Computational Physics (2015)  
Zürcher Fachhochschule ZHAW



# Cooling and heating with PV & Compression Chiller



## Example:

- Building 9m × 11.2m, 3 floors, low energy building
- Cooling in summer ( $T_{sp}=21^{\circ}\text{C}$ ) and heating in winter ( $T_{sp}=26^{\circ}\text{C}$ )
- PV field assumed to cover the entire roof (82m<sup>2</sup>)

Polysun 8.0 - Simulation Software - DESIGNER

Project System diagram Results Catalogs Options ?



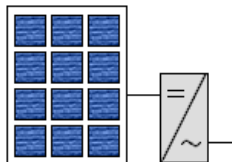
Project

- Project Project
  - Project overview
  - Location of the system
  - System diagrams
    - 50h: Photovoltaics with battery and...

Templates

- Favorites
  - 8a: Hot water (solar thermal)
  - 9a: Space heating (solar thermal)
  - 16a: Space heating (heat pump)
  - 22a: Space heating (heat pump)
  - 50a: Photovoltaics
- Standard templates
- Special
- Companies

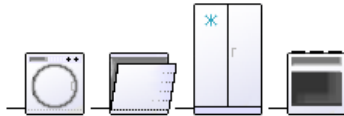
Project Project - System diagram 50h: Photovoltaics with battery and cha



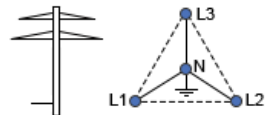
Photovoltaics: Photovoltaic module  
 Number of modules: 20  
 Total nominal power generator field: 3.6 kW  
 Orientation (E=+90°, S=0°, W=-90°): 0°  
 Tilt angle (hor.=0°, vert.=90°): 45°



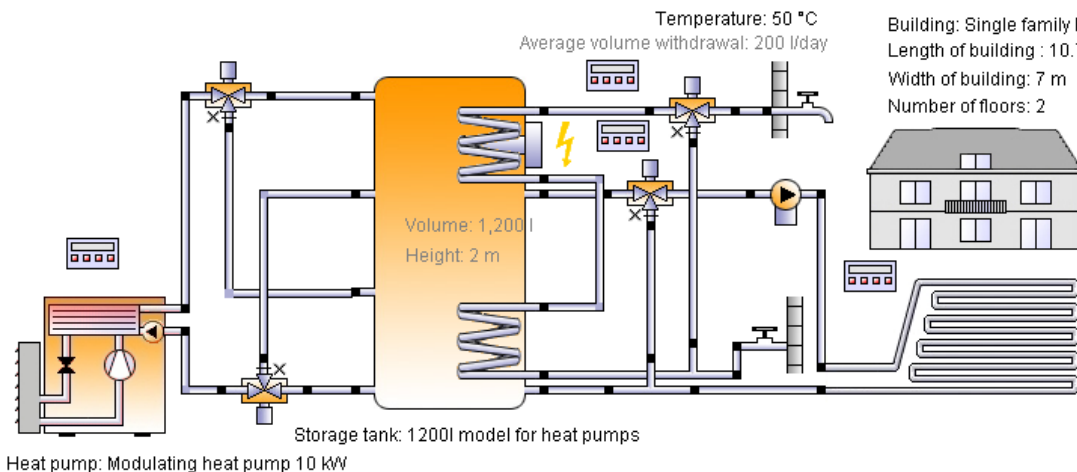
Battery: Hoppecke 24 OpzS 3000  
 Number of batteries: 1  
 Nominal capacity: 6 kWh  
 Total nominal capacity: 6 kWh



Number of electricity consumption profiles: 1  
 Consumption profile 1: Residential profile



External  
 Local grid  
 Feed-in

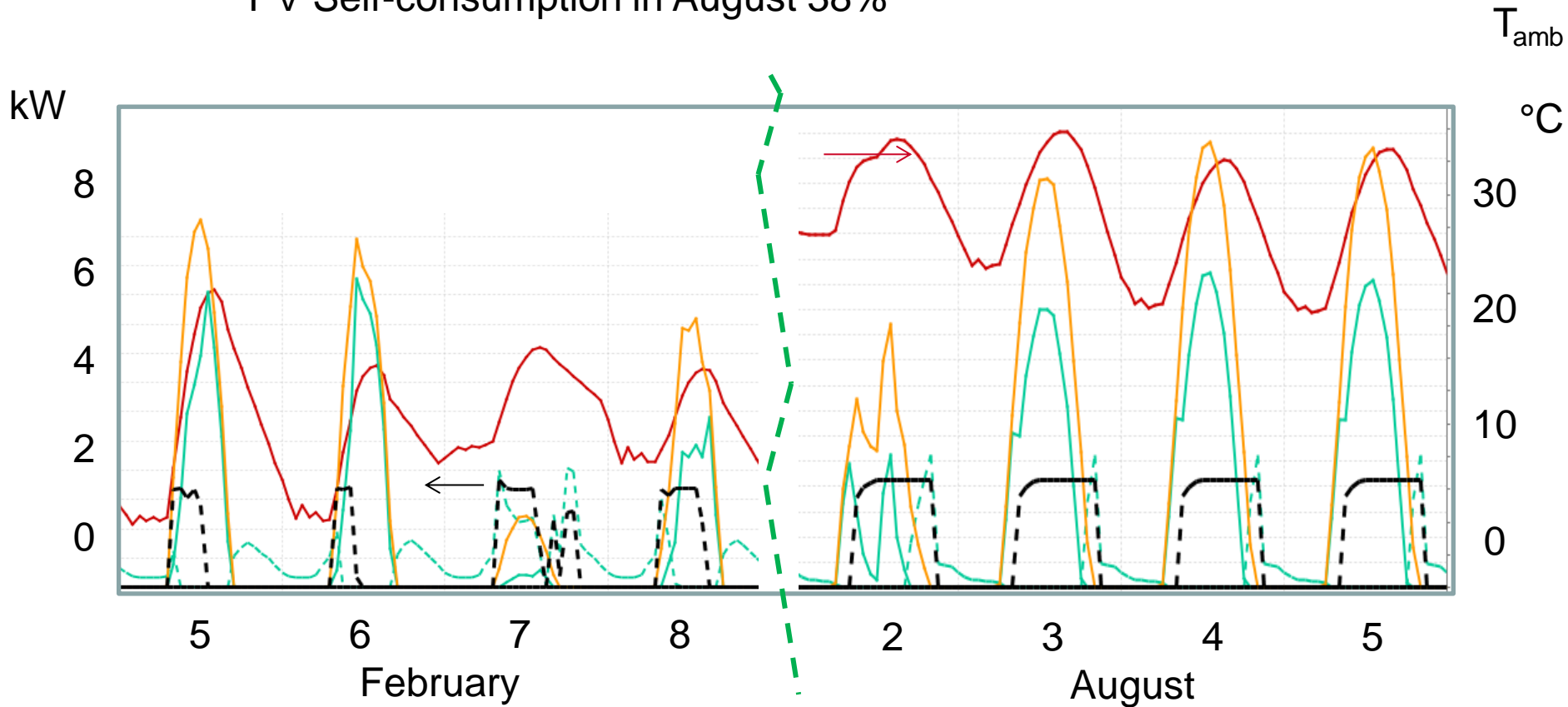


**Polysun PV Designer:**  
 Eigenverbrauch berechnen  
 mit Wärmepumpen,  
 PV-Moduldatenbank,  
 Wechselrichterzuordnung,  
 Batteriesysteme,  
 Eigenverbrauchsanalyse,

# Results for cooling in winter and summer

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PV Self-consumption in August 38%

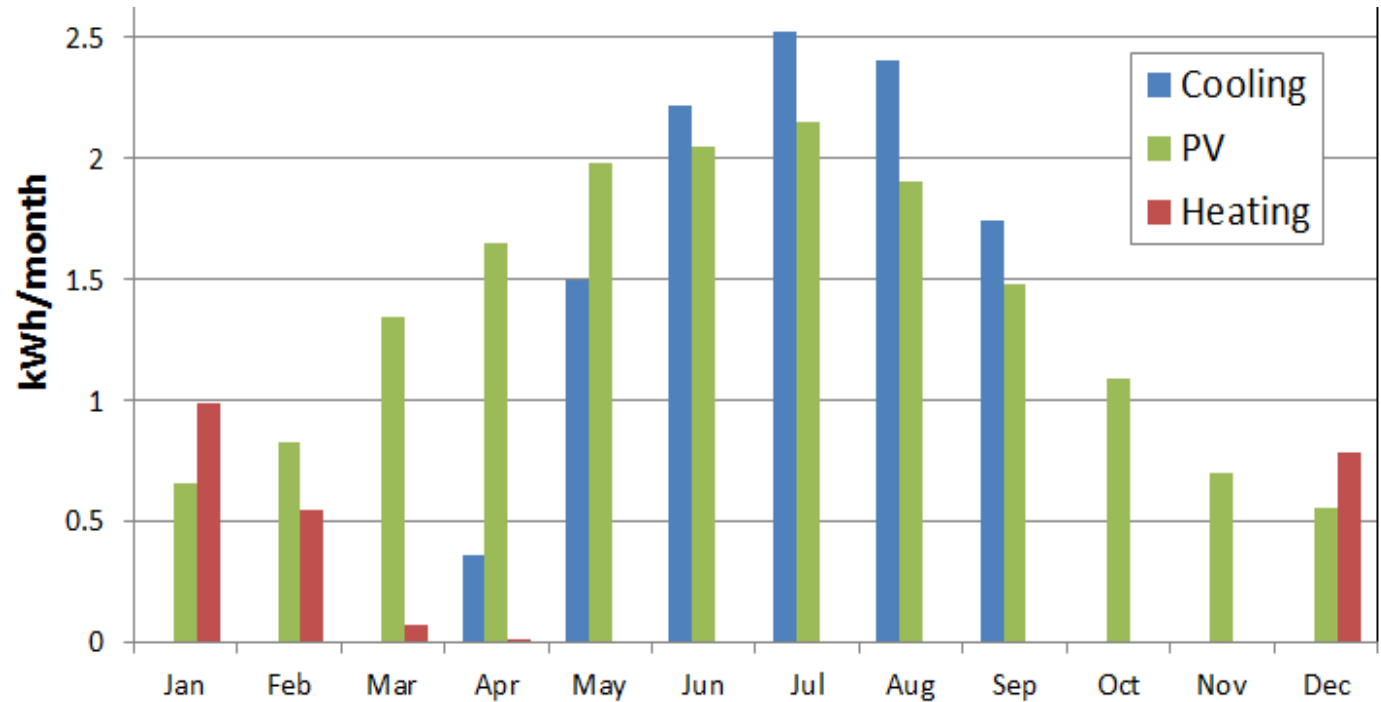
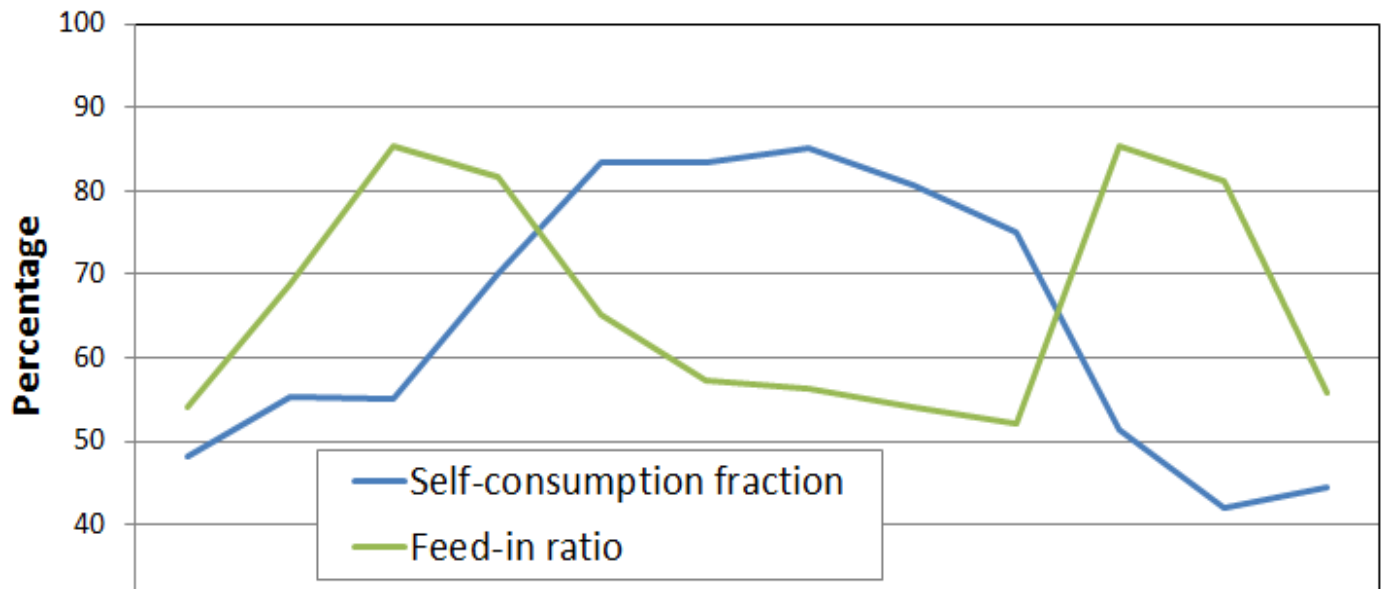


- Outside temperature
- Photovoltaic electric production
- Electric power to (solid) and from (dotted) grid
- Heatpump electric consumption



# Rooftop PV Installation 2° inclination

Location:  
Rome, Italy



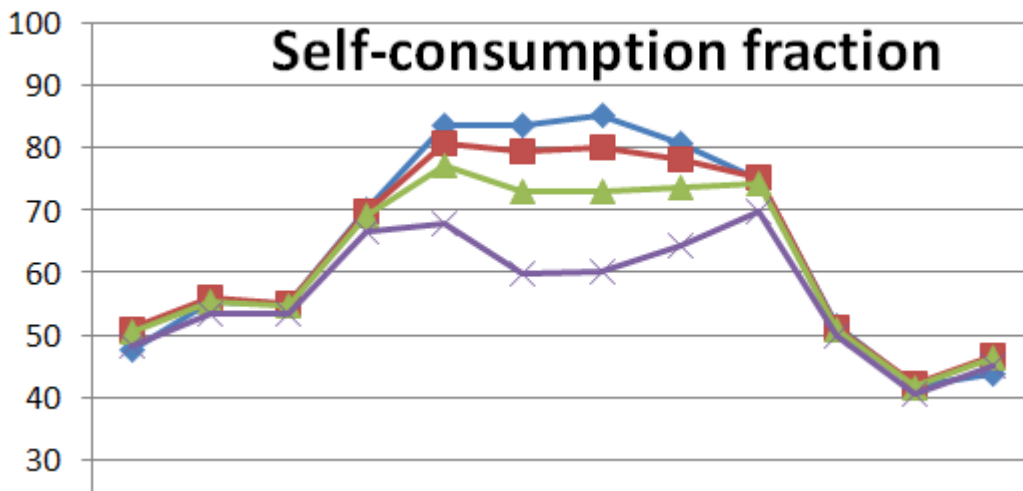




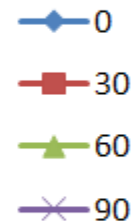
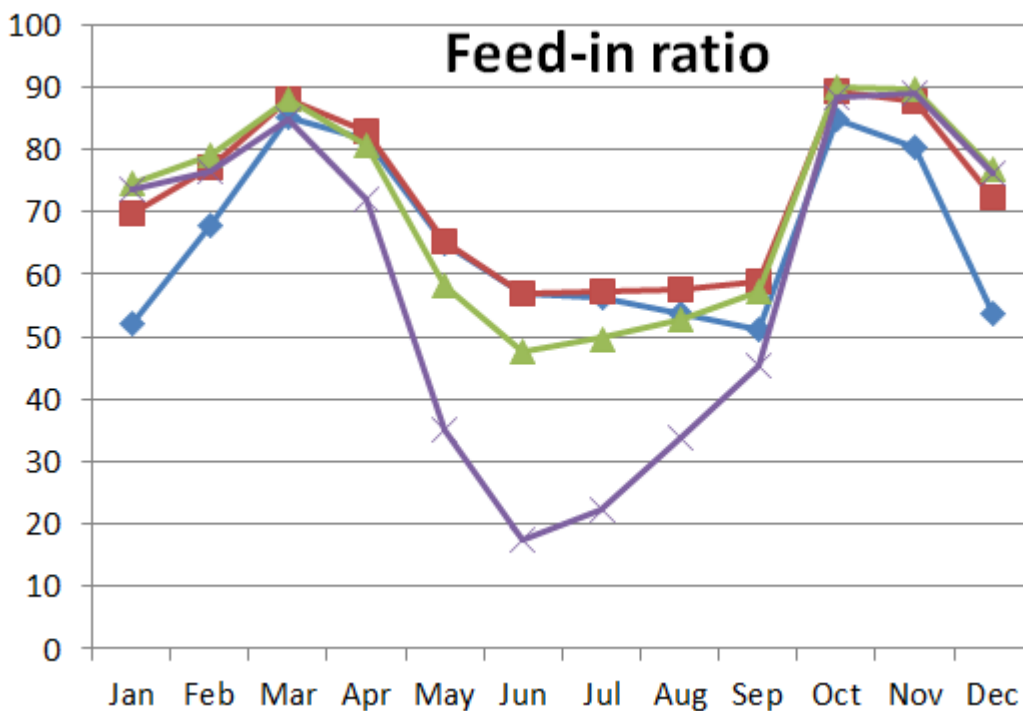
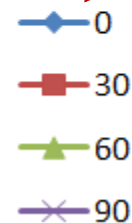


# Various tilt angles

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Paper presented at  
OTTI SAC in Rome



80m<sup>2</sup> PV,

Location:  
Rome, Italy









# Summary

- Grid-coupled PV: optimize self-consumption fraction and feed-in ratio.
- Use for cooling in summer and heating in winter
- Including batteries is readily available
- Facade challenge: solar radiation incident angle in summer
- Locations in Europe: propose to use  $\sim 60^\circ$  also in facades (which also can be used to provide shading in summer)



# Outlook: Polysun GUI also for facade

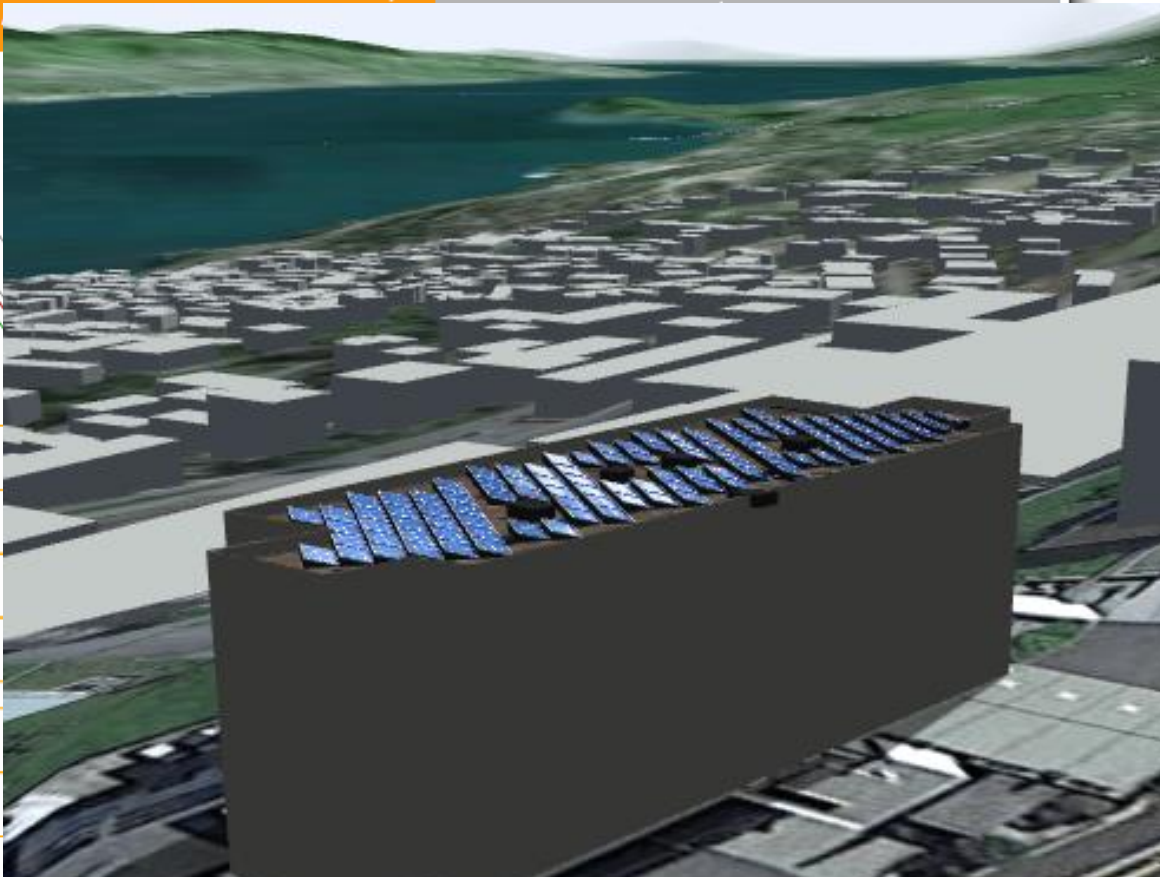
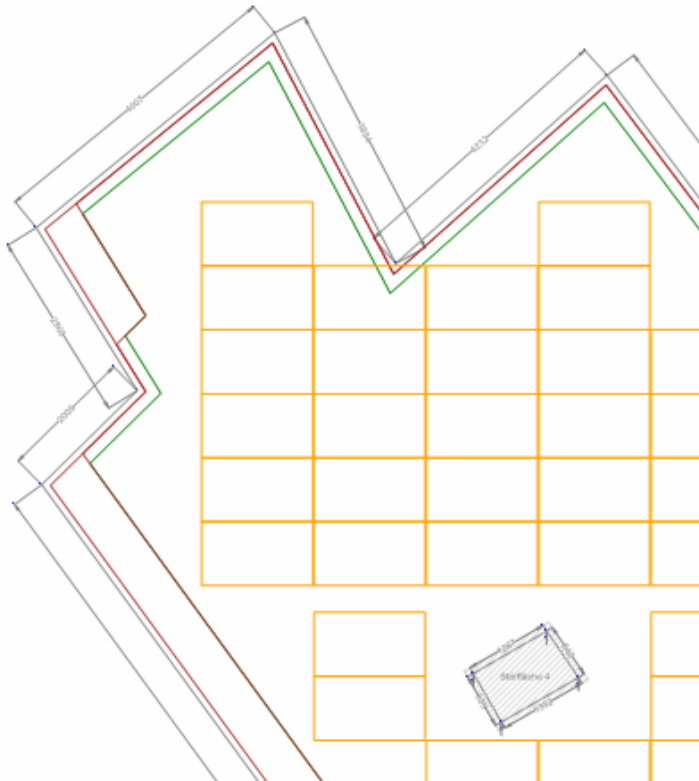
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polysun<sup>®</sup>  
PHOTOVOLTAIC SIMULATION

Home Projekt Dach PV-Module Konstruktion Anordnung **CAD-Plan** Polysun Elektrik Wirtschaftlichkeit



Aktuelles Projekt Tödistrasse Horgen  
Derzeitiger Bearbeiter: Andreas Witzig  
Leistung: 25.68 kWp (107 M)



**Polysun PV Constructor:** Dachplaner, Statikberechnung, PV-Moduldatenbank, Wechselrichterzuordnung, Batteriesysteme, Eigenverbrauchsanalyse,