eurac research



A simplified approach to HPs for the final user

National Workshop on
Heat Pumping Technologies

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17.11.2026, Pisa IT

Who we are

Eurac Research

Our research addresses the most demanding challenges of the future: promoting health, intact environments, clean energy, efficient political system and social systems.



Credits: Eurac Research/M. Spiluttini - Eurac Research headquarter in Bolzano

Institute for Renewable Energy

The Institute for Renewable Energy conducts applied research to accelerate the transition towards a low-carbon society.

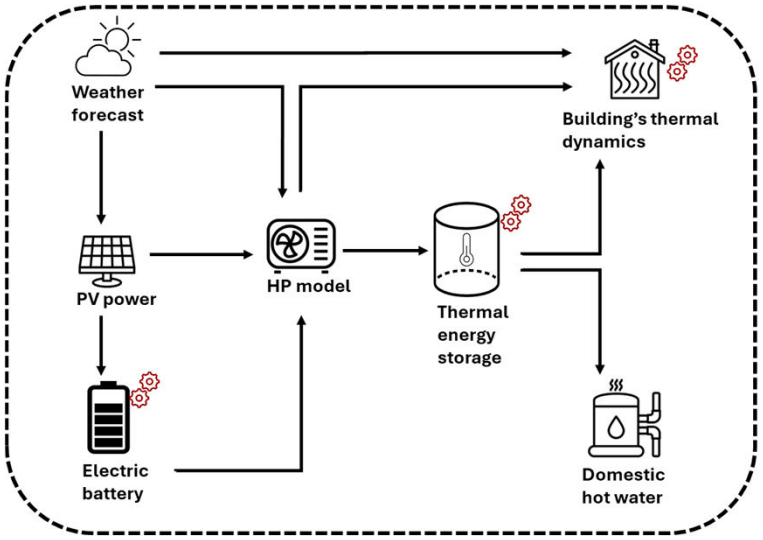


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Sustainable Heating and Cooling Systems Research group

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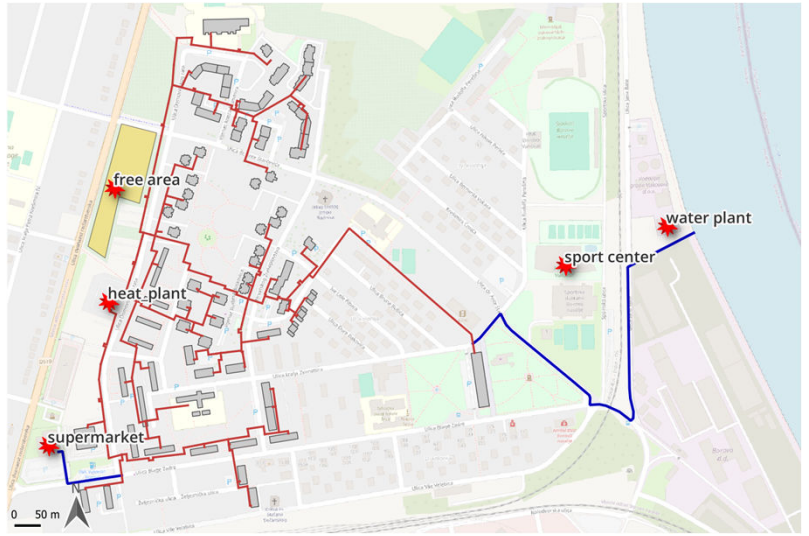
Advanced H&C controls



HVAC and HP development and testing



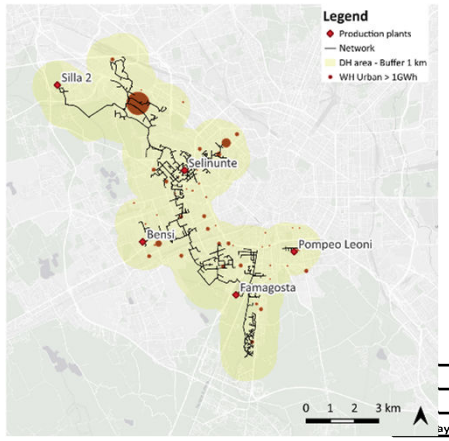
District Heating and Cooling



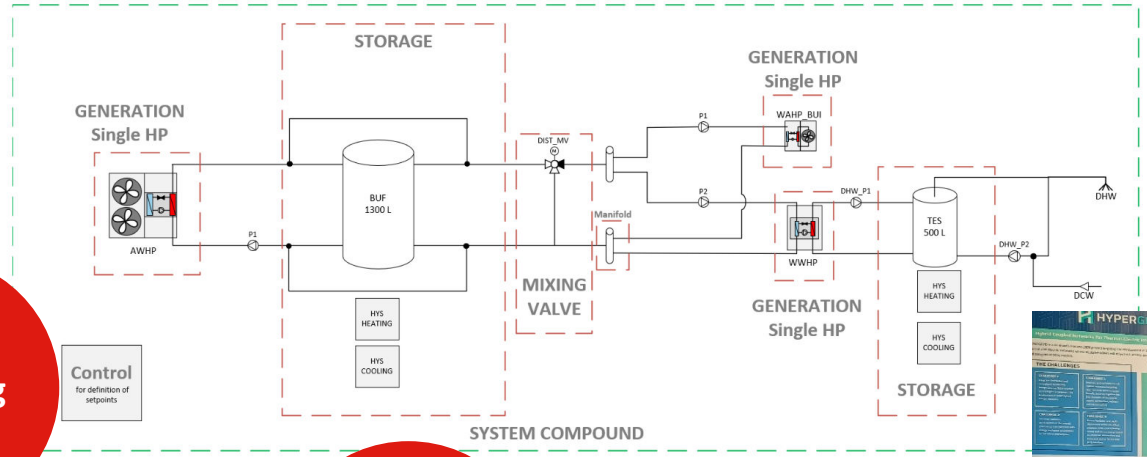
Teams and approaches: how

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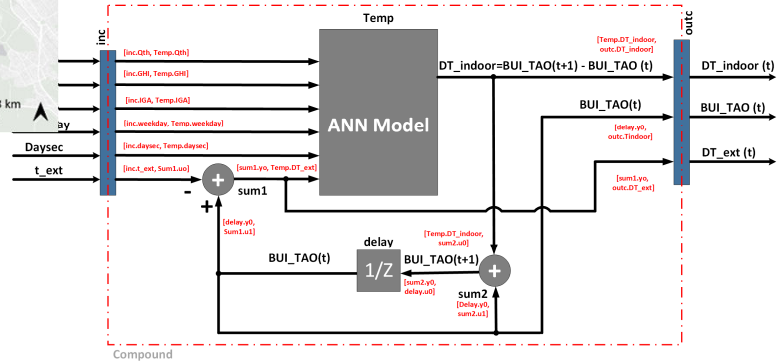
Mapping



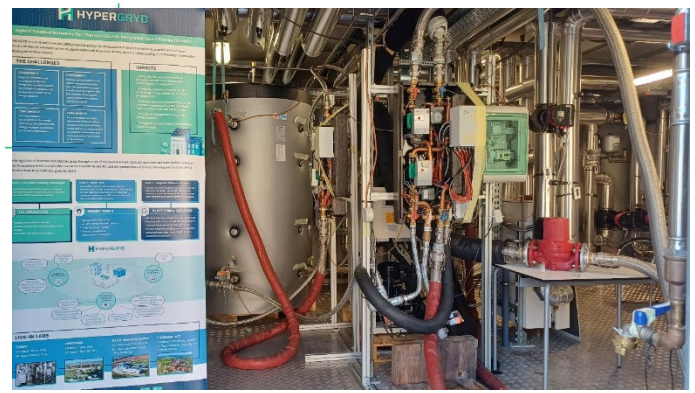
Modelling



Controlling



Optimizing



Testing

A simplified approach to HPs for the final user

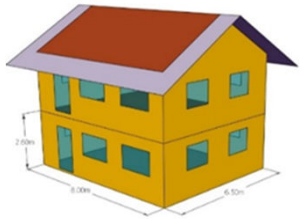
Tool - General information:

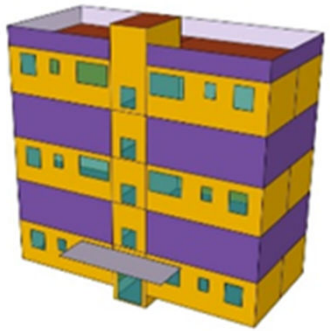
- The simulation tool is implemented in **Excel,** and it is based on **energy balances**
- It includes **predefined** climates, building archetypes and wall-constructions, space heating emission units and PV system sizes
- A **range of system configurations** can be simulated, accounting for integration with gas boilers and electric resistances
- Implement **economic evaluations**
- As final implementation the tool will be translated to a more user-friendly tool (e.g. web page)



Tool - thermal load profiles

- **Space heating** load profiles have been generated in **TRNSYS** according to **different stratigraphy** for the combination of the following cases**:**
  - Building type SFH and sMFH
  - Climates: Nordic, continental, Mediterranean
  - Four insulation levels (from new to existing)
- **Stochastic DHW load profiles** have been generated with **DHWcalc**



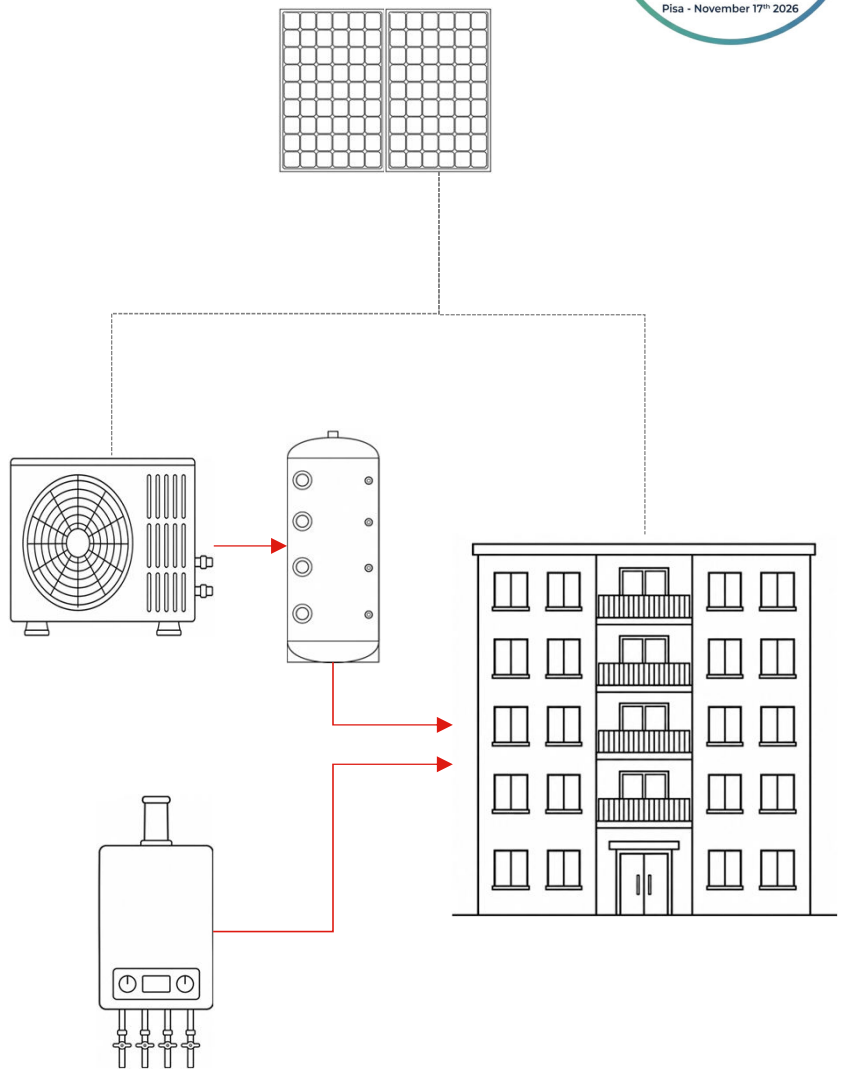


Selection of the load by:

- Typical case
- Final energy consumption and number of users.

Tool - system configuration:

- The tool considers **an air-to-water heat pump** solution, integrated to the storage tank
- The solution covers both **space heating and DHW** loads
- Possible to select different **storage charge strategies**
- The **gas boiler** or **electric heater** is a used as **back-up unit**
- Configurations for SFH and MFH:
  - Gas boiler
  - AW heat pump + optional electrical backup
  - Centralized GB + Centralized HP
  - (MFH) Centralized GB + Decentralized HP
  - PV and Thermal storage



Tool - Inputs

- General building inputs (location, orientation, net area, …)
- PV system description
- Thermal load inputs
- Set points
- Scenarios configurations
- Economic evaluation

Input parameters for economic and environmental evaluation		
Service life of the storage	15	years
Electrical energy cost	0.30	€/kWh$_{el}$
Natural gas cost	0.10	€/kWh
Natural gas primary energy factor total	1.05	-
Electricity primary energy factor total (from grid)	1.95	-
Electricity primary energy factor total (from PV)	1	-
Natural gas CO2 factor	0.205	kg/kWh
Electricity CO2 factor (from grid)	0.2	kg/kWh
Valorization of PV to grid	0.08	€/kWh$_{el}$
Purchase & installation cost of storage	3500	€
Purchase & installation cost of ducted HP	11500	€
Purchase & installation cost of central HP	0	€
Purchase & installation cost of gas boiler	0	€
Purchase & installation cost of PV	0	€
Purchase & installation cost of electrical resistance	0	€
Maintenance cost of storage	25	€/year
Maintenance cost of ducted HP	25	€/year
Maintenance cost of centralized HP	0	€/year
Maintenance cost of gas boiler	100	€/year
Maintenance cost of PV	100	€/year
Maintenance cost of electrical resistance	0	€/year
Incentives	65	[%]

Input parameters for energetic simulaiton			
Location	Bolzano	-	GENERAL BUILDING INPUTS
State	Italy	-	
Latitude	46°29'53.21"N	-	
Longitude	11°21'17.21"E	-	
Orientation of the building	0	°	
Name of building	Test 1	-	
Number of persons	3	-	
Building net area	150	m^2	
Peak PV production per dwelling	6	kW	PV SYSTEM INPUTS
Slope of PV panels	30	°	
Orientation of PV panels	0	°	
Target space heating demand (per dwelling)		kWh	THERMAL LOADS INPUTS
Target space cooling demand (per dwelling)		kWh	
Target domestic hot water demand (per dwelling)		kWh	
Start of heating season (Month)	October	-	
Start of heating season (Day)	15	-	
End of heating season (Month)	April	-	
End of heating season (Day)	15	-	
Design thermal power (SH)	6.5	kW	
Design temperature (SH)	-10	°C	
Temperature to switch off heating system	16	°C	
Design thermal power (SC)	5	kW	
Design temperature (SC)	35	°C	
Temperature to switch off cooling system	25	°C	
Supply temperature (storage heating)	52	°C	SETPOINT TEMPERATURES
Supply temperature (SH)	45	°C	
Supply temperature (DHW)	45	°C	
Supply temperature (storage cooling)	7	°C	
Supply temperature (SC)	12	°C	
Load considered for storage balance in heating mode	SH&DHW	-	SETTINGS OF THE DIFFERENT SCENARIOS
Thermal capacity of Storage heating	16.0	kWh	
Thermal capacity of Storage cooling	8.0	kWh	
HP thermal capacity (per dwelling)	10.0	kW	
Storage maximum discharge power (per dwelling)	20.0	kW	
Presence of gas boiler	YES	-	
Gas boiler efficiency	1.0	-	
Presence of electrical resistance	NO	-	
Electrical resistance maximum power (per dwelling)	5.0	kW	
HP maximum electrical consumption (per dwelling)	2.5	kW	
Enable added HP to use electricity from grid	YES	-	

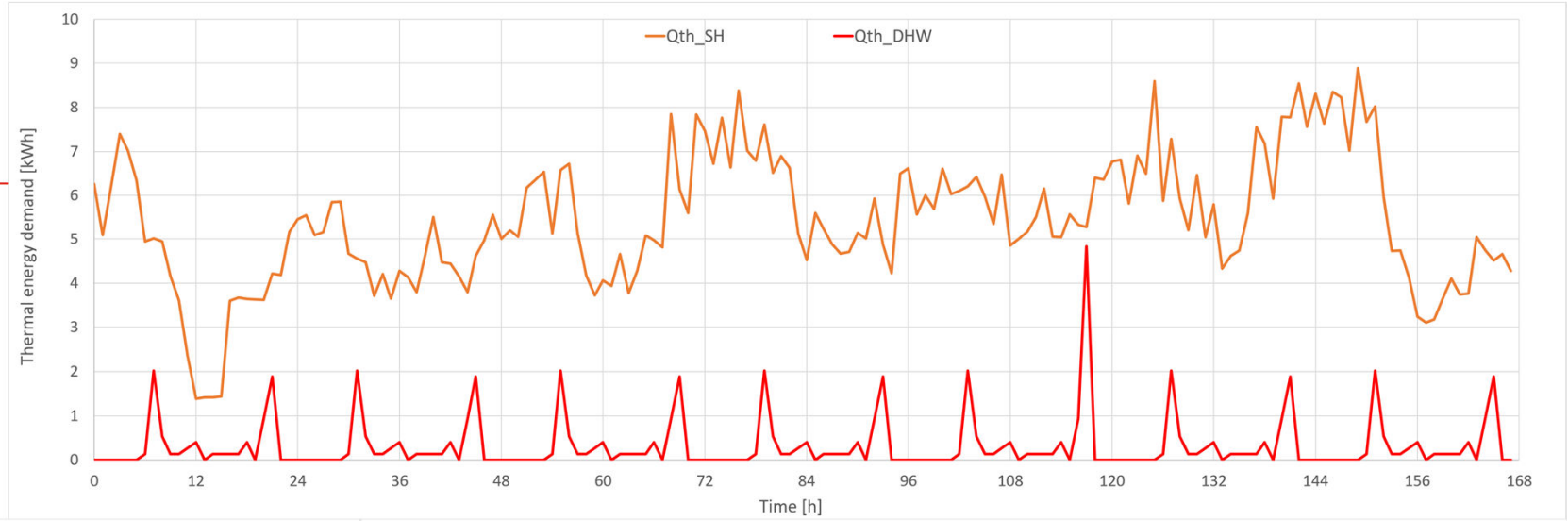
Tool - Outputs

Example: SFH, Stuttgart, PV 6kWp, HP limited to 2.5 kWel, 10-16 January

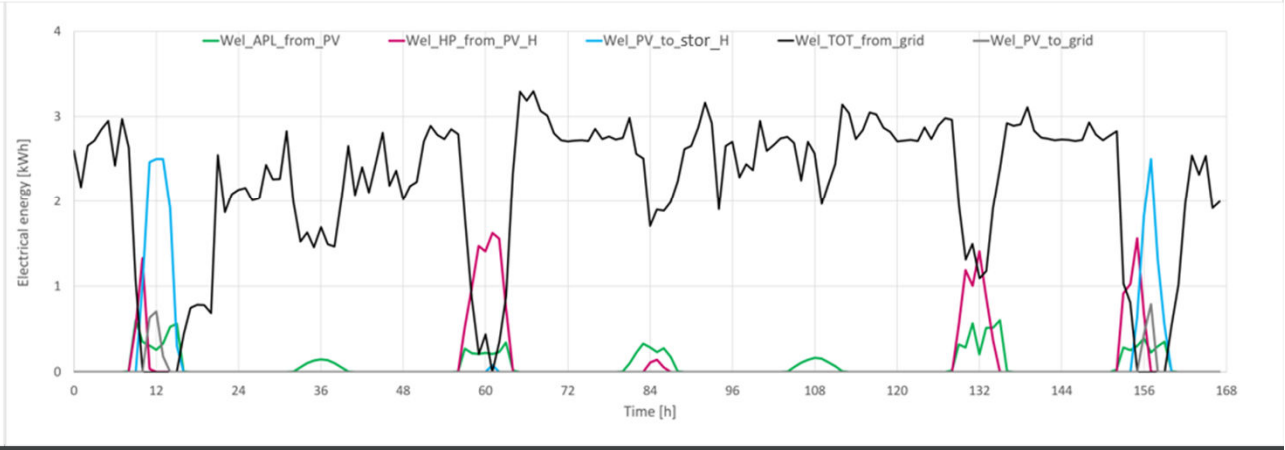
Hourly and daily balances

PV priority:

1. Appliances
2. HP
3. Storage
4. Grid





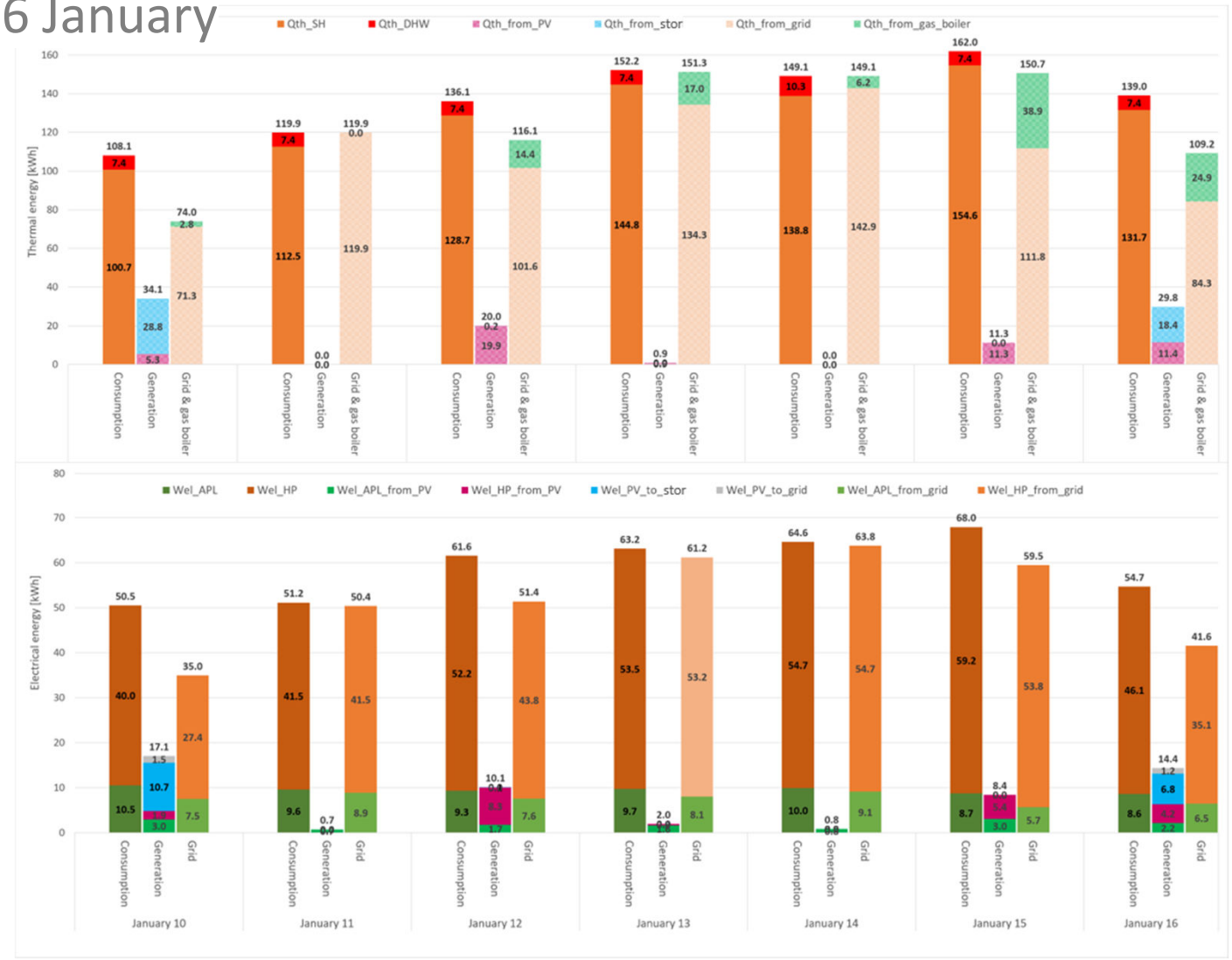


Tool - Outputs

Example: SFH, Stuttgart, PV 6kWp, 10-16 January

Hourly and daily balances:

- Thermal energy consumption
  - Distinguished in SH and DHW
  - Distinguished between generation
- Electrical energy
  - Consumption share
  - Generation PV and grid share

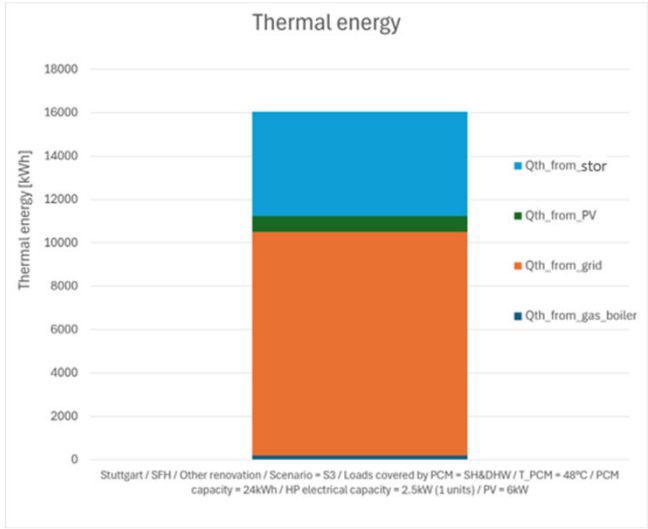


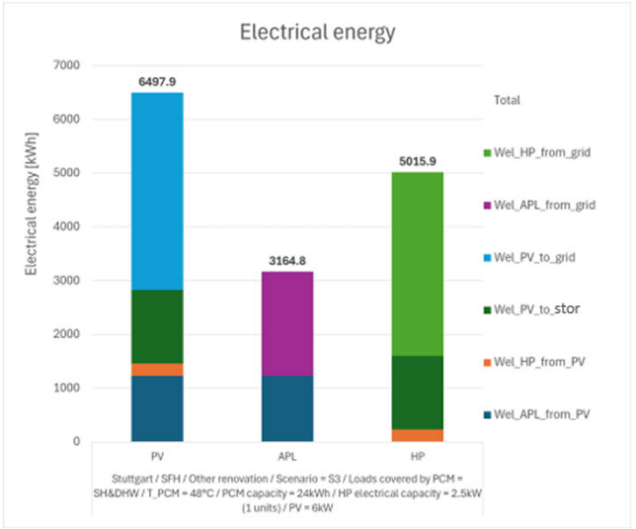
Tool - Outputs

Example: SFH, Stuttgart, PV 6kWp, 10-16 January

Annual KPIs:

- Thermal and electrical energy
- Self sufficiency and self consumption KPIs.
- Economic KPIs





Parametric analysis:

	Stuttgart		Rome	
PV capacity	*HP Thermal Self-Sufficiency*	*HP Electric Self-Consumption*	*HP Thermal Self-Sufficiency*	*HP Electric Self-Consumption*
3,5 kWp	27%	32%	56%	31%
6,0 kWp	32%	25%	63%	21%
10 kWp	38%	17%	68%	13%

Conclusions

- The tool implement a simplified calculation based on simulated profiles for different typical cases.
- The tool allows to allows to easily size the HP system to **cover the building thermal loads**, dramatically **decreasing the gas consumption**
- The tool allows to easily perform a parametric analysis in order to optimize the **PV electricity self-consumption**, eventually allowing to reduce or avoiding installation of electric batteries capacity
- Further work could consider
  - Inclusion of advanced control
  - Declination of the tool to Italian climates
  - Translation to a web-based tool

Thank you

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