Gestione ottimizzata di sistemi poligenerativi integrati con fonti rinnovabili, sistemi di accumulo e produzione di acqua atmosferica

Progetto PRIN 2022YSR9LM - Water-collection and Improvement of Sustainability in the HVAC
Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

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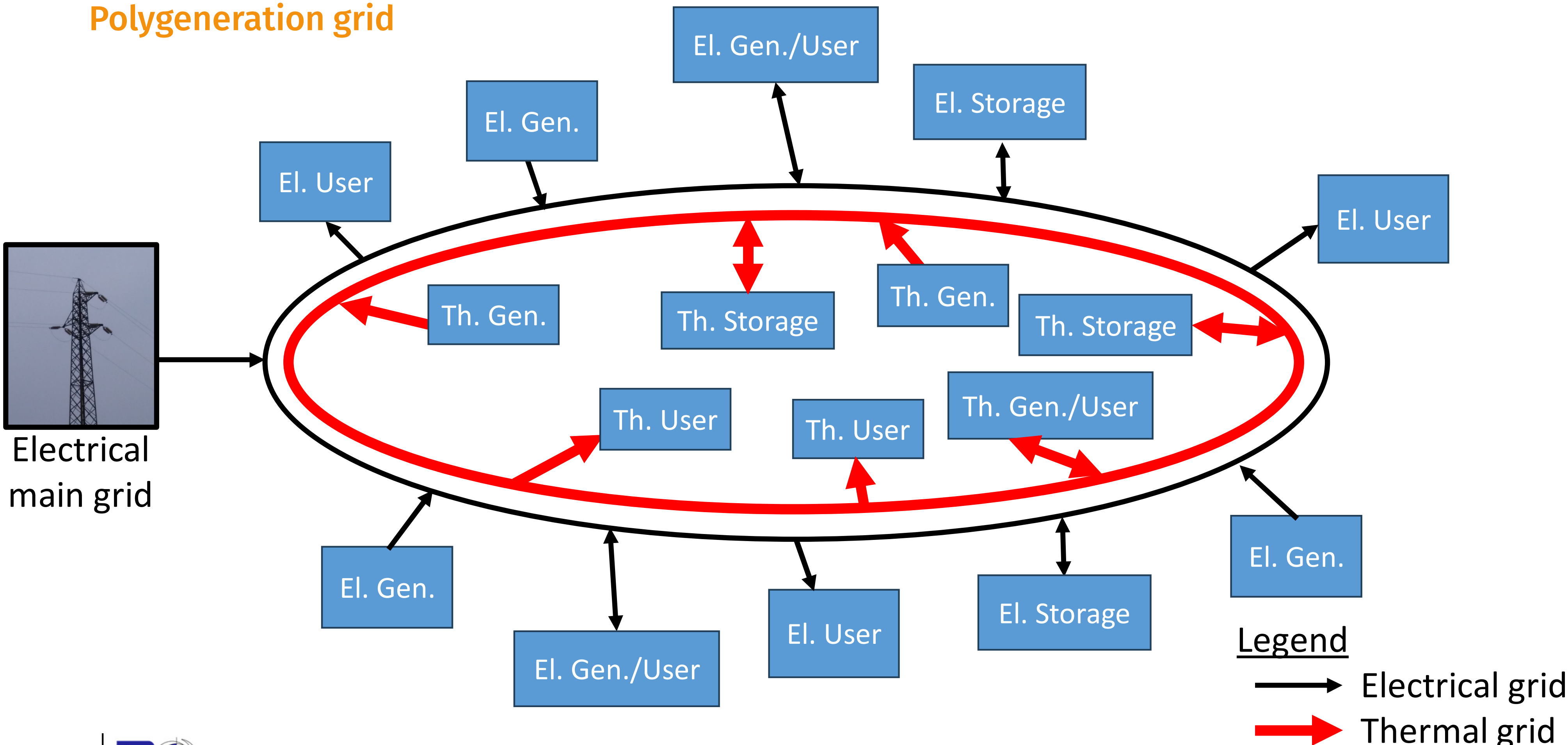
Motivation

Polygeneration grid



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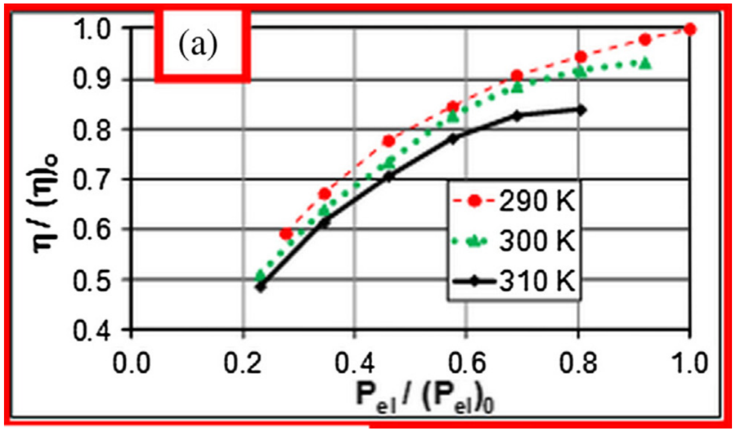
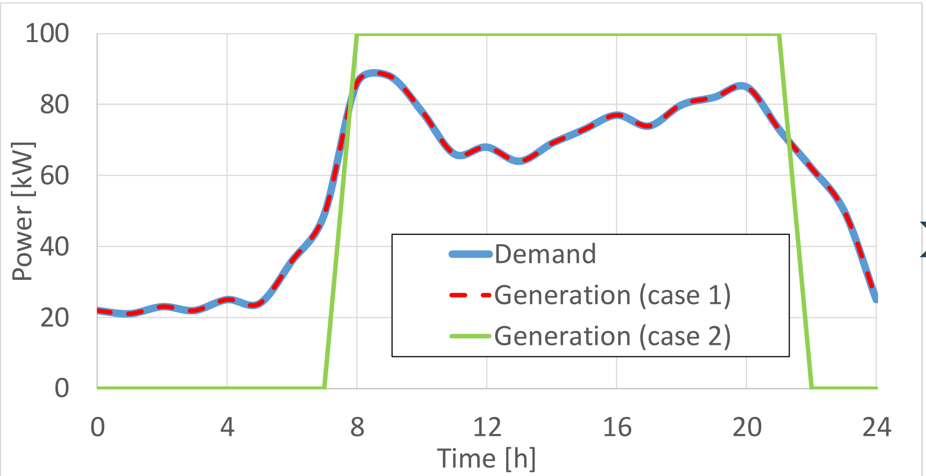
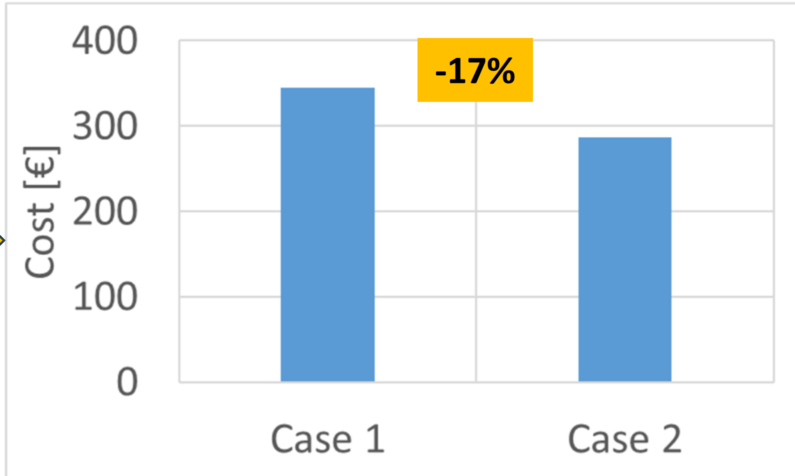
Motivation

Example with the T100 mGT (100 kW_{el})

NG cost: 0.5 €/sm³
24-h analysis







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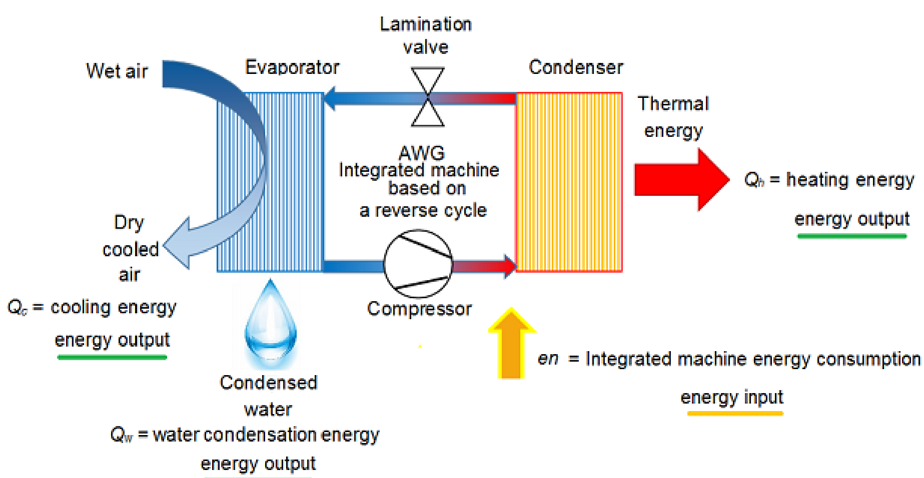
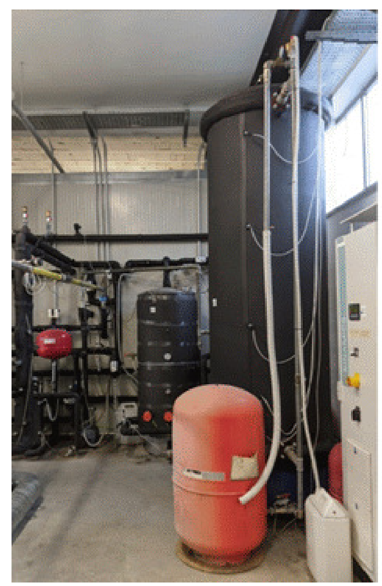
The WISHeR project

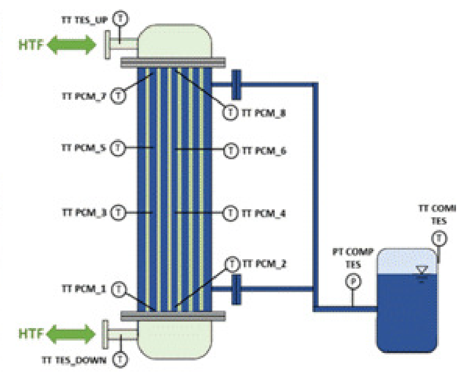
Basic aspects

<u>Project</u>

- PRIN2022: n. 2022YSR9LM
- Title: Water-collection and Improvement of Sustainability in the HVAC Retrofitting
- Duration: n.2 years
- Partners: UNIPV (Coordinator), UNIGE
- Objectives: definition of case studies, development of integration with HVAC systems, optimization, integration in smart grids with storage systems, integration with PCM systems, laboratory tests







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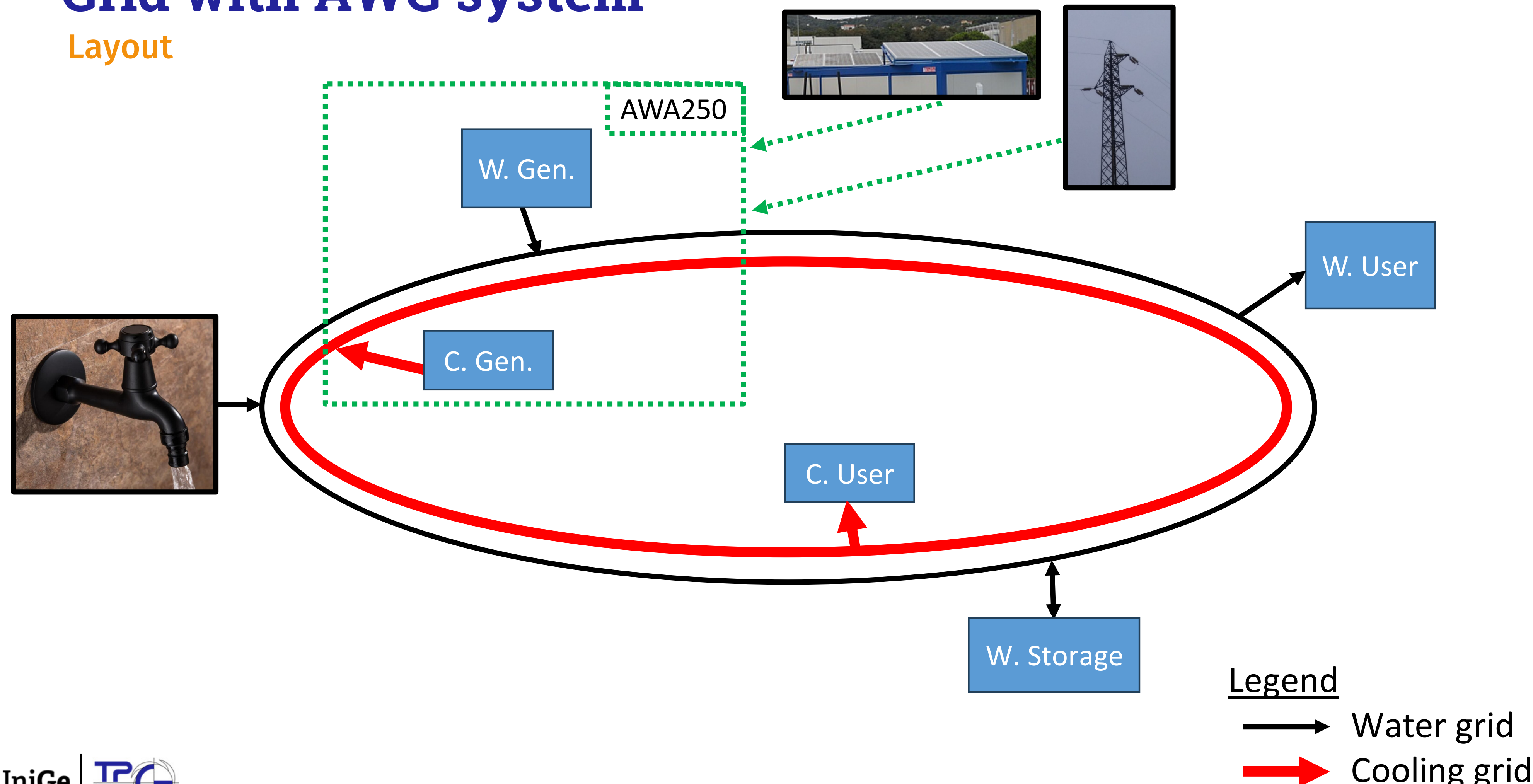
Grid with AWG system

Layout



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Grid with AWG system

AWA250

Nominal conditions

- Atmospheric conditions: 30°C e 70% relative humidity
- Water production: 2500 l/day
- Electrical consumption: 30 kW
- Air flow: 8000 m³/h
- Cooling fluid: R134a

AWA MODULA 250 SYSTEM SPECIFICATIONS

Nominal water production of 2,500 liters per day.

Economic effectiveness demonstrated in previous studies

- Example in Dubai (EAU) - https://seas-sa.com/wp-content/uploads/2019/09/AWA-250-Case-Study.pdf

description	Measure unit	results	AED/day	
Electrical energy saving	kWh/day	2640	1161.6	
LPG saving	litre/day	154	293	
Water saving	litre/day	1646	823	
AWA costs				
Electrical consumption	kWh/day	800	352	
Consumables and maintenance			139.3	
Final result				
Net daily saving			1,785.88	
Net yearly saving			651,846	

7. PAY BACK TIME EVALUATION

On the basis of the previous described results, it was possible to calculate the PBT of the machine, taking into account the following prices:

Description	Costs AED
AWA 250 HWAC machine	1,180,480
Installation	57,500
Total cost	1,237,980

Thus the PBT is less than 2 years (about 1 year and 11 months)

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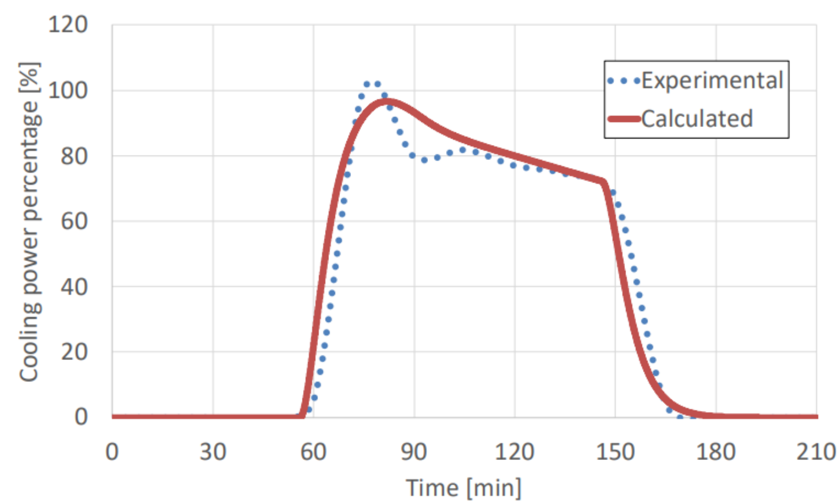
Component models

AWA250

- Interpolations of performance maps (steady-state part)
- First order delay blocks (transient behaviour)
- Experimental validation with a laboratory heat pump



PV panels

- Power production from previous laboratory measurements
- Generation in the 9-16 hours
- PV system size: 1.1 kWp
- Maximum generation: 650 W

Water storage tank

- Integrator: SoC calculation from inlet/outlet mass balance
- Size: 2000 l

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Energy Management System

Optimization problem

- Cost minimization
- Two decision variables
- Constrained optimization tool

$$J_{cost} = c_W \cdot m_{W_{grid}} + (c_{O\&M} + c_{el}) \cdot P_{el_{AWA250}} - c_{cool} \cdot P_{cool_{AWA250}}$$

$$P_{el_{AWA250}} = f\left(m_{W_{AWA250}}, WET_{AWA250}, RH_{amb}, T_{amb}\right)$$

$$P_{cool_{AWA250}} = f\left(m_{W_{AWA250}}, WET_{AWA250}, RH_{amb}, T_{amb}\right)$$

PV panels

- Considered for recalculation of electricity cost

Parameter	Minimum value	Maximum value	Unit
Water from the grid	0.00	0.03	kg/s
Water from the AWA250	0.0	0.06	kg/s
Water from the storage tank	-0.02	0.02	kg/s

Water storage tank

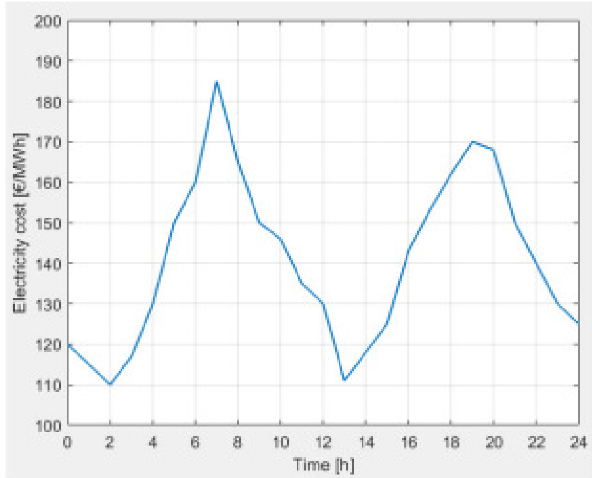
- Charging: electricity cost lower than the daily average and AWG active
- Discharging: electricity cost higher than the daily average
- Max SoC: 90%
- Min SoC: 10%

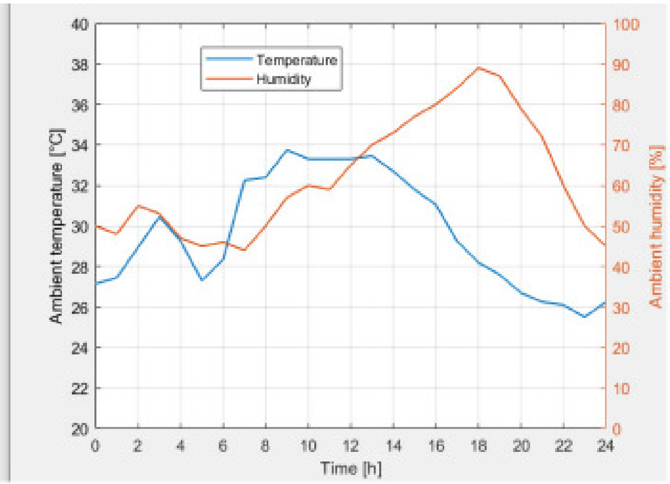
Results

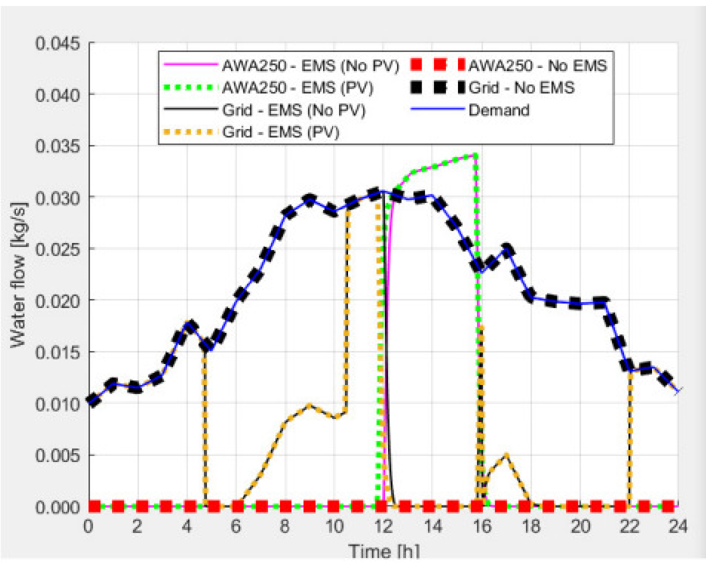
Real-time performance

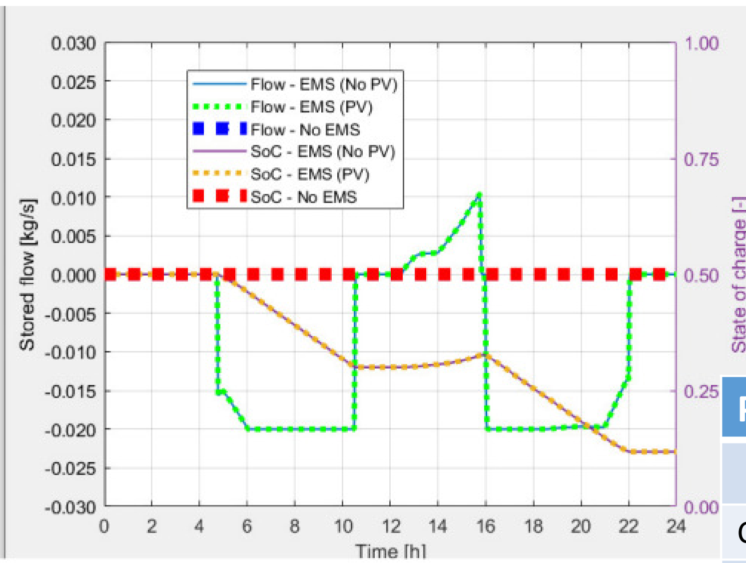
Costs:

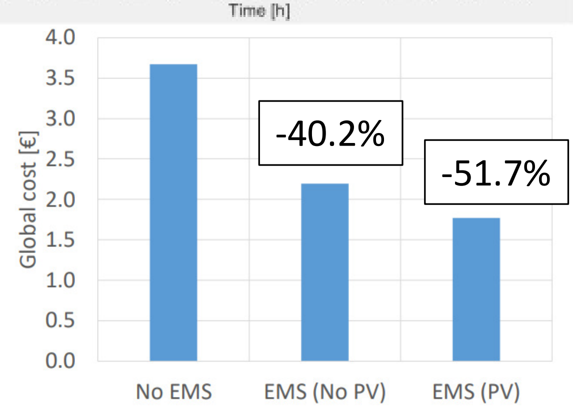
- Water (rete): 2.0 €/m^3
- Cooling energy: 45 €/MWh
- O&M: 10 €/MWh











Parametric analysis

	-10%	-5%	+5%	+10%
C. en. cost [%]	-17.4	-31.8	-82.0	-126.4
O&M cost [%]	-62.6	-57.3	-47.3	-42.3
PV gen. [%]	-50.5	-51.1	-52.3	-52.9

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Conclusions

- Importance of the EMS technology in smart grids.
- The WISHeR (PRIN2022).
- Development and validation of the component models (mainly the AWG).
- EMS development for variable cost minimization.
- Results for a 24-h simulation (EMS vs No EMS): -40.2% without the PVs.
- Results for a 24-h simulation (EMS vs No EMS): -51.7% with the PVs.

Future activities: integration with other components (e.g., storage based on PMCs), laboratory tests in cyber-physical mode.

Acknowledgements

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