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Integrids

eurac research

INTEGRIDS project

Integrated electric and thermal grids with energy flexible buildings

David Moser
Eurac Research – Institute for Renewable Energy

Final event project INTEGRIDS, Edifici energeticamente flessibili e reti energetiche integrate
Bozen, 9th July, 2020

Agenda

9.00 - 9.20	Apertura e introduzione: risultati del progetto INTEGRIDS	David Moser, EURAC
9.20 - 9.45	Comunità energetiche rinnovabili e smart contracts	Mario Tucci, ENEA
9.45 - 10.10	La flessibilità energetica, dalla definizione alla valutazione: l'esperienza nell'ambito del IEA EBC Annex 67 – Energy Flexible Buildings	Ilaria Vigna, Politecnico di Torino
10.10 - 10.30	La metodologia di calcolo dello Smart Readiness Indicator: il caso studio del NOI Tech Park	Roberta Pernetti, EURAC
10.30 - 11.00	Discussione e tavola rotonda (Stefano Nassuato- REGALGRID, Domenico Cimmino- EVOLVERE, Luigi Lanuzza- ENEL-X)	

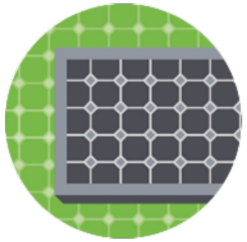
Project overview

- ERDF Funding

- Duration of the project
  (January 2017 – July 2020)

- Budget ~ Il budget complessivo del progetto INTEGRIDS è di 843.375 euro. Il contributo provinciale ammonta a 126.506,25 euro, quello nazionale a 295.181,25 euro, il contributo europeo (fondi UE FESR) a 421.687,50 euro.

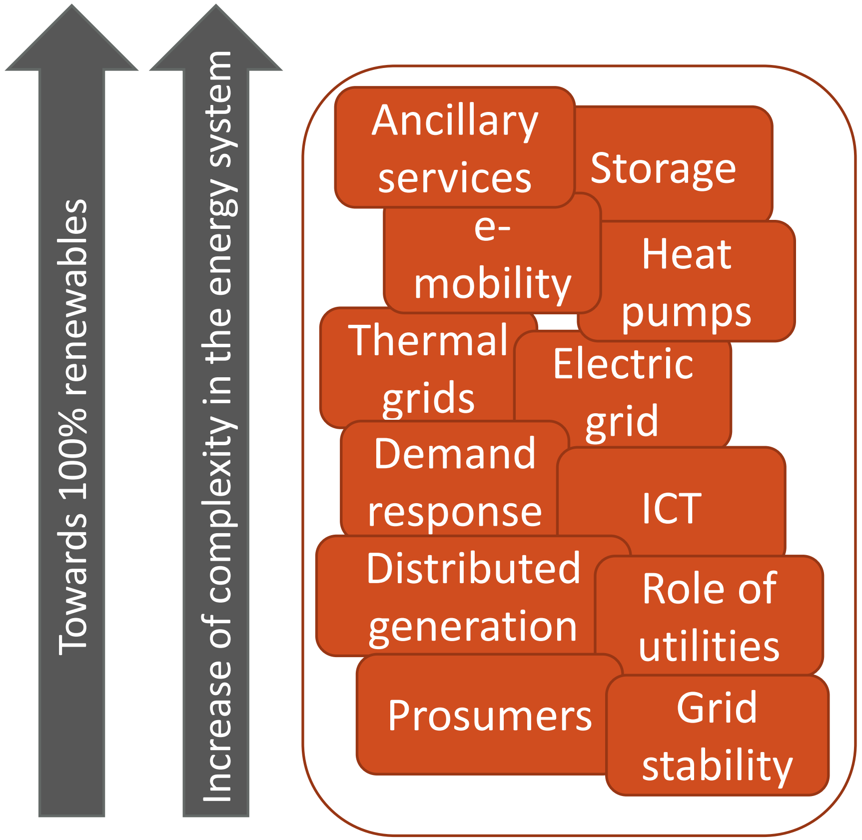
Sustainable
Heating & Cooling Systems



Photovoltaic
Energy Systems

Energy Efficient
Buildings

Context



INTEGRIDS will explore the concept of integrated energy grids defined as the synergy between thermal and electrical networks to enable high renewable energy penetration in efficient buildings and district.

Energy Communities

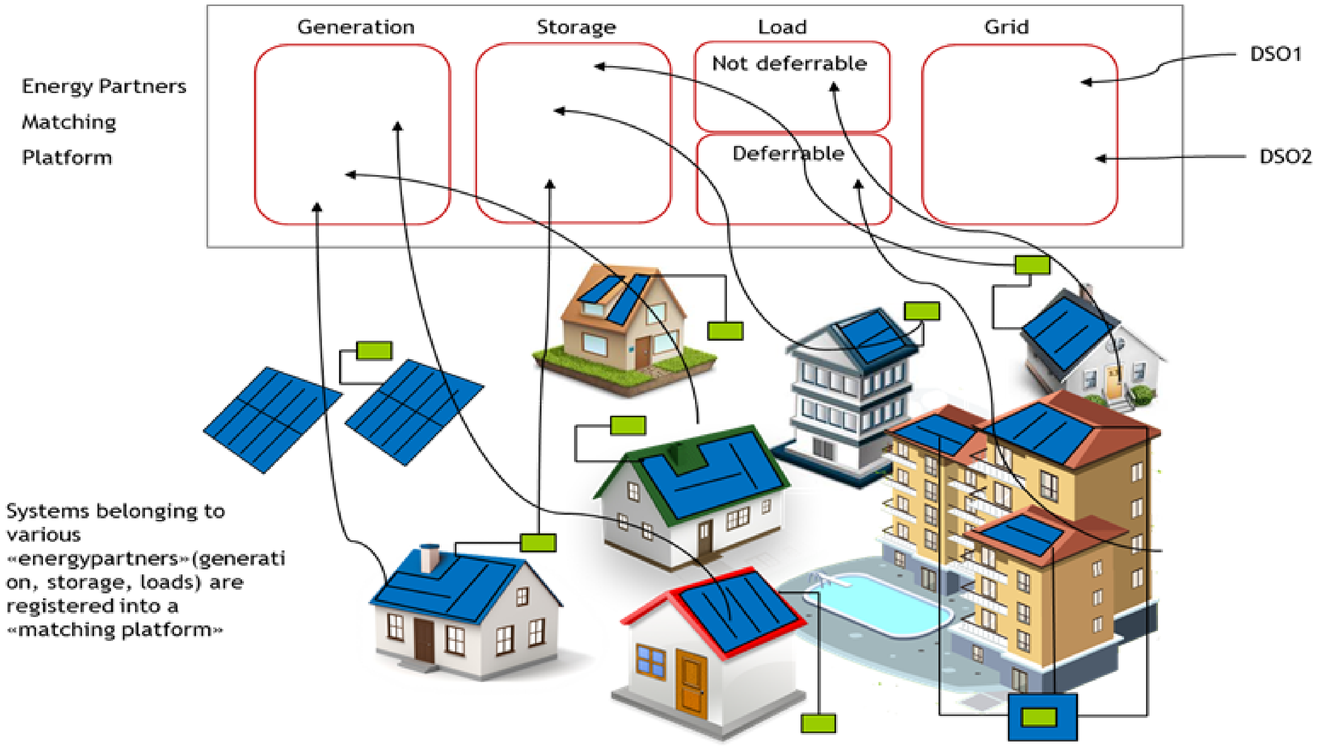
Da 1:1 a 1:n

EU Directive 2018:2001

Article 21

Renewables self-consumers

1. Member States shall ensure that consumers are entitled to become renewables self-consumers….



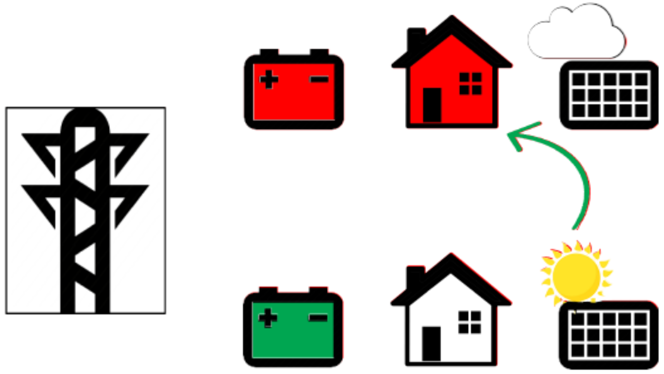
Article 22

Renewable energy communities

1. Member States shall ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community …..

Peer-to-peer is a new concept allowing each user to:

- consume the extra production of the neighbours
- sell its own extra production to the neighbour
- store it own overproduction without selling to the grid
- discharge the neighbours' battery to avoid buying from the grid



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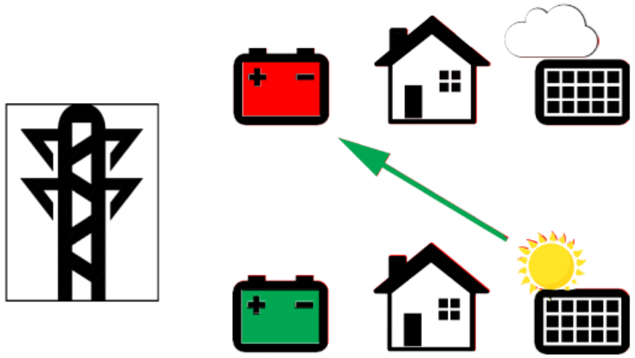

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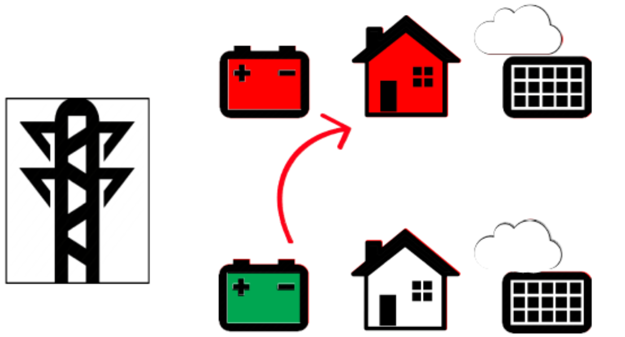

Objectives

MODELS FOR INTEGRATED GRIDS

FLEXIBILITY IN BUILDINGS and DISTRICTS

LABORATORY INFRASTRUCTURE

STAKEHOLDERS ENGAGEMENT

Objectives

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Integrids

- MODELS FOR INTEGRATED GRIDS
- FLEXIBILITY IN BUILDINGS and DISTRICTS
- LABORATORY INFRASTRUCTURE
- STAKEHOLDERS ENGAGEMENT

Models for integrated grids

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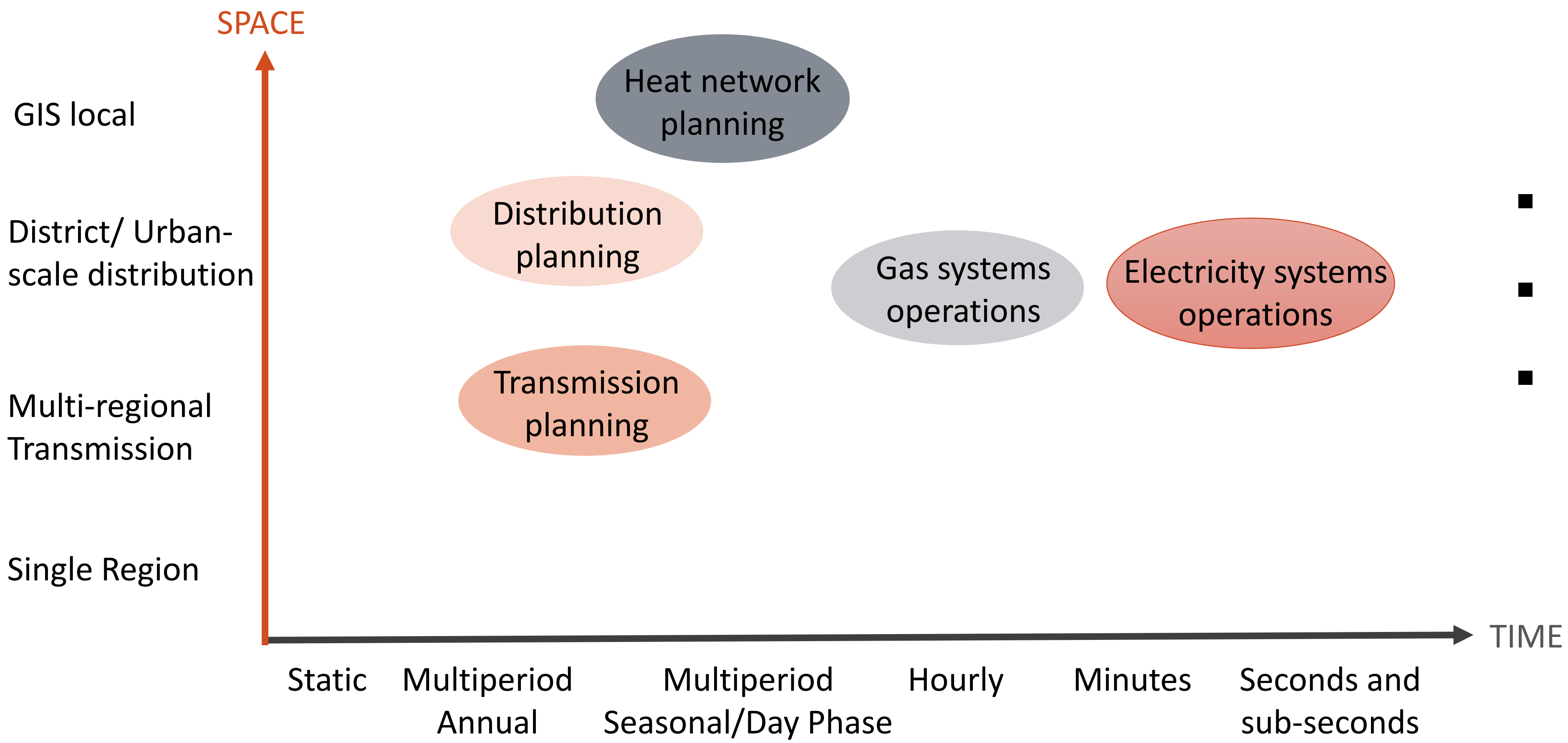
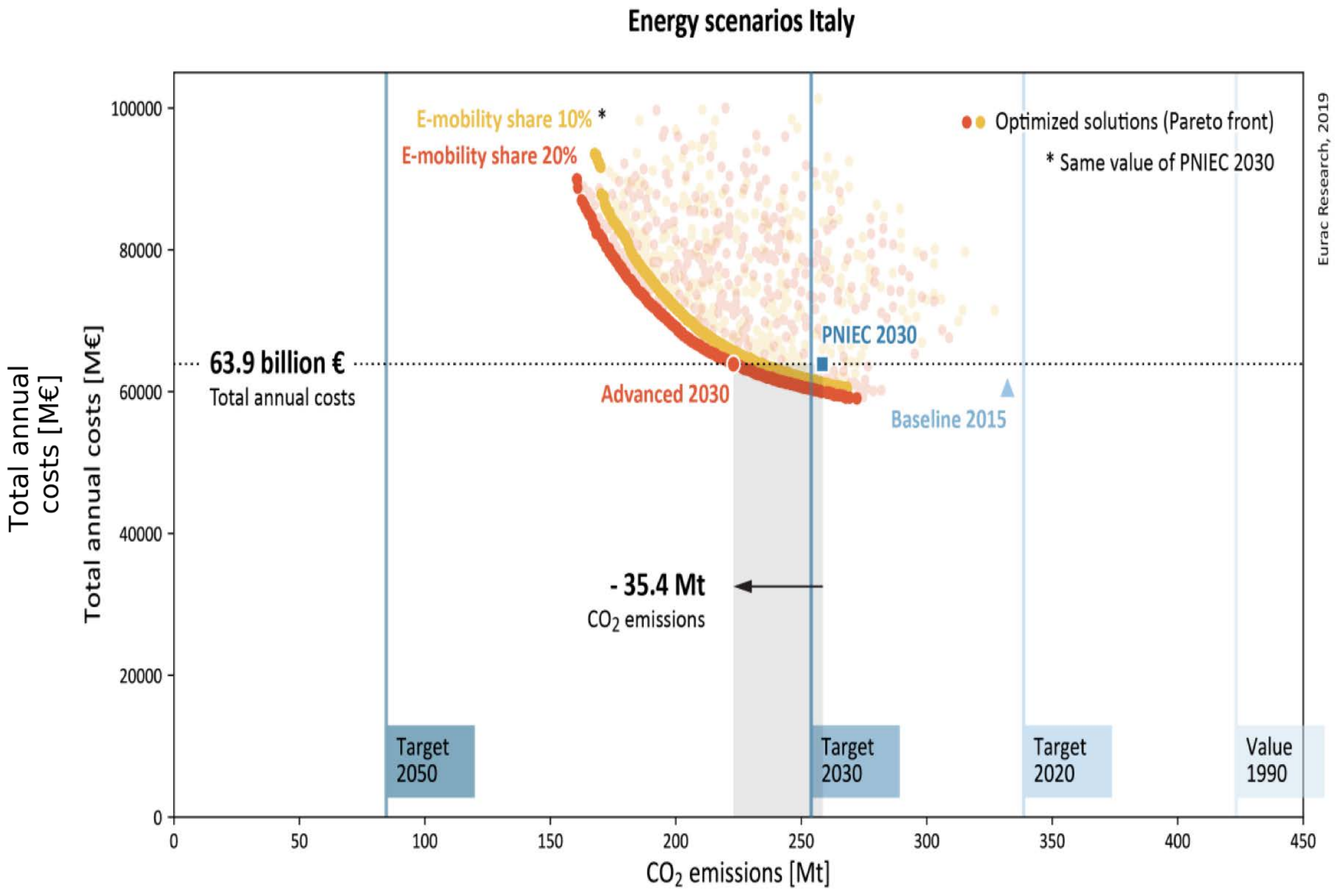


- Different time resolution
- Different spatial resolution
- Different level of accuracy

P. Mancarella, et al, "Modelling of integrated multi-energy systems: Drivers, requirements, and opportunities," *2016 Power Systems Computation Conference (PSCC)*, Genoa, 2016, pp. 1-22.

Modelli accoppiamento settori energetici: scala nazionale



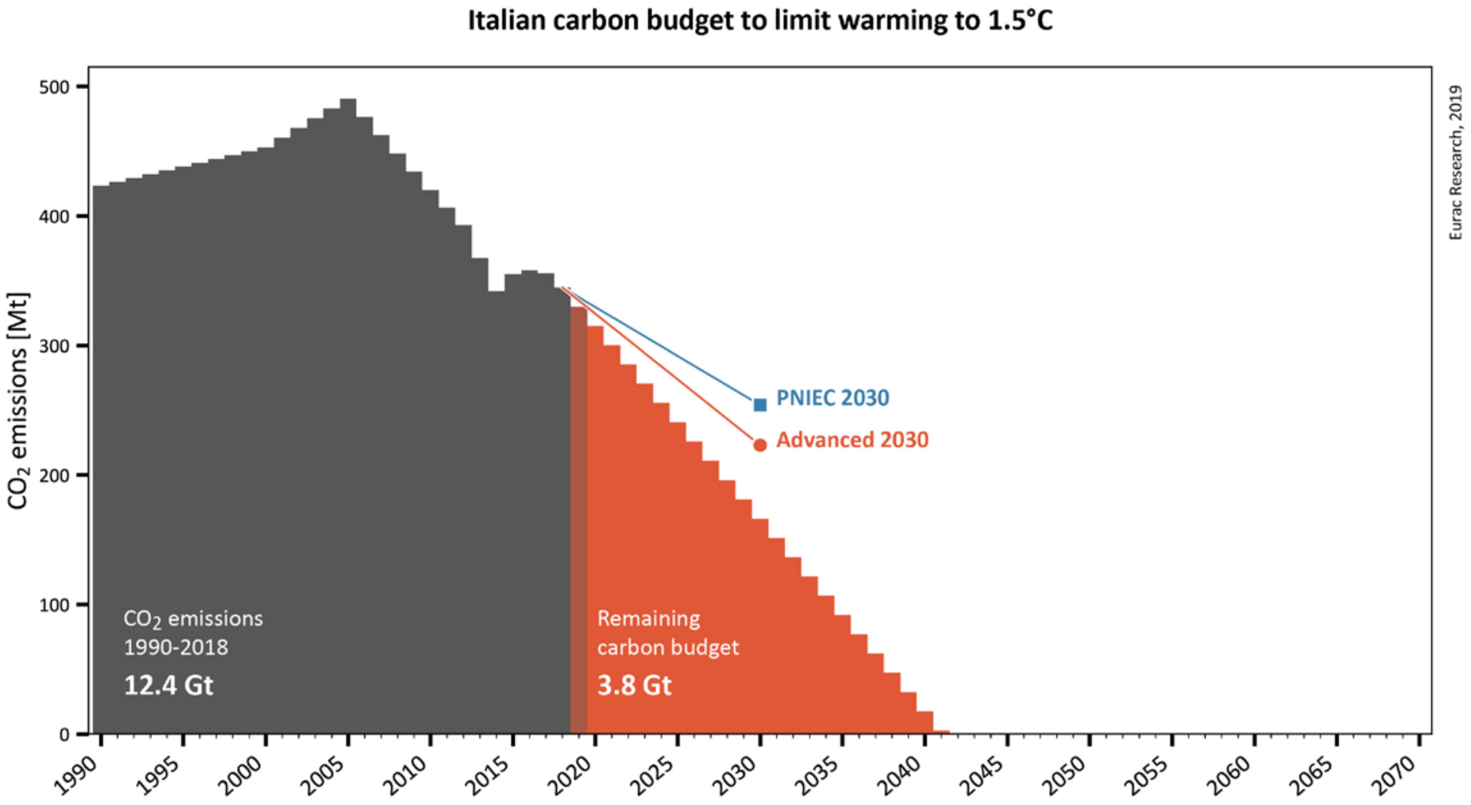
	Fotovoltaico	Eolico	Accumulo	Mobilità elettrica	Pompe di calore
Baseline 2015	19 GW	9 GW	0 GWh	3 TWh	0 %
PNIEC 2030	59 GW	23 GW	40 + 200 GWh	15 TWh	15 %
P20	86 GW	48 GW	0 + 400 GWh	3 TWh	30 %

Accumulo elettrico stazionario
Accumulo in veicoli elettrici

70 GW grandi impianti (industriale, greenfield e brownfield)
18 GW residential rooftop (potenziale 120 GW)

Multi-Objective Optimization Model EPLANopt for Energy Transition Analysis and Comparison with Climate-Change Scenarios
MG Prina, G Manzolini, D Moser, R Vaccaro, W Sparber, Energies 13 (12), 3255, 2020

Modelli accoppiamento settori energetici: scala nazionale

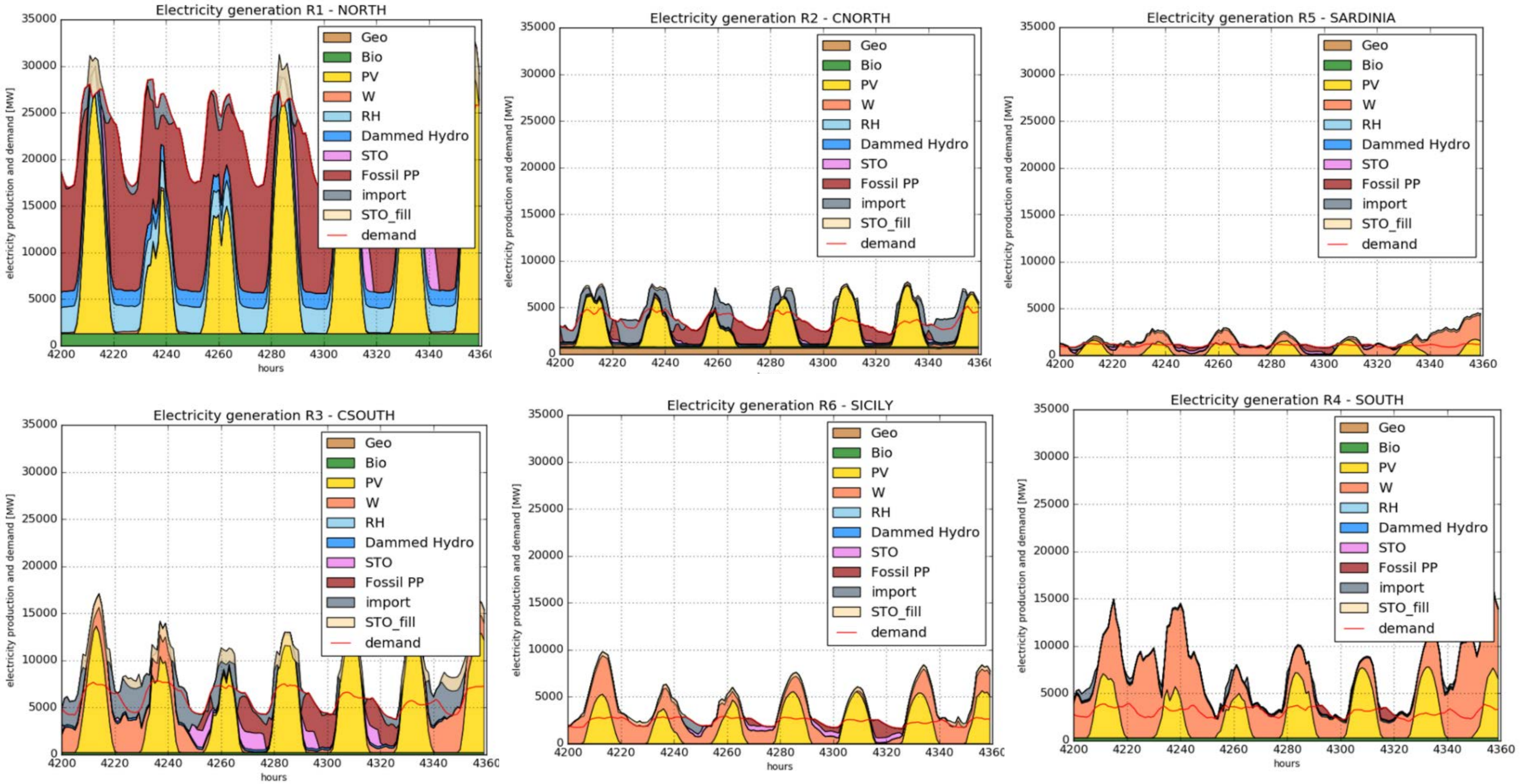


Necessità di:
- Sviluppare scenari alta penetrazione da rinnovabili per raggiungere target di decarbonizzazione
- Forte accelerazione della transizione energetica
- Fornire degli strumenti ai policy makers per il calcolo di costi-benefici

Multi-Objective Optimization Model EPLANopt for Energy Transition Analysis and Comparison with Climate-Change Scenarios
MG Prina, G Manzolini, D Moser, R Vaccaro, W Sparber, Energies 13 (12), 3255, 2020

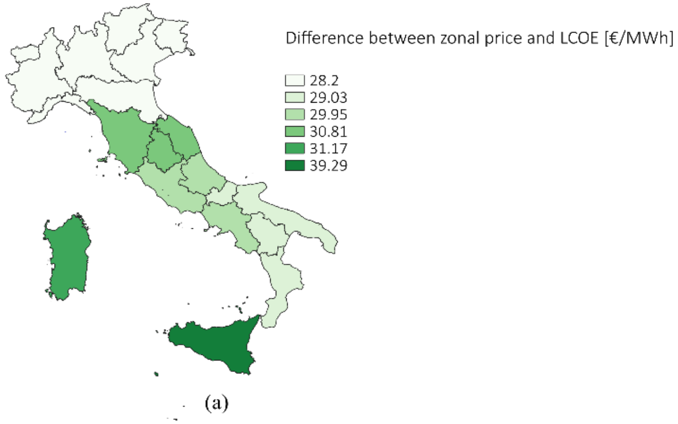
Modelli accoppiamento settori energetici: scala nazionale

- **Multi-regional level – Hourly generation and consumption resolution**



Costi integrazione impianti FV

Market parity of utility-scale PV plants without BESS
in the year 2020



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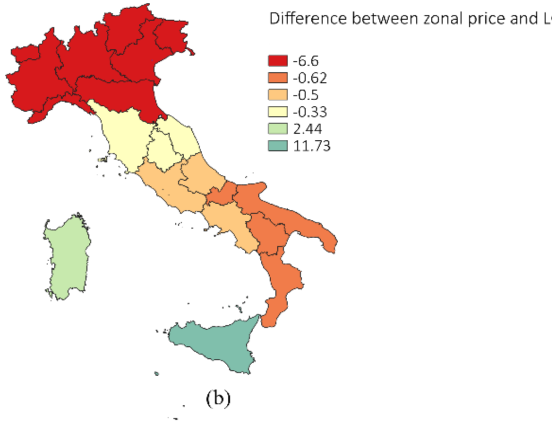
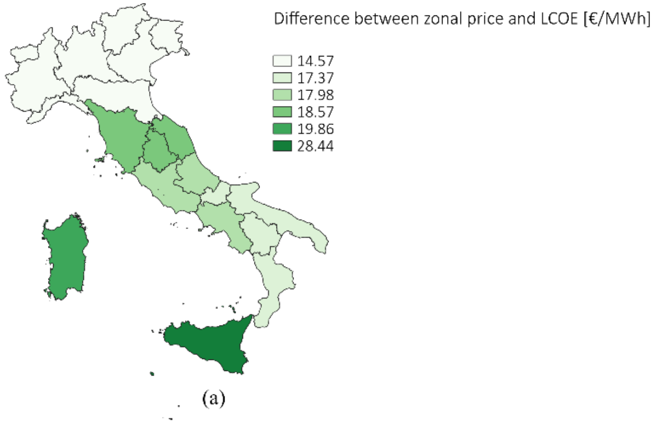
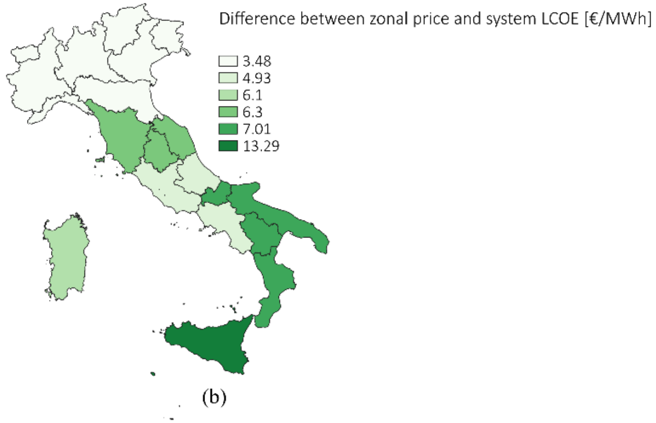


Market parity of utility-scale PV plants with BESS
in the year 2030



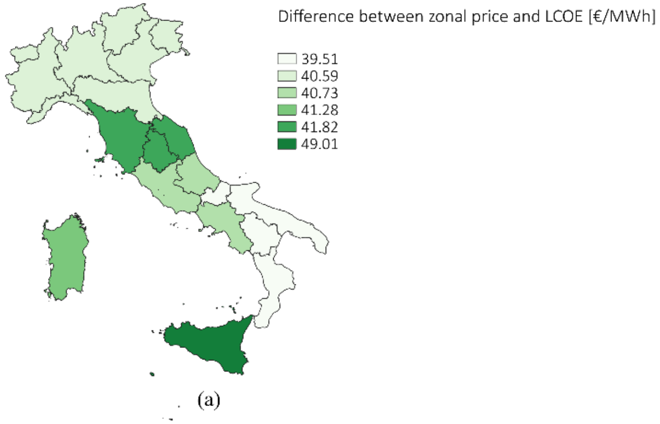
Market parity of utility-scale PV plants with BESS
in the year 2030 including the integration costs



PV Capex [€/kWp] 431
EES Capex [€/kWh] 251
PV Opex [% of Capex] 2%
EES Opex [% of Capex] 4%
Discount rate 7%

PV Capex [€/kWp] 275
EES Capex [€/kWh] 117
PV Opex [% of Capex] 2%
EES Opex [% of Capex] 4%
Discount rate 7%

Market parity of utility-scale PV plants without BESS
in the year 2030



Market parity of utility-scale PV plants without BESS
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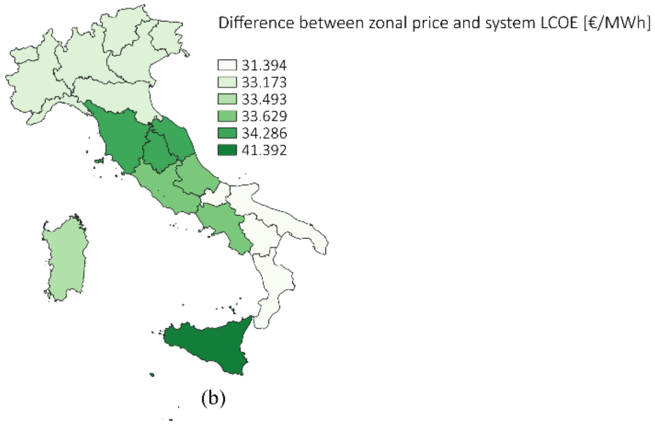
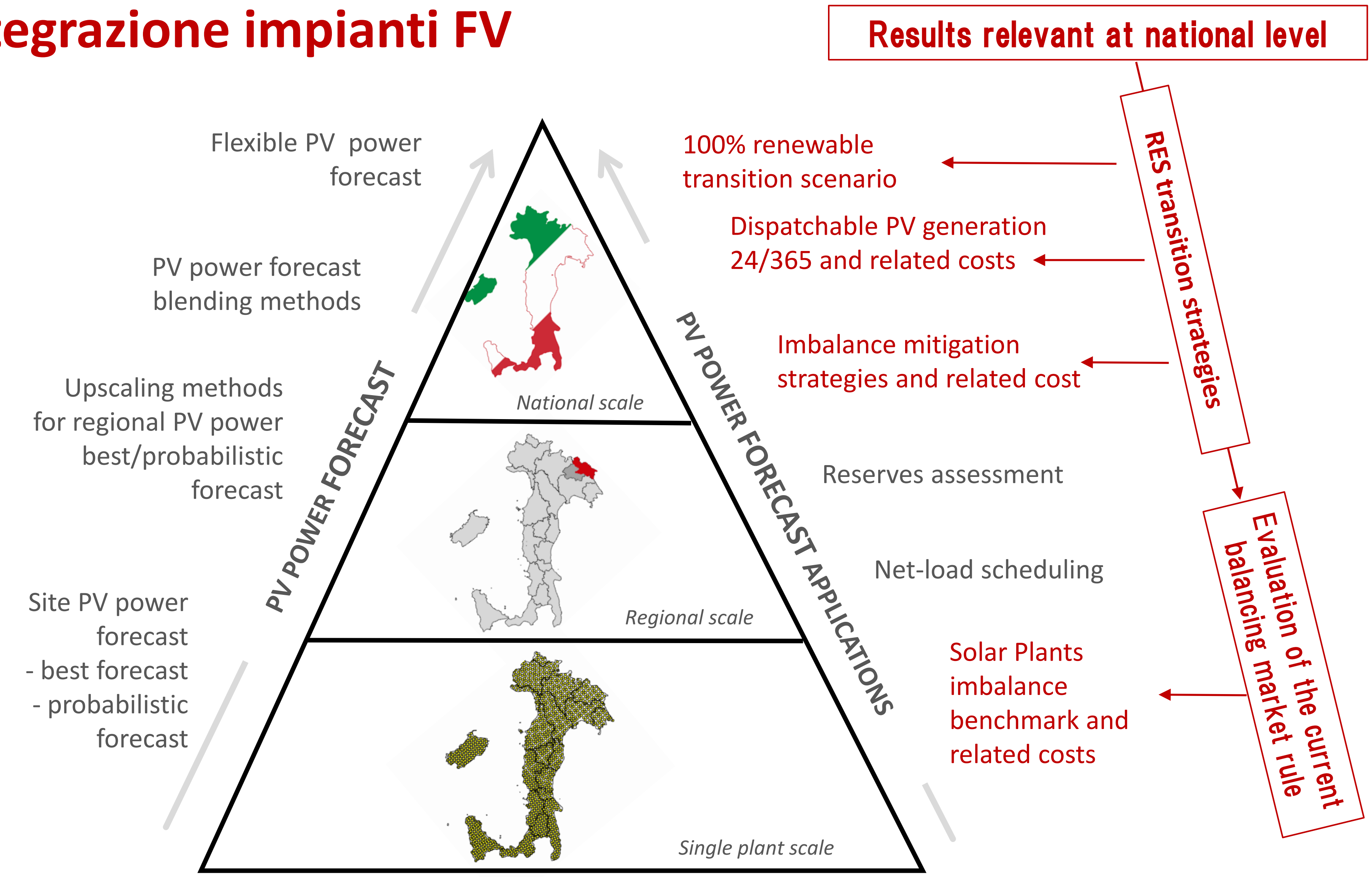
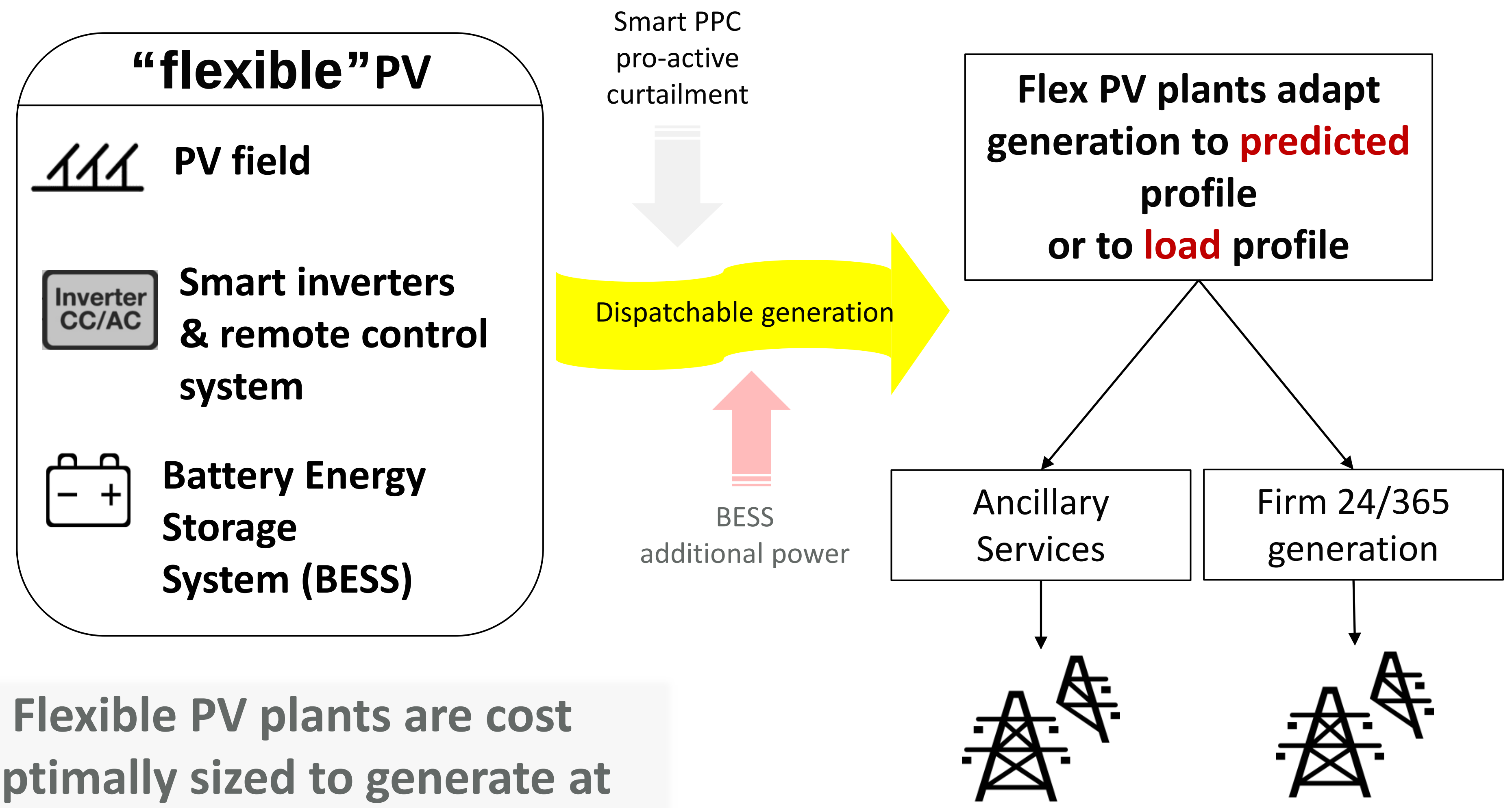


Costi integrazione impianti FV



Costi integrazione impianti FV

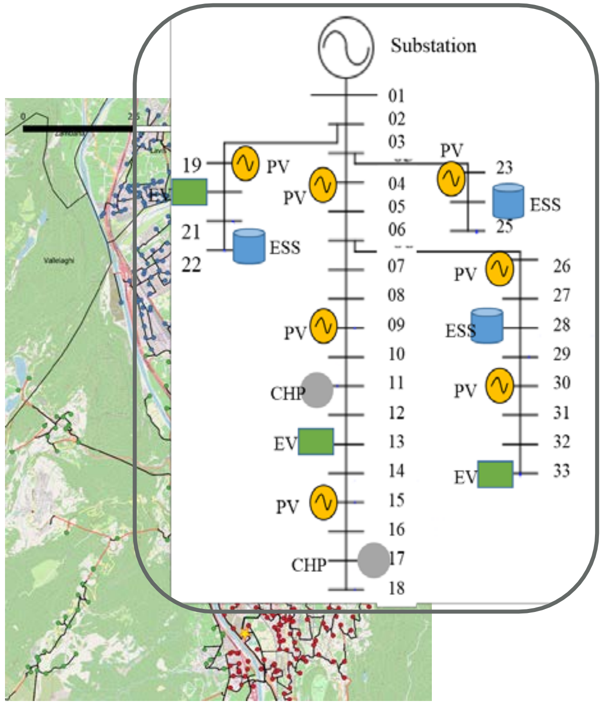


Flexible PV plants are cost optimally sized to generate at **energy costs lower than current costs**

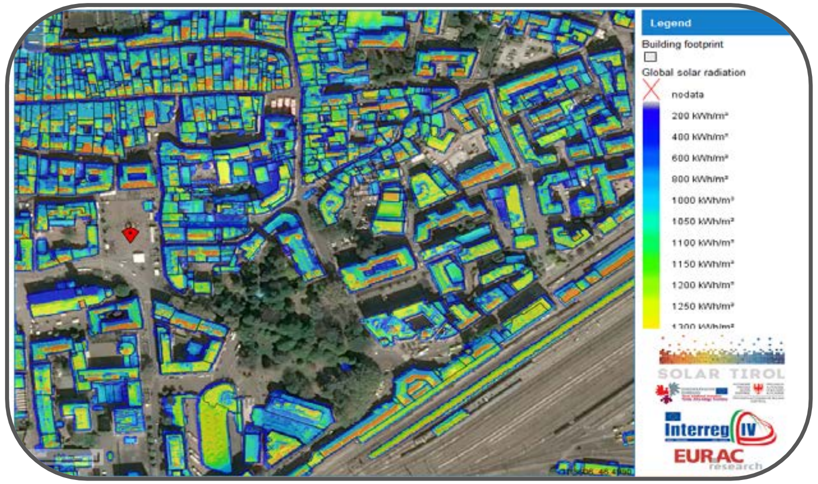
Italian protocol for massive solar integration: Imbalance mitigation strategies
M Pierro, R Perez, M Perez, D Moser, C Cornaro, Renewable Energy 153, 725-739, 2020

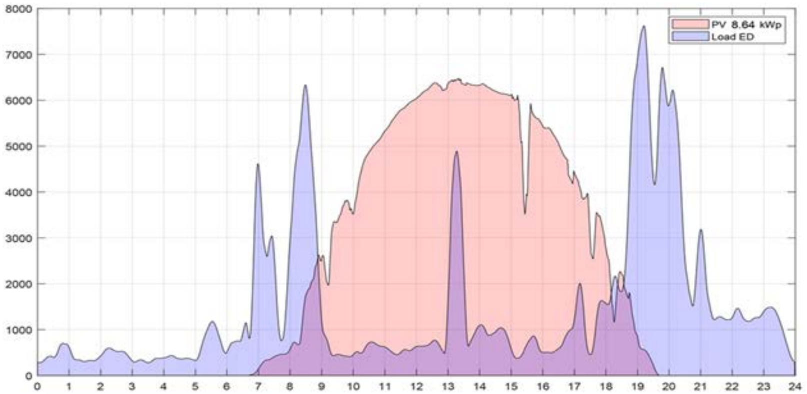
Reti di distribuzione BT/MT

- **Scala di distretto/urbano – Risoluzione secondi/minuti**

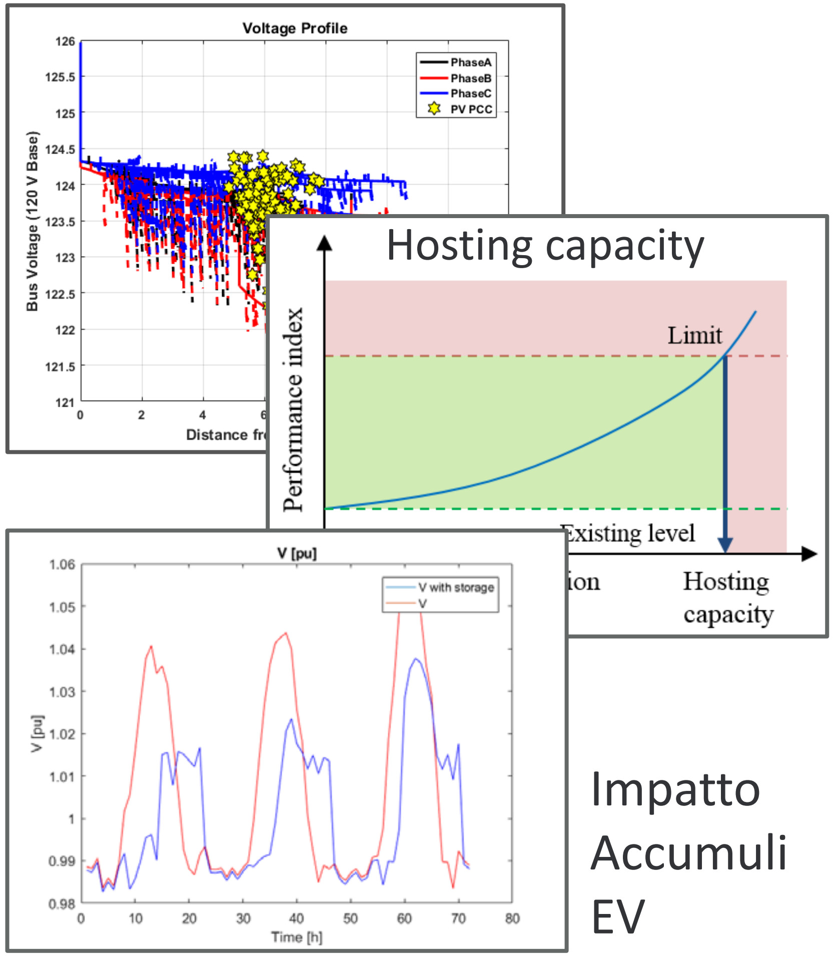


Rete di distribuzione BT/MT





Peak-time analysis

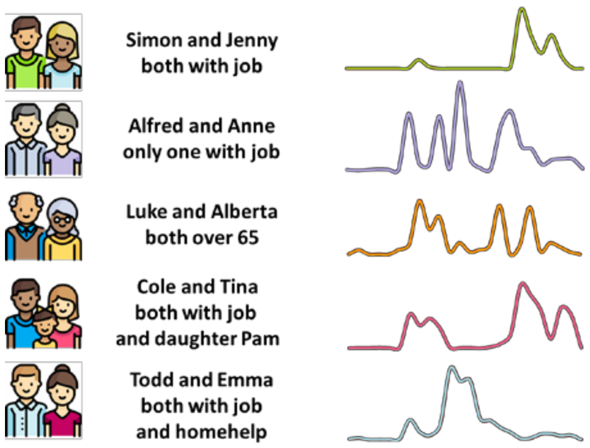


Impatto
Accumuli
EV

Profili di domanda e generazione misurati o modellati

Impatto della GD richiede l'analisi dei flussi di Potenza utilizzando serie temporali

Reti di distribuzione
Energy communities



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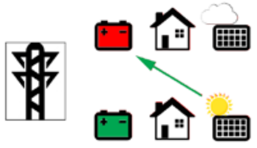

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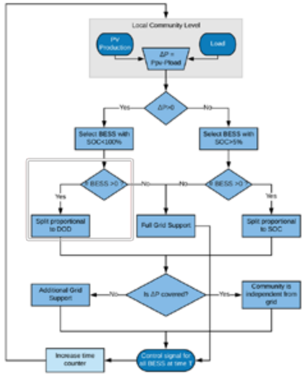
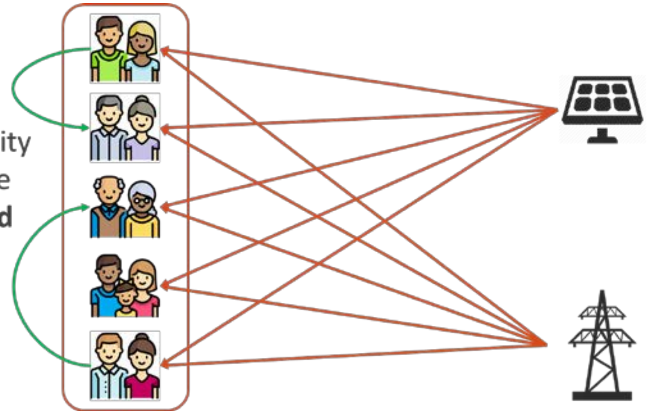
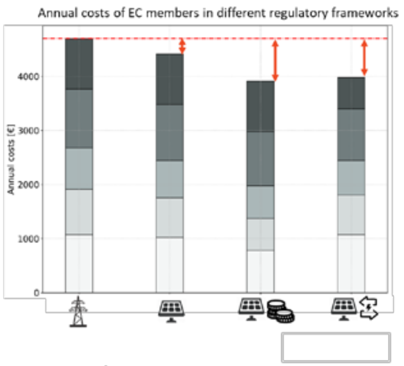


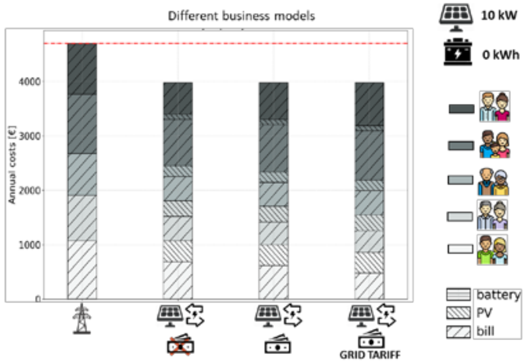
electricity can be **shared**



Hourly it evaluates:

- PV production
- PV consumption
- Shared energy
- Energy stored
- Energy supplied by the battery
- Energy sold to the grid
- Energy purchased from the grid





electricity from grid | PV panel installed | «net metering» | energy sharing | self-consumption tariff

Objectives

MODELS FOR INTEGRATED GRIDS

FLEXIBILITY IN BUILDINGS and DISTRICTS

LABORATORY INFRASTRUCTURE

STAKEHOLDERS ENGAGEMENT

Flexibility in buildings and districts

Energy Flexibility represents the capacity of a building to react to one or more forcing factors, minimizing the effects on a given time interval.

LOW FREQUENCY FORCING FACTORS

- Climate change
- Macro-economic factors
- Technological improvement
- Building intended use
- Energy production's cost

HIGH FREQUENCY FORCING FACTORS

- Internal loads
- Solar loads
- User behavior
- Energy prices

Vigna I., et al, "New domain for promoting energy efficiency: Energy Flexible Building Cluster". *Sustainable Cities and Society*, 38 (2018), 526–533.

Objectives

MODELS FOR INTEGRATED GRIDS

FLEXIBILITY IN BUILDINGS and DISTRICTS

LABORATORY INFRASTRUCTURE

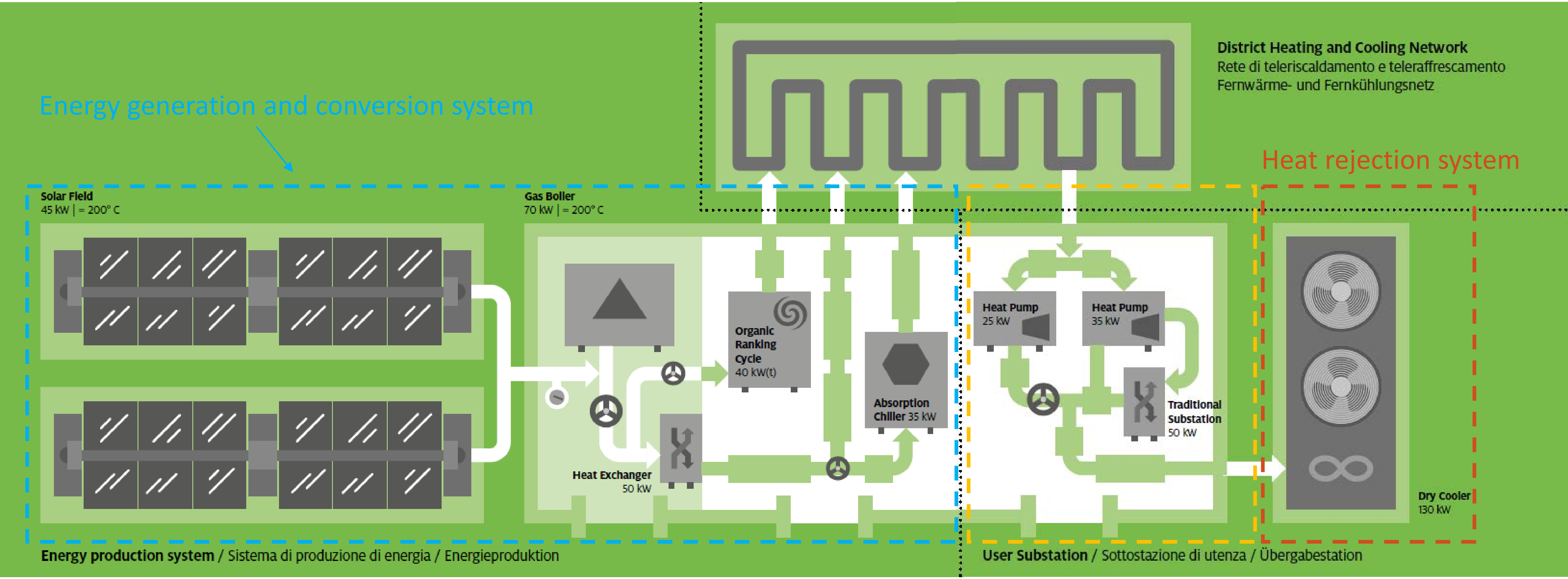
STAKEHOLDERS ENGAGEMENT

Laboratory
Energy Exchange lab

ExCHangE

- Traditional DH networks
- Heat-pump based DHC (H2020 flexynet project)

Laboratory
Energy Exchange lab



Laboratory
Energy Exchange lab

Generation units and network

Solar field

Network

Substations

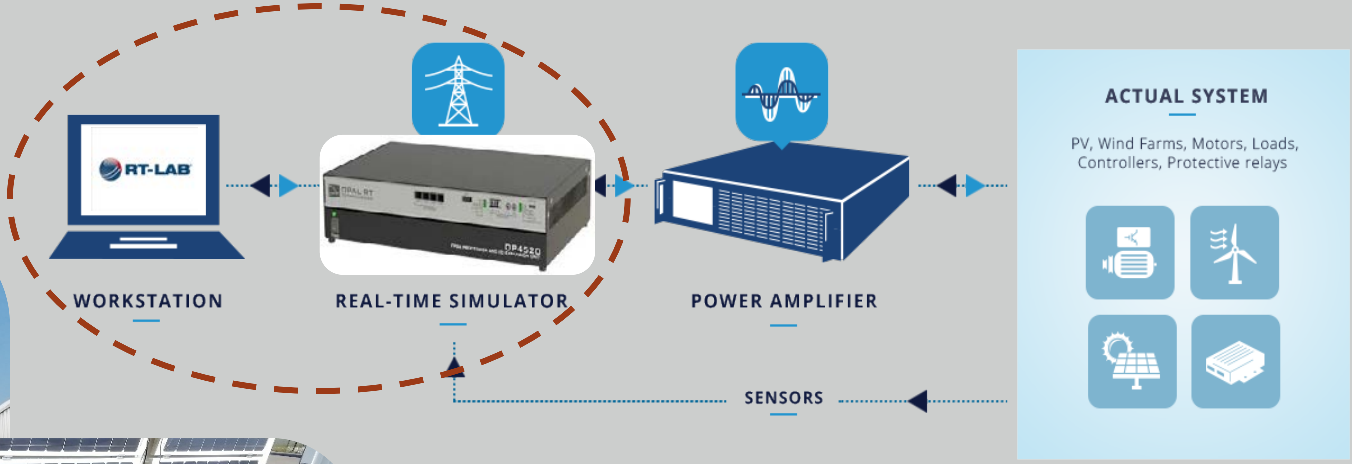
Laboratory
PV Integration lab

PV Integration

- Building Integrated PV
- Electronic load
- Electric grid real-time simulator

Laboratory
PV Integration lab

- Different PV installations



- Real-time electric grid simulator
  - Control prototyping
  - HIL
  - PIL (not amplifier)

Laboratory Multilab

MultiLAB

- Test facades
- Building energy demand profiles

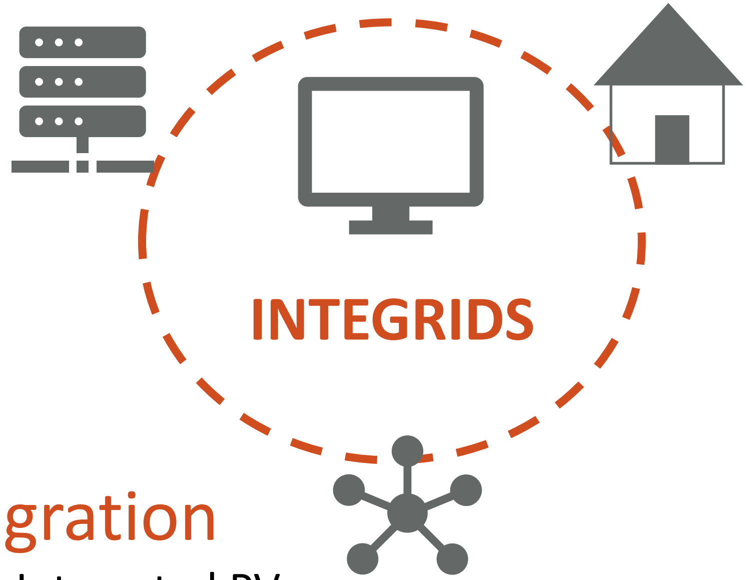
Laboratory Multilab

Two identical environmental chambers which can rotate to obtain the desired orientation to

- Testing building envelop components such multifactional facades systems
- Analysis on human thermal comfort and on indoor environmental quality

Laboratory INTEGRIDS
Renewable Energy Communities Lab

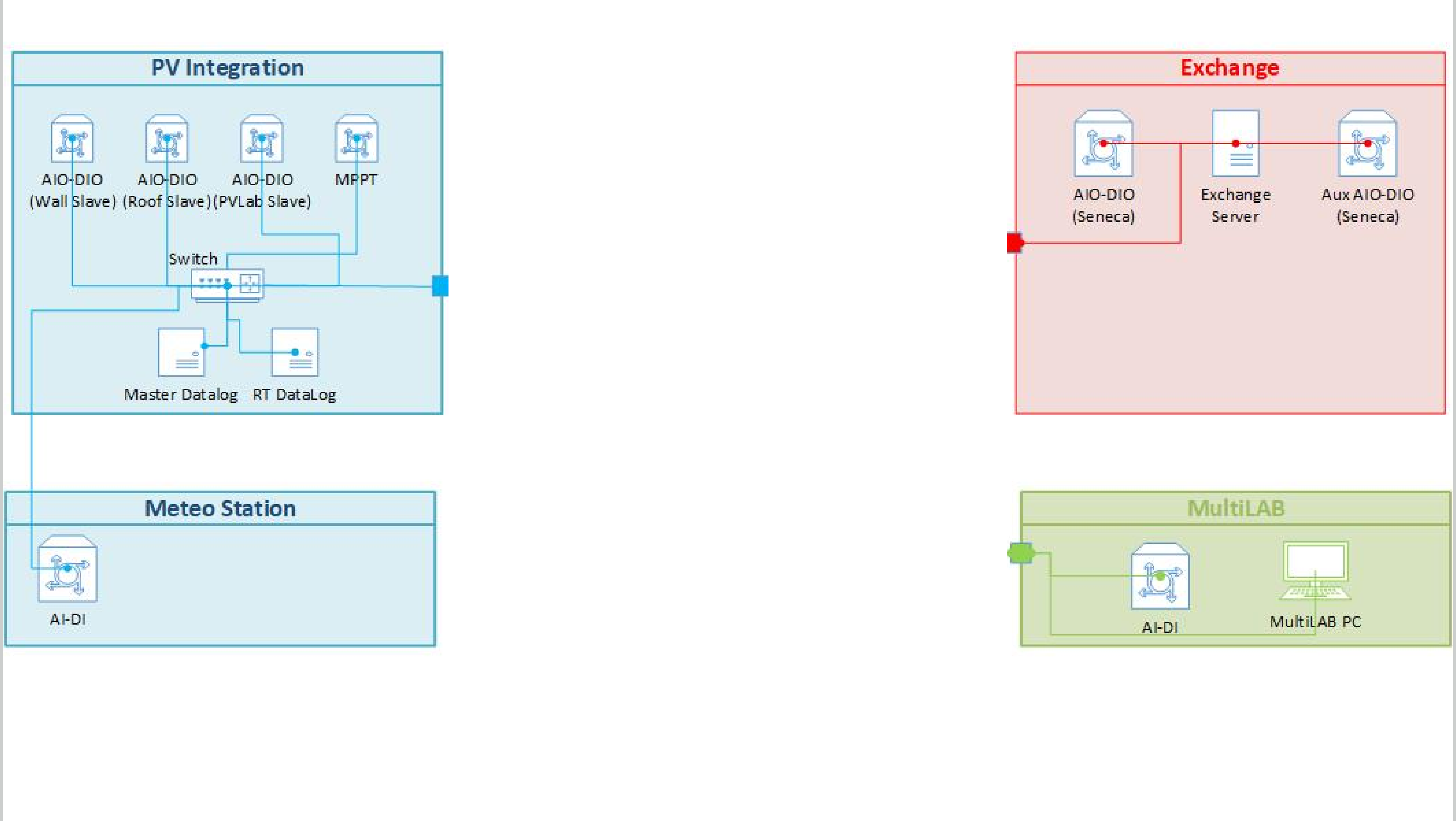
ExCHangE
- Traditional DH networks
- Heat-pump based DHC (H2020 flexynet project)



MultiLAB
- Test facades
- Building energy demand profiles

PV Integration
- Building Integrated PV
- Electronic load
- Electric grid real-time simulator

Laboratory INTEGRIDS



INTEGRIDS Online Mode:

- At least two of labs run in the same time for the same experiment

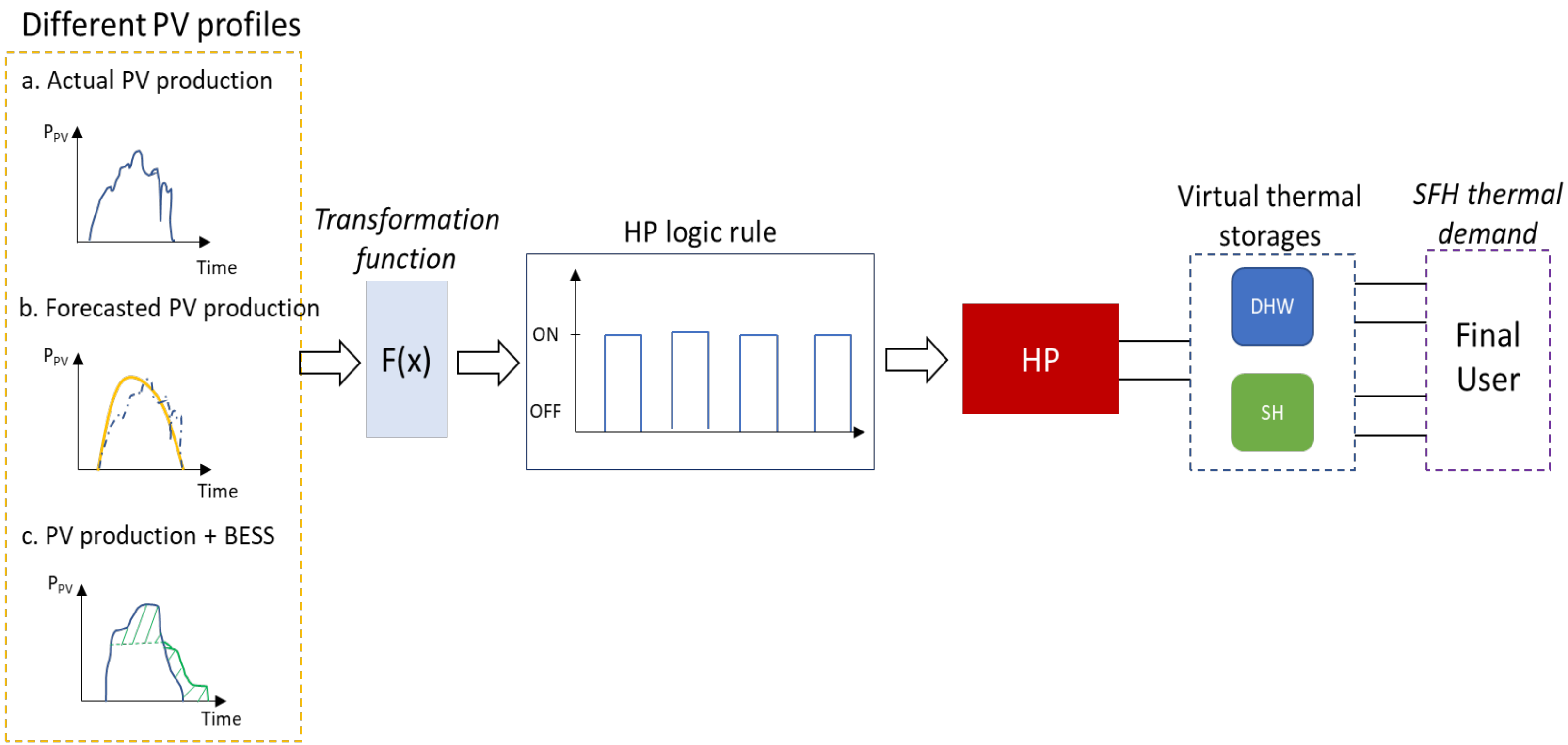
(e.g. cover the Exchange HP demand with PV production)

INTGRIDS Offline Mode:

- Data stored in the Database can be used from a single lab to run an experiment

(e.g. using building profiles produced by Mulitlab for Exchange lab tests)

INTEGRIDS experiment example (offline and online test):



Cover the HP electricity with PV production in different scenarios:

- Current PV production – online mode
- Forecasted PV production – smart HP management
- Forecasted PV production and BESS use to mantain rule-based HP

GOAL: Maximize use of RES for heating sector

Laboratory INTEGRIDS

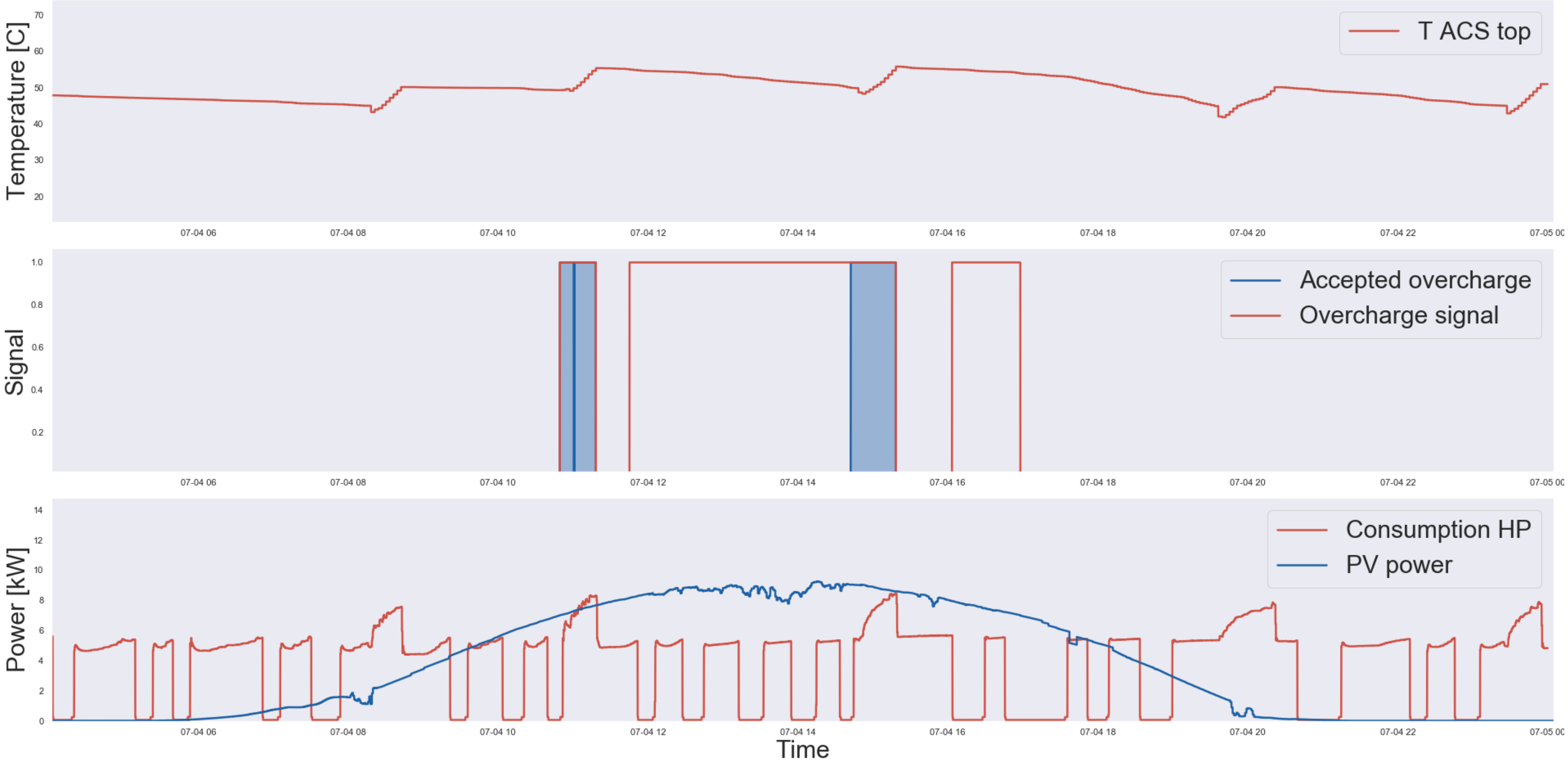
Online control logics

- Read PV system power
- Verify DHW storage status
- If possible, increase temperature setpoint to increase self-consumption
- Save data in the database

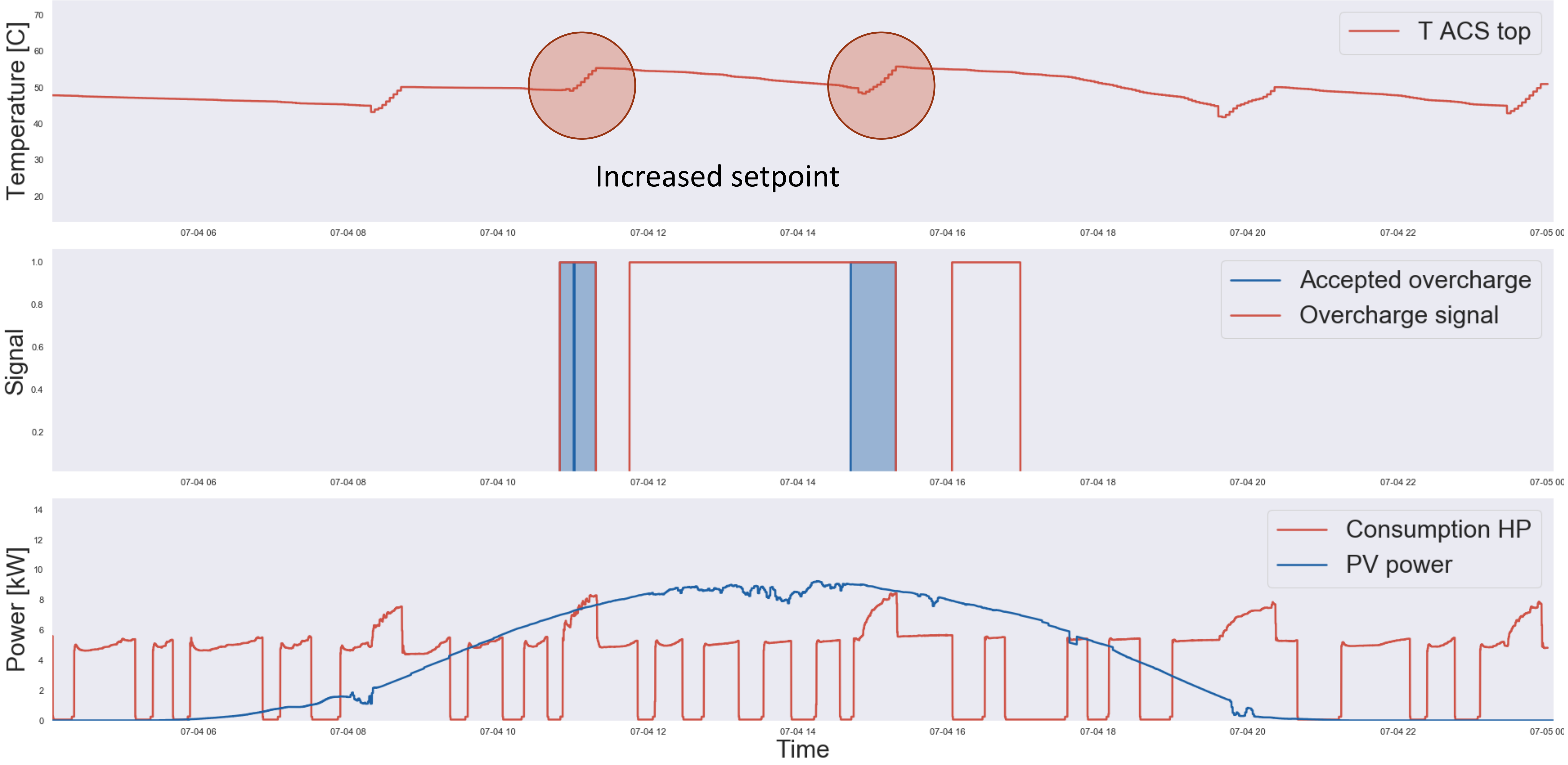
Safety

- PV power calculated in real time from weather data
- Calculated and measured power compared to check possible error
- If PV measured power is not available, use calculated value

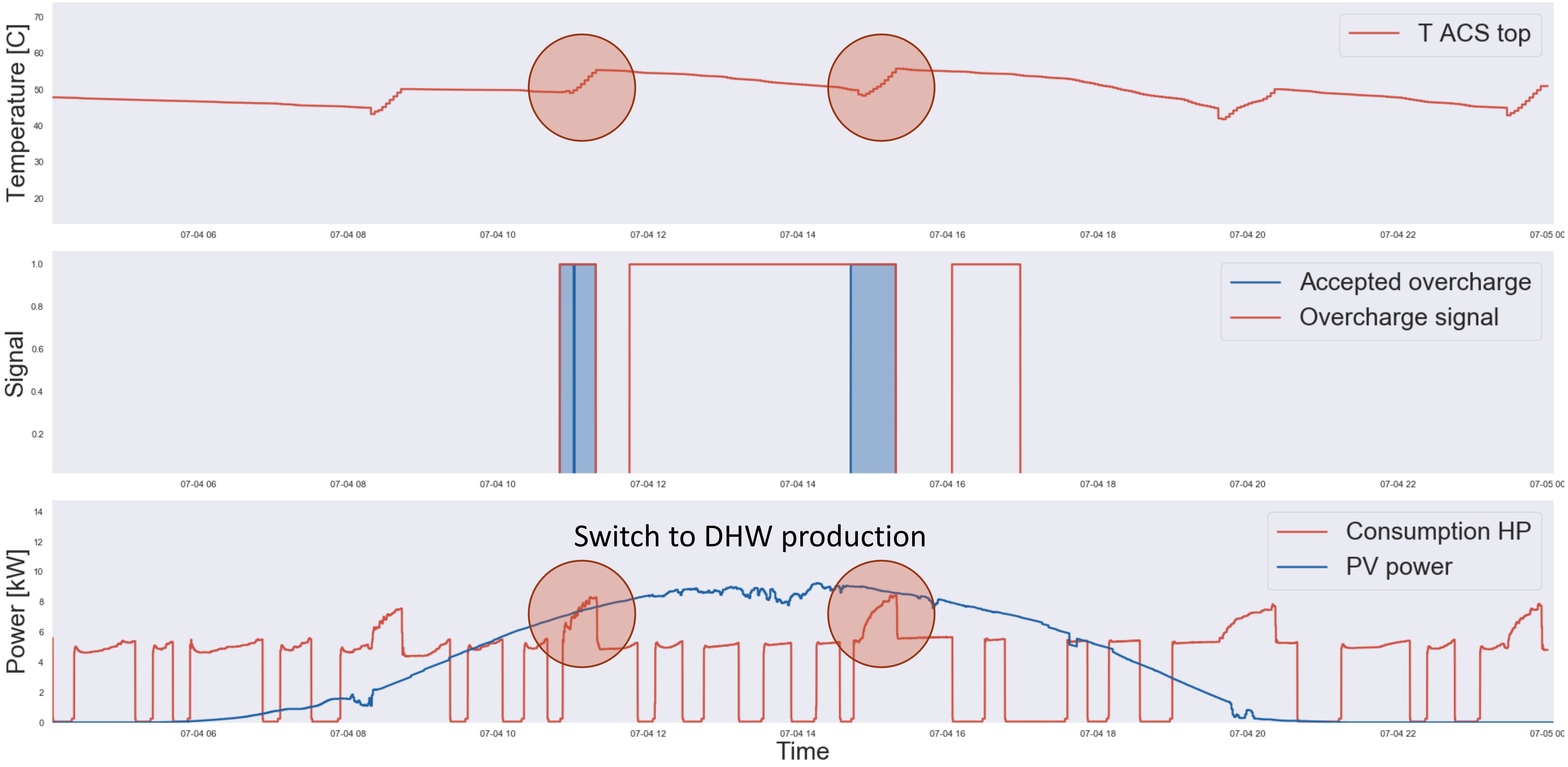
Laboratory INTEGRIDS



Laboratory INTEGRIDS



Laboratory INTEGRIDS



Objectives

MODELS FOR INTEGRATED GRIDS

FLEXIBILITY IN BUILDINGS and DISTRICTS

LABORATORY INFRASTRUCTURE

STAKEHOLDERS ENGAGEMENT

Engage local stakeholders

- **Local Project Advisory Board (PAB) Members:**

KlimaHaus CasaClima	Energy certification of buildings
Confcooperative	New districts and buildings
alperia	Utility / electrical grid/ district heating
H2 South Tyrol	Expert in the filed of H2 and e-mobility
edyna	Electrical grid and e-mobility
SYNECO	Consultant in the energy sector
IPES	Owner of social housing
SEV	Cooperative small energy producers
energytech	Engineering company
IDM Südtirol Alto Adige	Expert in the energy sector and industry contact

- **National Project Advisory Board (PAB) Members:**

RSE Ricerca Sistema Energetico	Research on energy system
Grid Parity 2	Virtual power plant concept and ESCO
Politecnico Milano	Research on renewable energy and energy efficiency

Dissemination

Deliverables available at
http://www.eurac.edu/it/research/technologies/renewableenergy/projects/Pages/EU-FESR---INTEGRIDS.aspx

- Classification and challenges of bottom-up energy system models-A review
  MG Prina, G Manzolini, D Moser, B Nastasi, W Sparber
  Renewable and Sustainable Energy Reviews 129, 109917, 2020
- Italian protocol for massive solar integration: Imbalance mitigation strategies
  M Pierro, R Perez, M Perez, D Moser, C Cornaro
  Renewable Energy 153, 725-739, 2020
- Multi-objective investment optimization for energy system models in high temporal and spatial resolution
  MG Prina, V Casalicchio, C Kaldemeyer, G Manzolini, D Moser
  Applied Energy 264, 114728, 2020
- Residual load probabilistic forecast for reserve assessment: A real case study
  M Pierro, M De Felice, E Maggioni, D Moser, A Perotto, F Spada
  Renewable Energy 149, 508-522, 2020
- Multi-Objective Optimization Model EPLANopt for Energy Transition Analysis and Comparison with Climate-Change Scenarios, MG Prina, G Manzolini, D Moser, R Vaccaro, W Sparber
  Energies 13 (12), 3255, 2020

Dissemination

Predictive Energy Control Strategy for Peak Shaving and Shifting Using BESS and PV Generation Applied to the Retail Sector, G Barchi, M Pierro, D Moser
Electronics 8 (5), 526, 2019

Transition pathways optimization methodology through EnergyPLAN software for long-term energy planning
MG Prina, M Lionetti, G Manzolini, W Sparber, D Moser
Applied Energy 235, 356-368, 2019

Incorporating combined cycle gas turbine flexibility constraints and additional costs into the EPLANopt model: The Italian case study, MG Prina, L Fanali, G Manzolini, D Moser, W Sparber
Energy 160, 33-43, 2018

New domain for promoting energy efficiency: Energy Flexible Building Cluster, Ilaria Vigna, Roberta Pernetti, Wilmer Pasut, Roberto Lollini, Sustainable Cities and Society, 38 526-533, 2018

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Integrids

eurac research

“We ensure quality and sustainability in a PV driven energy transition”

David Moser
Group Leader
PV Energy Systems group
e-mail: david.moser@eurac.edu

Thank you!