ETIP-PV working group
Digital PV and Grid

MAPPING THE RELEVANCE OF DIGITALISATION FOR PHOTOVOLTAICS

ETIP Photovoltaics

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The European Technology and Innovation Platform for Photovoltaics

etip-pv.eu

WHAT IS “DIGITALISATION”?

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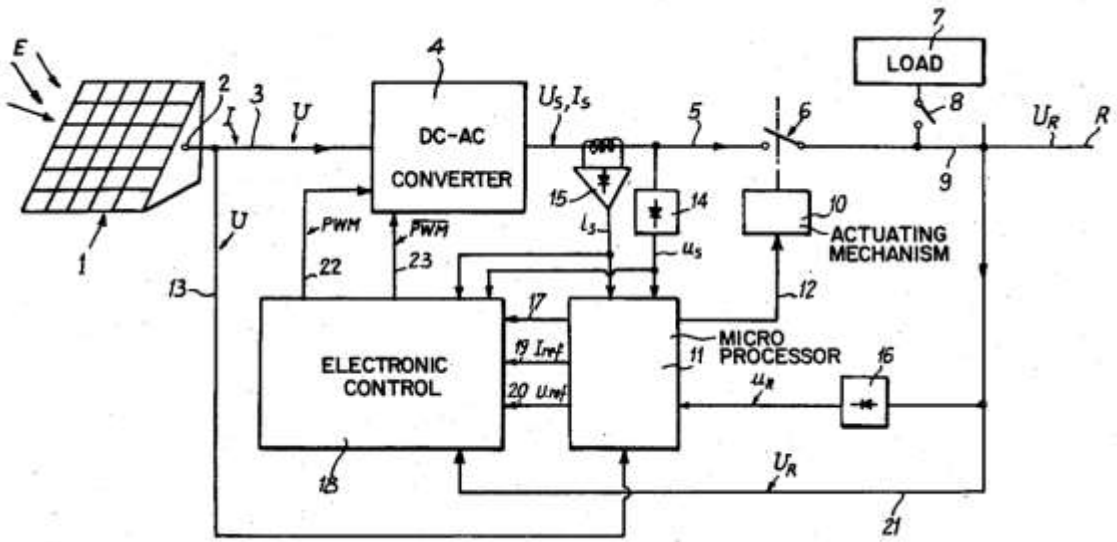

R. Corbefin and G. Vacelet, ‘Process and system for producing photovoltaic power’, US4390940A, Jun. 28, 1983

- **Digitisation** is the process of changing from analog to digital form, also known as digital enablement. Said another way, **digitization** takes an analog process and changes it to a digital form without any different-in-kind changes to the process itself.

- **Digitalisation** is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.

Source: Gartner IT glossary

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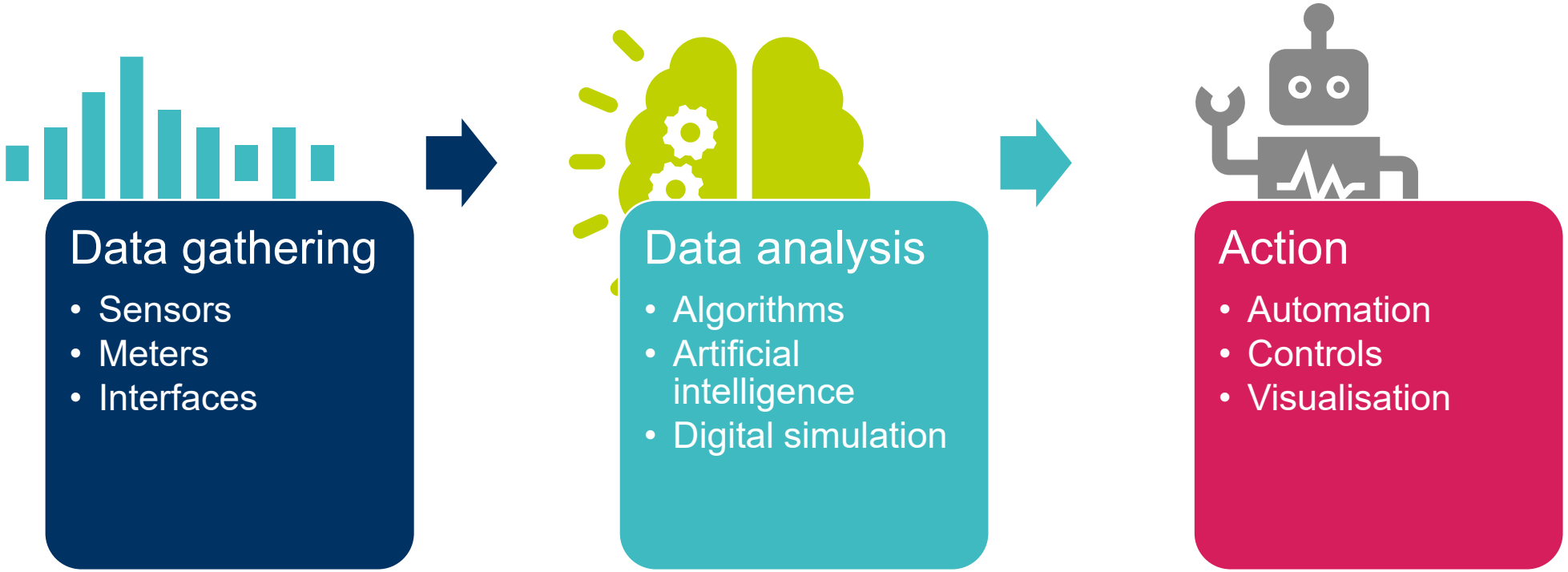
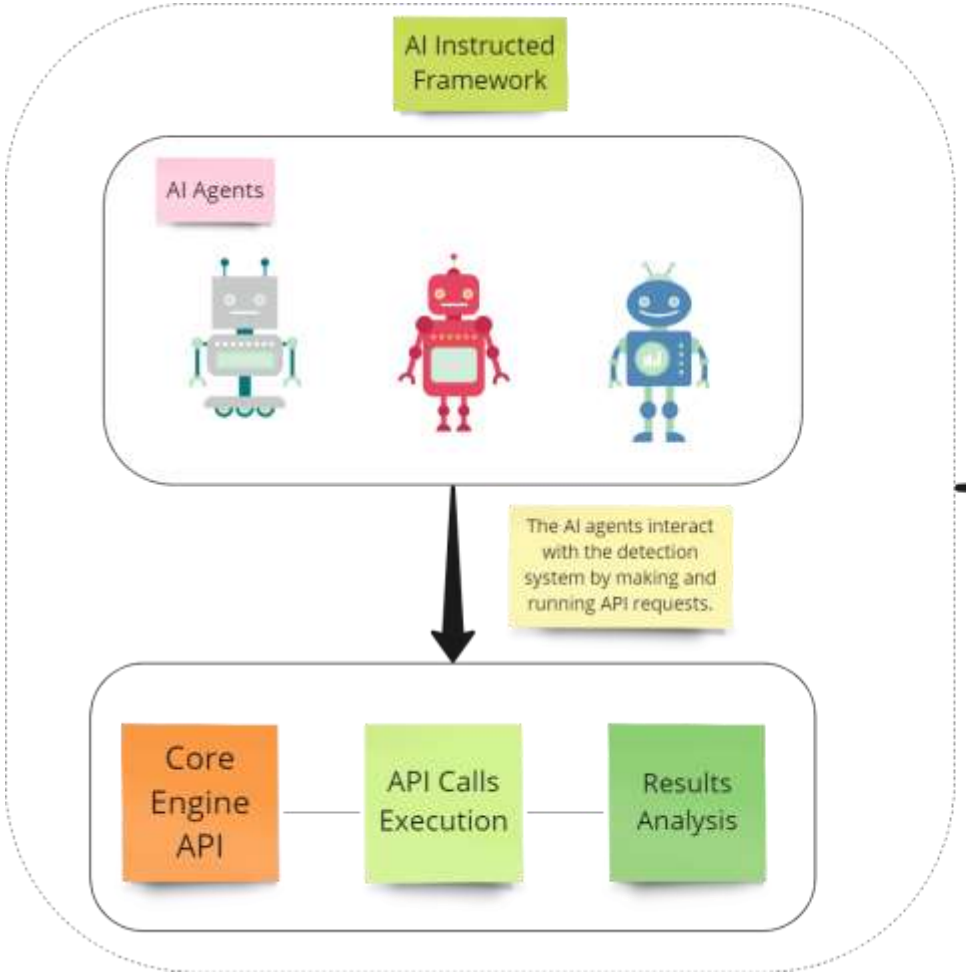
WHAT IS “DIGITALISATION”?

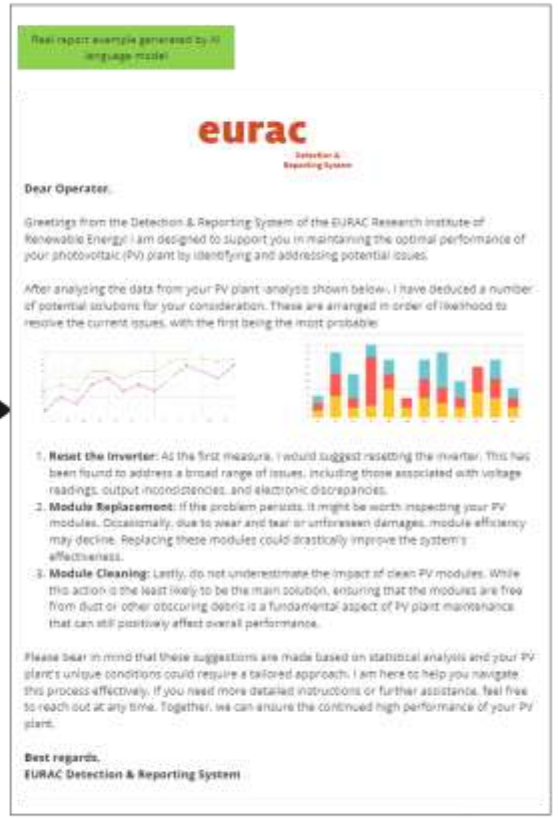


IEA (2019), Energy efficiency and digitalisation, IEA, Paris
https://www.iea.org/articles/energy-efficiency-and-digitalisation

SCIENCE FICTION?
MEET YOUR AI AGENTS



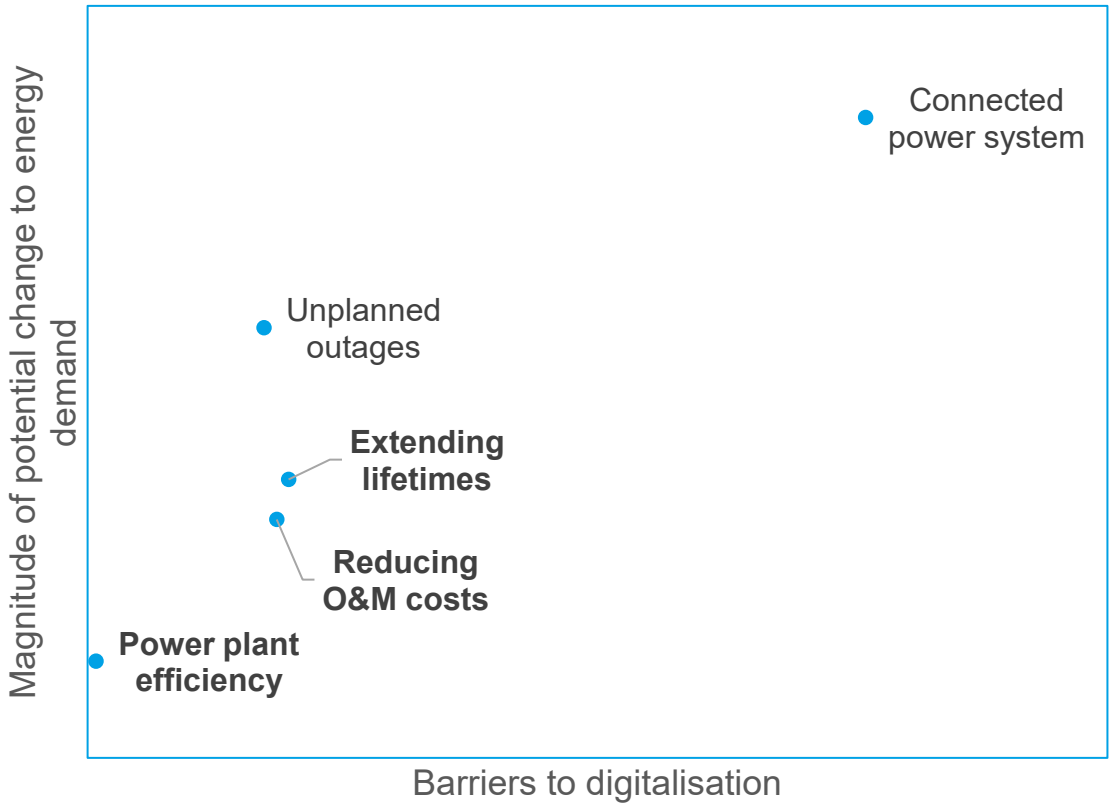
After analyzing and deciphering the results from the framework, the AI agents produce reports, simplifying comprehension for the operators.

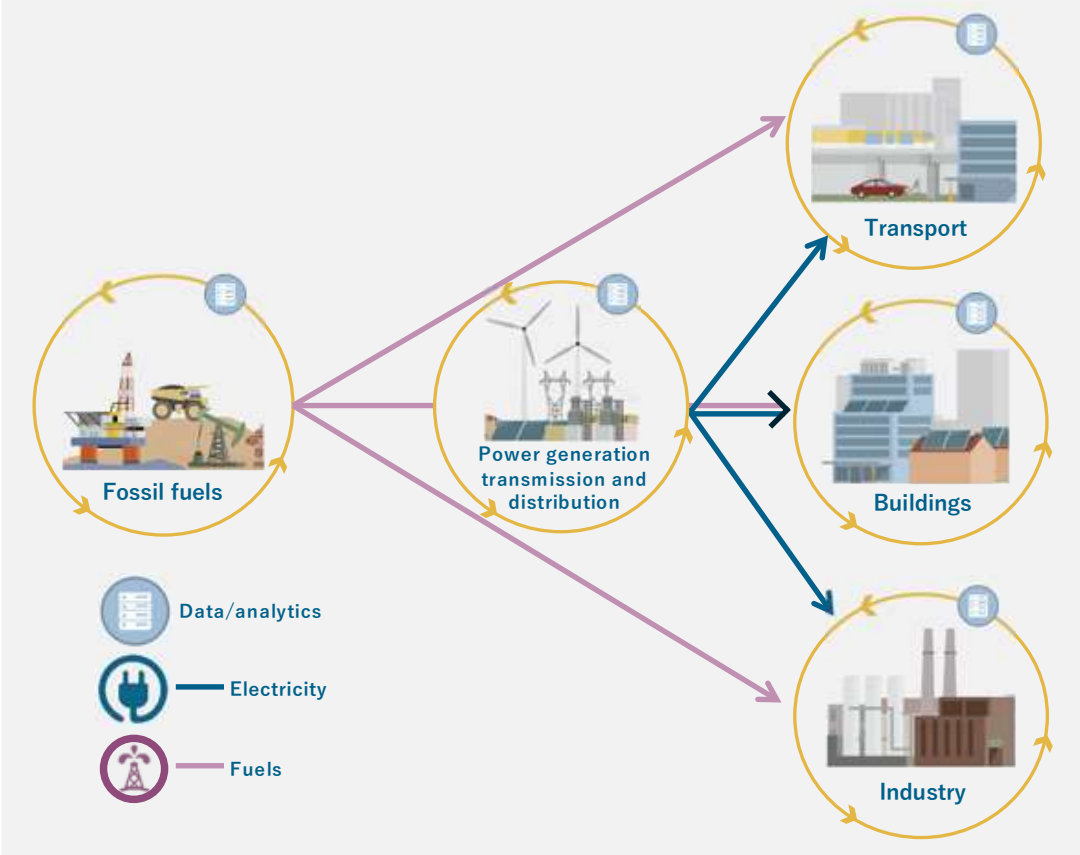


courtesy of Mousa Sondoqah, Eurac Research

eurac research | ETIP Photovoltaics | csem

DIGITALISATION: SHORT-TERM BENEFITS





IEA (2017), Digitalisation and Energy, IEA, Paris https://www.iea.org/reports/digitalisation-and-energy

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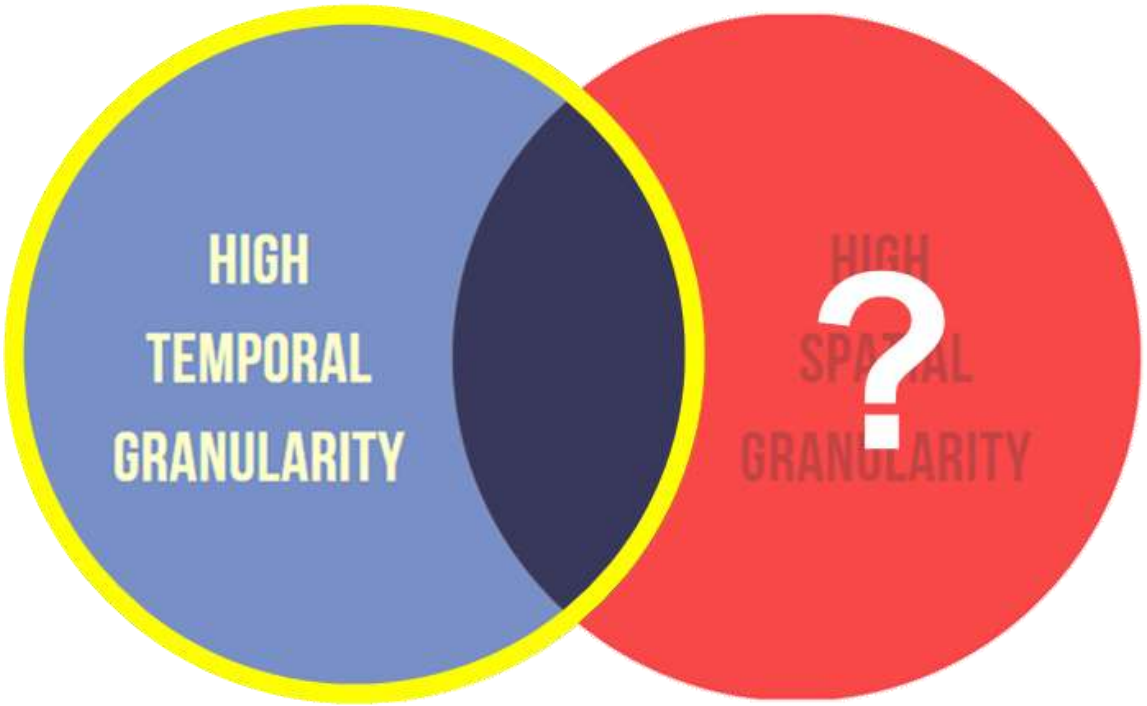
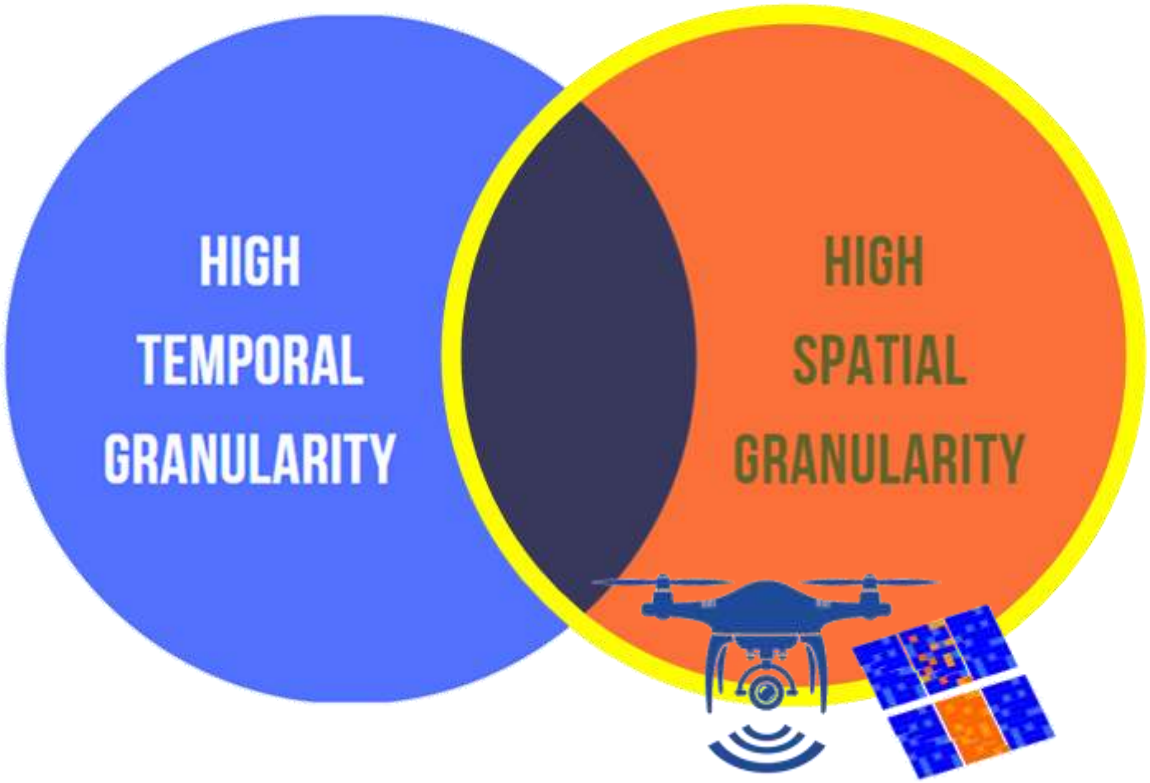
MONITORING DATA LIMITATIONS



- Time series from inverters, instrumentation
- Insufficient spatial granularity, especially in utility-scale PV plants.
- At component / subsystem level:
  - Undetected losses or failures
  - Triggered false-negatives
  - Root-cause analysis practically impossible, time- and labour- intensive.
- Typically ~30% of PV plants still underperform, at global scale, according to 3E.

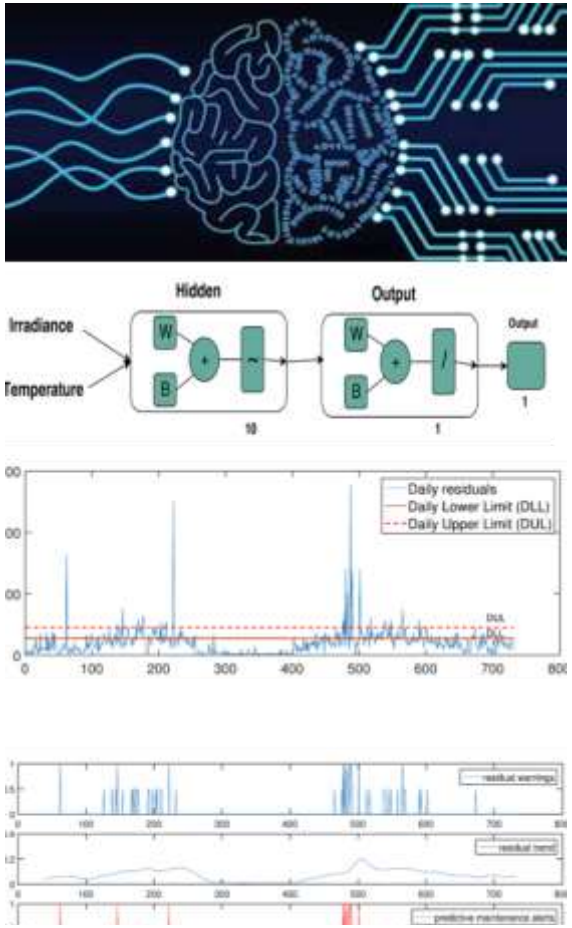
MONITORING DATA LIMITATIONS

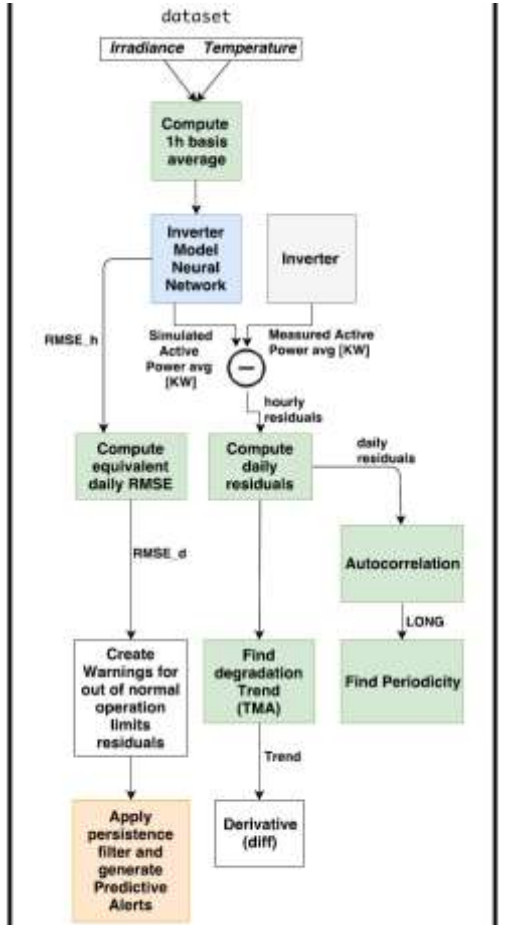


- Very high spatial granularity
- From system and string level, down to module and submodule/cell level :
  - Detection, diagnosis.
  - Root-cause analysis possible.
  - Time- and labour- efficient.
  - 1.5x up to 4x higher “diagnostic capacity”
- Limitations:
  - Snapshot assessment
  - Decoupled from PV monitoring → assessment rather than root-cause analysis
- Solution: **data fusion**

DATA FUSION AND AUGMENTATION

- Data augmentation with open-source data can increase accuracy of anomaly detection and classification algorithms
- Example:
  - OpenWeatherMap
  - Clear Sky Model
  - COPERNICUS:
    - infrared imaging
    - cloud cover
  - Passive reflectance at 550 nm → information on aerosol density

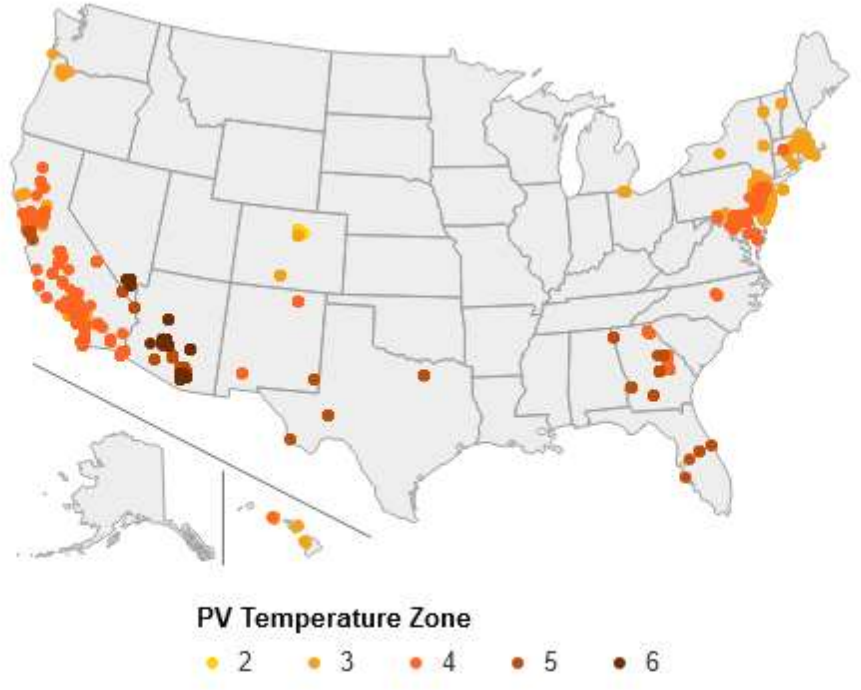




M. De Benedetti et a., Neurocomputing 310 (2018), 59-68

OVERCOMING MACHINE LEARNING BOTTLENECK DATA REPOSITORIES EXAMPLES

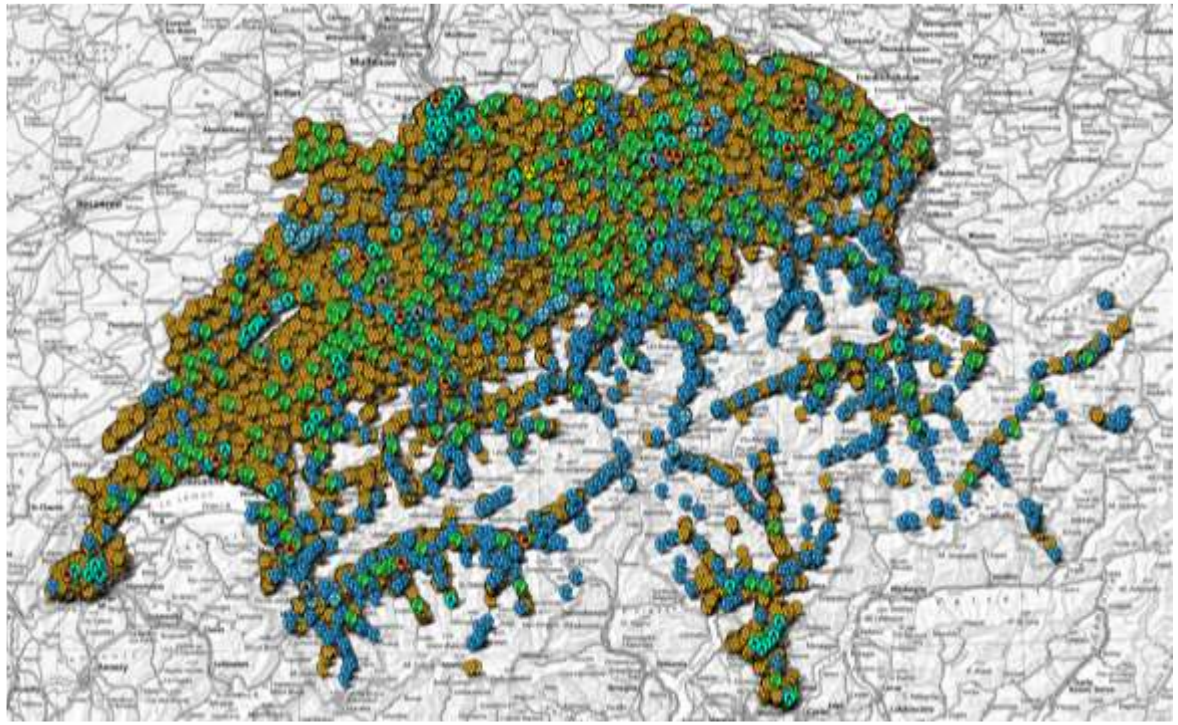
- Portugal: Observatório da Energia (observatoriodaenergia.pt). High-quality data on energy and PV
- IEA PVPS Task 13-ST2.5: PLR Determination Benchmark Study (https://osf.io/vtr2s/)
- France: BDPV (bdpv.fr) residential PV system database; 15k+ PV systems, 10+ years data
- Europe: Collaborative Platform for Simulation and Monitoring - COPLASIMON (coplasimon.eu)
- Europe: Pearl PV CKAN repository (ckan.pearlpv-cost.eu)



US PV Temperature Zone for each system, based on Karin et al. 2019 and pvcz 0.2.4.

US: PV fleet performance data initiative (https://www.nrel.gov/pv/fleet-performance-data-initiative.html)

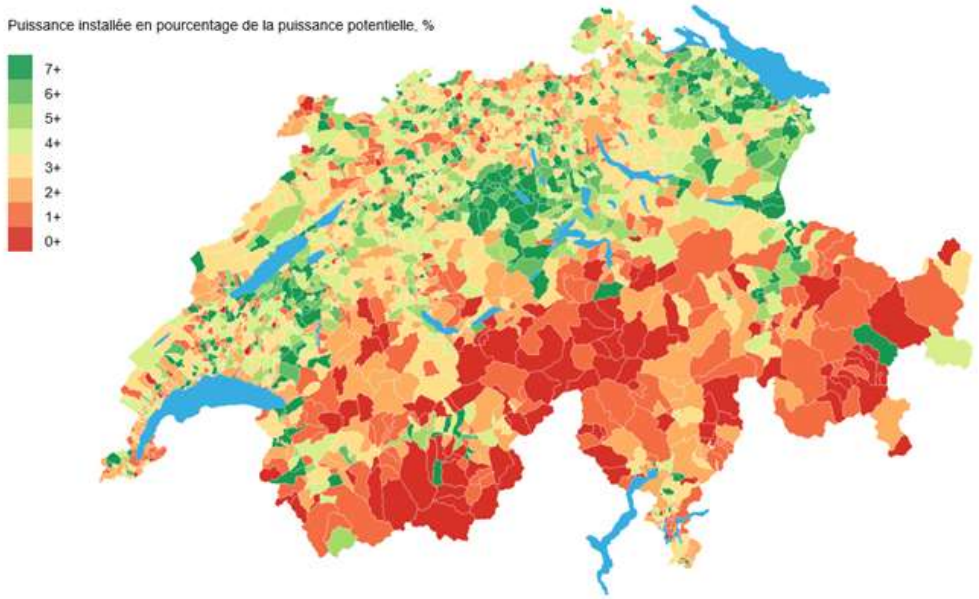
OVERCOMING GRID AND PLANNING BOTTLENECKS WITH OPEN DATA: SOURCES



- Power production units; Source: Swiss Federal Office of Energy, Swisstopo.
- Available: https://www.uvek-gis.admin.ch/BFE/storymaps/EE_Elektrizitaetsproduktionsanlagen

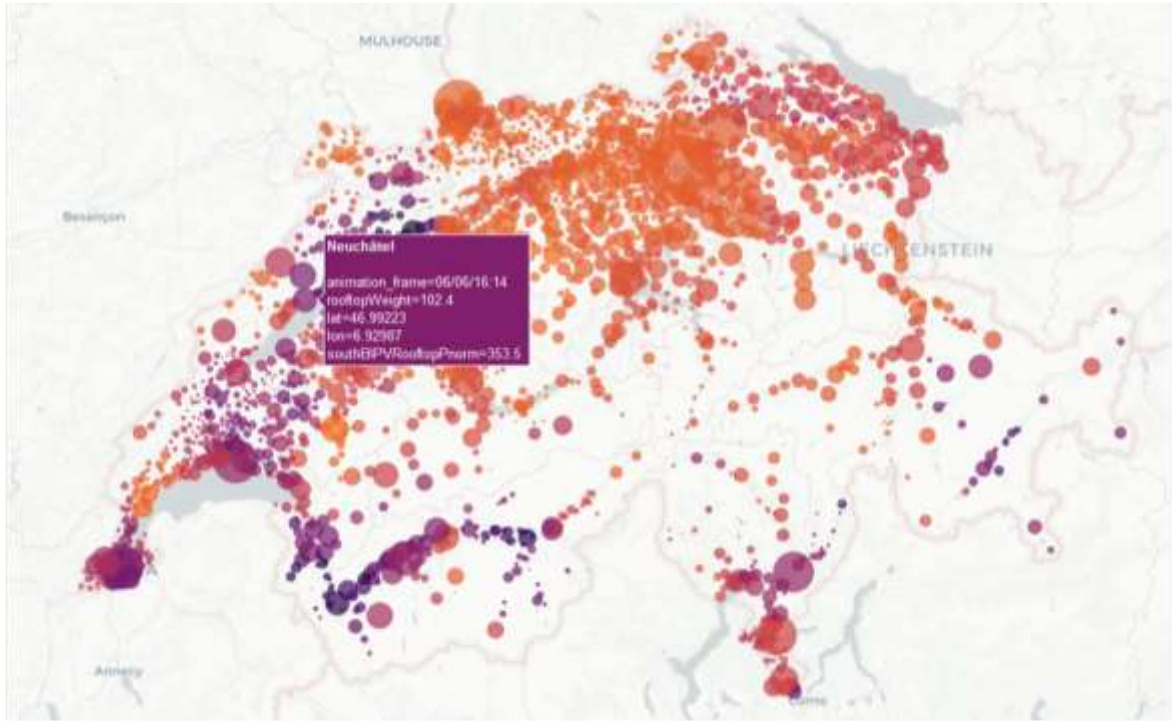
- Rooftop PV potential; Source: Swiss Federal Office of Energy, Swisstopo.
- Available: https://www.uvek-gis.admin.ch/BFE/sonnendach/index.html?featureId=4728178

OVERCOMING GRID AND PLANNING BOTTLENECKS WITH OPEN DATA: USE CASES



Sources des données de pvpower.ch

- Policy advocacy, benchmarking
- Comparison of installed power vs. potential per municipality



- Strategy, prospective studies
- Hour-by-hour simulation of energy balance by municipality in 2050 (source: CSEM)

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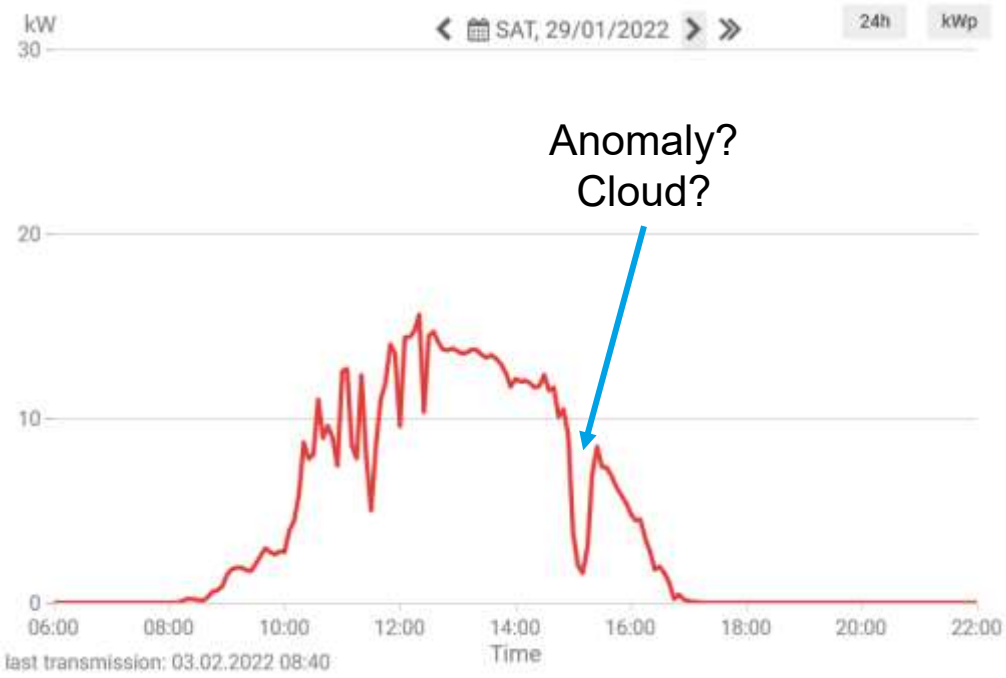
DATA SHARING FOR O&M: POWER IN NUMBERS



Data from single system: low value

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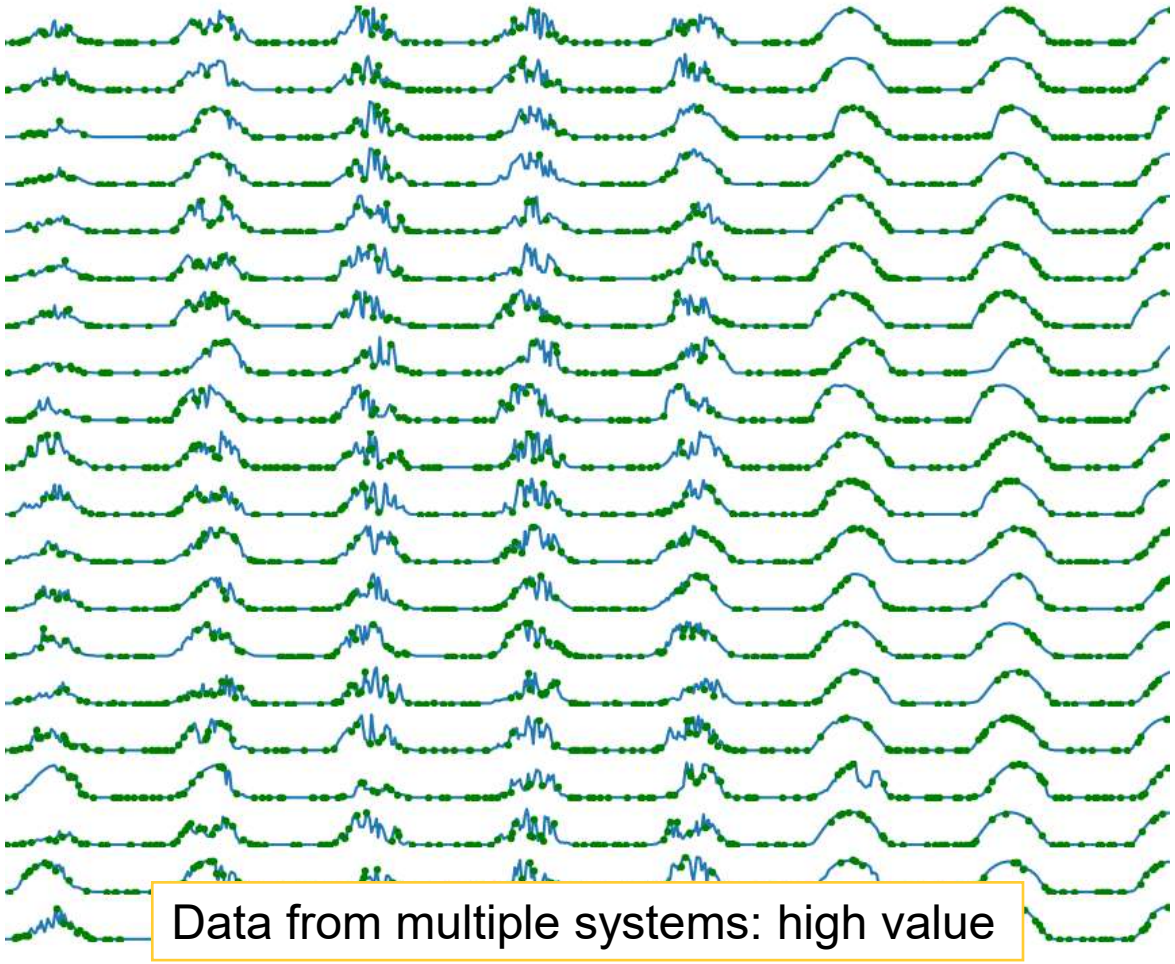
DATA SHARING FOR O&M: POWER IN NUMBERS



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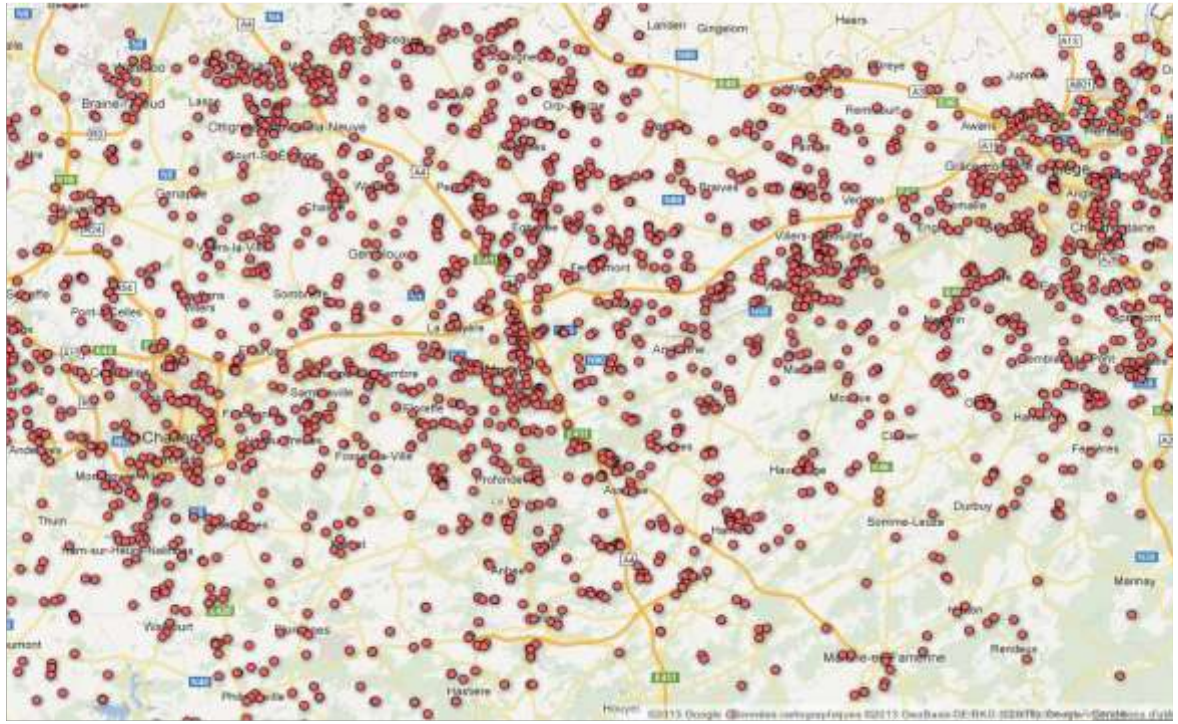
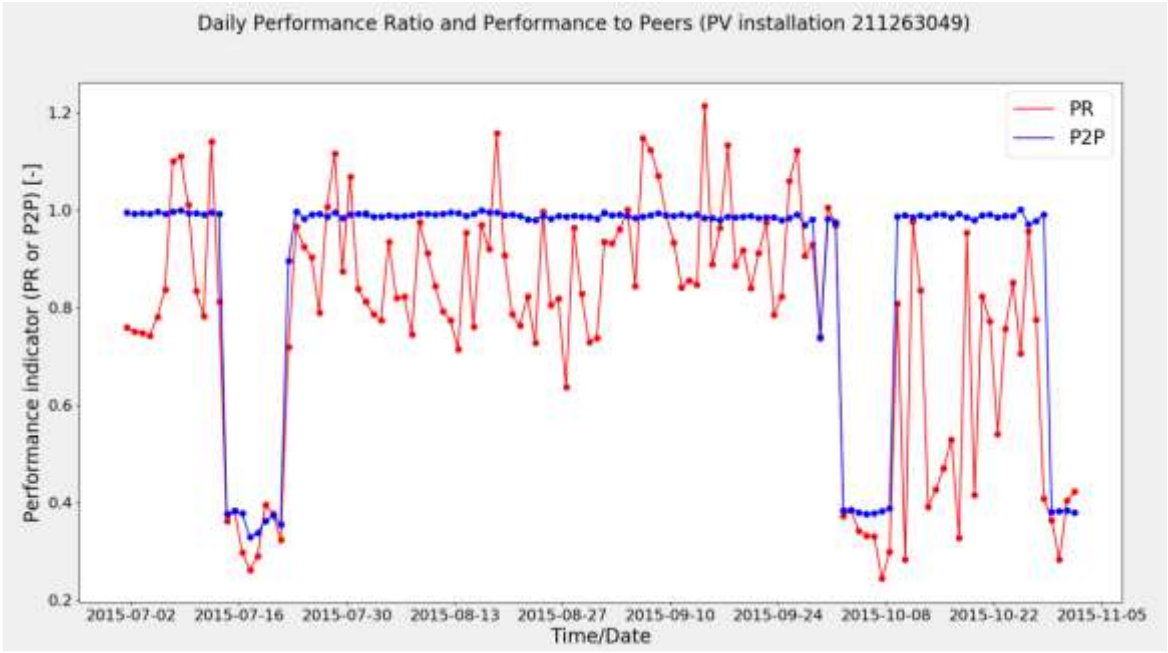
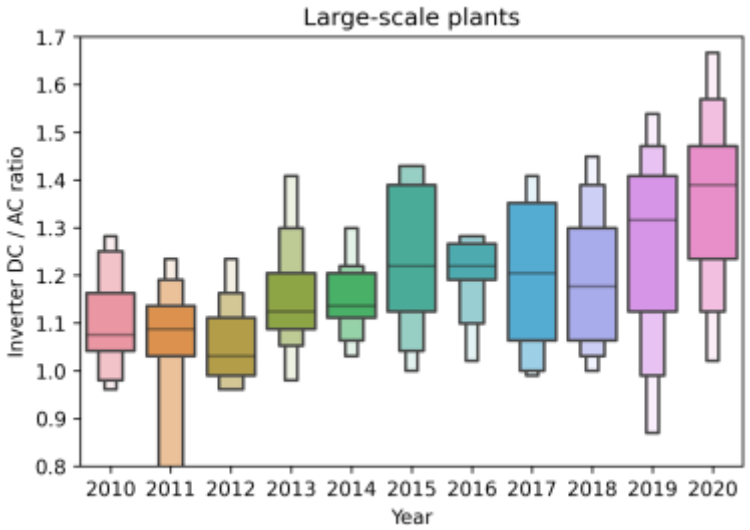


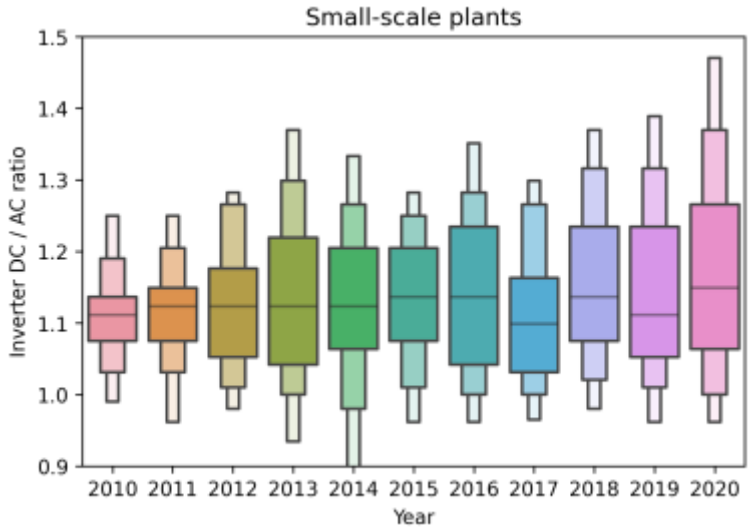


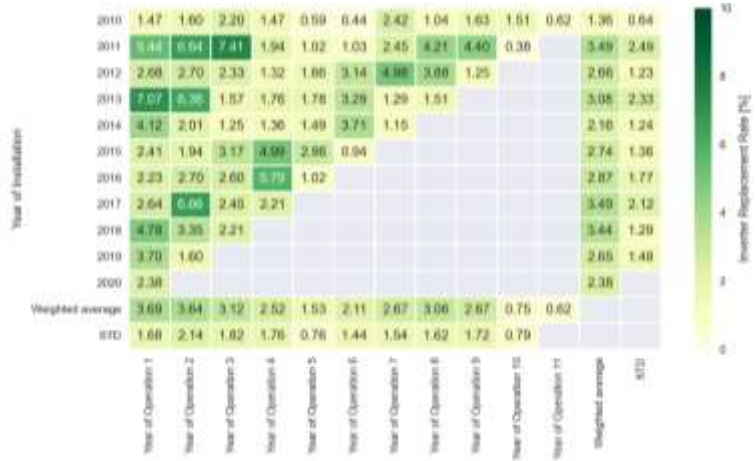
- Network of PV systems around Brussels
- Performance-to-peers indicator more stable and discriminating than performance ratio

J. Leloux, L. Narvarte, A. Desportes, and D. Trebosc, 'Performance to Peers (P2P): A benchmark approach to fault detections applied to photovoltaic system fleets', *Solar Energy*, vol. 202, pp. 522–539, May 2020, doi: 10.1016/j.solener.2020.03.015.

FROM DATA TO INSIGHTS: INVERTER PERFORMANCE







- DC/AC ratio: large-scale plants
- DC/AC ratio: small-scale plants
- Inverter replacement

Detailed report available on the TRUST-PV website: https://trust-pv.eu/reports/733/

Funded by the European Union
TRUSTPV SOLAR PV, PERFORMANCE & RELIABILITY
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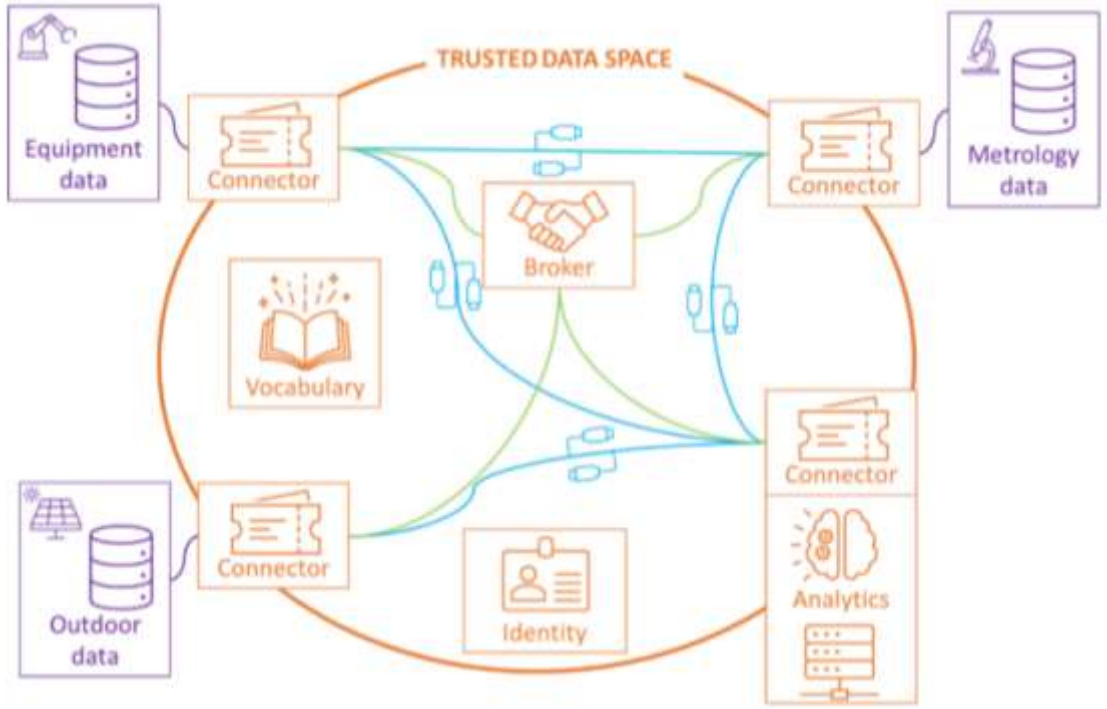
MULTI-ACTOR TRUSTFUL DATA EXCHANGE

- Central approach in the EU's digital strategy: **data spaces**
- Core concepts:
  - Data sovereignty
  - Decentralisation
  - Connectors
- First deployment of data space for PV sector in the **PILATUS project**
  - Objective: total quality management and process improvement along entire supply chain
  - First four connectors deployed



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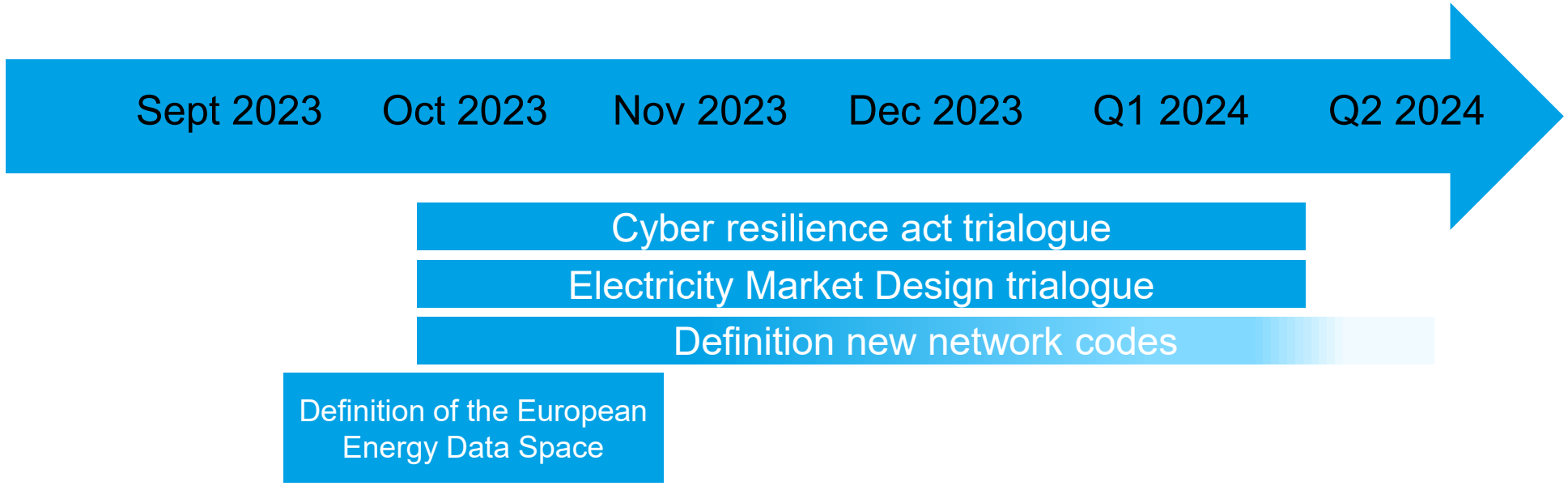
This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI)

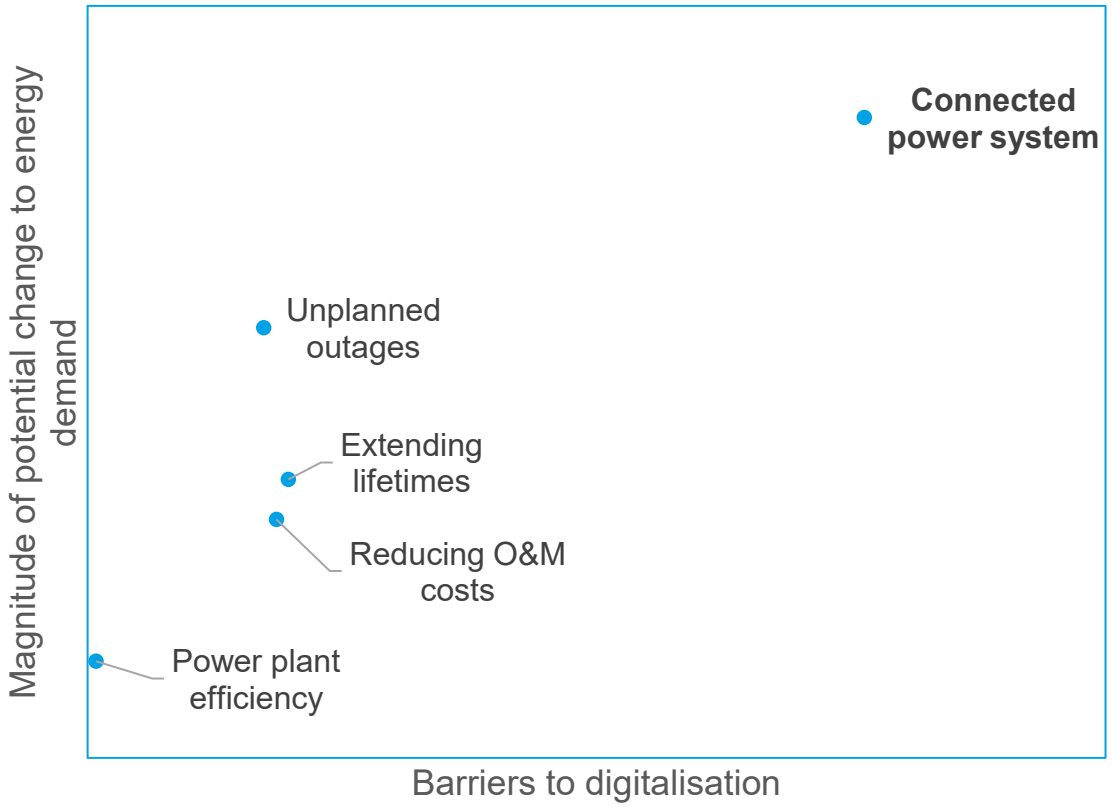
ACCELERATING EUROPEAN FRAMEWORK

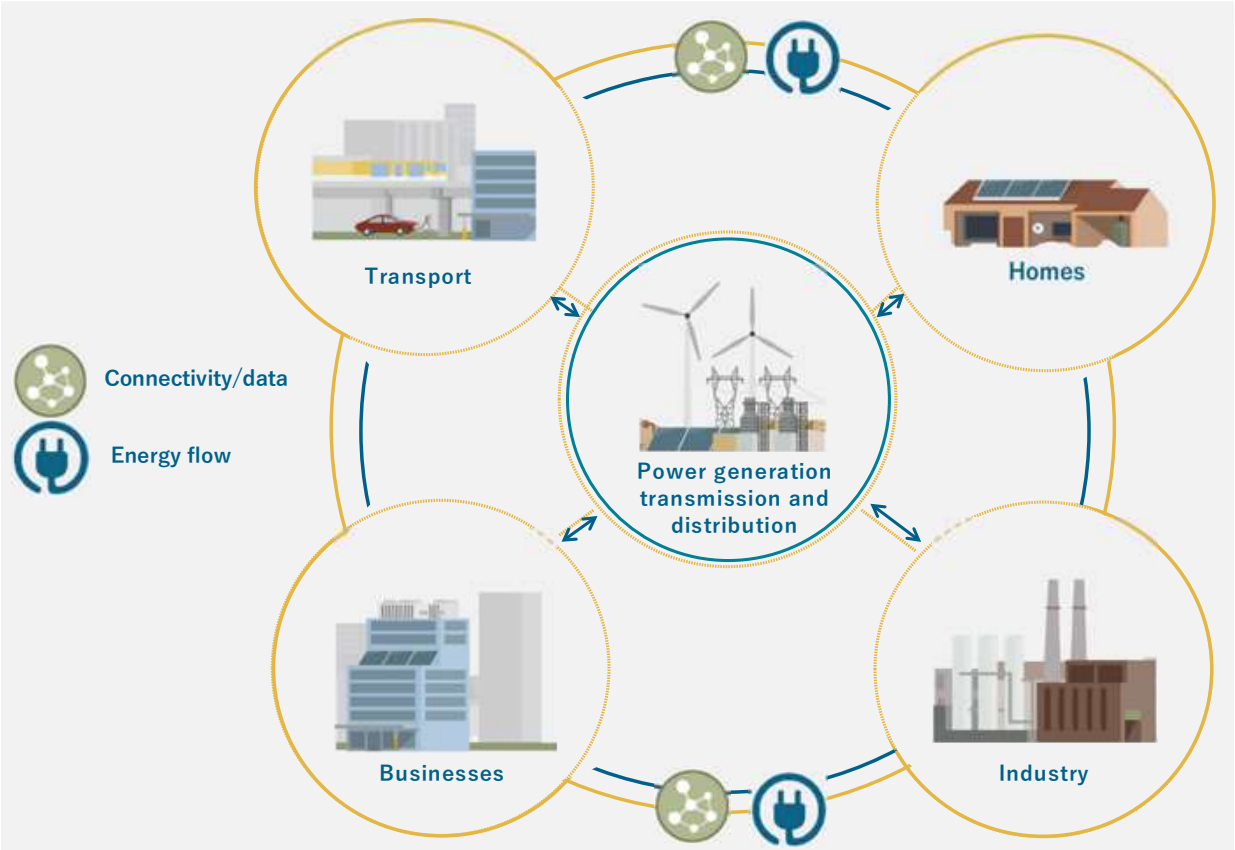


- **European Data Strategy** to streamline the use of data, define ownership and better allocate value from data production, enable new business, applications & processes
- **Cyber Resilience Act** defining key requirements for the PV industry, notably utility scale projects (e.g., localisation of data storage)

- **Electricity Market Design**: digitalization and consumers are at the heart of the revised EU laws on the electricity market
- **Energy Data Space**:
  - Facilitate energy data exchange, enable the energy transition “behind the meter”, unlock flexibility
  - Expert group on energy data space by end of 2024 (focus likely on consumers/rooftop PV)

DIGITALISATION: LONG-TERM BENEFITS



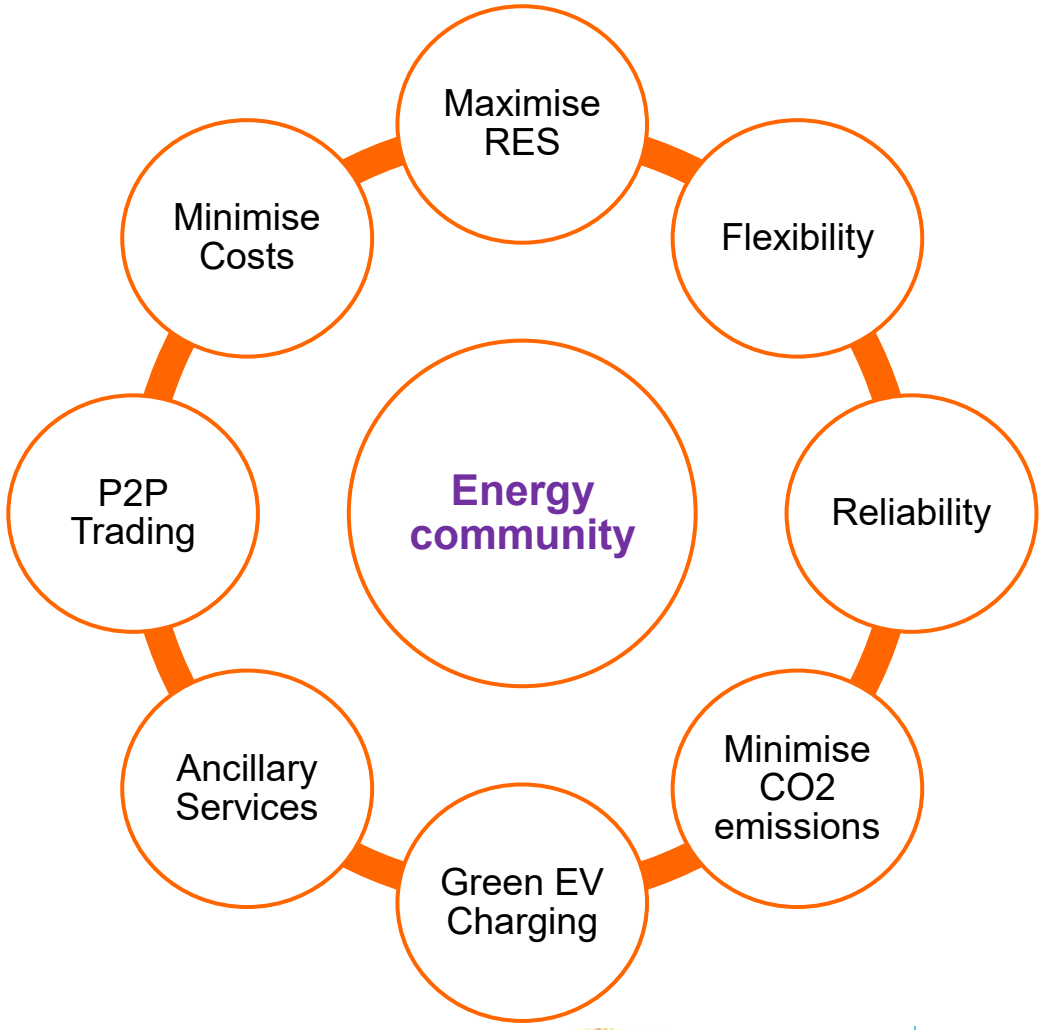


IEA (2017), Digitalisation and Energy, IEA, Paris https://www.iea.org/reports/digitalisation-and-energy

MANAGING ENERGY COMMUNITIES THROUGH SMART DATA SPACES

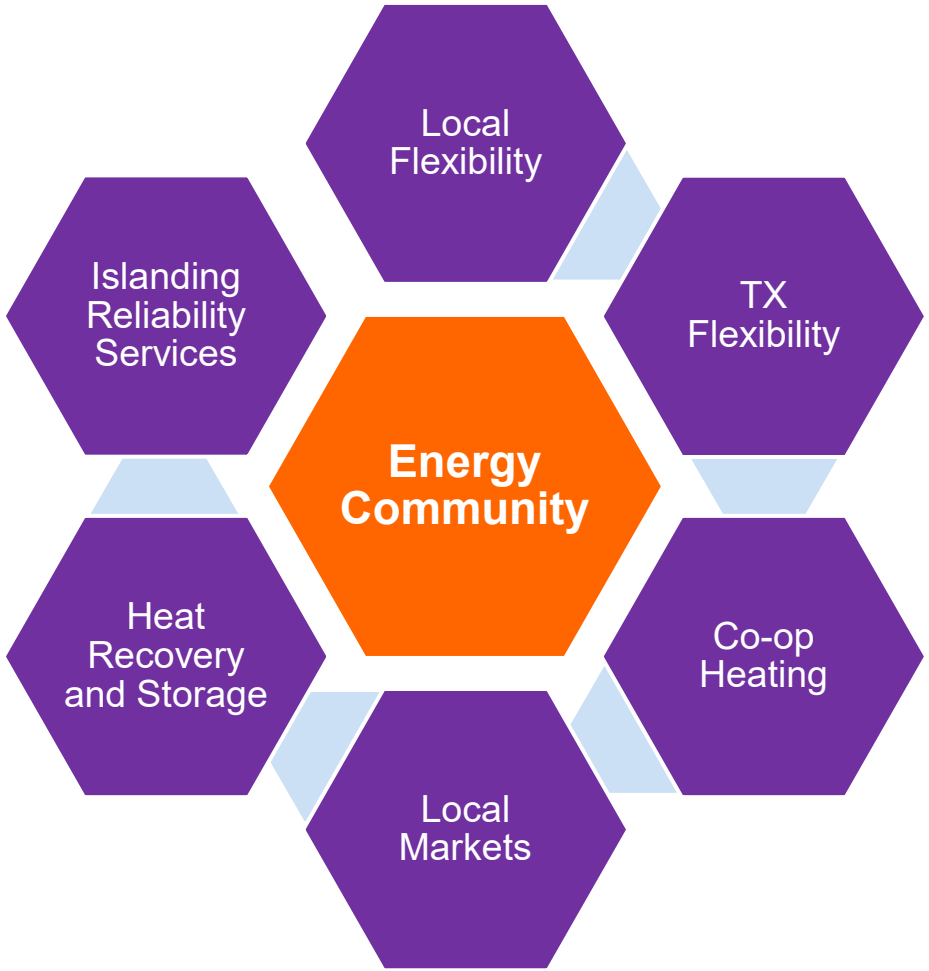
Energy Communities:

- Possible use cases facilitated through smart use of data
- Appropriate tools currently being deployed.
- Data providers:
  - Smart meter data from end users
  - Distributed generation data
  - Storage system data
  - EV charging data
  - DSO: Shareable system data
  - Publicly available weather data



https://eneuron.eu/

ENRICHING BUSINESS POSSIBILITIES THROUGH ENHANCED DIGITALIZATION



Estimated business benefits of digitalisation:

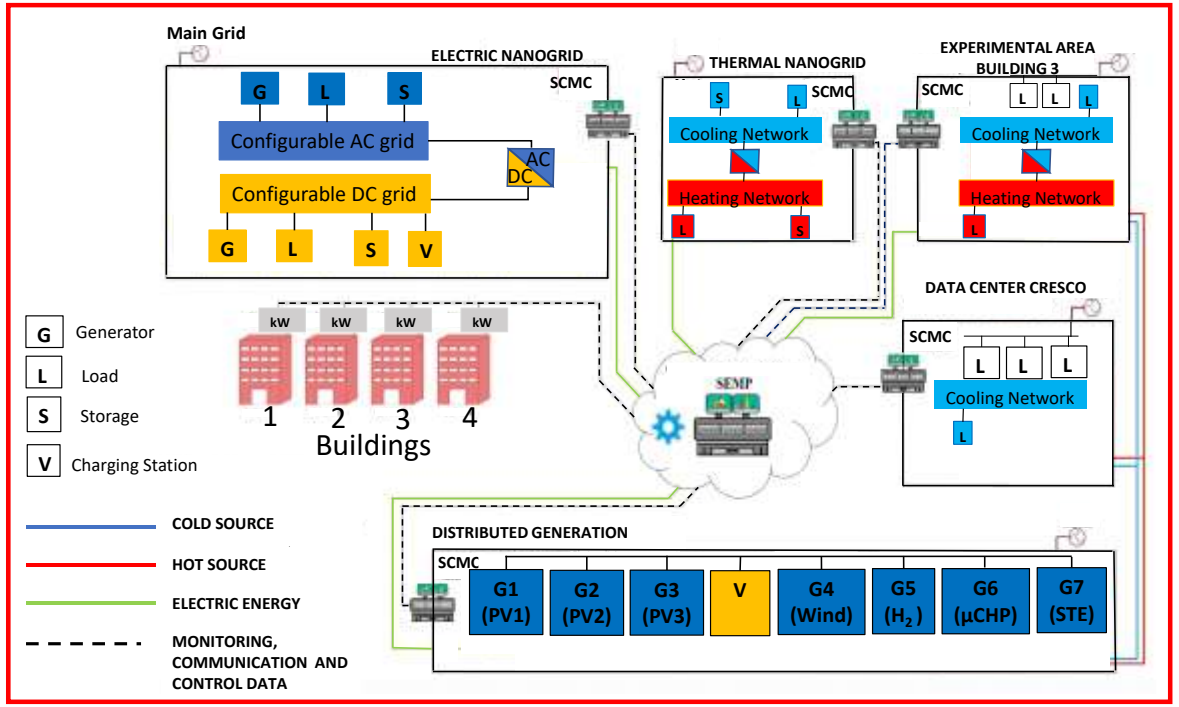
- +10% increase in value of PV electricity
- +50% increase in penetration levels in given grid
- 15% to 35% reduction in annual electricity costs through P2P trading and energy communities

https://eneuron.eu/

PILOT DEPLOYMENT: ENEA'S MISSION PROJECT

- **MISSION project: multi-vector integrated smart systems and intelligent microgrids for accelerating the energy transition** (MISSION) project.
- Objective: to study, design and implement technological solutions enabling the transition of networks towards integrated and **smart multi-energy distribution systems** based on different energy carriers.
- Digitalisation can contribute to guarantee an adequate level of:
  - energy security
  - adequacy
  - reliability
  - Resilience

  in grids and microgrids also facing anomaly and fault conditions.



Schematic architecture MISSION demonstrator at Research Centre ENEA Portici (Naples)

You are invited!

Data, AI, IoT
Opportunities and Challenges for PV Innovation

21/09/2023, 17:00-18:00 – Room 5B

17:00-17:10 Introduction of ETIP PV and the Strategic Research and Innovation Agenda for Photovoltaics (SRIA PV) with focus on PV digitalization related roadmaps

17:10-17:50 Three rotating round table **discussions** about:

- **Digitalization of PV manufacturing**
- **Digitalization of PV systems**
- **Smart Energy Integration of PV**

17:50-18:00 Conclusions

The European Technology and Innovation Platform for Photovoltaics

etip-pv.eu

Public consultation: where should PV R&D go?

2024 update of PV SRIA

SCAN ME to answer the survey by 31/10

Survey link

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State Secretariat for Education, Research and Innovation SERI