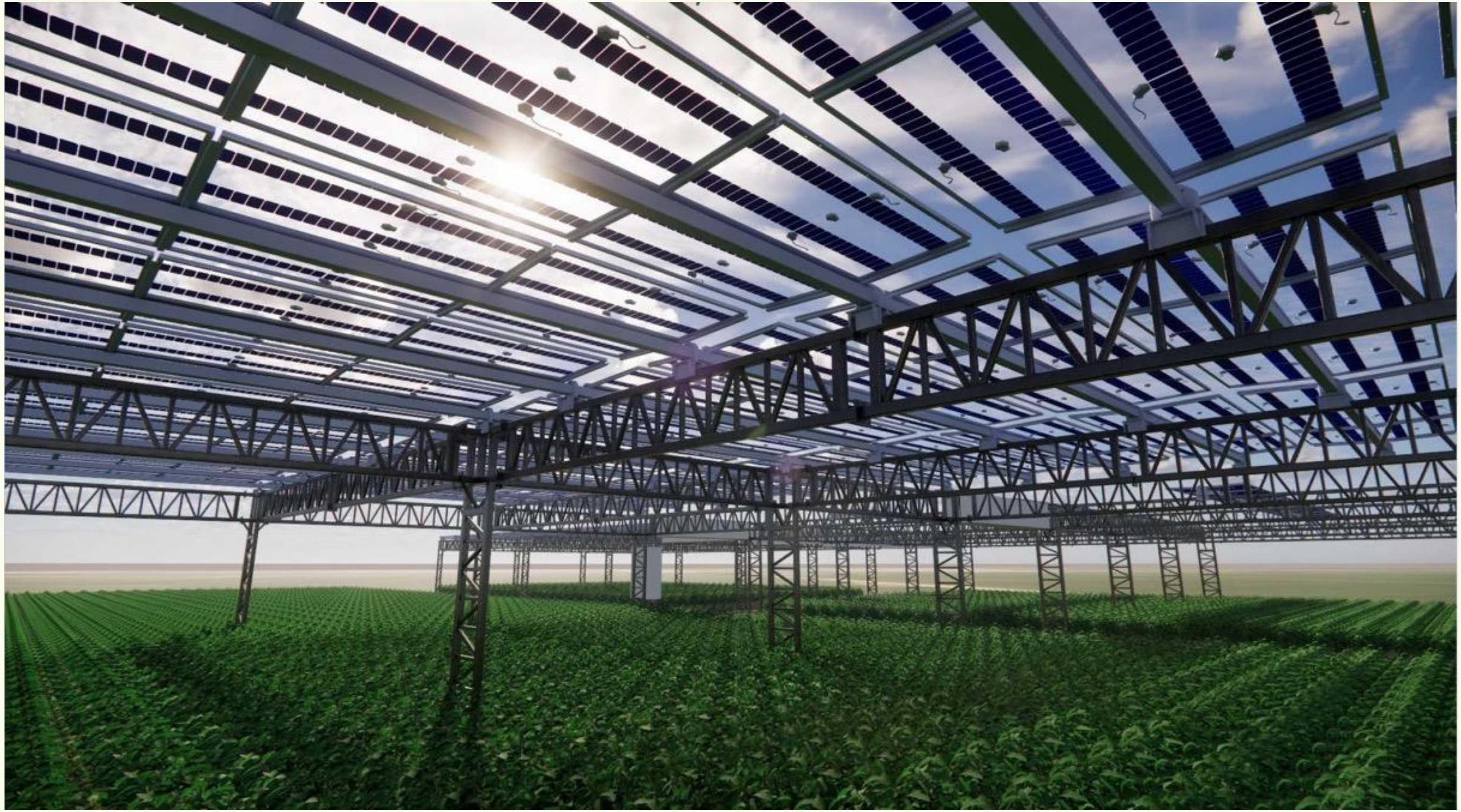
# AgriPV system with climate, water and light spectrum control for safe, healthier and improved crops production

Colin Osborne (University of Sheffield, UK)

Funded by the European Union

# What is AgriPV?

## Optimize solar energy usage by crops and for renewable energy



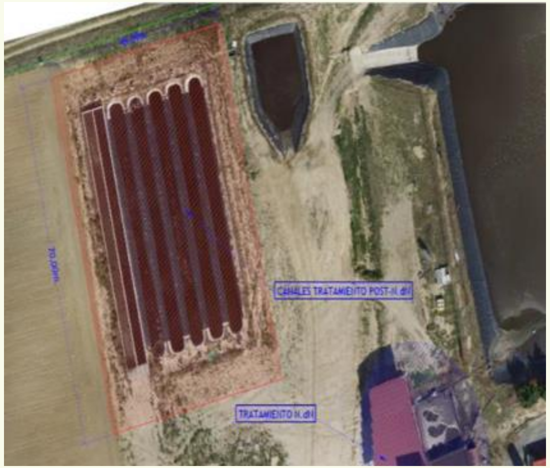
## GOAL – To boost the energy-agricultural synergy of agriPV technologies to enhance growth conditions and increase land use efficiency, crop yield and renewable energy generation.

PV 4 Plants

1. Involve end-users (citizens, civil society, public authorities and NGOs) in agriPV implementation decision making processes
2. Create methodology to elucidate crop performance (health and yield) under customised light spectrum and transparency
3. Adapt, test, manufacture and implement a novel dynamic agriPV system based on colour converters and solar panels, with integrated rainwater harvesting
4. Proactive Facility Control and Operation for the agriPV system, increasing PV power output and plant growing conditions
5. Increase the share of recyclability and reusability in all phases
6. Demonstrate and validate solutions and different agriPV configurations in a range of scenarios and climatic conditions
7. Boost scalability and replicability, via evaluation of financial support mechanisms, multi-criteria assessment, innovative local/rural business models and dissemination/exploitation activities

# Installations one year apart


Bursa – Turkey
Tomato & Green peas



Avila – Spain
MicroAlgae

Hoje Taastrup – Denmark
Cress, Spinach, Lettuce, …

PV 4 Plants

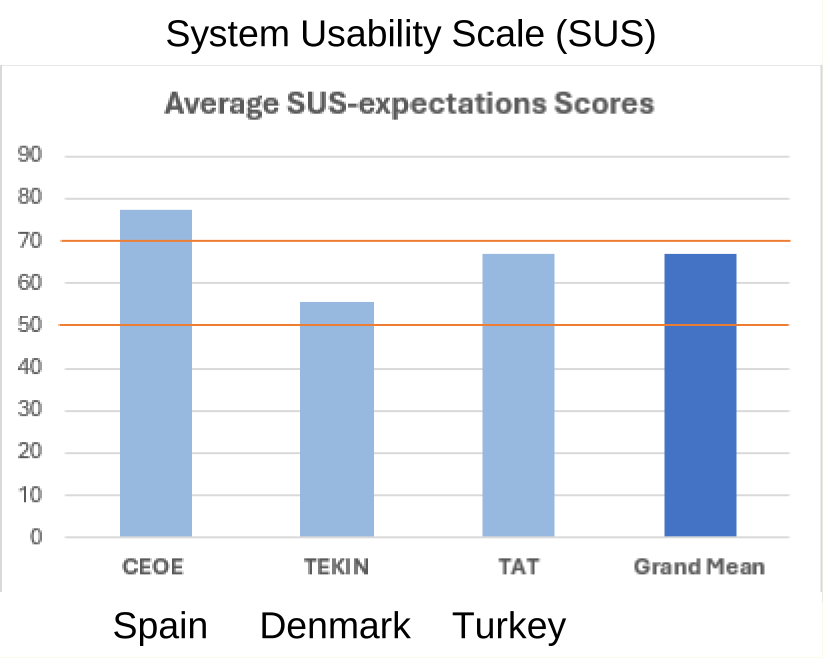

DTU
The University Of Sheffield.
kalyon-PV
SMART FARM SENSING
DIPUTACIÓN DE ÁVILA
ENER2CROWD.com
CEOE Ávila
tat
TEKIN'S GARTNERI
CIUBE
ODTÜ GÜNAM
R2M SOLUTION


## So far, stakeholders are OK with the plan...

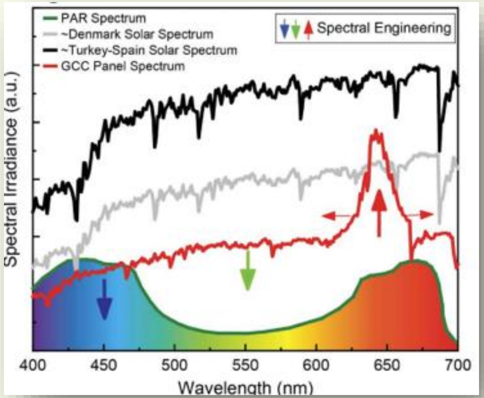
Spain stakeholders in Acceptable Region,

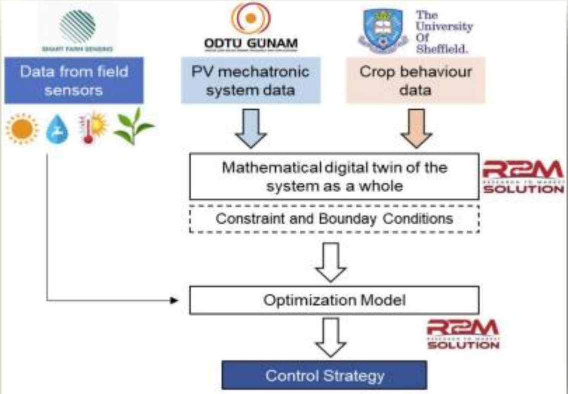
others in Marginal Region

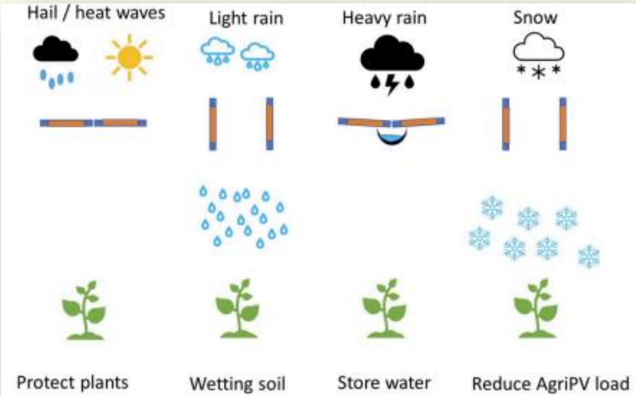
(as defined by Bangor et al. (2009))



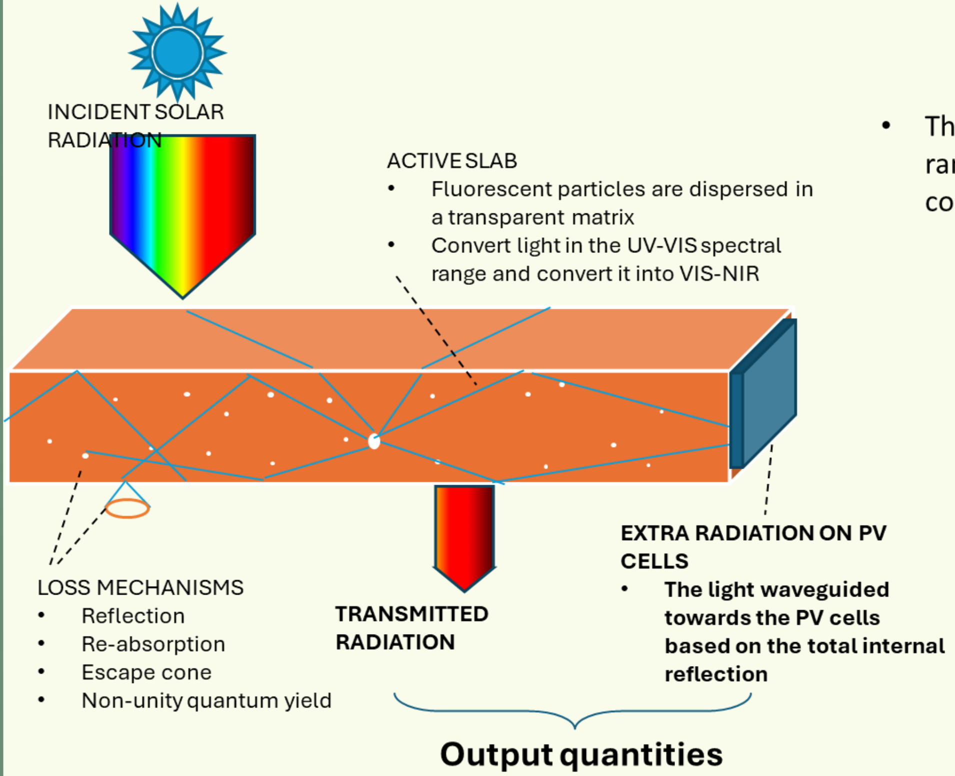
# Innovations

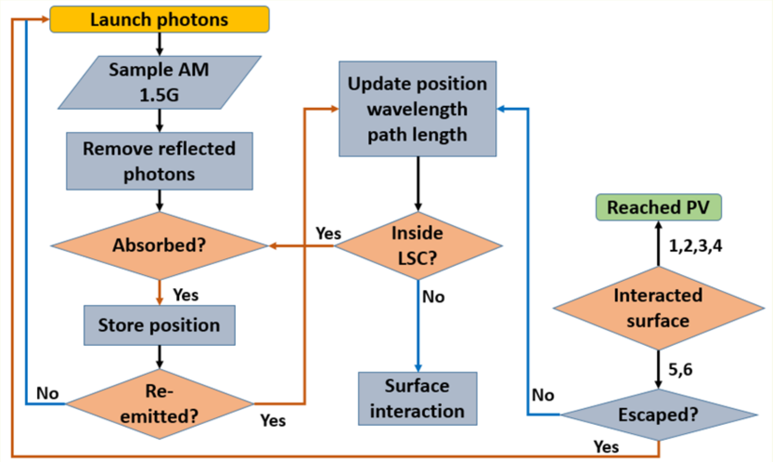



# Simulation & test platform are ready

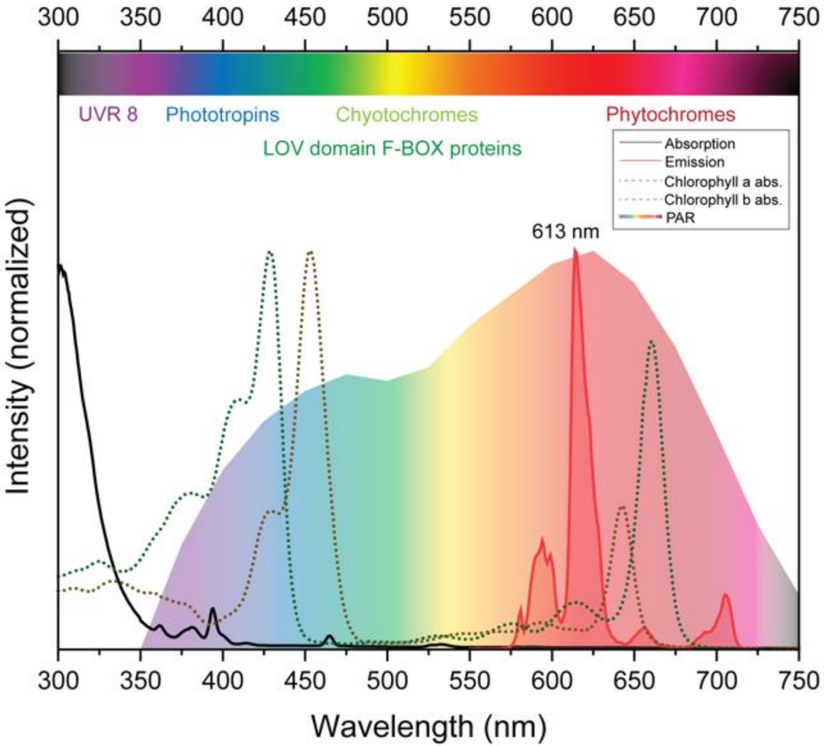



- The Monte Carlo algorithm is a computational technique that uses random sampling to solve mathematical problems or simulate complex systems.

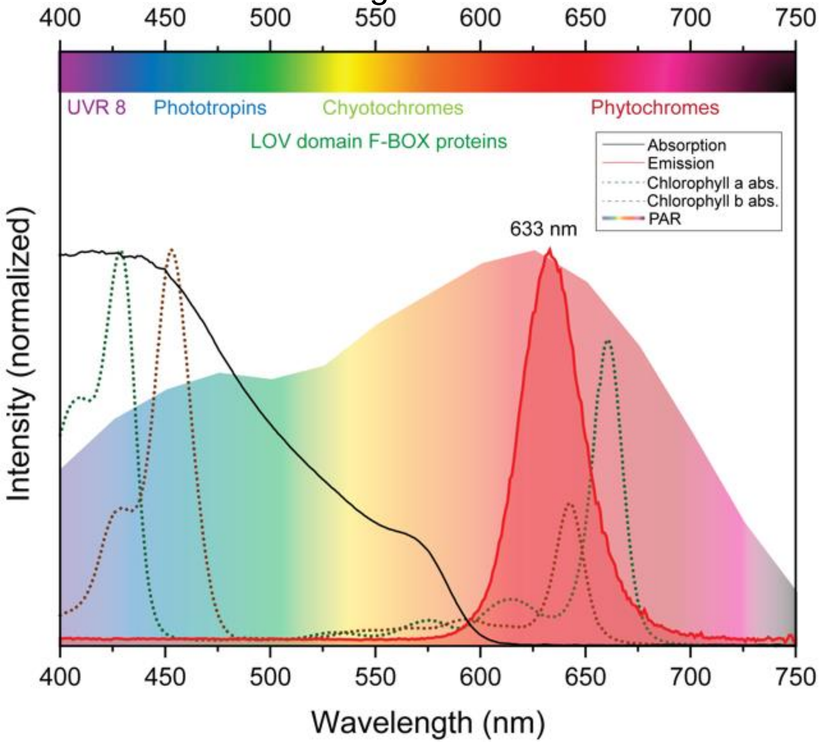


# Alternative Luminescent Materials

Europium-doped glass nanobeads



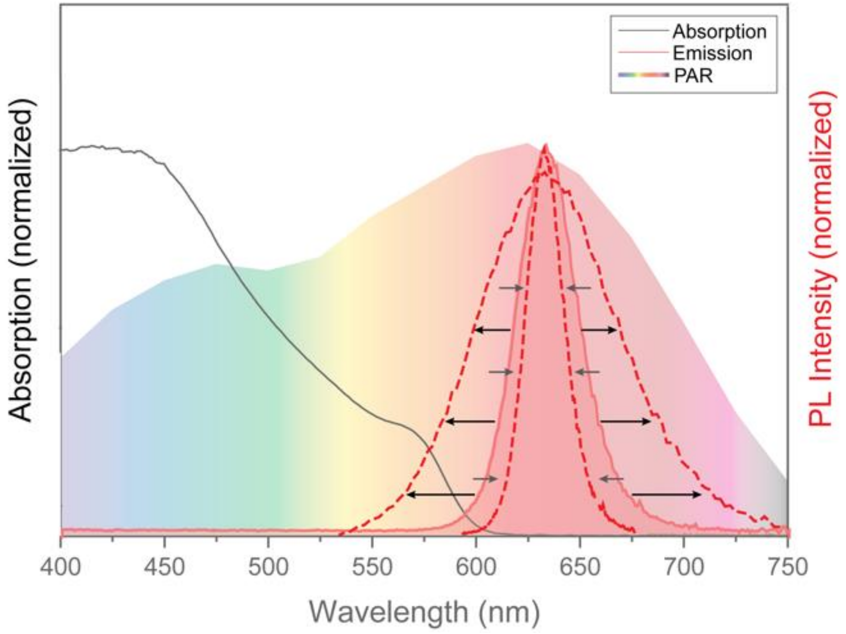

Perovskite-based glass nanobeads



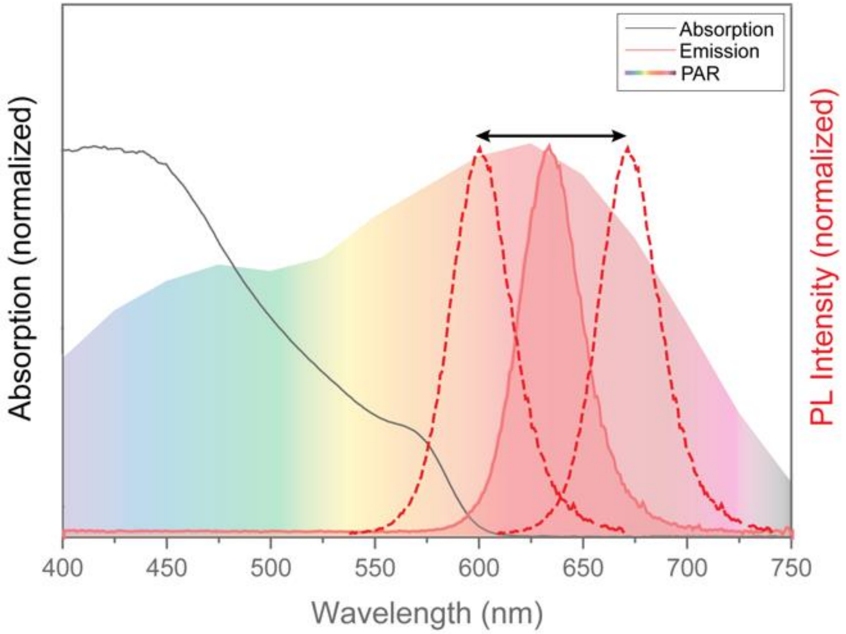

These materials were tested for potential adaptation and improved performance in different climates and crops

# Perovskite-based glass nanobeads

tunability of spectrum in terms of peak width




tunability of spectrum in terms of peak position

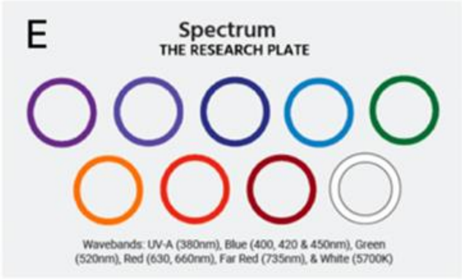



This tunability highlights the flexibility of perovskite-based glass nanobeads for enhancing red emission, which can be adapted for improved performance in various climates and crops.

# Impacts of light spectrum on crop performance

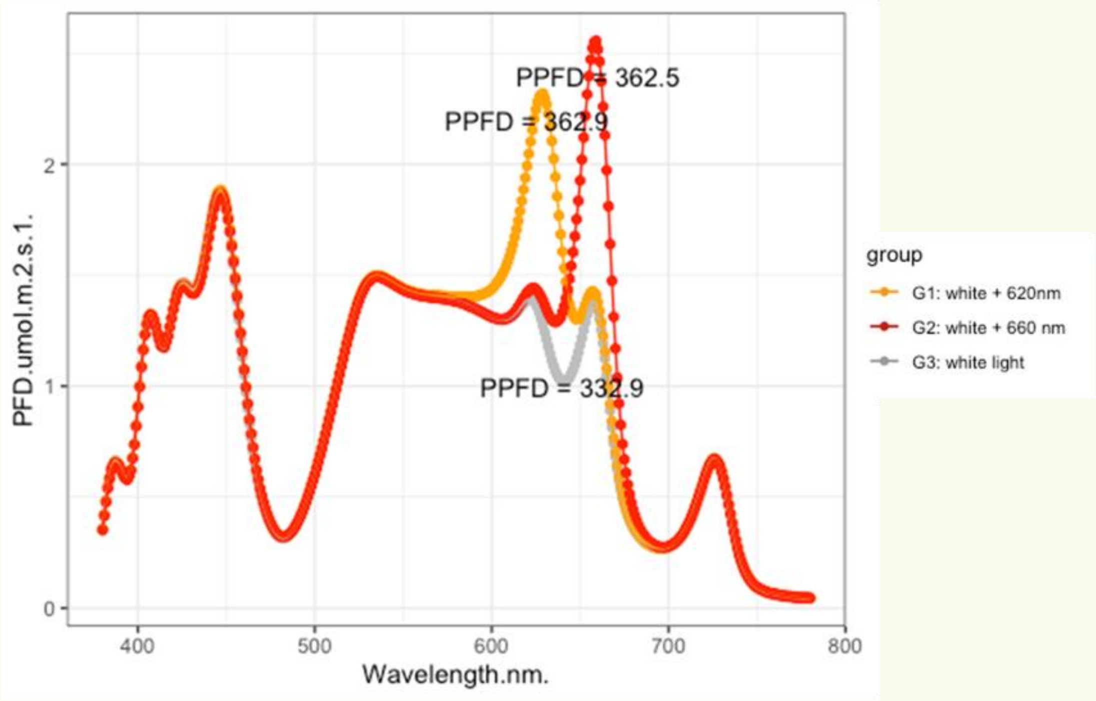
3 x controlled environment plant growth rooms

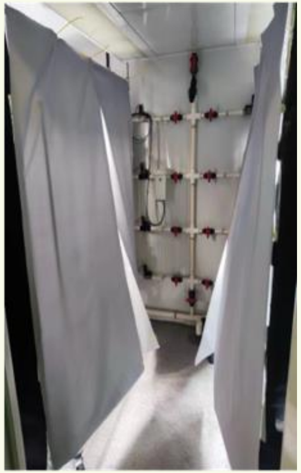
2 x growing areas per room

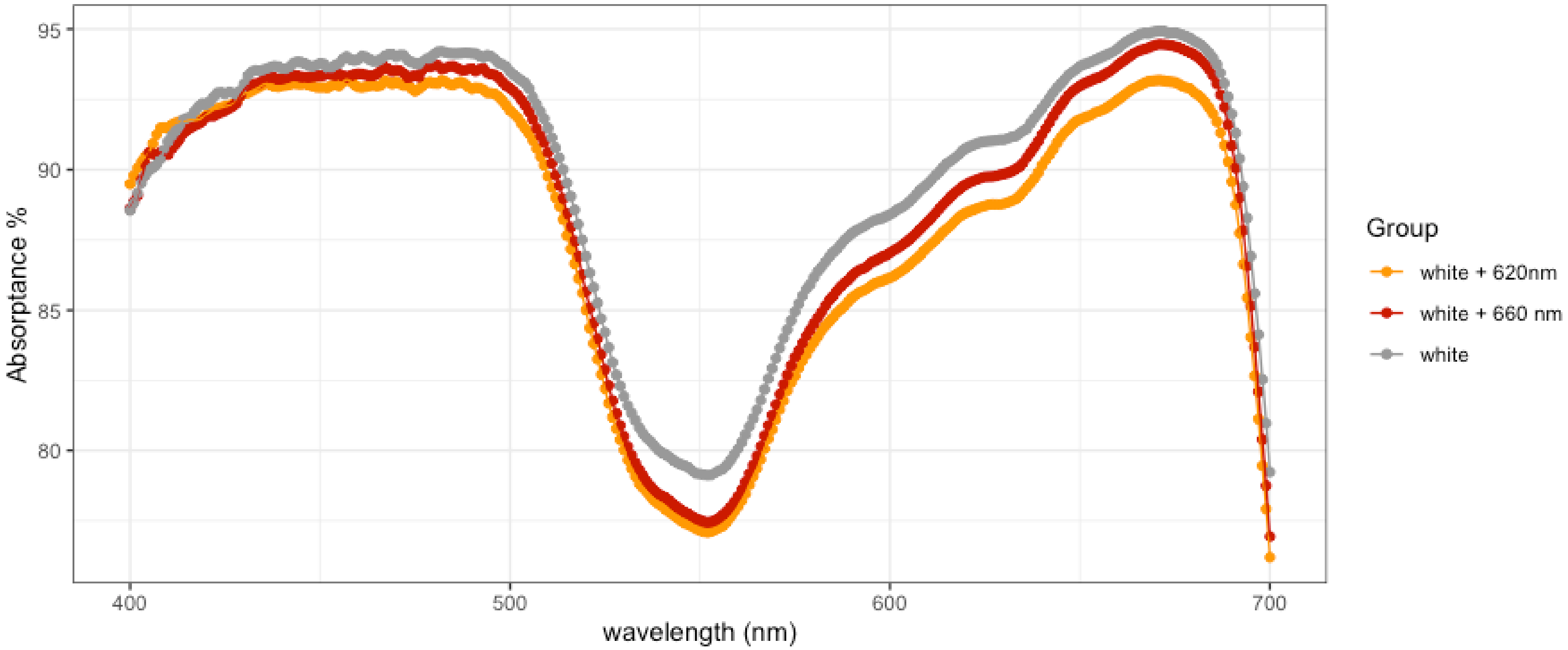

9-channel tunable LED lighting units

# Indoor tests for tomato from Bursa



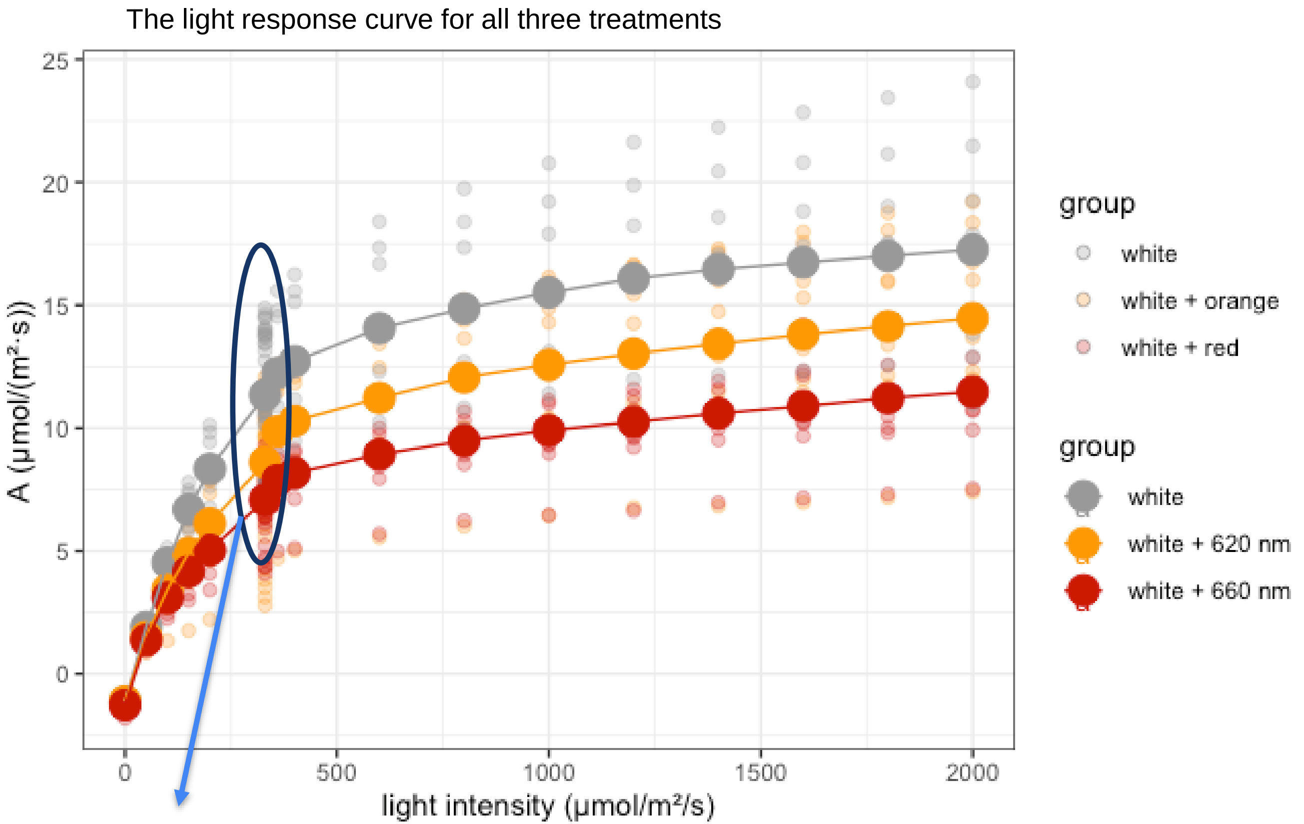



# Light absorptance in the visible spectrum



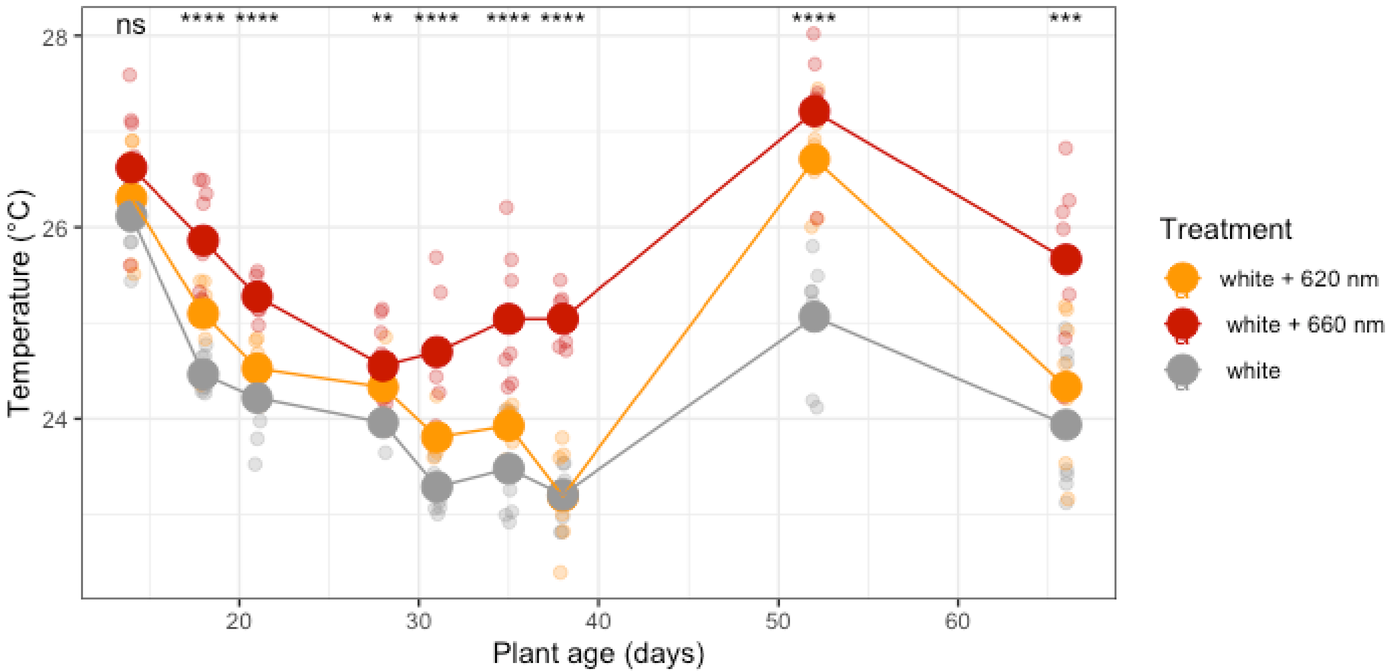

Slightly lower absorptance in red wavelengths for plants growing under 660 nm or 620 nm enrichment

# Photosynthesis



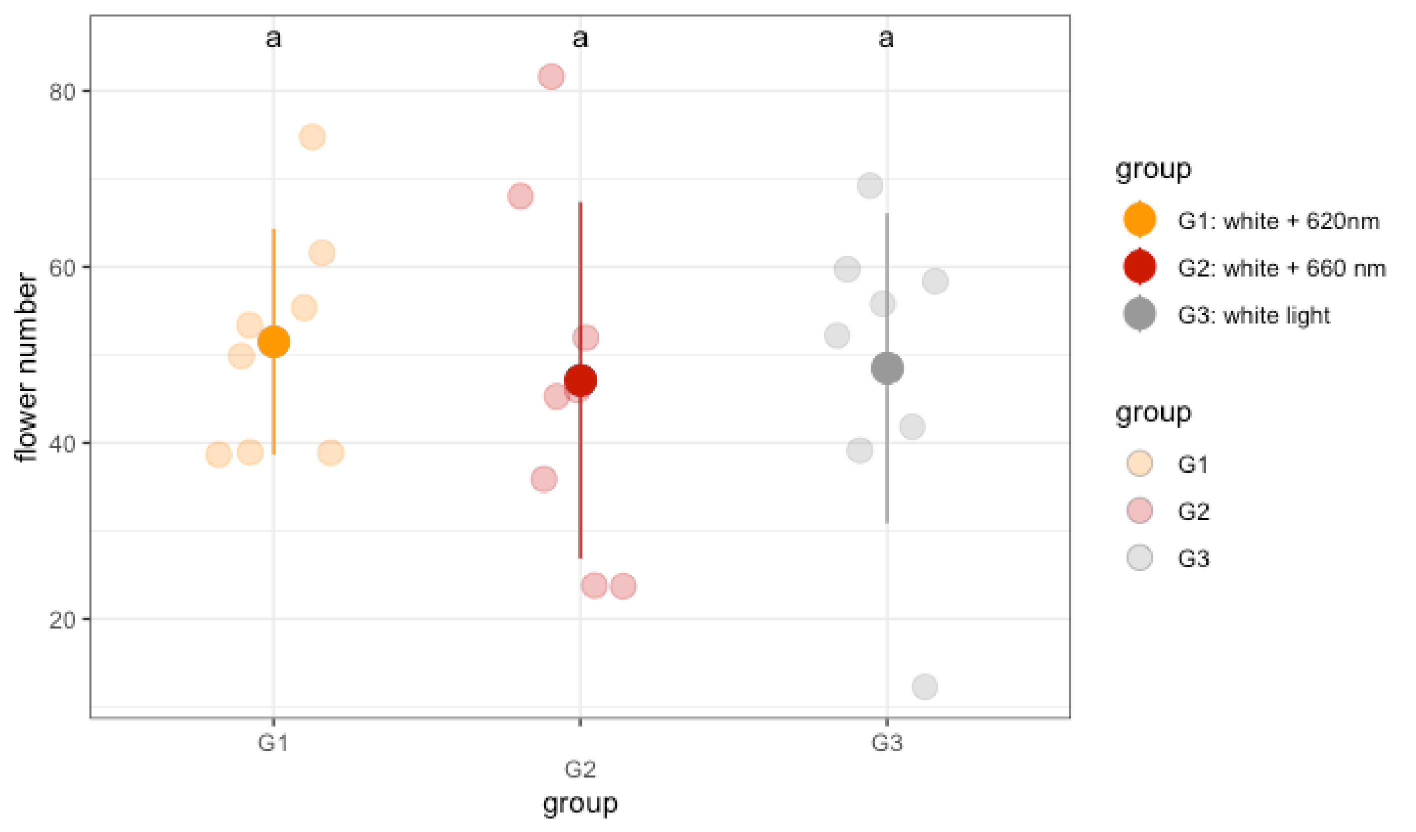

Our experimental growth conditions

# Thermal imaging



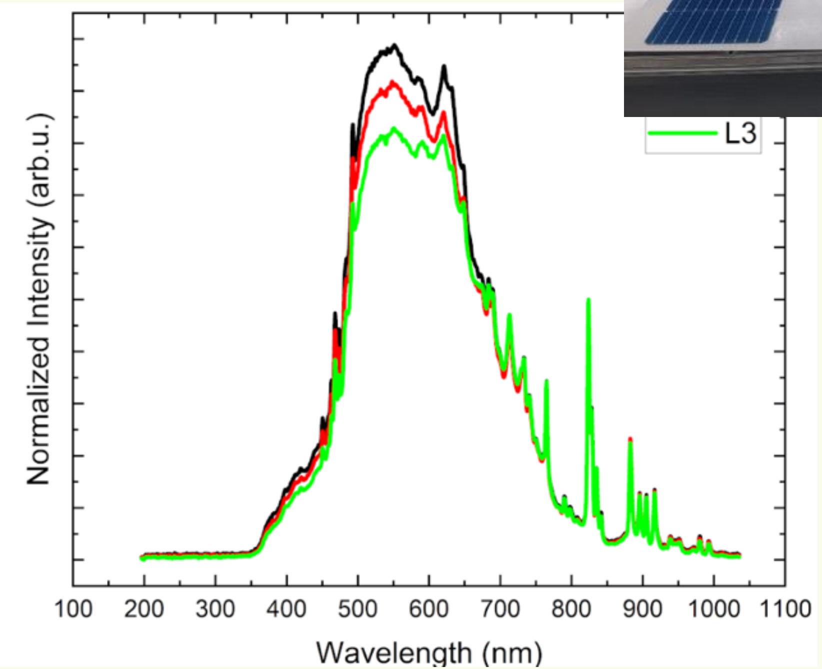

Leaf temperatures in the increased red light treatment group were consistently the highest.
Implies lower evaporation from the leaves in this treatment which saves water.

# There are no significant differences in flower number among three groups



# Spectral shift is achieved

# Panels are in fabrication

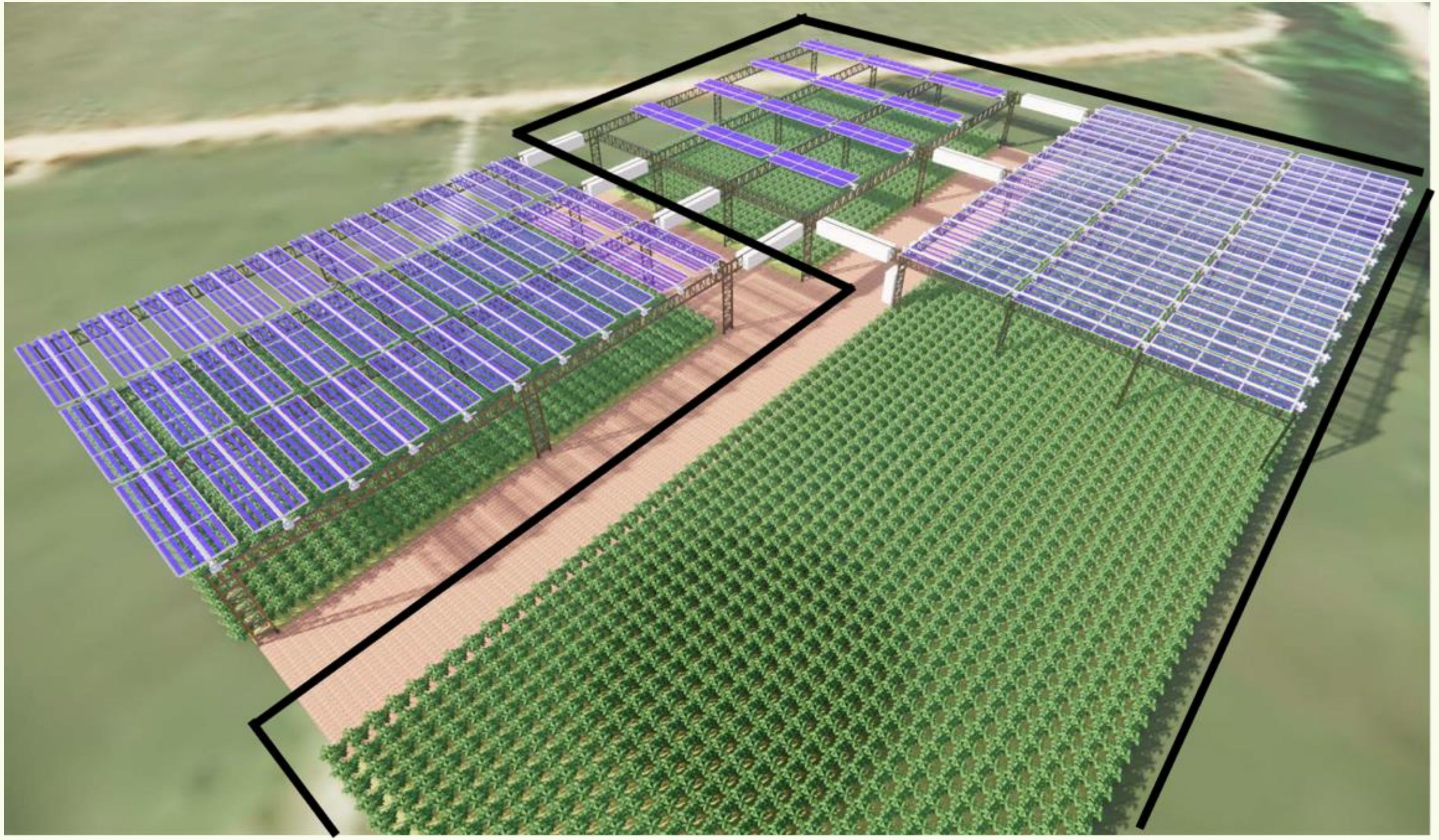



One field with the innovation

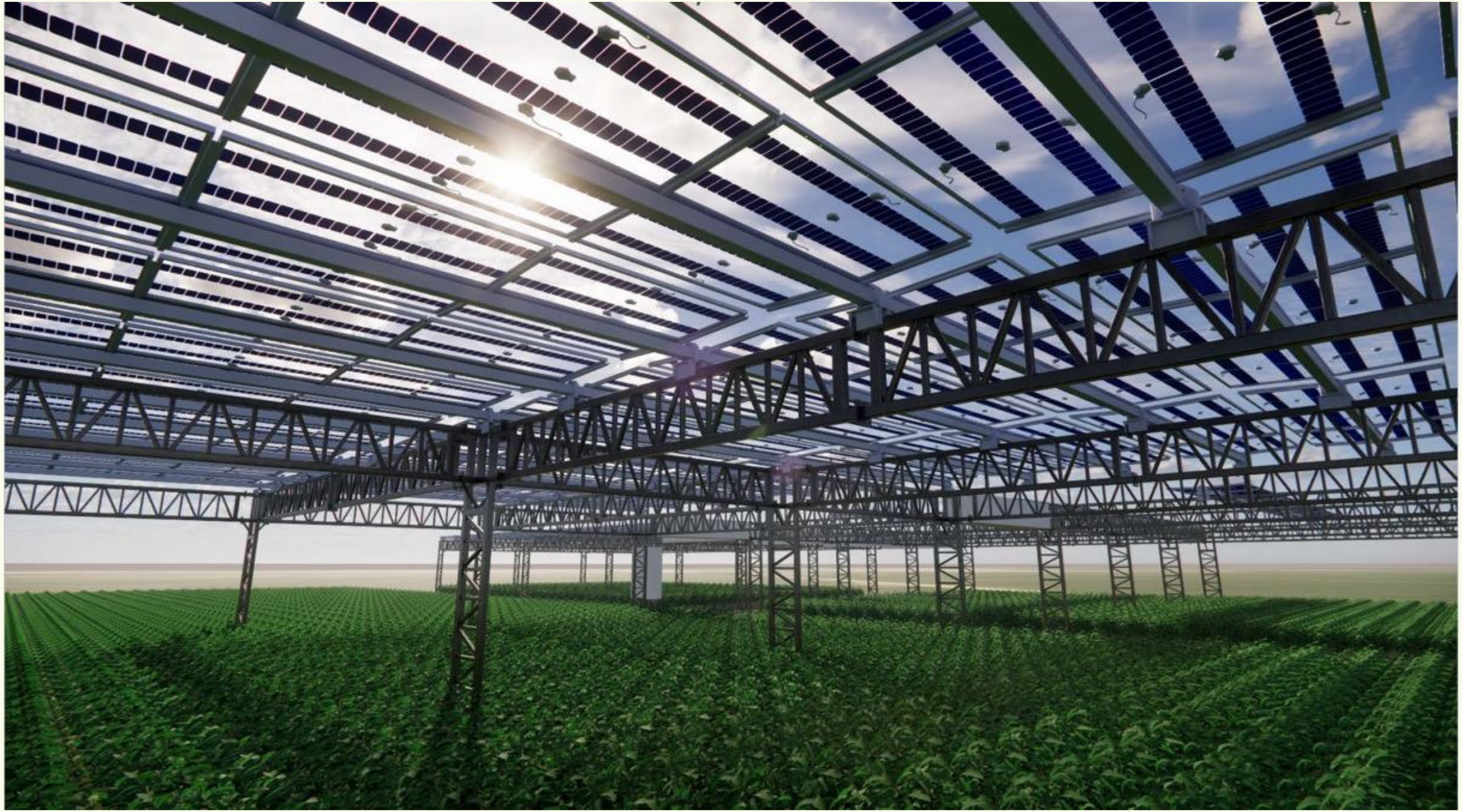
One reference field with standard PV panels

One reference field with no AgriPV

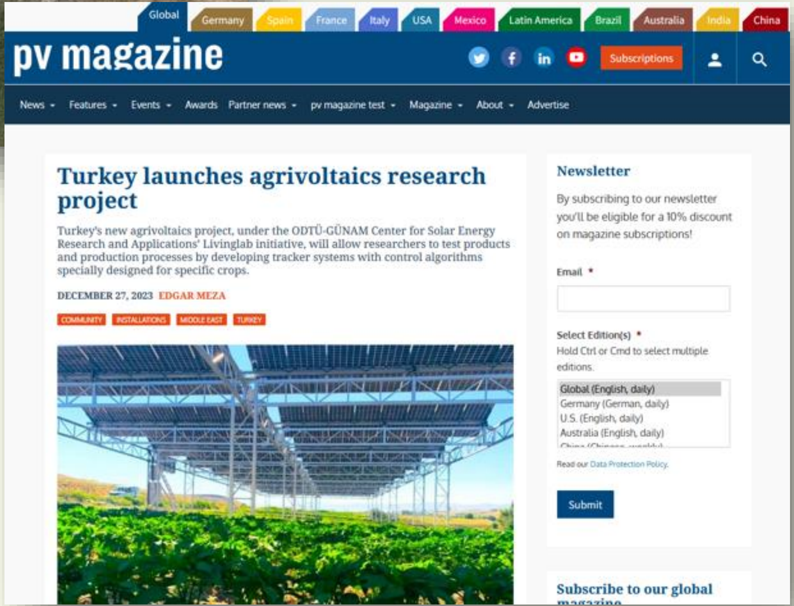
One reference field funded by another project



# To be installed in October-November in Bursa, Turkey



# Turkey's First AgriPV Project



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## Turkey launches agrivoltaics research project

Turkey's new agrivoltaics project, under the ODTÜ-GÜNAM Center for Solar Energy Research and Applications' Livinglab initiative, will allow researchers to test products and production processes by developing tracker systems with control algorithms specially designed for specific crops.

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PEDvolution

Interoperable solutions to streamline PED evolution and cross-sectoral integration

# PEDvolution | Interoperable solutions to streamline Positive Energy District evolution and cross-sectoral integration

## PROJECT OVERVIEW, VISION & EXPECTED RESULTS

Maria Pavlopoulou, **Sympraxis**

**Sustainable Places 2024**

24th September 2024 (online)

Co-funded by the European Union

Co-funded by the European Union (under grant agreement Nº 101138472). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

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**State Secretariat for Education, Research and Innovation SERI**

The Swiss project participants received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

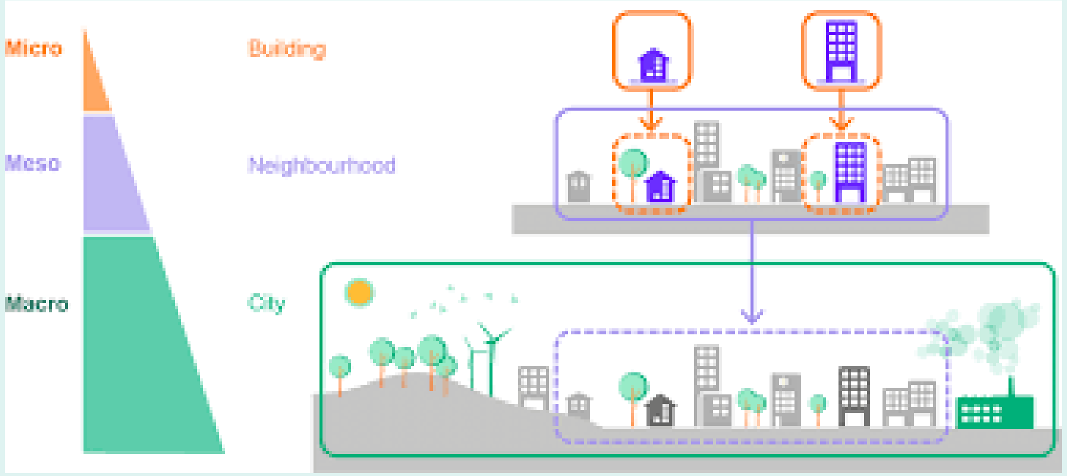
# MOTIVATION for PEDvolution

## The EU Context

- The built environment is key to Europe's transition to a **climate-neutral society** by 2050.
- An **estimated 97% of dwellings are not fit for purpose**, therefore a clean energy system and a just transition require more than isolated technological solutions for individual buildings.
- To optimally decarbonise the urban environment, it is crucial to **implement fully interoperable solutions at the neighbourhood or district level.**
- These type of solutions **improve energy efficiency as well as integrate local renewables and excess heat sources more effectively**.

# WHAT IS A PED?

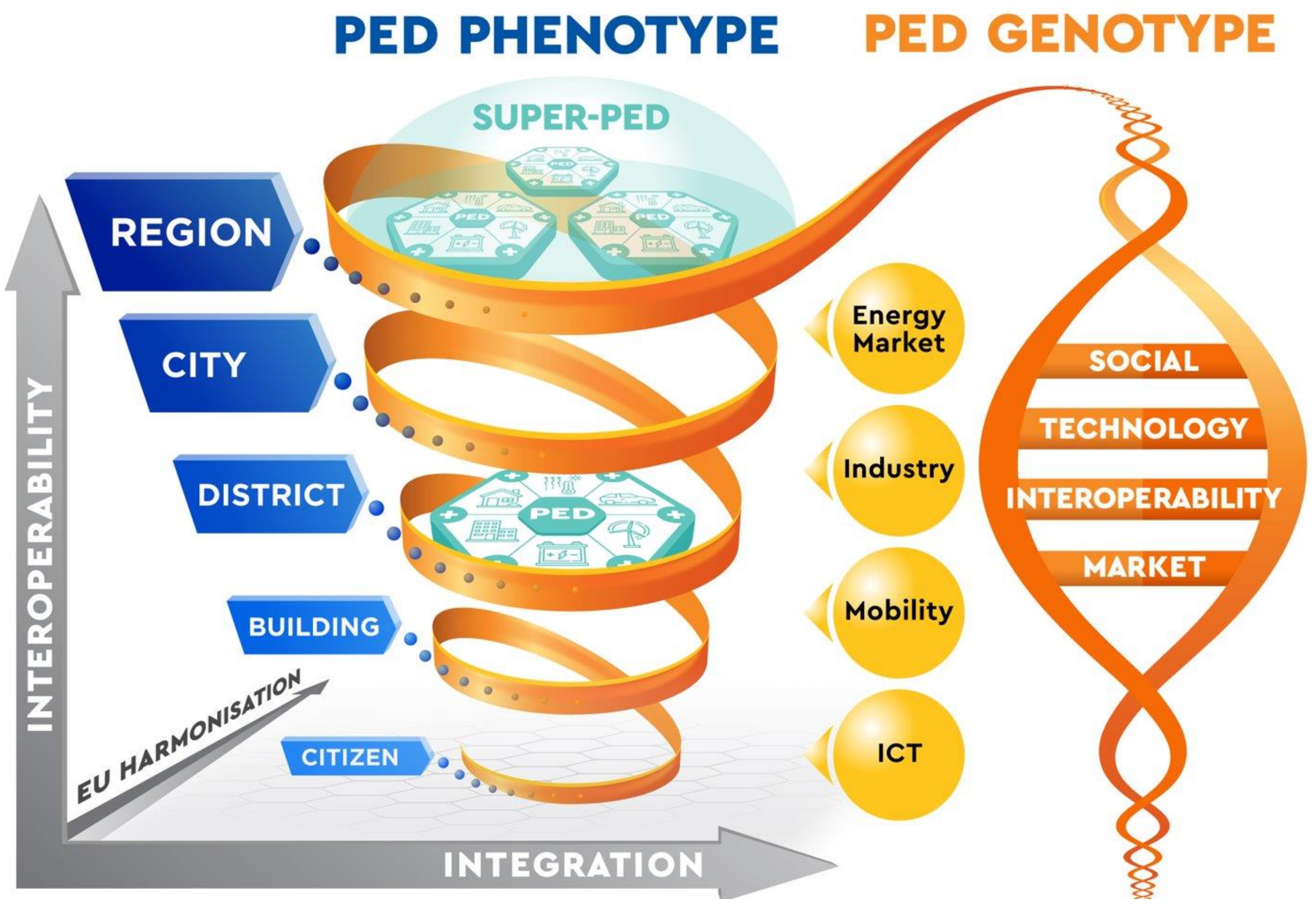
- A Positive Energy District (PED) is an urban area that produces at least as much energy on an annual basis as it consumes.
- The purpose of a PED is not to be an island isolated from the rest of the energy system, but rather a functional and flexible part of the larger whole.
- The impetus to develop whole positive energy districts instead of single buildings is based on the possibility of sharing resources, managing energy systems efficiently across many buildings and reaching economies of scale.



# SPECIFIC NEEDS ADDRESSED

- **Improve energy efficiency** coupled with a better integration of local renewables and local excess heat sources within the districts.
- **Increase citizen participation** and integration of consumers and energy communities in the value chain of the energy system.
- **Improve cross-sectorial integration** on energy and non-energy sectors within PEDs (between buildings, the users and the regional energy, mobility and ICT systems).
- Demonstrate **fully interoperable solutions** for planning, design, development and management of **PEDs**.

# PEDvolution CONCEPT (1/2)




•PED Genotype: PED's set of genetic material, built through a unique combination of Social-Technology-Interoperability-Market related aspects.

•PED Phenotype: the set of observable characteristics of the PED resulting from the interaction of its genotype with the environment (e.g. energy market, industry, mobility, (geo)politics).

❖ The PEDvolution solutions will design, process, optimise and strengthen the PEDs genotype- and/or phenotype.

# PEDvolution CONCEPT (2/2)

PEDvolution paves the way for cross-sectoral integration of ever-evolving PEDs.

Seven interoperable solutions **accommodating the constant evolution of PEDs**:

1. PED Design and Planning Toolset
2. Dynamic Decision Support Guideline for PED Development
3. PED Readiness Assessment
4. PED Energy Manager
5. Data Exchange, Integration and Interoperability Platform
6. PED Business Models
7. PED Social Innovation tool

Seven interoperable solutions that **design, process, optimise and strengthen the PEDs genotype and/or phenotype**.

**Tested, demonstrated and validated in at least six real-life PEDs** across Europe, paving the way for replication, upscaling and mainstreaming.

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# FACTS & FIGURES

- **TOPIC:** HORIZON-CL5-2023-D4-01-03 – Interoperable solutions for positive energy districts
- **PROJECT NUMBER:** 101138472
- **TYPE OF ACTION:** Horizon - Innovation Action
- **START DATE:** 01/01/2024
- **END DATE:** 31/12/2026
- **DURATION:** 36 months
- **3 Phases:** Analyse, Co-develop, Demonstrate
- At least **6 PED demonstration sites**
- **TOTAL BUDGET:** 4 999 587.19€
- **EU CONTRIBUTION:** 4 303 393.34€

# THE PEDvolution PARTNERSHIP

## 15 ORGANISATIONS | 7 EUROPEAN COUNTRIES

inlecom — Bringing innovative ideas to life
Greece (Project Coordinator)

SMART INNOVATION NORWAY
Norway

vito
Belgium

SWW wunsiedel — wir bewegen
Germany

TU WIEN — TECHNISCHE UNIVERSITÄT WIEN
Austria

INTRACOM TELECOM
Greece

NTNU | Department of Architecture and Technology
Norway

offsetenergy
Slovenia

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Slovenia

**AFFILIATED ENTITY**

gorenjske elektrarne

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Germany

TEAM sympraxis
Greece

Es geht!
Germany

**ASSOCIATED PARTNERS**

zhaw — Zurich University of Applied Sciences

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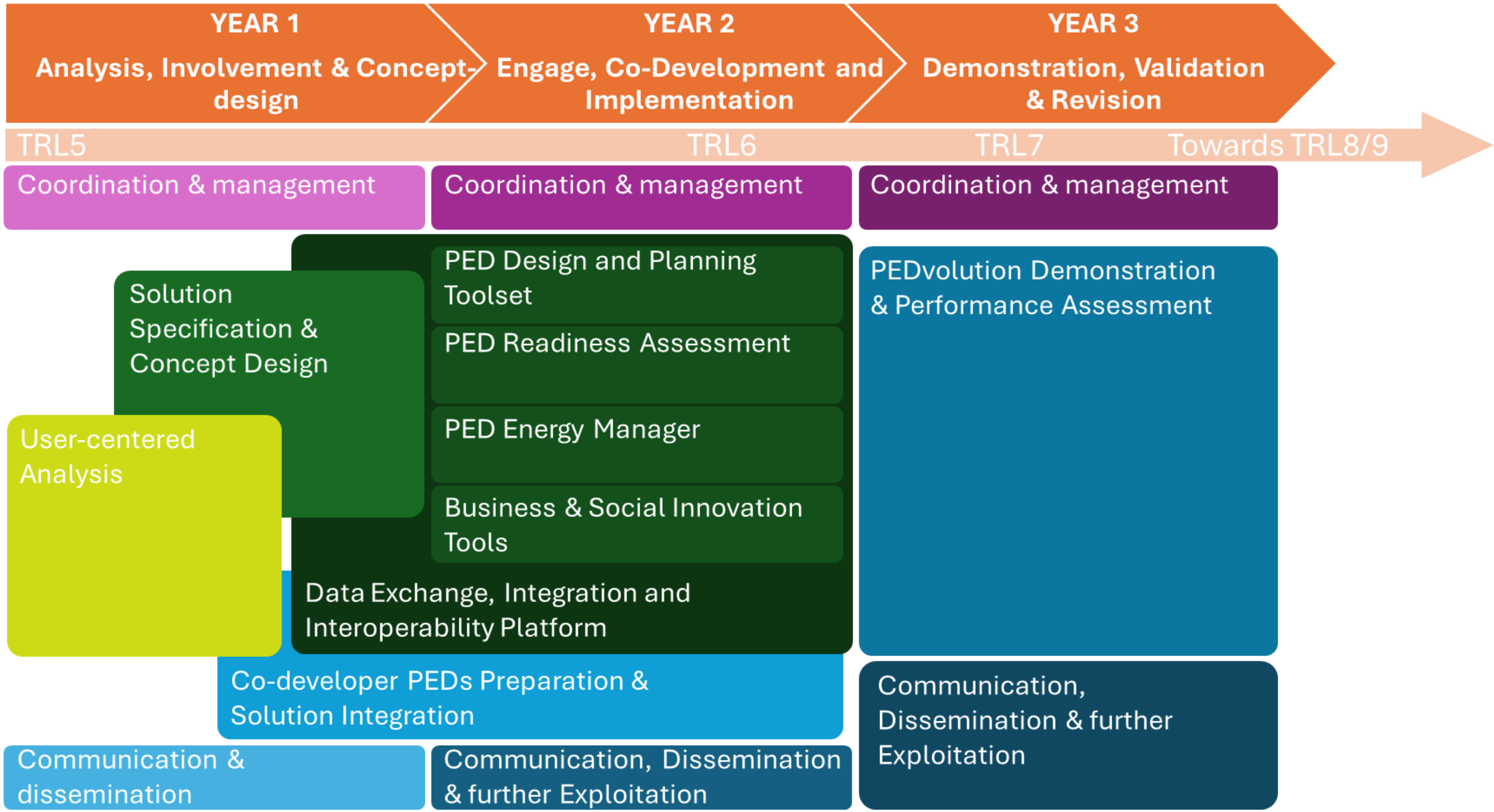
# PROJECT APPROACH HIGHLIGHTS



# TARGET GROUPS - WHO IS IT FOR?

- Energy service providers (ESCOs)
- Mobility service providers
- Residents/ Energy consumers /End users
- Energy Prosumers
- PED developers and managers
- PED Investors
- Local, Regional Authorities & City Planners
- Policy Makers
- Standardisation bodies
- General Public

# 3 PEDvolution CO-DEVELOPER SITES

Schönbrunn village with 2 SUPER-PED levels
Wunsiedel, GERMANY
Relevant PEDvolution partners: SWW, ZENOB, ESG

Residential neighbourhood Planina
Kranj, SLOVENIA
Relevant PEDvolution partners: EG, GEK

Gemeinschaft Hard
Winterthur, SWITZERLAND
Relevant PEDvolution partners: WIN, ZHAW

# SCHÖNBRUNN VILLAGE

Wunsiedel, GERMANY
2 SUPER-PED levels
Relevant PEDvolution partners: SWW, ZENOB, ESG

- In operation
- 400 households & 9 Businesses
- 1230 residents
- Local heating networks using regionally produced pellets
- Renewable electricity and heat through cogeneration unit (CHP), combined with distributed PV production

- Automated energy and flexibility management functionalities for sector coupled operation.
- Better utilisation of energy potential of biomass and PV while providing services to DSO grid.
- Cross-sector optimisation for sector-coupled units (e.g. CHP) and complex customers.
- Identification of surplus energy in the local environment, channelled to heating and electricity storage facilities.
- All SWW RES and sector coupled asset, to be integrated in next level approach: SWW PED.
- Establishment of a regional PED: SWW PED level to ZENOB PED.

KEY STAKEHOLDERS

- SWW Wunsiedel GmbH: DSO and district heating operator
- ZENOB: Joint venture promoting and financing innovative energy solutions
- Local brewery in Schönbrunn: Energy and storage provider
- WUNpellet: Producer and supplier of pellets for Schönbrunn CHP
- District heating network customers: Residential and business

# RESIDENTIAL NEIGHBOURHOOD PLANINA

Kranj, SLOVENIA
Relevant PEDvolution partners: EG, GEK

- **In planning stage**
- **4,300 apartments & 40 businesses**
- **1600 residents**
- **2 hydropower plants, multiple rooftop PVs, CHP with 5MW excess heat potential, eV charging stations, and nearby household with potential for replacing natural gas with district heating**

- Relies on the Planina communal boiler house, which currently boasts two boilers with a combined capacity of 17 MW, fuelled by natural gas. The facility features two CHP aggregators, enabling the simultaneous generation of electricity and heat.
- In the nearby Labore industrial zone, waste heat is abundantly produced as a by-product of industrial processes, presenting a valuable resource. A fraction of this heat can be directly employed for district heating, while innovative methods, can harness the remainder.
- This surplus heat is directed towards supplying the adjacent Planina district heating network.

KEY STAKEHOLDERS

- Municipality of Kranj: The municipality of Kranj owns the land where the "Planina Kranj" boiler house is situated, and it is actively engaged in the 100 Climate Neutral Cities initiative.
- Elektro Gorenjska, d. d. (EG): electricity distribution system operator
- Gorenjske elektrarne, d. o. o. (GEK): renewable energy resources generation and energy management company
- Domplan: district heating and natural gas network operator
- Companies in the industrial zone: enable the utilization of waste heat
- Community: inhabitants as well as resident businesses

# GEMEINSCHAFT HARD

Winterthur, SWITZERLAND
Relevant PEDvolution partners: WIN, ZHAW


- **In operation**
- **45 apartments and 40 businesses**
- **250 residents**
- **Solar plant and gas boiler generate heat for the development**
- **Hydroelectric power**
- **Attached photovoltaic plant for electricity production**

- Transition to a fully renewable energy source, by abandoning the current gas district heating.
- Establish an energy community in order to increase self-consumption.
- Facilitate the move towards electric and shared mobility within the community.

KEY STAKEHOLDERS

- Hard Community: inhabitants as well as resident businesses
- Stadtwerke Winterthur: the local DSO providing the energy infrastructure and regulatory boundaries
- City of Winterthur: public authority taking care of the implementation of the local energy and climate concept to achieve net zero by 2040
- ZHAW Zurich University of Applied Sciences: local science partner supporting the implementation of PEDvolution with applied research
- Local service organisations: providing technologies and manpower for the PED implementation

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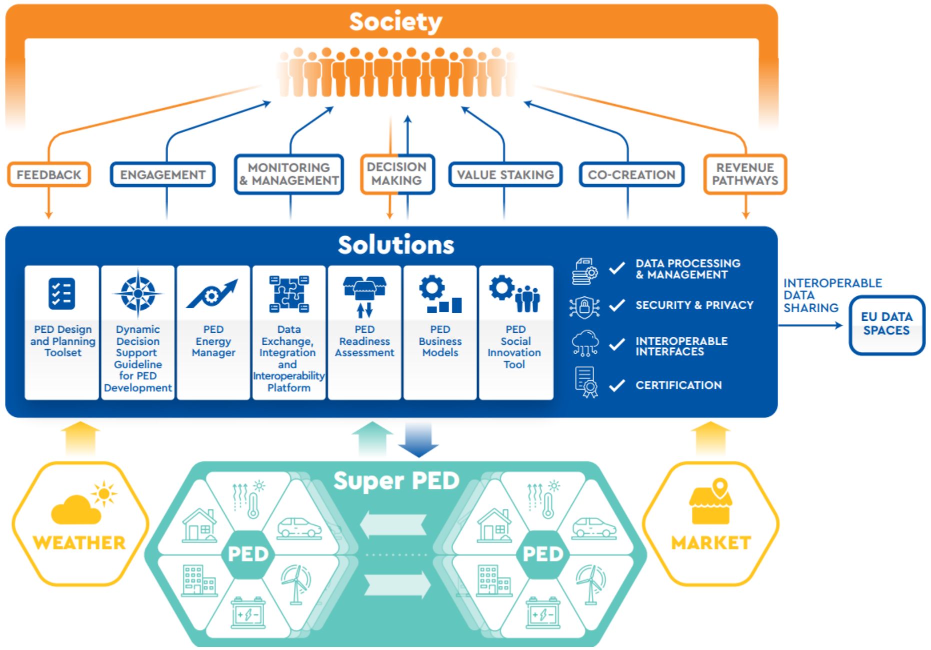
# EXPECTED OUTCOMES

1. **Increased availability of tools, guides** and **interoperable solutions** for planning, design, development and management of PEDs.
2. **Improved integration of energy** (e.g. distributed renewable energy generation, waste heat utilisation, storage) and **non-energy sectors** (e.g. mobility) within PEDs.
3. **Improved integration of PEDs in energy systems** and improved contribution of PEDs to energy grid robustness regarding dependencies to energy supplies.
4. **Increased social entrepreneurship** and **citizen participation and engagement** in energy communities.
5. **Increased participation of consumers and energy communities** in the **value chain** of the energy system.

# 7 INTEROPERABLE SOLUTIONS

1. PED Design and Planning Toolset
2. PED Readiness Assessment
3. Dynamic Decision Support Guidelines for PED Development
4. PED Energy Manager
5. Data Exchange, Integration and Interoperability Platform
6. PED Business Models
7. Social Innovation Tool



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## PED Design and Planning Toolset

1

- A **Digital Twin planning tool** to empower developers and managers to accelerate district development pathways towards achieving or further evolving a PED.
- The tool will provide accurate energy models of buildings and district assets as a basis to generate renovation pathways along district heating/cooling grids based on local conditions.

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## PED Readiness Assessment

2

- A systematic process of **monitoring and determining the performance** of a neighbourhood or district, in relation to the essential characteristics of a Positive Energy District.

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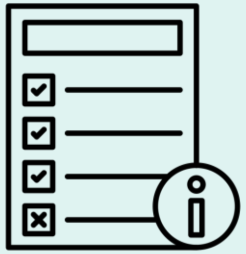
3

## Dynamic Decision Support Guidelines for PED Development



- Targeted **guidelines and efficient workflow for PED** development decisions related to the choice of technologies and strategies with respect to urban planning, energy efficiency and integration of local renewable energy sources.

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## PED Energy Manager

4

- **Multi-level toolset** for efficient management of energy processes within PEDs.
- Controls energy processes in residential and non-residential environments, assesses and extracts flexibility, optimises the operation in multi-sector environments and exploits flexibility on several energy and flexibility markets.

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5

## Data Exchange, Integration and Interoperability Platform

- The PEDvolution interoperability platform will comprise the **digital backbone of the PEDvolution approach**, providing a central node for trustworthy exchange of data, access to sophisticated PED design, planning, management and flexibility tools, thus enabling effective sector integration targeted to a multitude of energy and non-energy carriers.

- The goal is to unify energy node information flows by pursuing a digital integration strategy for all relevant energy data, district infrastructure and service models.

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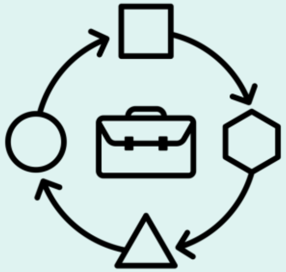
## PED Business Models



6

- A set of **building blocks**, known as 'business model patterns,' that have been proven successful in community-based business solutions.
- The tool's process will show PEDs how to **adapt business model patterns to the local context** and combine them to create promising business models.

## Social Innovation Tool

7

- A methodology that allows users to **assess the state of the community** and to understand the priorities, values and views of different stakeholders or actors to design an energy solution or related activities to be compatible with local needs.

- The aim is to contribute to **long lasting adoption** of planned or existing energy innovation in a PED.

PEDvolution
Interoperable solutions to streamline
PED evolution and cross-sectoral integration

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# Thank you for your attention!

## Any questions?

[www.pedvolution.eu](http://www.pedvolution.eu)

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**State Secretariat for Education,**
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SUSTAINABLE PLACES 2024

# Building Resilience through Cascading Impact Analysis: A European Perspective


***F.V. De Maio**[1], S. Osmani[1], R. Valsecchi[1], P. Basso[1], M. Cademartori[1], R. Chirico[1], C. Fuggini, C. Huang[2], I. Van Bever[2], A. Meslem[2]*

**1 Rina Consulting SpA**
**2 NORSAR**

**Florencia V. De Maio –** Structural and Risk Engineer


# OUR KEY COMPETENCES

SUSTAINABLE PLACES 2024

**A multi-disciplinary team of Civil, Environmental, Structural and Hydraulic Engineers, Geologists, Risk Analysts, Urban Planners, Experts in Risk Management and Business Continuity, that works together as a SINGLE TEAM to support our clients in building Resiliency**

## Our Key Competences Embrace

- **Civil, Structural and Hydraulic design of civil infrastructures through the all life-cycle phases**
- **Climate Change Risk Assessment (CCRA)**
- **Risk and Resilience Analysis**
- **Civil and Environmental Feasibility Study, Plans and Design activities for both normal and emergency operations**
- **Geology Engineering and Geotechnical Design**
- **Development of data-driven Decision Support Systems**

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European Commission

SUSTAINABLE PLACES 2024

**Multi-hazard and Risk-informed system for Enhanced Local and Regional Disaster risk management**

## MAIN CHALLENGES

- Different phases of both hazards and risks processes are often addressed **separately**
- Risk analyses are not performed from a **multi-disciplinary perspective**
- **Compounding and cascading effects of hazards are not regularly included within risk and resilience assessments**

## SOLUTIONS

Multi-hazard Disaster Risk Assessment
Scientific Models and Scenarios

Service-oriented and Multi-Objective Optimisation

Decision makers' requirements and preferences

Context-driven Solutions
Implementation of actions and support policy improvements

Risk-informed decisions


The consortium consists of **18 partners**

# Assessment of the cascading impacts

Definitions of **key concepts** regarding **dependencies** between critical infrastructures

Selection of **sectors** for analysis, **hazards**, and **disaster databases**

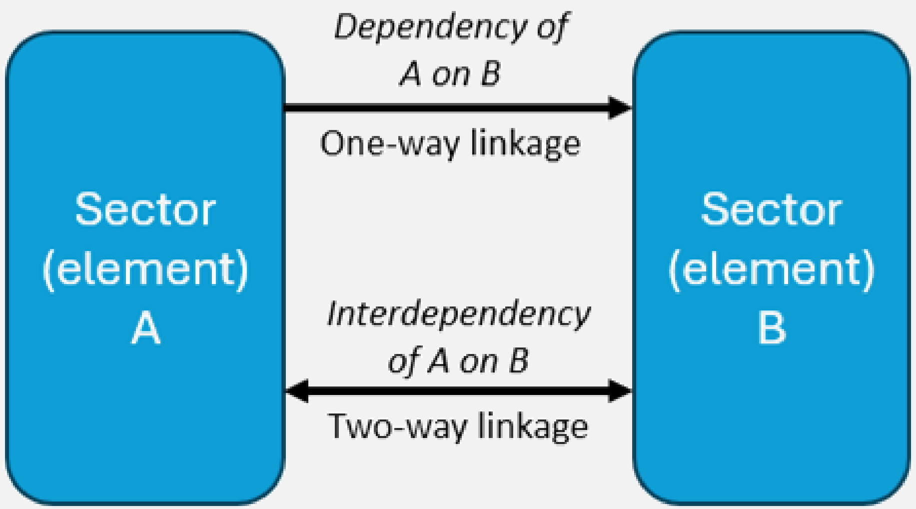
**Methods** to assess cascading impacts

**Machine learning** algorithm selection

**Validation** of the methods for cascading impacts assessment thought the **case studies**

**Direct impacts** arise from disruptions of critical elements, causing **immediate effects** on society

**Cascading impacts** <u>propagate</u> through **interdependent infrastructures**, amplifying disruptions across sectors




Types of linkages in a critical infrastructure system (adapted from Rehak, 2016)

# Interdependency of Critical Infrastructure

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**Geographical**

when local events can create state changes in all infrastructures; it occurs when elements of multiple infrastructures are in close **spatial proximity**

**Cyber**

when an infrastructure is dependent on the information transmitted through the **information infrastructure**

**Physical**

when each of two infrastructures are dependent on **the material output of the other**

**Logical**

when the state of each of two infra-structures depends on the state of the other via control, regulatory or through a mechanism not a physical, cyber or geographic connection.

# Materials and Methods

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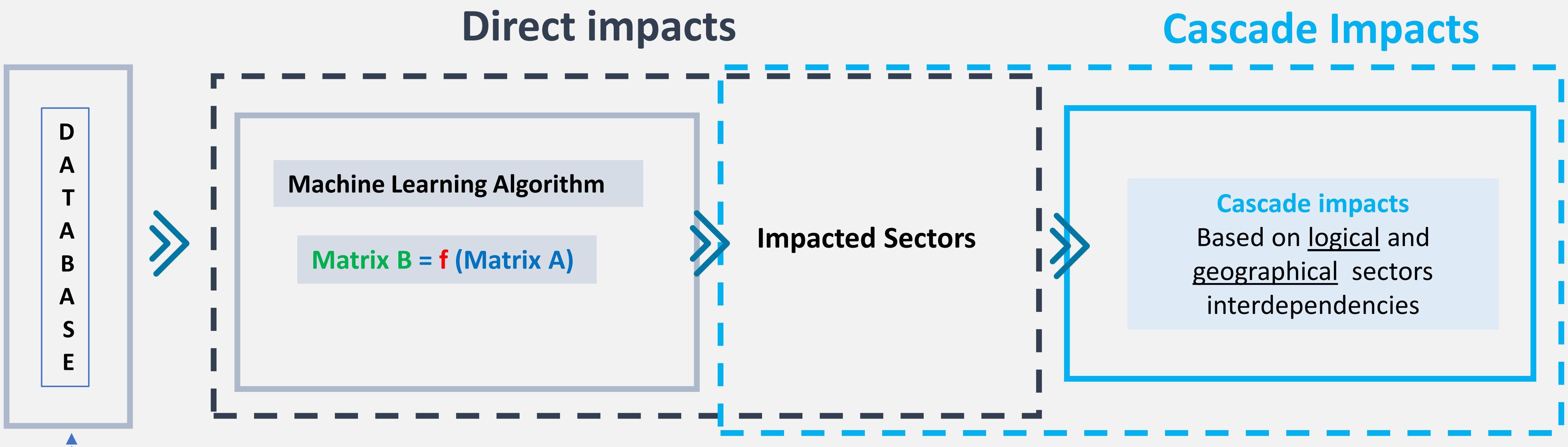
The methodology developed for assessing cascading impacts is grounded **in machine learning (ML) algorithms** capable of discerning patterns in data and leveraging them to predict outcomes for new data.




***Continuous Updating and Monitoring***

**Direct impacts** arise from disruptions of critical elements, causing **immediate effects** on society

**Cascading impacts** propagate through **interdependent infrastructures**, amplifying disruptions across sectors

# Materials and Methods

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ML requires a **constantly evolving database of past events for model <u>training</u> and <u>testing</u>**.

Direct impacts

Cascade Impacts

D
A
T
A
B
A
S
E

Starting from the comparison between **the existing loss databases**, ***DesInventar*** has been selected for the development of the machine learning for the following reasons:

- The events are **geolocated**: this is a crucial aspect to enable the analysis to be carried out;
- provides the **damage of a large set of sectors**;
- The collection of historical disaster losses data is provided in a **systematic way**.

***Continuous Updating and Monitoring***

A significant challenge for applying ML to cascading impact assessment **lies in data scarcity**.

# Directs Impacts

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The direct impacted sectors are obtained considering a **geographical dependency** (Rinaldi, 2001).

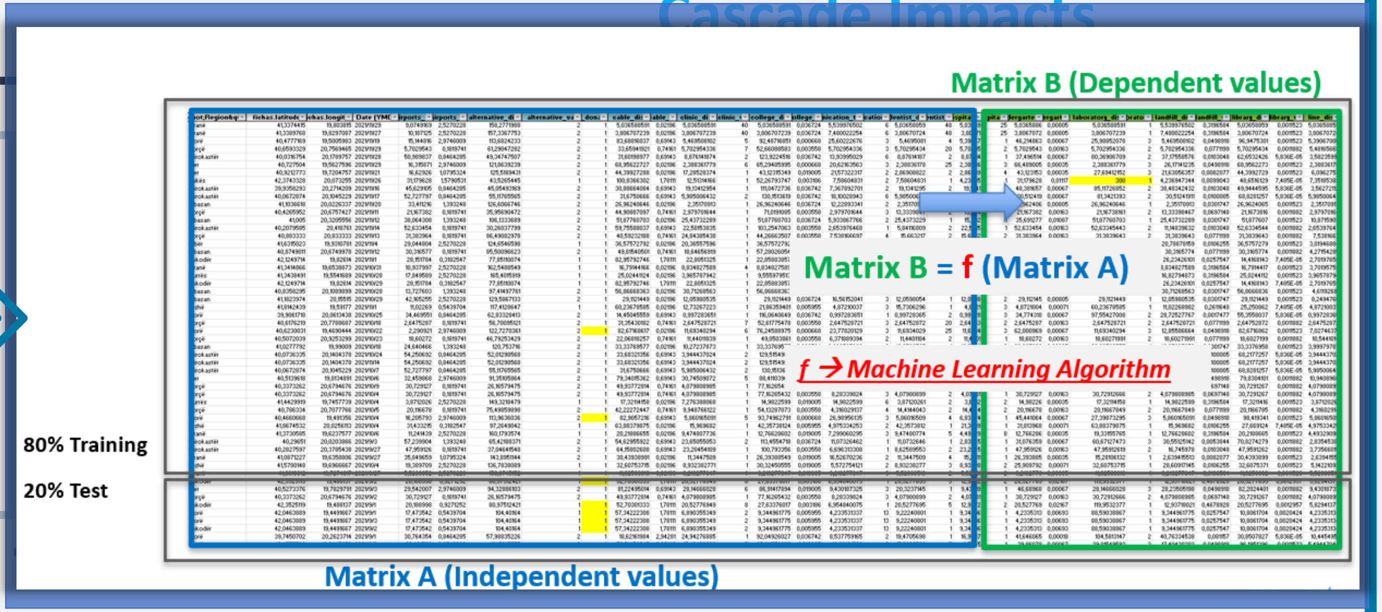
## Direct impacts

D
A
T
A
B
A
S
E

Machine Learning Algorithm

Matrix B = f (Matrix A)

*Continuous Updating and Monitoring*



# Cascading impacts

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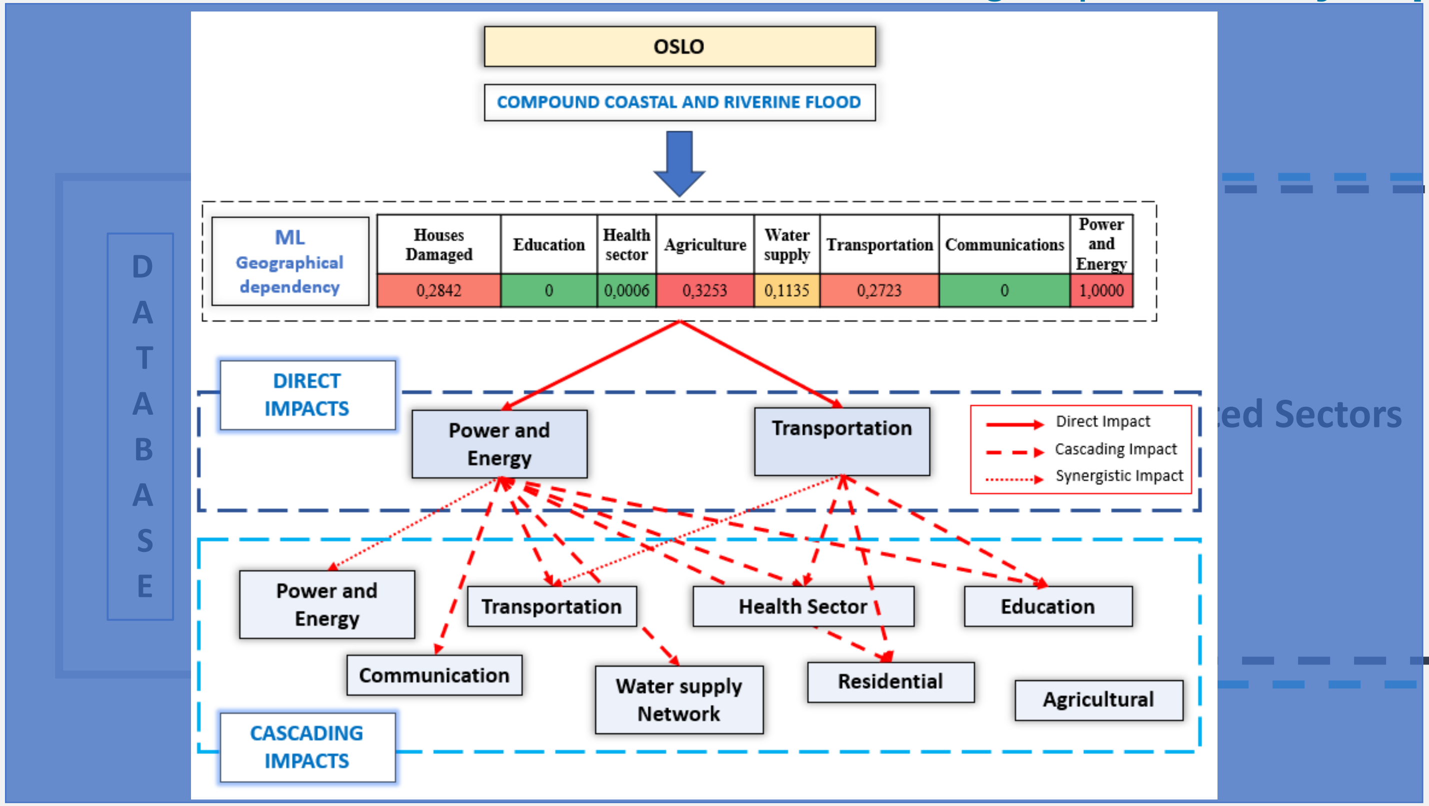
The indirect impact phase of the methodology involves assessing cascade impacts based on the initial group of **directly impacted sectors**.




## Cascade Impacts

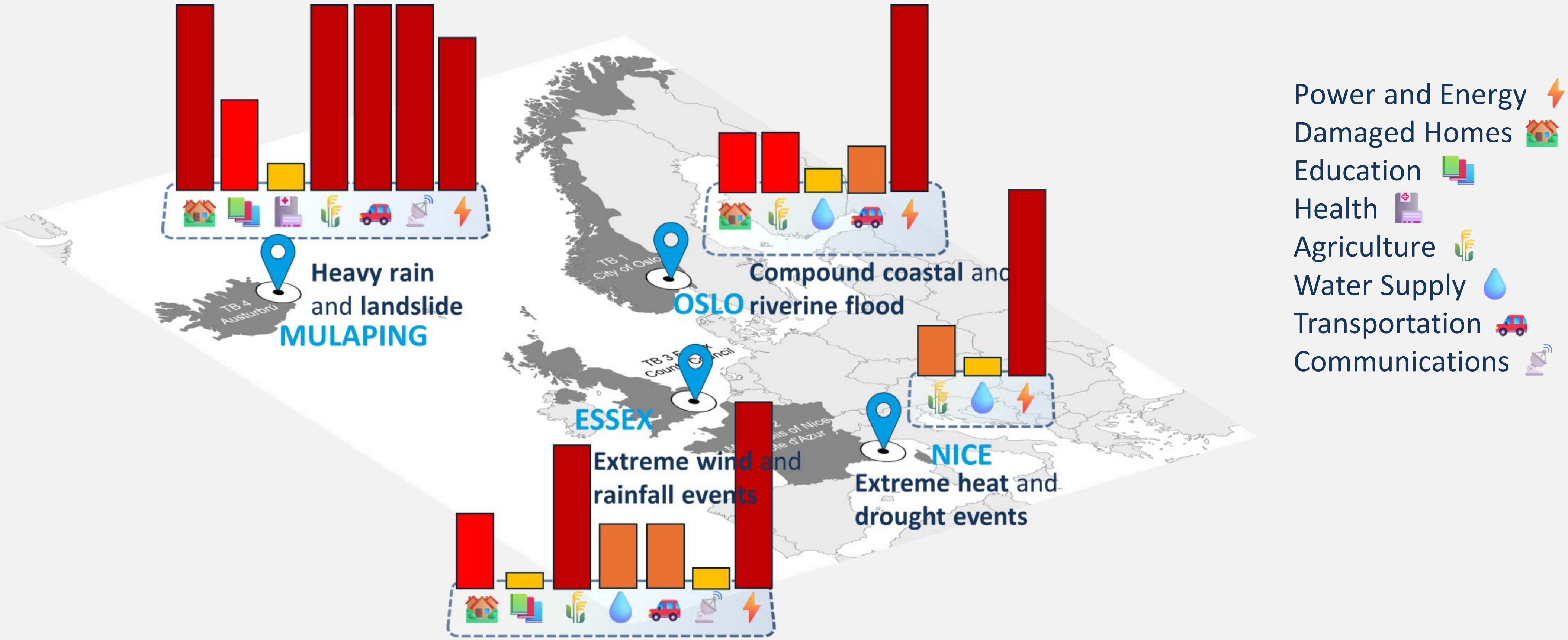
**Cascade impacts**

Based on logical and geographical sectors interdependencies

In this phase, the focus shifts from the primary impact of the event **to understanding the secondary consequences across various sectors.**

# Results

In order to ensure the robustness of their developed method, the researchers applied the methodology to **4 case studies**. These case studies encompassed a **diverse range of scenarios**, allowing them to test the method's effectiveness in real-world situations beyond the controlled environment of the initial development phase.




By analyzing the results from each case study, the researchers aimed to **validate** the method's ability to consistently produce reliable and accurate outcomes

# Conclusion and Future Developments

- Applicable for describing cascading impacts among a broad variety of societal sectors and critical infrastructures
- Appropriate to a large portfolio of infrastructure’s assets
- Non-availability of a sufficient number of historical event data in the case studies, which is essential for a machine learning-based methodology
- The involvement of stakeholders in the MEDiate project as partners and actors of the same project indeed represents an opportunity to improve this aspect
- Each individual phase can be refined or substituted with more detailed analysis or methods

Scan me

RINA

# Thank you for your attention

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**florencia.demaio@rina.org**

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Our experience. Your growth.

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circe

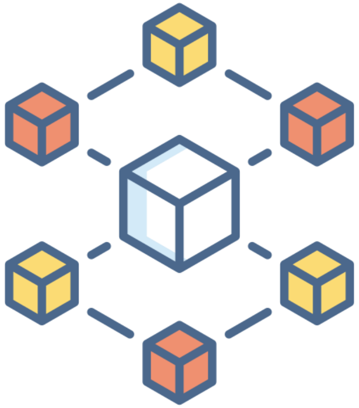
# eFORT

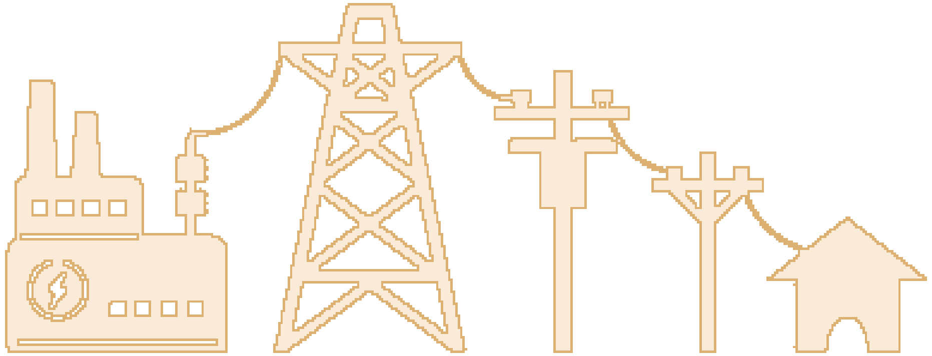
*Grid verification and monitoring layer by blockchain technology*

This project has received funding from the European Union's Horizon Europe Energy Research and Innovation programme under Grant Agreement No. 101075665

# Table of contents







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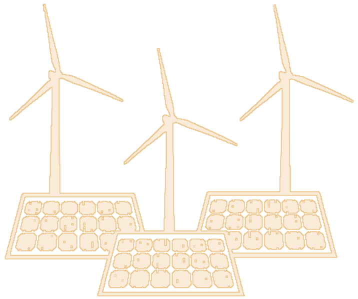
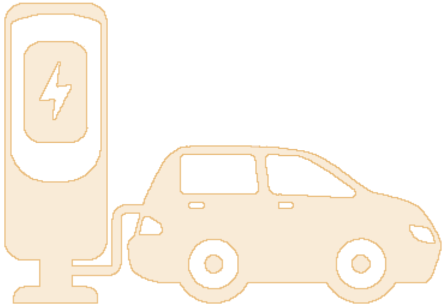
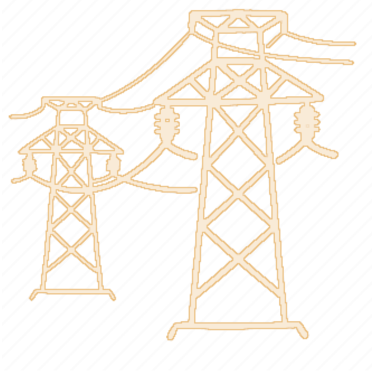
# What's CIRCE?

Description & Activity lines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# CIRCE is energy

## 25 YEARS OF R&D&i SERVICE TO COMPANIES, THE SOCIETY AND THE ENVIRONMENT

We are a technology centre funded in 1993, seeking to provide innovative solutions for a **SUSTAINABLE DEVELOPMENT**.

**CIRCE's purpose** is to anticipate and transfer technological solutions for their sustainability and competitiveness.




**100%**
**SELF-FUNDING**
Every fund of the centre is achieved
in competitive public programs
and private contracts

74 Horizon 2020 projects
> 22 coordinated
31 Horizon Europe projects
> 7 coordinated

+50% success ratio in the Project proposals completely elaborated by CIRCE

**+100 million €**
for our partners in the European projects CIRCE





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# Activity lines

INNOVATION FOR THE INDUSTRIAL SECTOR

## 01

### RENEWABLE ENERGY

WIND

SOLAR

BIOMASS

RENEWABLE ENERGY INTEGRATION IN GRID

## 02

### FUTURE ELECTRIC GRIDS

ELECTRIC NETWORKS

ICTs

SMART GRIDS

POWER ELECTRONICS & ENERGY STORAGE

## 03

### SMART MOBILITY

ELECTRIC VEHICLE

SUSTAINABLE MOBILITY

## 04

### INDUSTRY 4.0

COMBUSTION

ICTs

## 05

### ENERGY EFFICIENCY

INDUSTRIAL ENERGY EFFICIENCY

SUSTAINABLE CONSTRUCTION

SOCIAL ENERGY RESPONSIBILITY

## 06

### CIRCULAR ECONOMY AND SUSTAINABILITY

EFFICIENT USE OF THE RESOURCES

WASTE & EMMISSIONS REDUCTION

SUSTAINABLE ECONOMY

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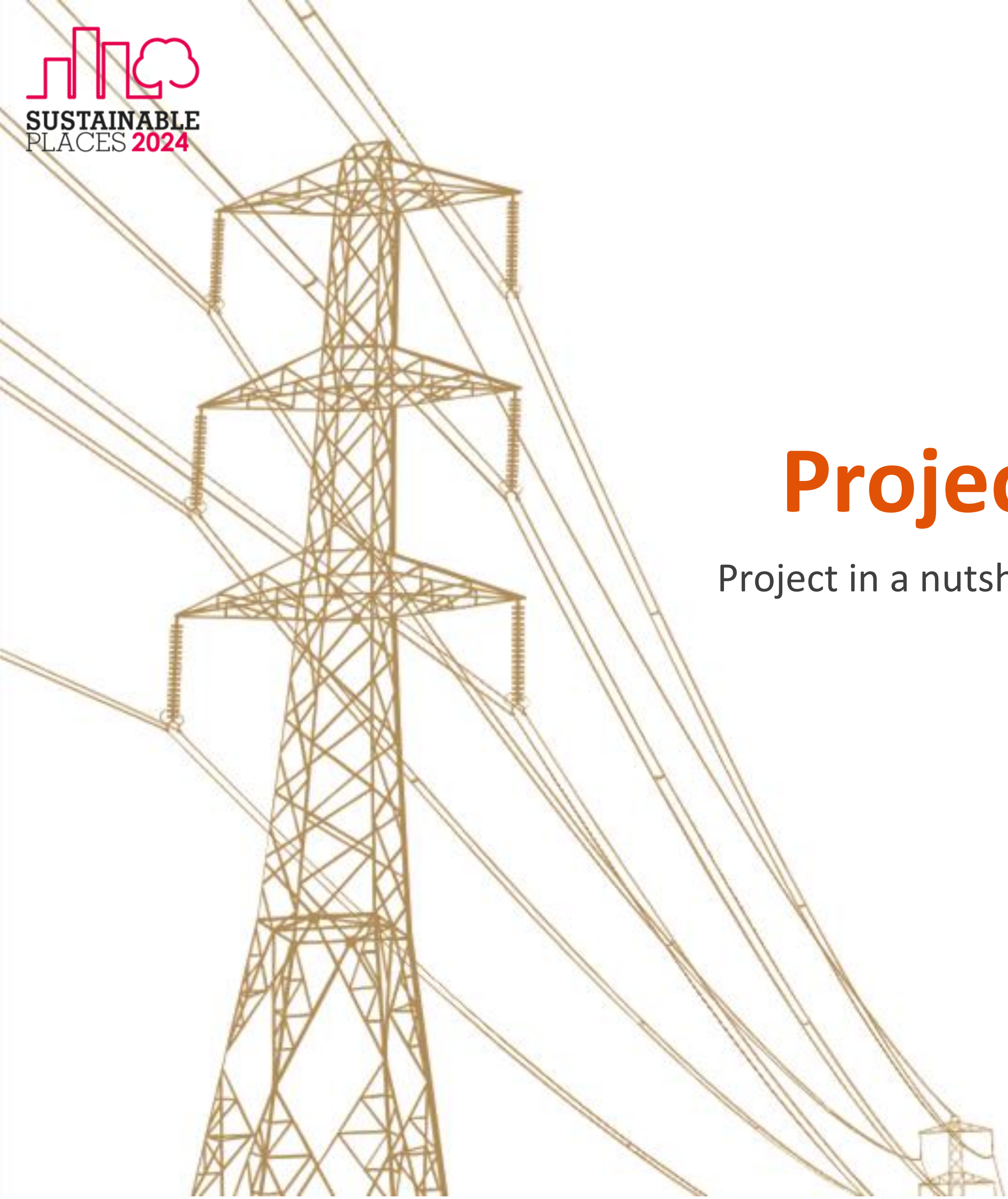
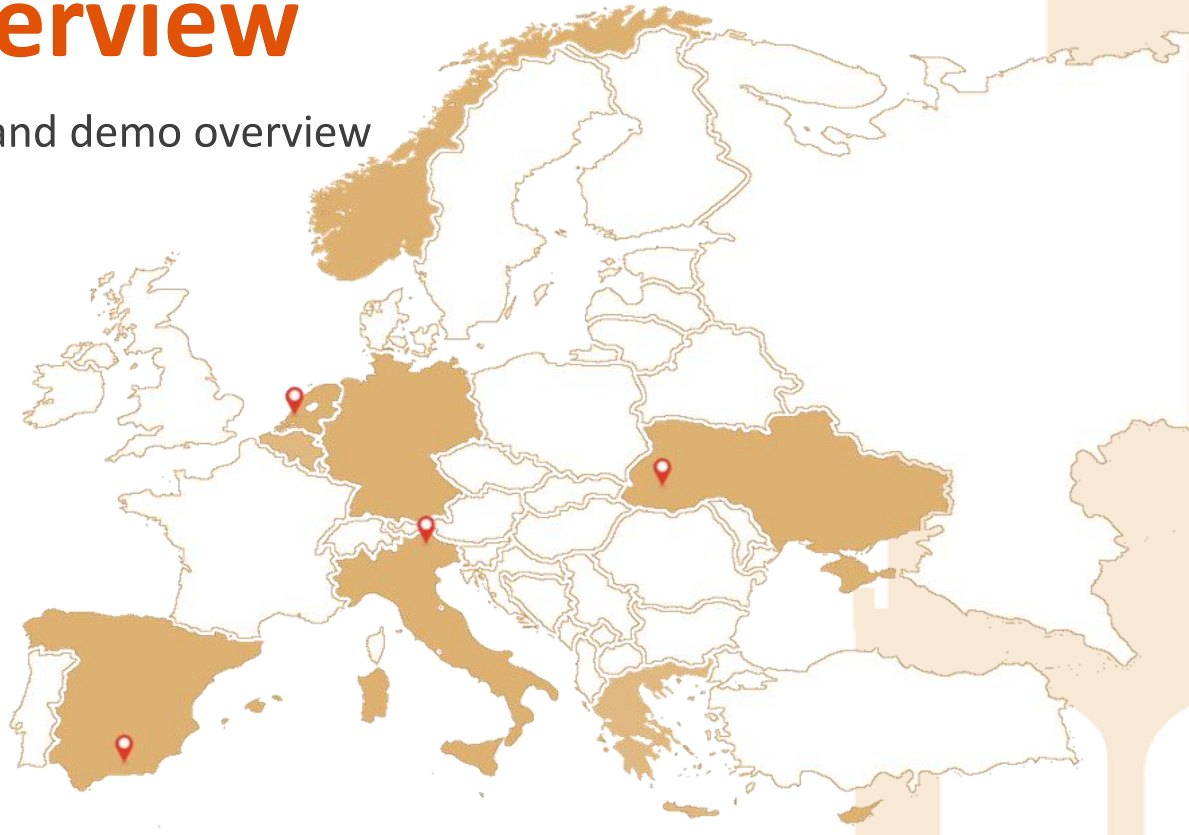


# Project Overview

Project in a nutshell, target and demo overview



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# The project in a nutshell

**Programme**
**HORIZON**

**Total budget**
**9 321 022.50€**

**Project Coordinator**
**CIRCE**

**Total partners**
**23 partners**

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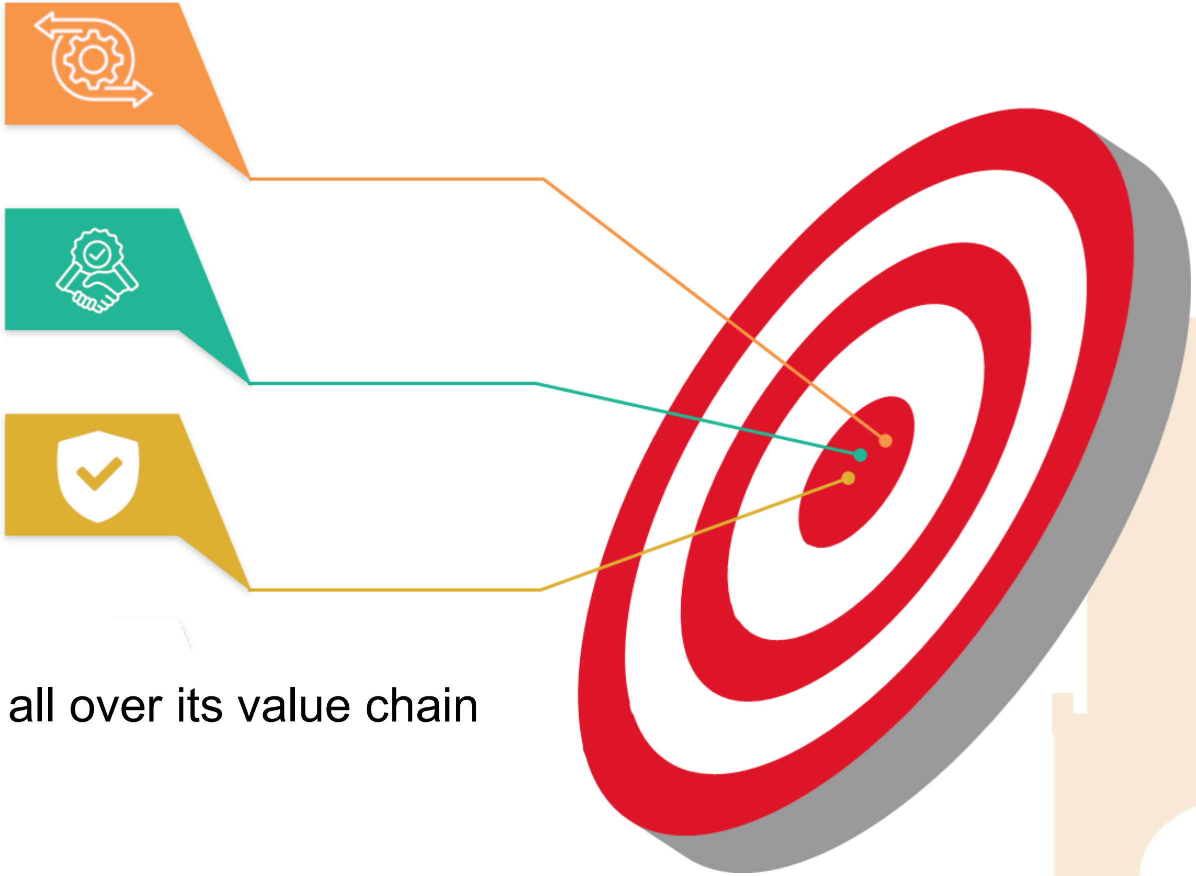
# Main objective

Transform the current Electrical Power and Energy System (EPES) into a more…

Resilient

Reliable

Secure



…system all over its value chain

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# Demo overview

- **D1 – Escúzar (Granada, Spain)**
  - Microgrid and user level
  - DER resources

- **D3 – Sarentino Valley (Italy)**
  - MV and LV distribution
  - Smart plant regulation and grid control

- **D2 – Delft (The Netherlands)**
  - Pan-European transmission system (TENNET infrastructre in NTH and Germany)
  - Generation, substations and TSO-DSO points

- **D4 – Iltsi (Ukraine)**
  - Substation secure operation and design
  - Digital SAS

JSC

iSolutions

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# Blockchain

Basics, types and our use

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# Blockchain’s foundations

**Distributed**
Data is shared across multiple nodes.

**Immutable**
Records cannot be altered once added, ensuring permanent data integrity.

**Trazeable**
Every transaction is transparently recorded and can be easily traced back to its origin.

**Secure**
Usage of cryptographic techniques to protect data.

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# Different types of blockchains

| | Public (Permissionless) | Private (Permissioned) | Hybrid (Permissioned & Permissionless) | Consortium (Permissioned) |
|---|---|---|---|---|
| **Advantages** | + Independance<br>+ Transparency<br>+ Trust | + Access control<br>+ Performance | + Access control<br>+ Performance<br>+ Scalability | + Access Control<br>+ Scalability<br>+ Security |
| **Disadvantages** | - Performance<br>- Scalability<br>- Security | - Trust<br>- Auditability | - Transparency<br>- Upgrading | - Transparency |
| **Use Cases** | Cryptocurrency<br>Document validation | Supply chain<br>Asset ownership | Medical records<br>Real estate | Banking<br>Research<br>Supply chain |

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# Our solution

Usage, network infrastructure, data model

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# Usage

**01**

## Maintenance

Installations
Repairments
Removals
Upgrades

**02**

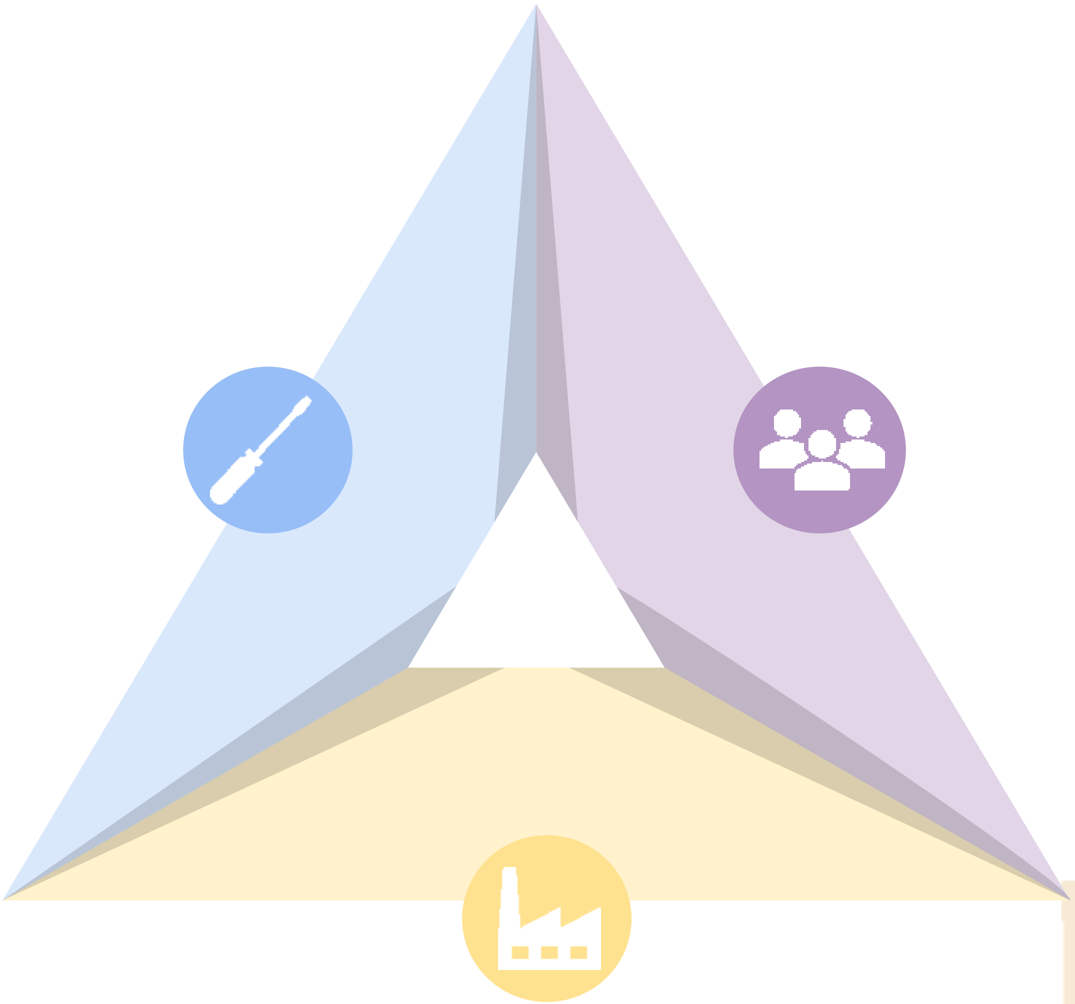
## Owners

Cyberattacks
Contractual documents
Components state

**03**

## Manufacturers

Technical specification
Documentation



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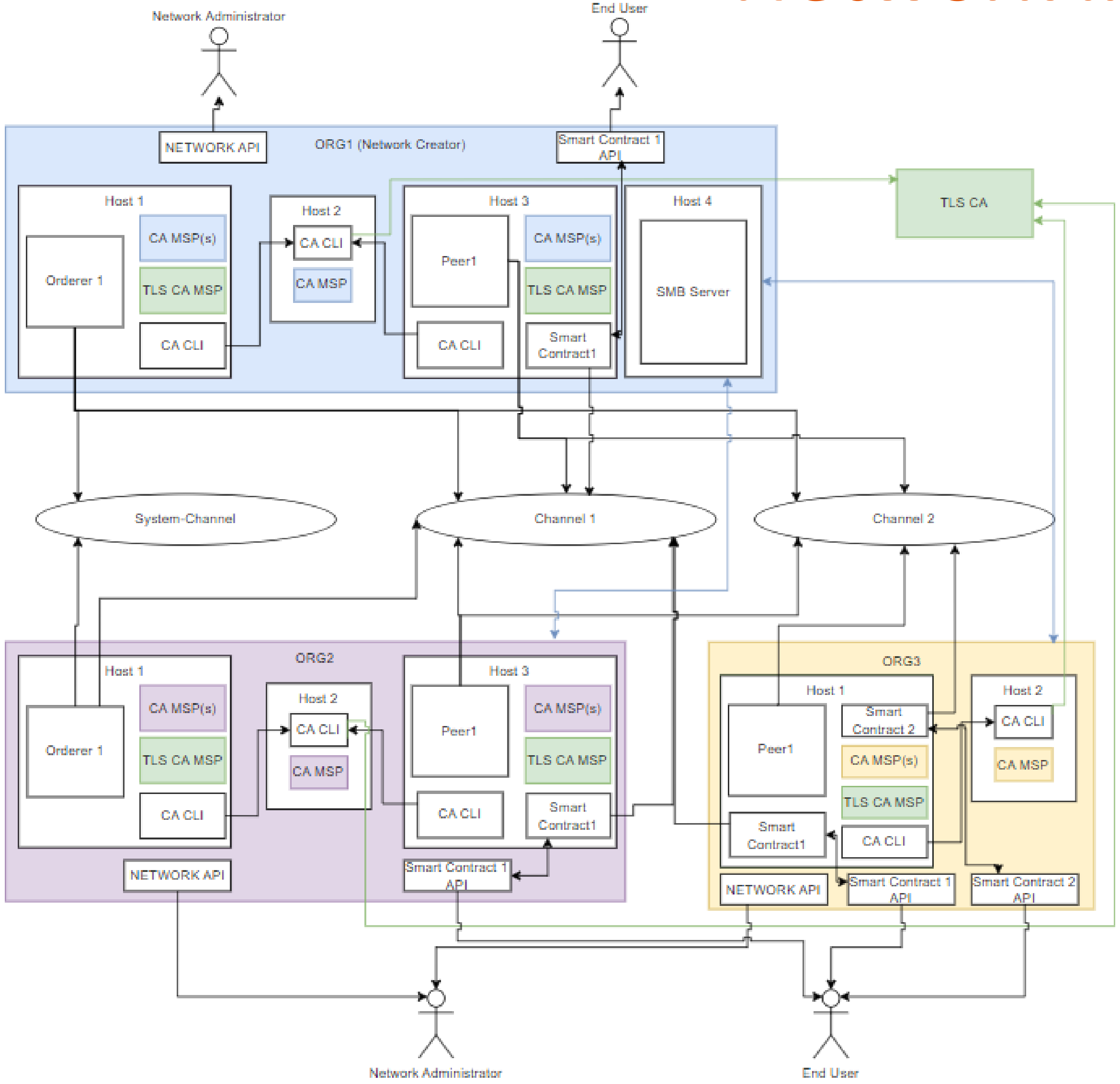
# Network Infrastructure




Componentes

- TLSCA: Issues network membership certificates
- Organization: Group of related peers
- ORG CA: Issues Organization membership certificates
- Channel: Private communication pathway, allows a specific group of participants to share data
- Ledger: Record of all the transactions generated by peers
- Orderer: Maintain the ledger current and consinstent across a channel
- Peer: Stores a copy of the ledger and create transactions
- Smart contract: Definition of the executable logics that generates new transactions

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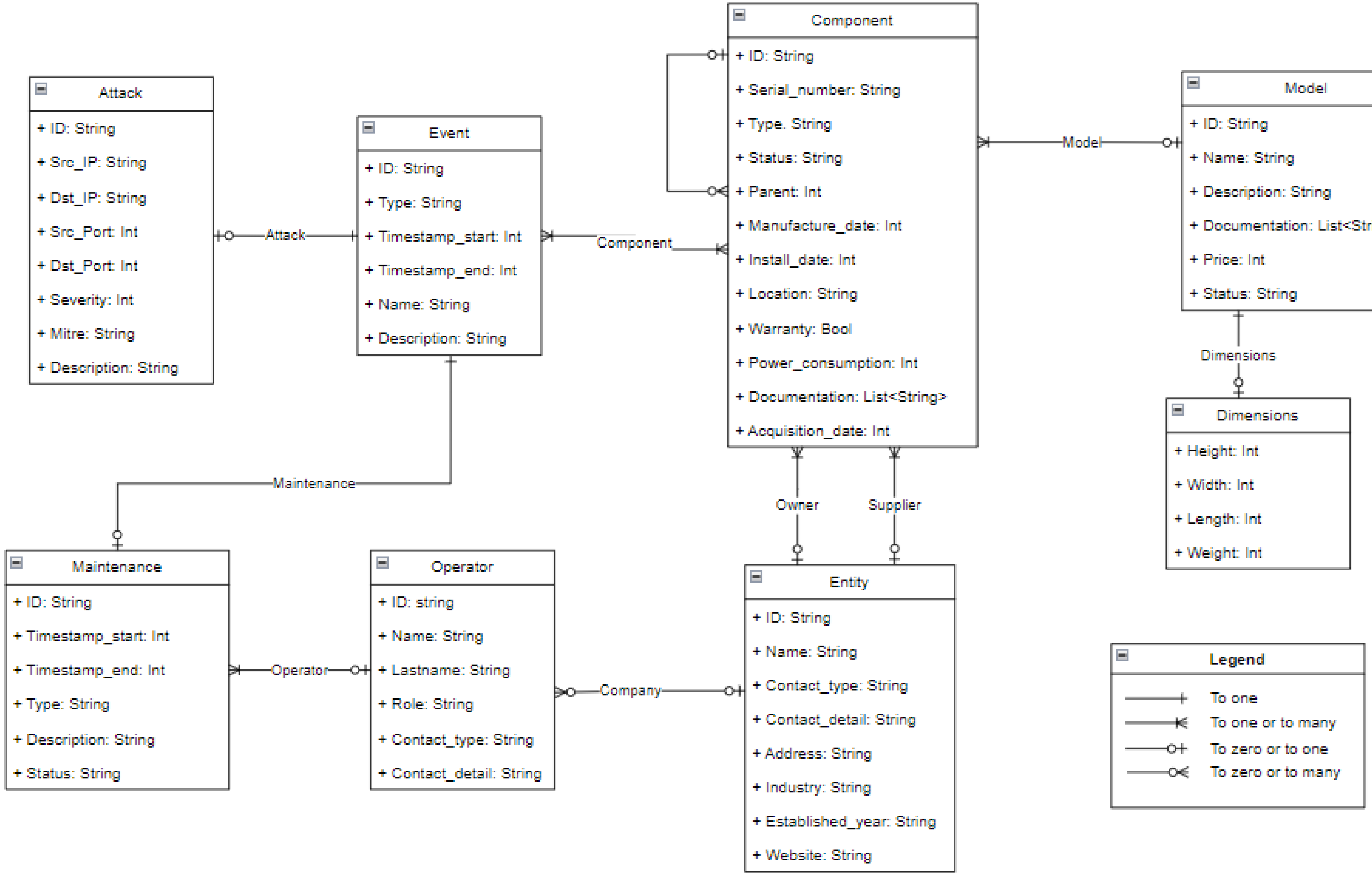
# Data model

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# Next steps

Our proposed usage

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# Expected output


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# Thank you!

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SUSTAINABLE PLACES 2024

23–25 Sept 2024 | Luxembourg

# Towards the energy transition: the role of the RES, the energy storage systems and the hydrogen


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*University of Calabria*

*Italy*

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# SUMMARY

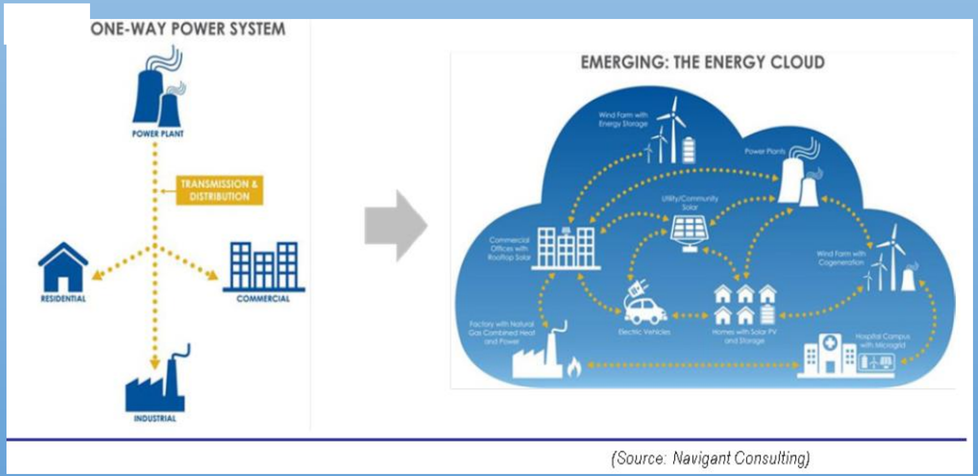
***Introduction:*** *Energy transition…Deep Decarbonization…Towards 2050*

***Renewable Energy Source:*** *the problem*

***Energy Storage Systems:*** *the role*

***The Hydrogen:*** *an opportunity*

# Energy Transition…



(Source: Navigant Consulting)

*The energy transition is characterized by a continuous increase in the penetration of generation systems from renewable sources (RES), from a massive increase in energy efficiency (with attention to energy consumption of buildings) and, contemporary, from increased use of electricity to meet the needs traditionally required for the direct use of fossil fuels (in particular domestic heating and systems related to mobility and road transportation).*

***A transition toward a «Zero emission» energy system – DEEP Decarbonization***


***«all Electric scenario»***

***Deep increase of RES***

***ambitious 2050 environmental, energy and climate targets***

***To support this energy transition will require a system management exploiting new flexible resources in order to ensure adequate levels of system stability, safety and resilience ….***

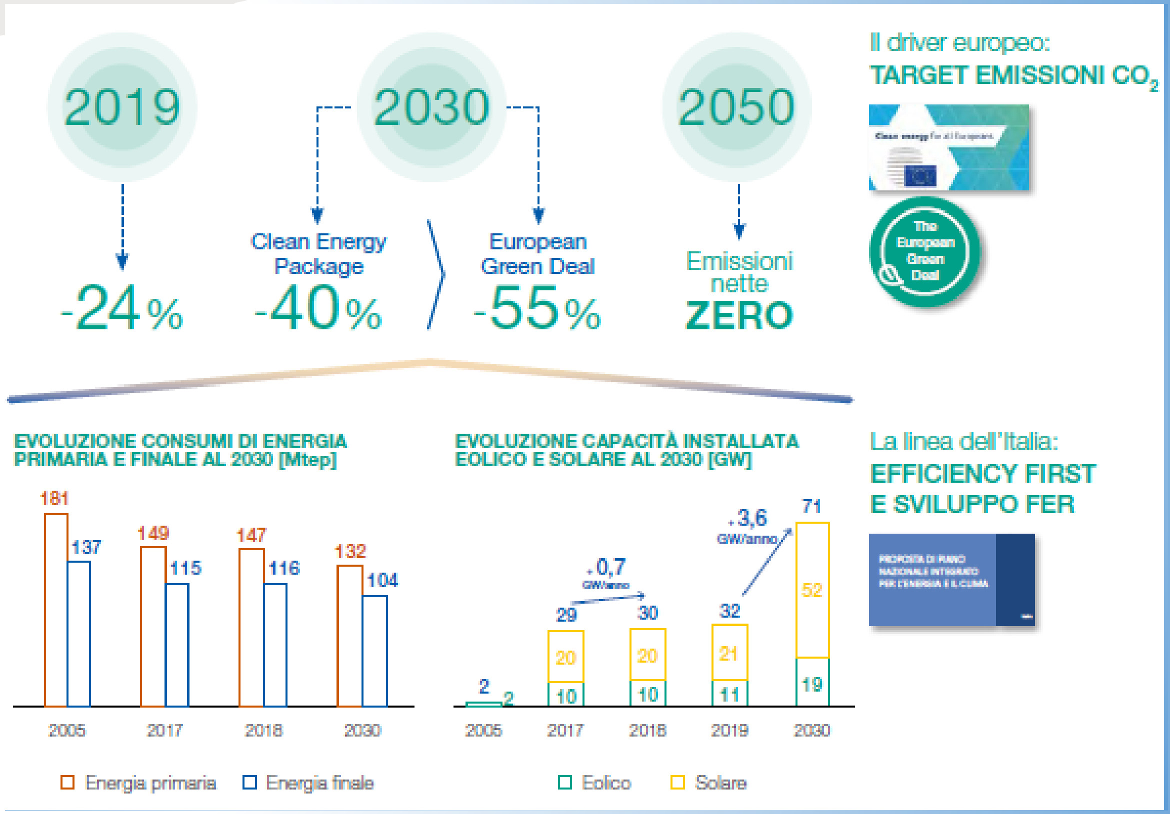
***and so a new paradigm of produce, consume, and share energy***

# Towards 2050…

*The European Commission (EC) outlines the need for a REPowerEU plan meant to address the EU's need for energy independence, based on two key pillars:*

*(a) diversifying gas supplies;*

*(b) reducing faster the use of fossil fuels in our homes, buildings, industry and power system, by increasing energy efficiency gains and renewables (e.g. decentralised renewable energy generation), as well as through demand electrification (e.g. Power-to-X)*



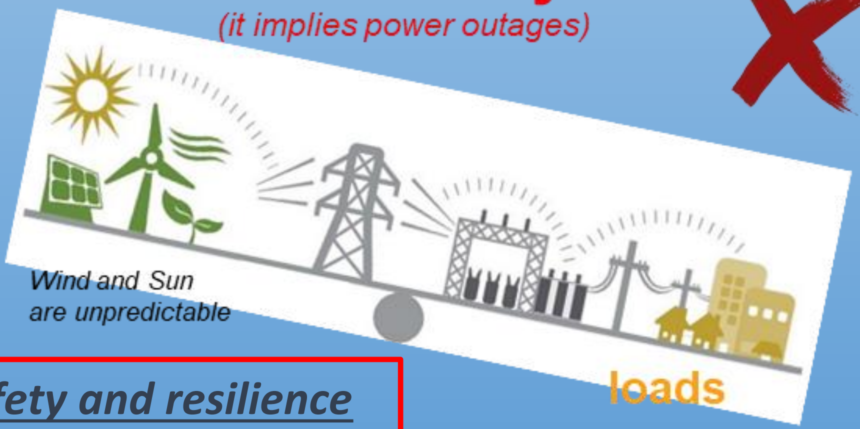

According to the latest IPCC re…
panel on climate change) it is …
emissions immediately, using rene…
gas and oil, than to remove …

# RES… …the problem!

- *Uncontrollability* of the RES (in particular solar and wind);
- *Unpredictability* of the generation capacity;
- *No match* between *generation profile and load profile* of the users, continuous 'chase' of the *Balancing*.

## Umbalanced system

*(it implies power outages)*



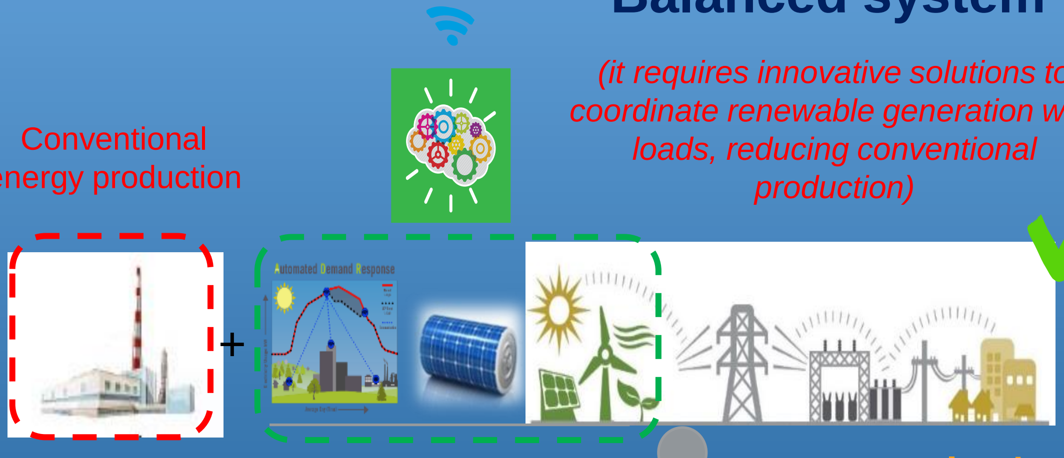

*Necessity for the national electricity system of higher levels of stability, safety and resilience*

## Smart digital and technological solutions:

- *Smart meter to monitor*
- *Micro-nano grids to integrate*
- *Smart Storage Systems to increase the programmability*
- *Management Units to manage*
- *Smart Appliances and IoT device to communicate and control*
- *Smart interoperable platforms to coordinate distributed resources*

## Balanced system

*(it requires innovative solutions to coordinate renewable generation with loads, reducing conventional production)*

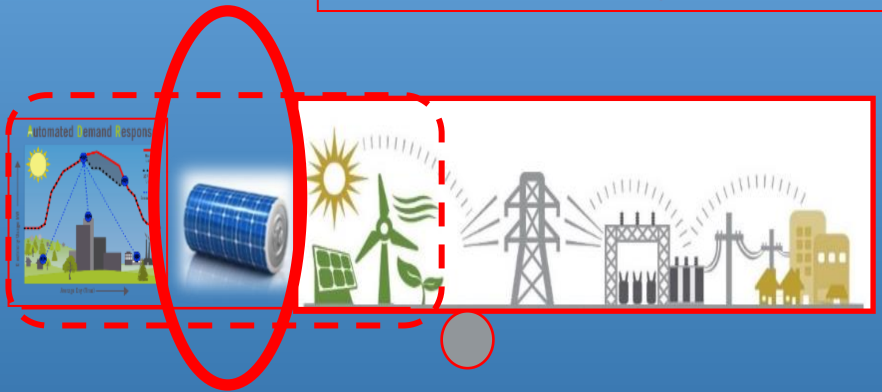


# RES…the problem!

The development of technological solutions for energy storage (such as batteries, hydrogen, synthetic gas, etc.) and advanced technologies for applications in smart grids and for Power to Gas, will allow to accelerate the process of smartisation of integrated energy networks, favoring the deep decarbonisation of the national and European economic system.

**Energy storage is the key element that will allow maximizing the efficiency of energy systems, the use of clean energy in mobility and a substantial use of renewables, both for "power intensive" services, providing support for network reliability; and for "energy intensive" services, to solving network congestion and make themselves available for "load shifting".**


Balanced system



# The Role of…
# …STORAGE Systems…distributed

*…Among these resources, the energy storage systems (ESSs) will play a significant role. ESSs can achieve very high performance in terms of response speed and power modulation…*

***The decreasing cost of conventional energy storage system such as litio-ion batteries is stimulating new possibilities for energy storage deployment at a local level. In this context, aggregating many local energy storage systems (ESSs) operating as a single distributed energy storage system (DESS) is a very promising new flexibility resource.***


Smart Storage Systems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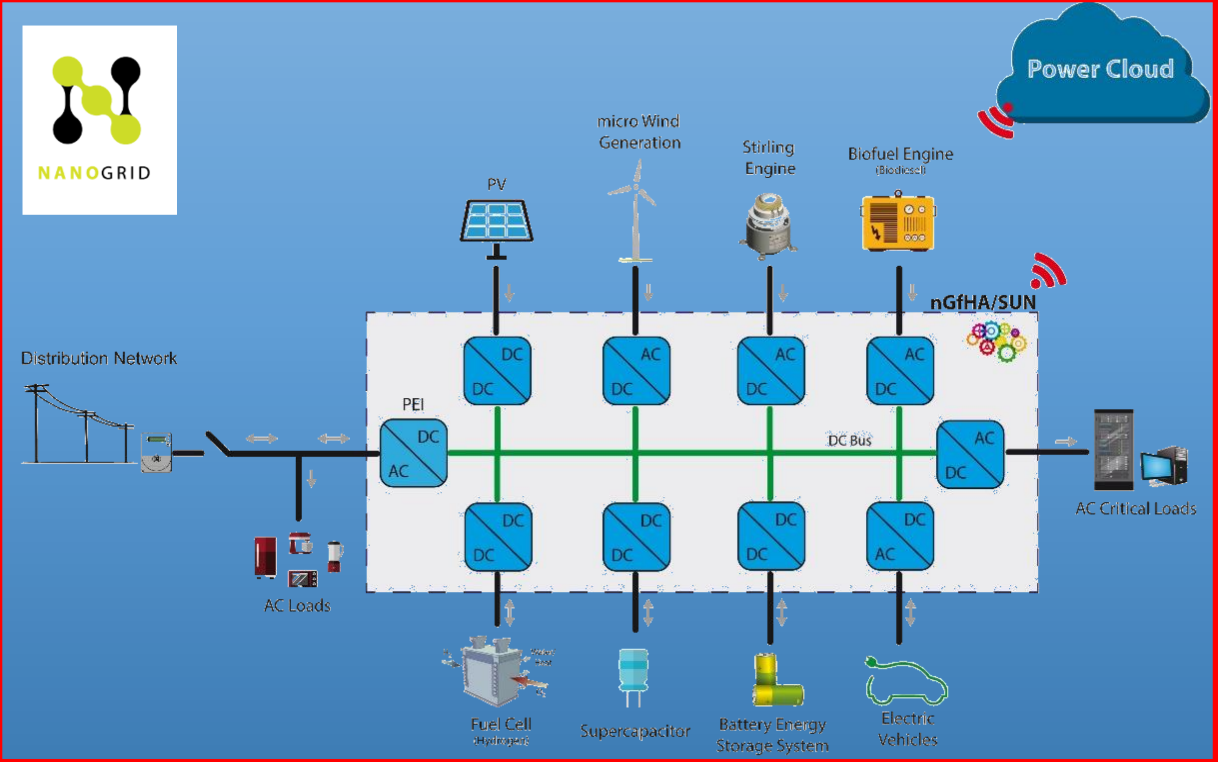
# RES and Energy storage systems integration…
# …DC Nanogrid…

an ***hybrid energy system*** for a single user house/multiple units in residential buildings, which has nominal power that does not exceeding 10kW and able to integrate several different types of generation and storage systems and operating both in grid-connected and stand-alone configuration to supply loads in areas where distribution network is not present.”




**Modular and Flexible solution**

**Technological solution: a hybrid system to maximize self-consumption, storage and sharing with other DCnanogrids of energy from renewable sources.**

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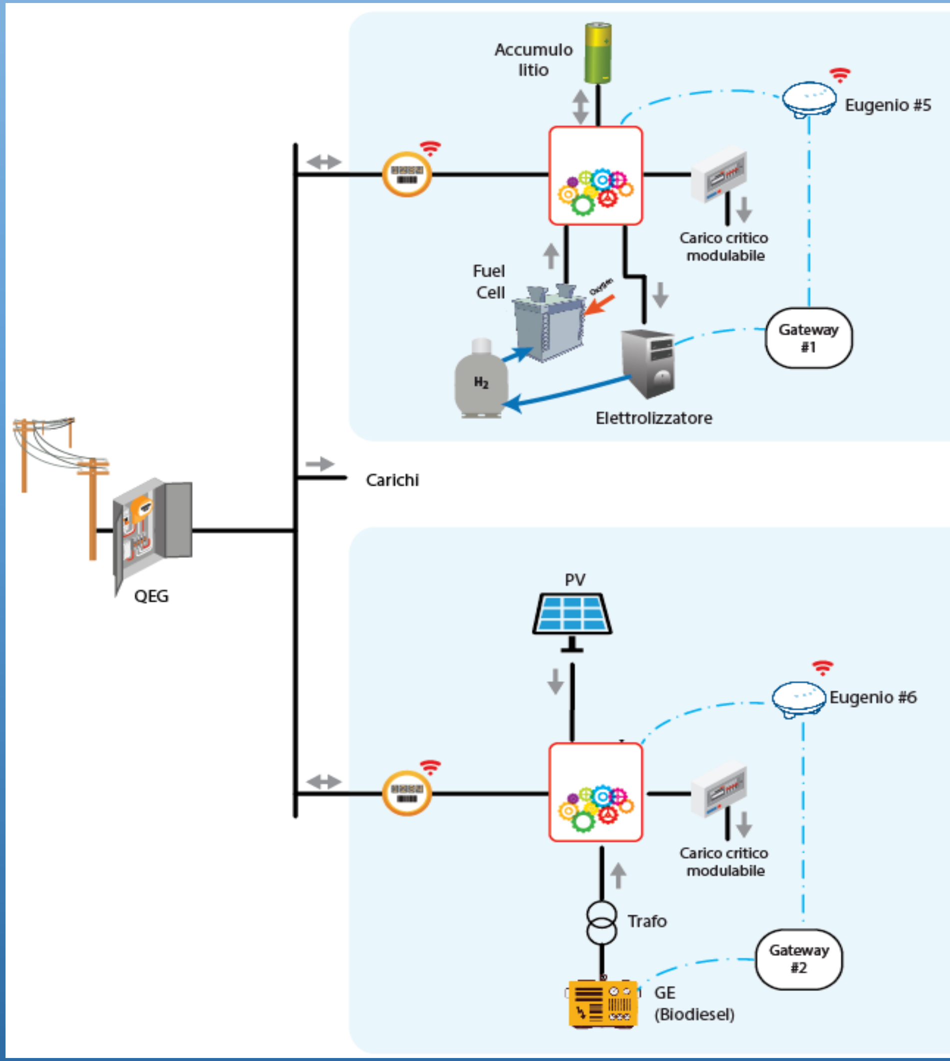
# …DC Nanogrid…



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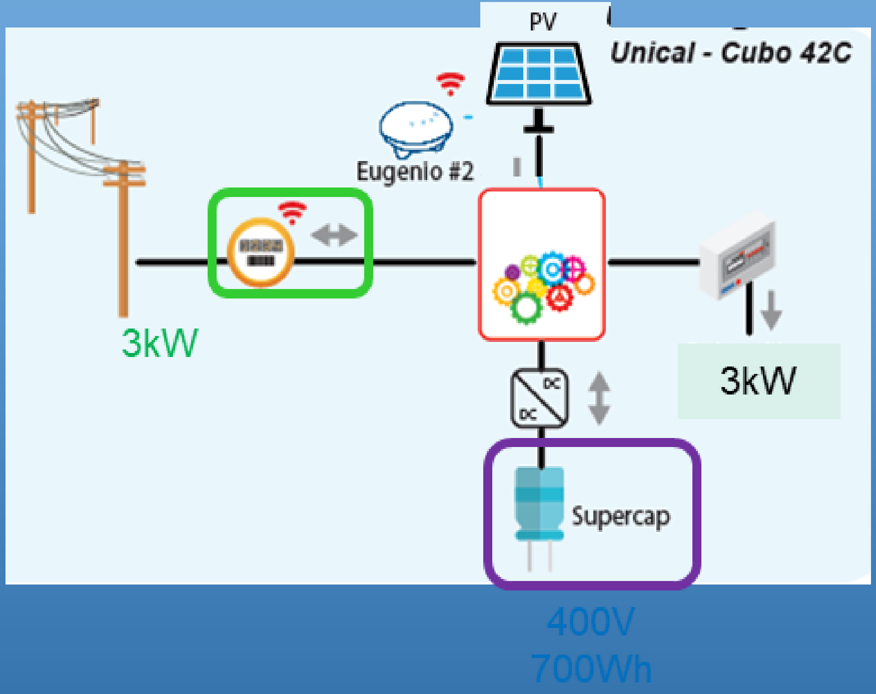
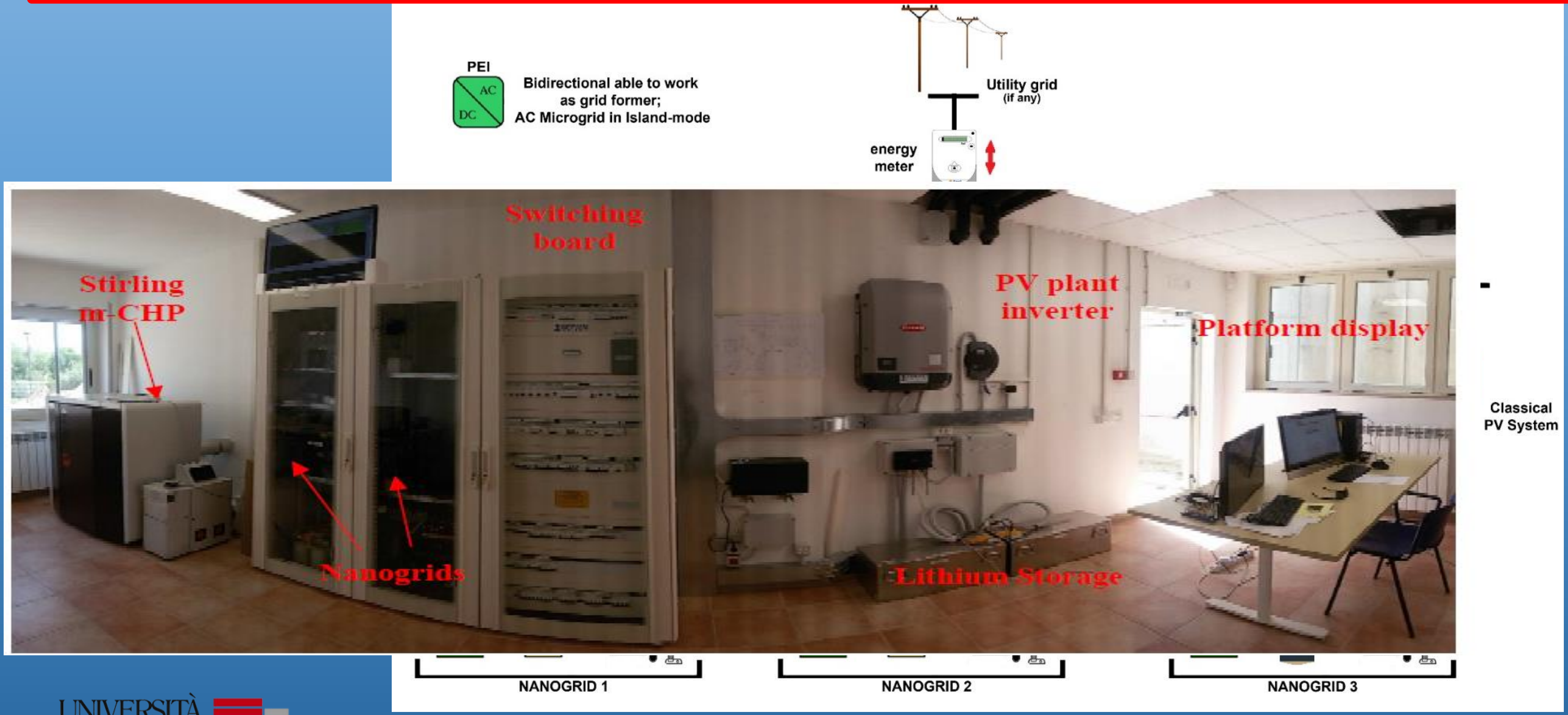
# ...DC Nanogrid...


NanoGrid#2


PV
Unical - Cubo 42C
Eugenio #2
3kW
3kW
DC
DC
Supercap
400V
700Wh

# …hybrid AC/DC Nanogrid…

**It consists of three nanogrids installed and connected to a common DC bus operating as a unique hybrid AC/DC microgrid. This microgrid integrates two PV plants, one stirling –engine mCHP, a litium battery energy storage, several electric loads and some controllable loads. Moreover, one heat pump with a thermal storage is installed.**

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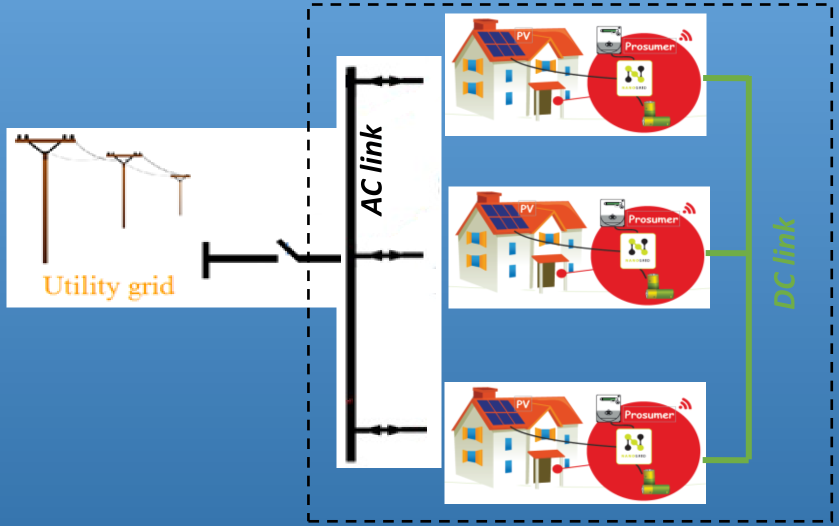
# …DC Nanogrid…

according to a bottom-up approach, can be gradually set up an islanded microgrid, in line with the number of users which, time by time, will connect each other to improve the reliability and the continuity of the system as a whole.

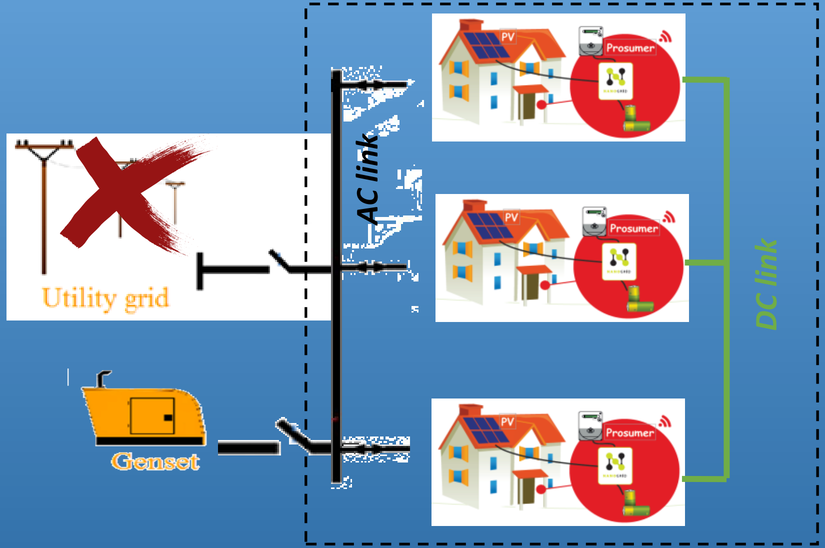
…multiple linked DC/AC Nanogrdi make a microgrids that can be connected to the utility grid.

**Grid connected mode**




AC/DC microgrid

**Islanded mode**




DC microgrids

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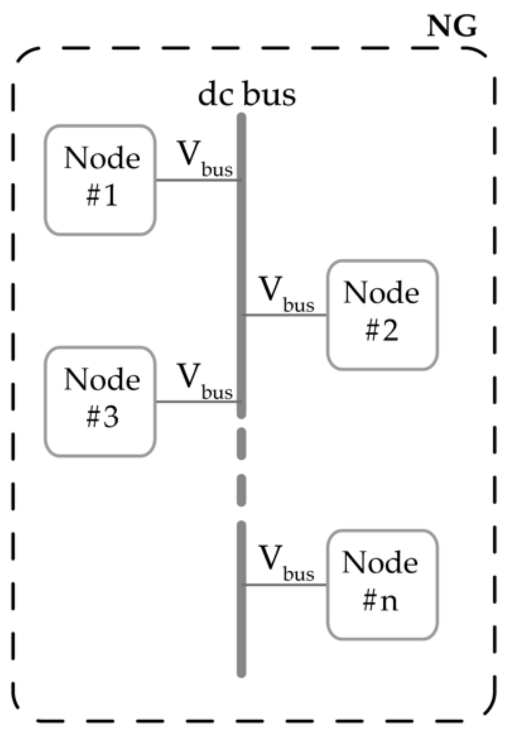
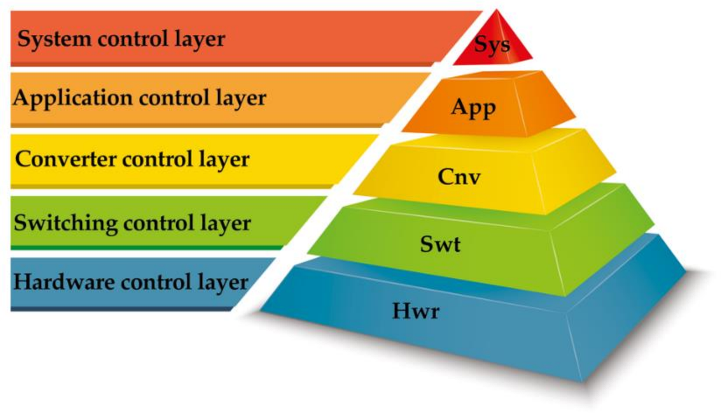
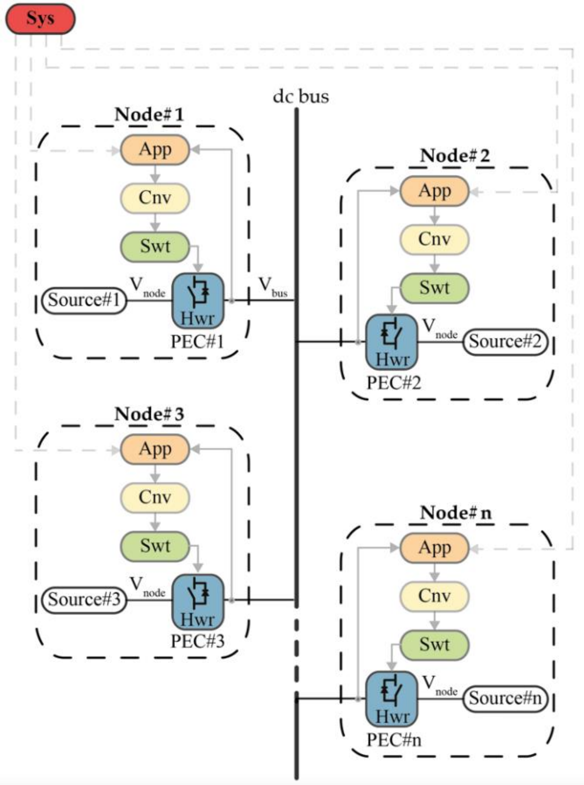
# …DC Nanogrid control strategy…

Flexible and Advanced DBS: a distributed control strategy

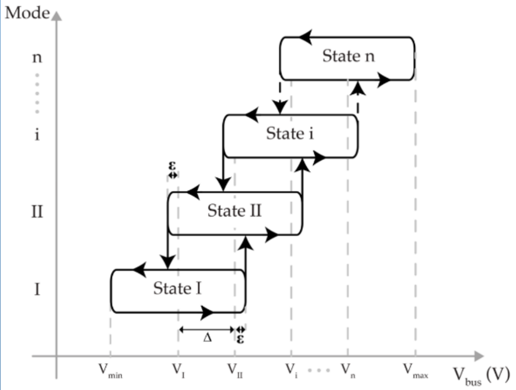



**Hierarchical control architecture**




**DBS State machine**

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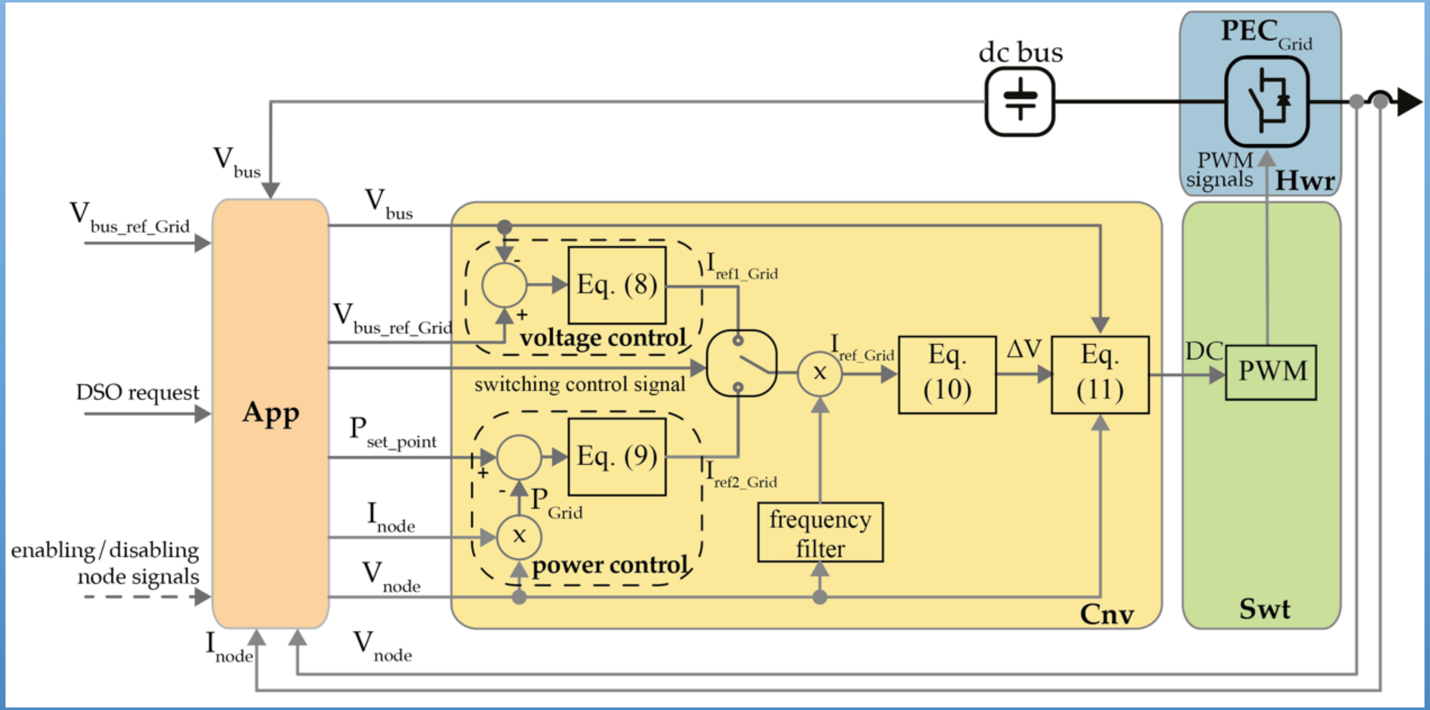
# …DC Nanogrid control strategy…

Grid node




For more information look the publication:

G. Brusco, D. Menniti, A. Pinnarelli, N. Sorrentino, Juan C. Vasquez, Flexible and Advanced DBS: A distributed control strategy for a DCNanogrid, Electric Power Systems Research, Volume 233, 2024, 110439, ISSN 0378-7796, https://doi.org/10.1016/j.epsr.2024.110439.

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# Why Hydrogen…

Hydrogen as an energy vector to decarbonize sectors with high energy demand:

- **H2 for transport: Solutions for sustainable mobility systems (sectors difficult to electrify, such as heavy industry, shipping, aeronautics and road transport with heavy vehicles)**
- **H2 for Network Balancing Solutions for innovative utilities and sector coupling (as long period energy storage system for Renewable Integration)**
- **H2 for Industry Procurement for green industrial processes**
- **H2 for Commercial Use Fuel Cells for business continuity and heating**

# Why Hydrogen … There are three ways of integrating and operating the hydrogen resource

Power to Gas (PtG) allows the decarbonisation of the energy production and end-use sectors, to store energy over long periods, even seasonal, to transport and distribute it even over long distances, increasing the resilience and security of the energy system

Power to Power (PtP) allows the creation of long-term storage systems that tend to be charged by the overproduction of renewable energy sources during the summer, to then provide energy during the winter and to deal with contingent situations of island operation ( causes the reduction of the adequacy of the "resilience" for the growing penetration of RES), in combination with storages capable of providing regulating capacity for the stability of the frequency in the island microgrid and of responding to loading ramps that cannot be addressed with "slow" storages like hydrogen which must satisfy the base-load.

Power to Grid (PtGr) allows the hydrogen storage system to be integrated with non-programmable renewable sources and with short-term storage systems (supercap and lithium based) in order to provide regulating functions to the AC microgrid or ancillary services to the grid .

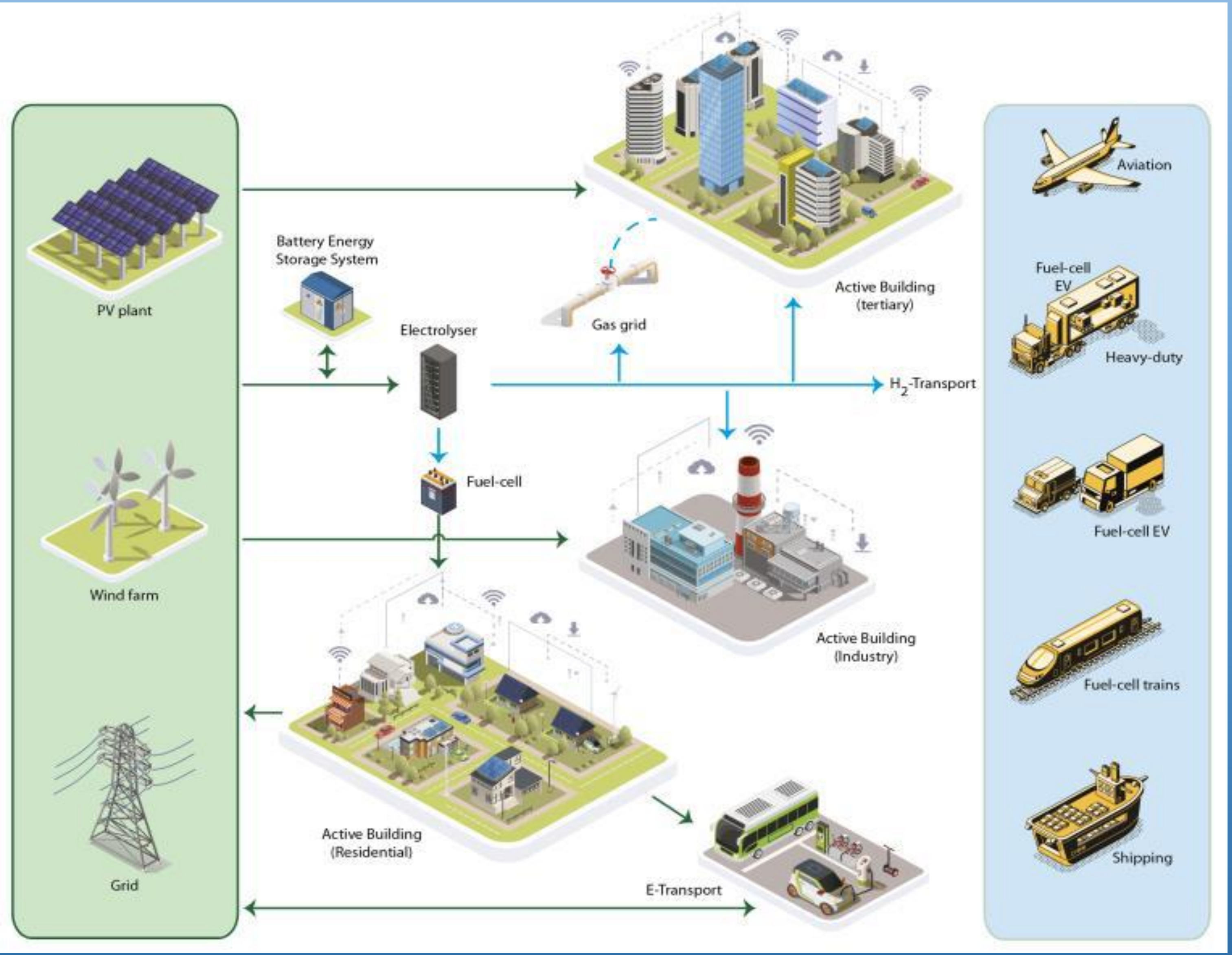
# What Hydrogen…Green

**GREEN --- from surplus of electricity generation from local renewable sources (additional, contemporary and on site) (PV, on/off shore wind, hydroelectric power plants…)**

**The green hydrogen is a priority for achieving environmental targets but at the same time requires a massive increase in renewable electricity capacity. Therefore, it is absolutely a priority to accompany a green hydrogen project with careful planning of interventions to increase the renewable capacity.**

# Multi-Carrier Energy and cross-sectoral framework

**The advent of new technologies such as CHP units, electric heat pumps, EV, hydrogen-fuel-cell system has led to the integration between various multi-energy systems.**
**Hence, multiple energy systems need to cover not only electricity but all energy sectors.**
**In this respect, a critical case for attaining stable energy systems is considering the role of multiple energy systems in which energy carriers interact optimally at various surfaces.**

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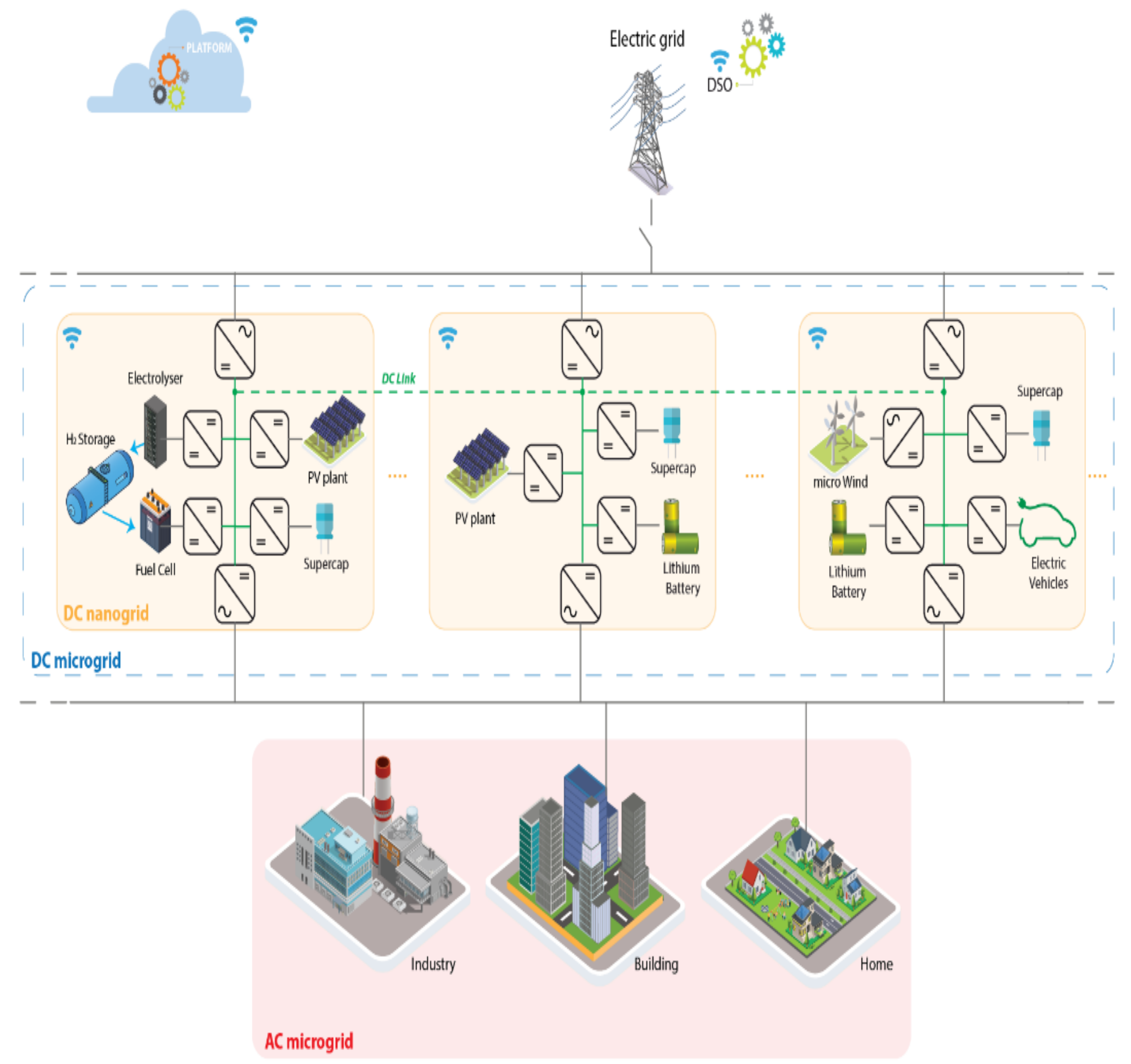
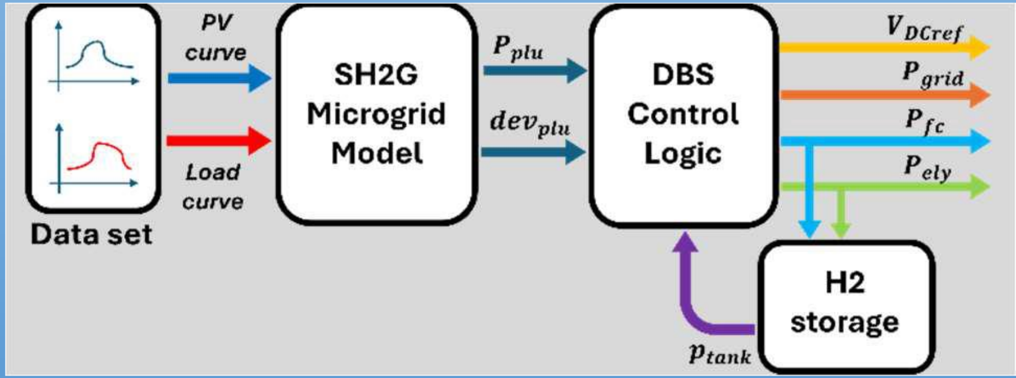
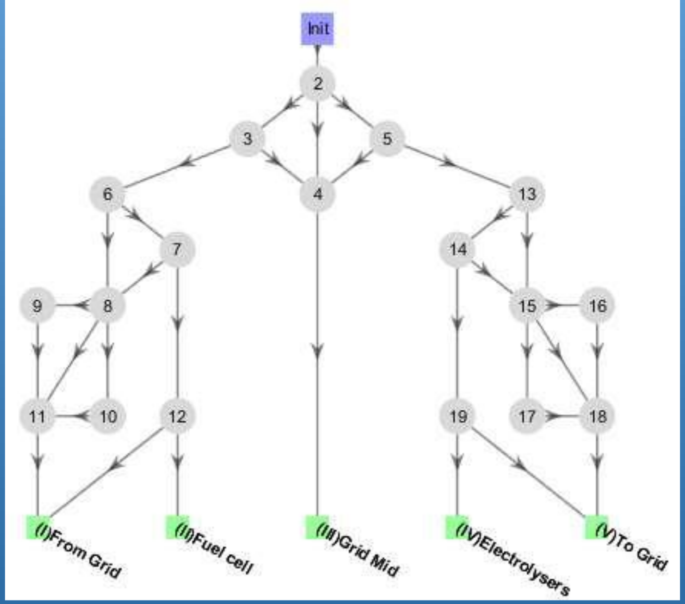
# Multi-Carrier Energy and cross-sectoral framework



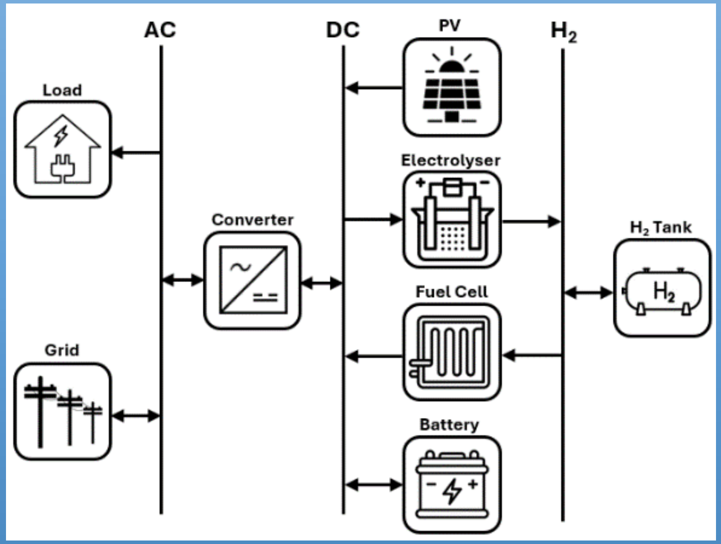

## Structured approach on designing the DC Bus Signaling (DBS) control strategy

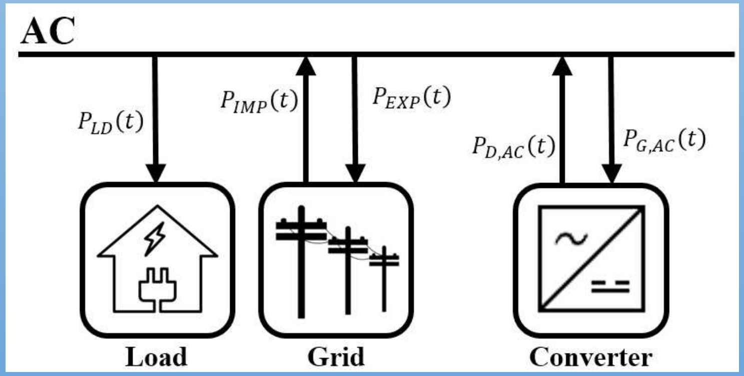


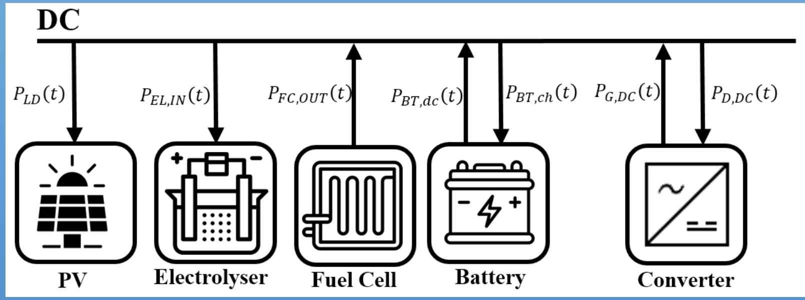

## Stateflow method that implements a State Machine (SM)

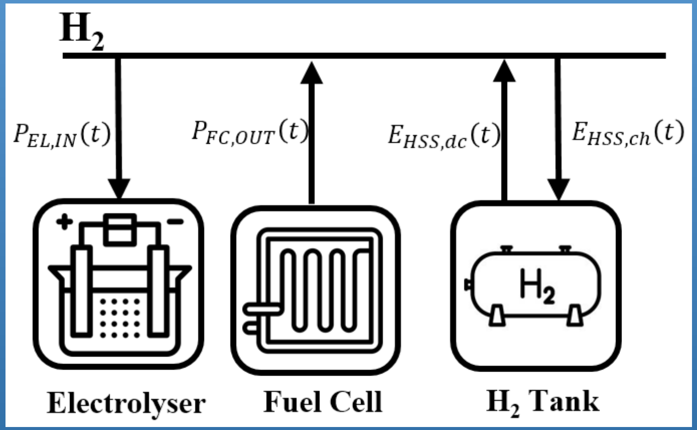


# Mixed-Integer Linear Programming (MILP) model




$$OF_1: \max\left(\sum_{T} P_{self}(t)\cdot \triangle t\right)$$

$$OF_2: \min(C_{tot})$$

$$P_{self}(t) = \min\left(P_{PV}(t) + P_{BT,dc}(t) + P_{FC,OUT}(t), P_{LD}(t) + P_{BT,ch}(t) + P_{EL,IN}(t)\right)$$

$$C_{tot} = C_{inv} + C_{OM,fix} + C_{OP,var} + C_{IMP} - C_{EXP}$$

$$P_{EL,OUT}(t)\cdot \triangle t + E_{HSS,dc}(t) = P_{FC,IN}(t)\cdot \triangle t + E_{HSS,ch}(t) \quad \forall t \in T$$

$$P_{PV,size,min} \le P_{PV,size} \le P_{PV,size,max}$$
$$P_{k,rated,min} \le P_{k,rated} \le P_{k,rated,max}$$
$$CAP_{BT,min} \le CAP_{BT} \le CAP_{BT,max}$$
$$CAP_{H_2,min} \le CAP_{H_2} \le CAP_{H_2,max}$$

# Thanks for your attention!

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Co-funded by the European Union

*This project is co-funded by the European Union's Horizon Europe innovation actions programme under the Grant Agreement n°101138211. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.*

SUSTAINABLE PLACES 2024

# SEEDS

*Cost-effective and replicable RES-integrated electrified heating and cooling systems for improved energy efficiency and demand response*

**Rongling Li**

PI of SEEDS

DTU

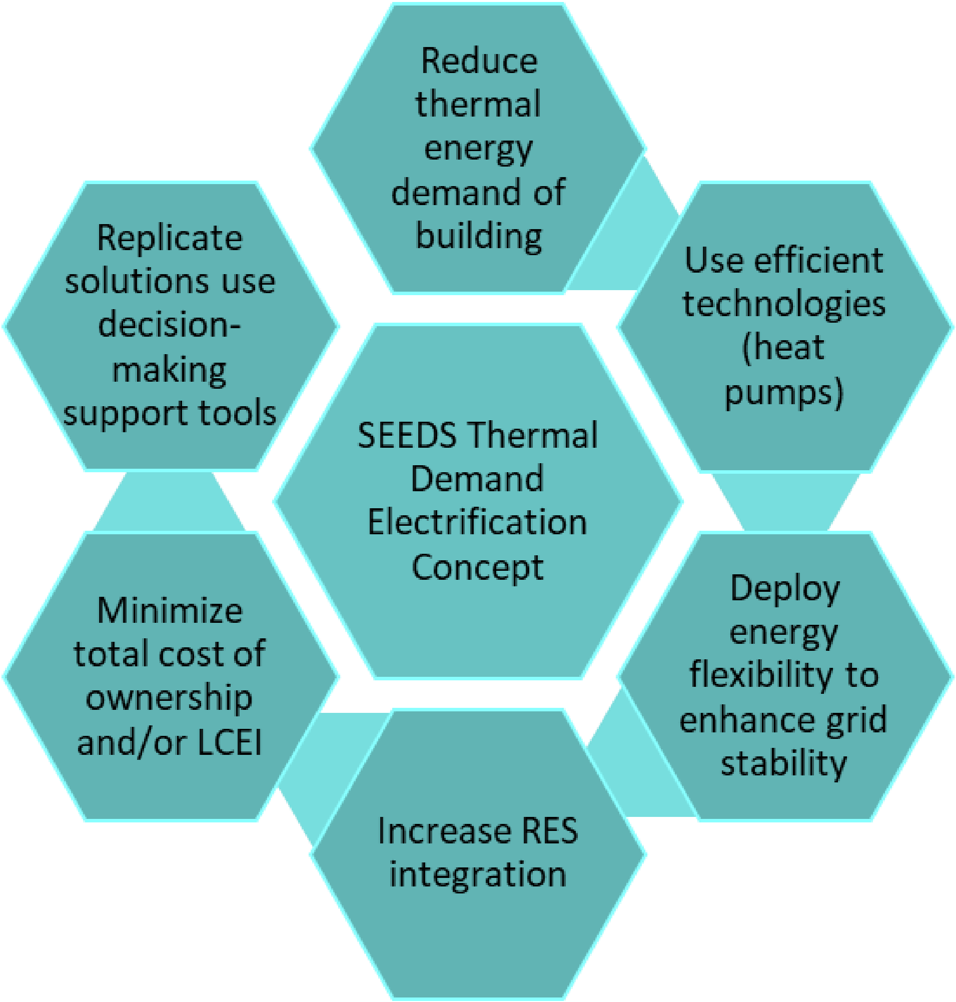
Associate Professor, Department of Civil and Mechanical Engineering, Technical University of Denmark

Operating Agent, IEA EBC Annex 82 & Annex 96 “Grid Integrated Control of Buildings”

Board member of Horizon Europe Built4People Partnership

# SEEDS Concept

To boost the electrification of thermal demand in buildings in Europe through an integrated and scalable methodology that results in energy efficient renovation and smartification of HVAC systems that provide the requested thermal comfort.



# SEEDS at a glance

**26**
PARTNERS

**6**
PILOT SITES

**48**
MONTHS

## DURATION

1 January 2024 – 31 December 2027

## KEYWORDS

*Energy efficient buildings, heat pump, RES integration, energy efficiency renovation, deploying energy flexibility*

# TIMELINE

SEEDS

| 2024 | 2025 | 2026 | 2027 |
| --- | --- | --- | --- |
| Design, permission, tender | Construction, installation, algorithms | Measurements, testing | Implementation, upscaling |

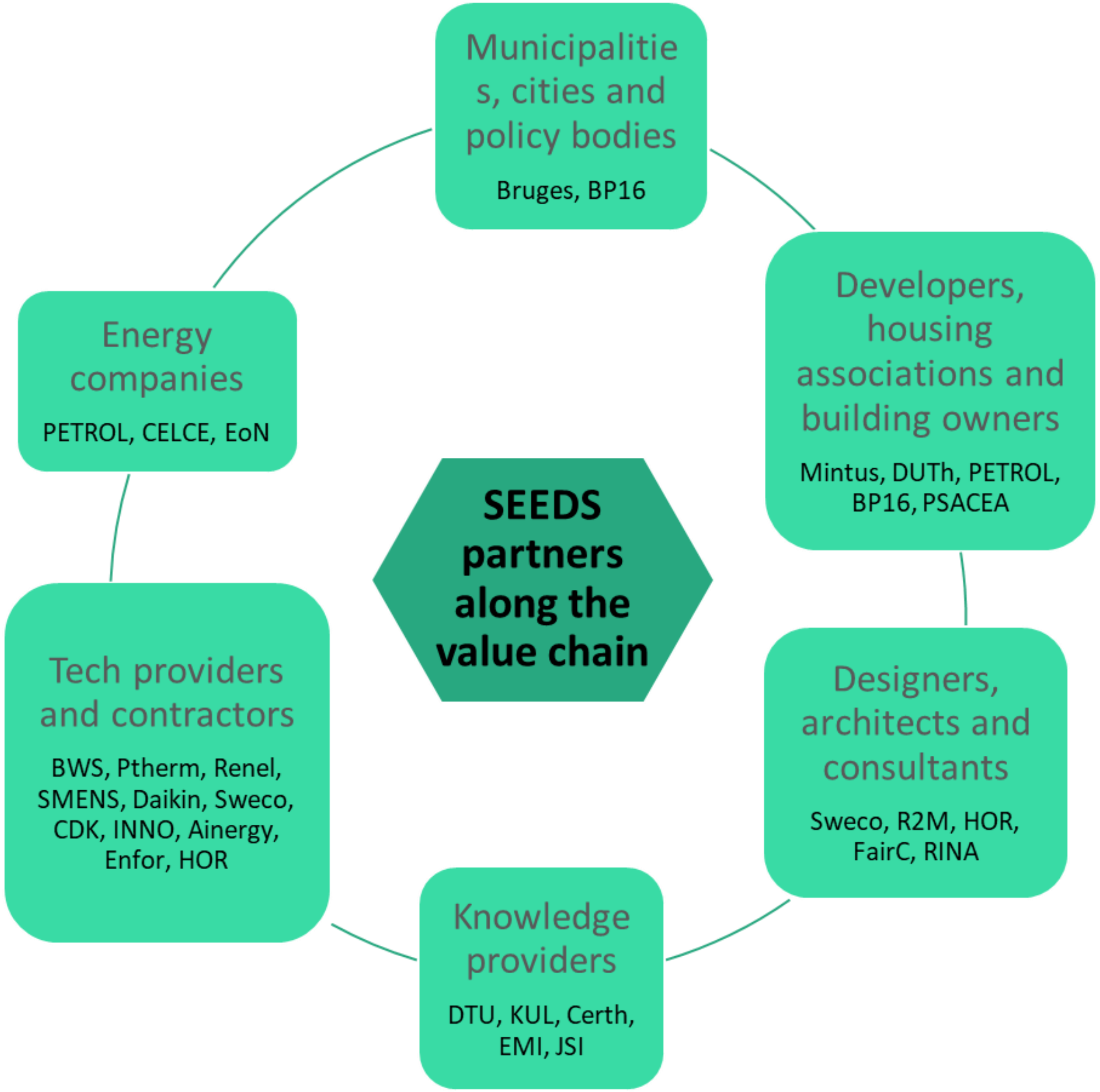
# The consortium

SEEDS

SEEDS unites **26 partners**: a multidisciplinary and complementary team of SMEs, LEs, RTOs, and stakeholders that constitute the **whole (local) value chain** of energy efficiency in buildings and thermal demand electrification, from **8 Member States** or associated Member States.

DK BE HU SI GR IT FR UA

# SEEDS value chain

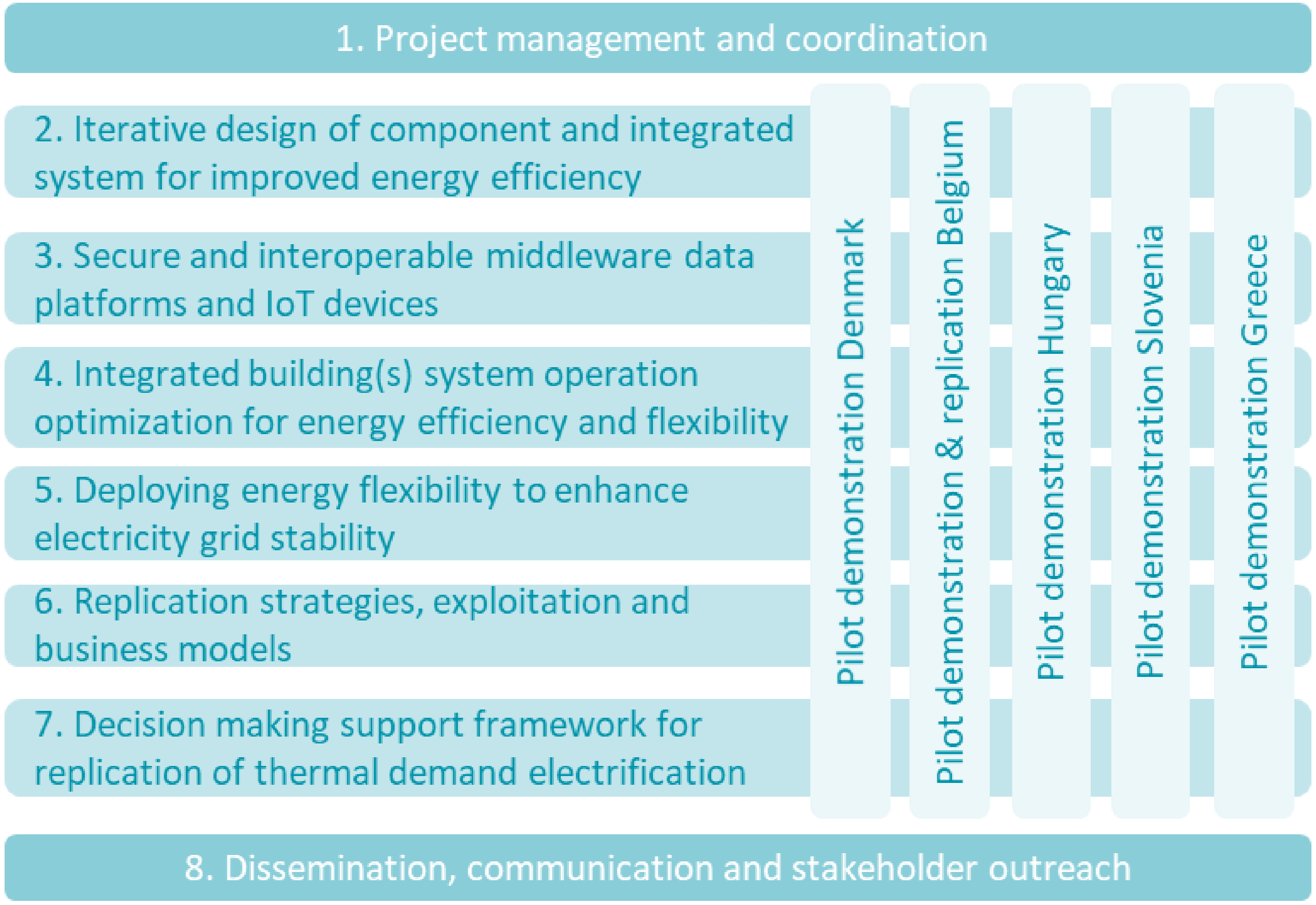


# 6 pilot sites & 8 participating countries

# The team

# SEEDS Workflow

SEEDS




**6 pilot projects** to demonstrate how promising innovations in smart and sustainable electrification of building thermal demand can become widespread

**6 focus areas** integrated with the implementation of the pilots

# Pilots

**Belgium pilot** will lead the way to electrify culture heritage houses in historical cities in Europe

- Integrated design of a collective hybrid heat pump system
- Smartification of heat pump to facilitate MPC
- Integrated optimal control and sizing
- Adaptive hydronic scheme for seasonal switch
- MPC in a cluster of residential
- Replication from Pilot 1 to Pilot 2

# Pilots

SEEDS

**The Hungarian pilot** - façade renovation with reusable materials and nonintrusive HP system

- VRV heat pump system to replace individual room gas burners
- Demountable External Thermal Insulation Composite System to increase reusability
- Integrated BIPV & energy storage
- Integration of VRV with thermal storage into BEMS and microgrid controller system
- Interaction with the DSO (EoN) platform for energy flexibility

# Pilots

SEEDS

**The Greek pilot** - optimal use of existing RES and smartification of hybrid HP with natural refrigerant

- PV and Reflection System
- Multi-source (air, geothermal, solar thermal) HP with natural refrigerant
- Optimized electrification systems dimensioning & scheduling
- Data-driven AI solutions for
  - Modulation control for multi-source HPs
  - Tracking for Reflector systems
  - Predictive Maintenance
  - Thermal Comfort and Energy Consumption Management
  - Microgrid power flow analysis
  - Thermal flexibility forecasting

# Pilots

**Danish pilot** will deploy energy flexibility using real-time dynamic prices

- Integrative design of battery, EV charger, chiller and ventilation system
- Management of electricity production, storage and consumption and minimize electricity costs
- Digital platform facilitating the implementation of optimal system operation
- Controllers for deploying energy flexibility using real-time prices

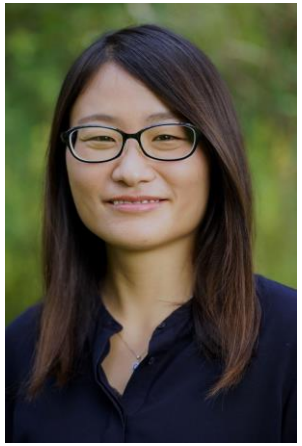
# Pilots

**Slovenia pilot -** market bidding of energy flexibility provided by HPs and batteries to enhance grid stability

- Near real time data acquisition and dynamic control for enabling electricity flexibility services (balancing services)
- Multi-criteria characterization models of micro energy sources
- Multi-objective optimization and aggregation for energy flexibility
- Aggregator platform for market bidding to include micro energy sources into a bulk of flexibility providing devices, that can be linked with existing flexibility devices to participate in the flexibility markets (TSO, DSO)
- Test & evaluate market biding decision support platform

# Follow us and get in touch!

SEEDS



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