Digital Energy lab

Innovative Technology Solutions for
Smart Grid 2.0 Applications
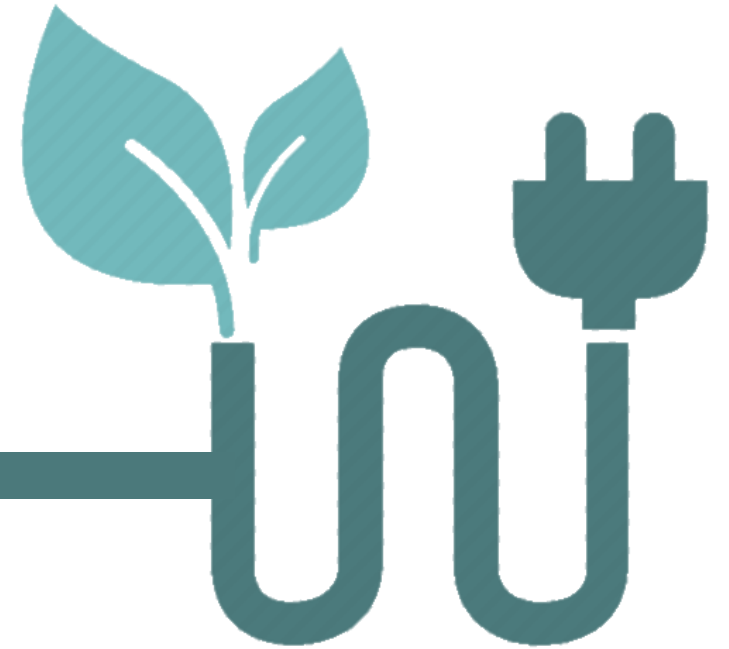
Who we are

CERTH:

Founded in **2000** - one of the leading R&D centres in Greece

Includes 5 institutes:

- Information Technologies Institute (ITI)
- Chemical Process & Energy Resources Institute (CPERI)
- Hellenic Institute of Transport (HIT)
- Institute of Applied Bioscience (INAB)
- Institute of Bio-Economy and Agri-Technology (IBO)

Information Technologies Institute:

- Part of **CERTH since 2000**
- Leading Institution of Greece in the fields of Informatics, Telematics and Telecommunications, etc.
- A total budget of **135 M€**
  - ~15 M€ funding per year (last 3 years)

FIRST in Greece for the last 12 consecutive years in participation at competitive research grants (FP7, H2020, Horizon Europe)

CERTH Cooperation Schemes with Industry

✓ Offering R&D Services (contractual basis)
  - ✓ Specific **R&D** based on Industry needs
  - ✓ **Feasibility** Studies & **Proof** of **Concepts**
  - ✓ Access to **Infrastructure** (Smart Home, 3D Printing, HPC)
  - ✓ Rapid **prototyping** (embedded systems/hardware)

✓ Connecting to **funding sources**
  - ✓ Cooperation in **Open Cal**ls and National/EU funded projects

✓ Technology **Scouting**
  - ✓ Towards New Products Development

✓ **Ancillary** services
  - ✓ Training on new technologies (i.e., AI)
  - ✓ Patent support

Active role as Digital Innovation Hub

Active Cooperation through Clusters (i.e., IsZEB concept)

Research & Development

Innovation Management

Ecosystem

Digital Energy Lab

- Started in 2017

- Interdisciplinary team of >50 engineers and scientists

- Over 30 research projects (majority: H2020)

- Supporting over 10 PhD students

- Supervised by Dr. Dimosthenis Ioannidis & Dr. Dimitrios Tzovaras

- Over 100 journal and conference publications in last 5 years

From simulation
to real-life implementation,
the **Digital Energy Lab**
brings to life
Smart Grids 2.0

Meet the Core Team!

Dr. Dimitrios Tzovaras
CERTH President, Research A'

Angelina Bintoudi
Junior Researcher, Microgrids, Power Electronics & Optimisation

Lampros Zyglakis
Junior Researcher, ICT in Power Systems

George Skaltsis
Junior Researcher, Power Systems, Energy Efficiency

Dr. Dimos Ioannidis
Researcher C', Team Leader

Paschalis Gkaidatzis
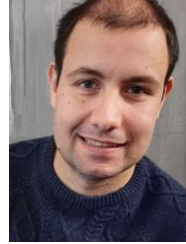Senior Researcher, Power Systems

Christos Timplalexis
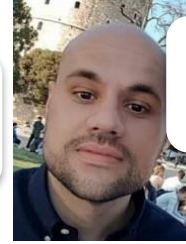Junior Researcher, Machine Learning in Power Systems

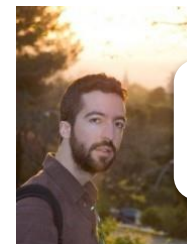**Zoi Boutopoulou**
Junior Researcher, Microgrids, Power Systems

Stelios Zikos
Senior Researcher, Energy Efficiency

Nikos Katsaros
Junior Researcher, Microgrids, Power Electronics & Optimisation

Napoleon Mpezas
Junior Researcher, Data Analysis in Power Systems

Ioannis Moschos
Junior Researcher, Power Systems, Energy Markets

Dr. Krinidis Stelios
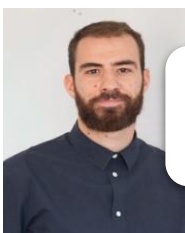Senior Researcher, Project Manager

Alexandros Kanlis
Senior Hardware engineer, Smart Meters and Embedded Sensors

Aris Apostolidis
Senior Hardware developer, Embedded Engineer & Fog-enabled Sensors

Angeliki Veliskaki
Junior Researcher, Power Systems, Smart Grids

Nikos Tsalikidis
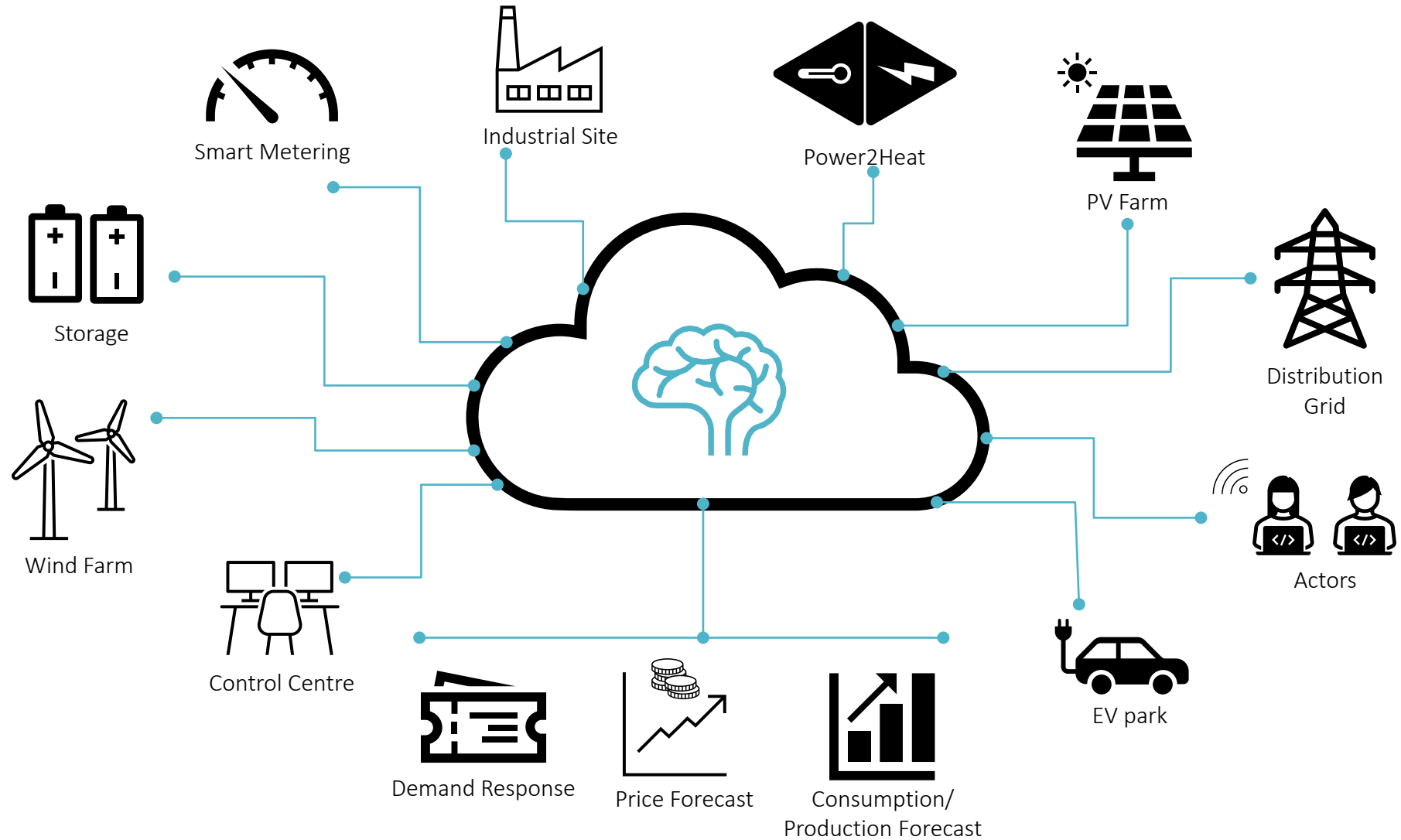Junior Researcher, Machine Learning in Energy Efficiency

Dr. Paris Koukaras
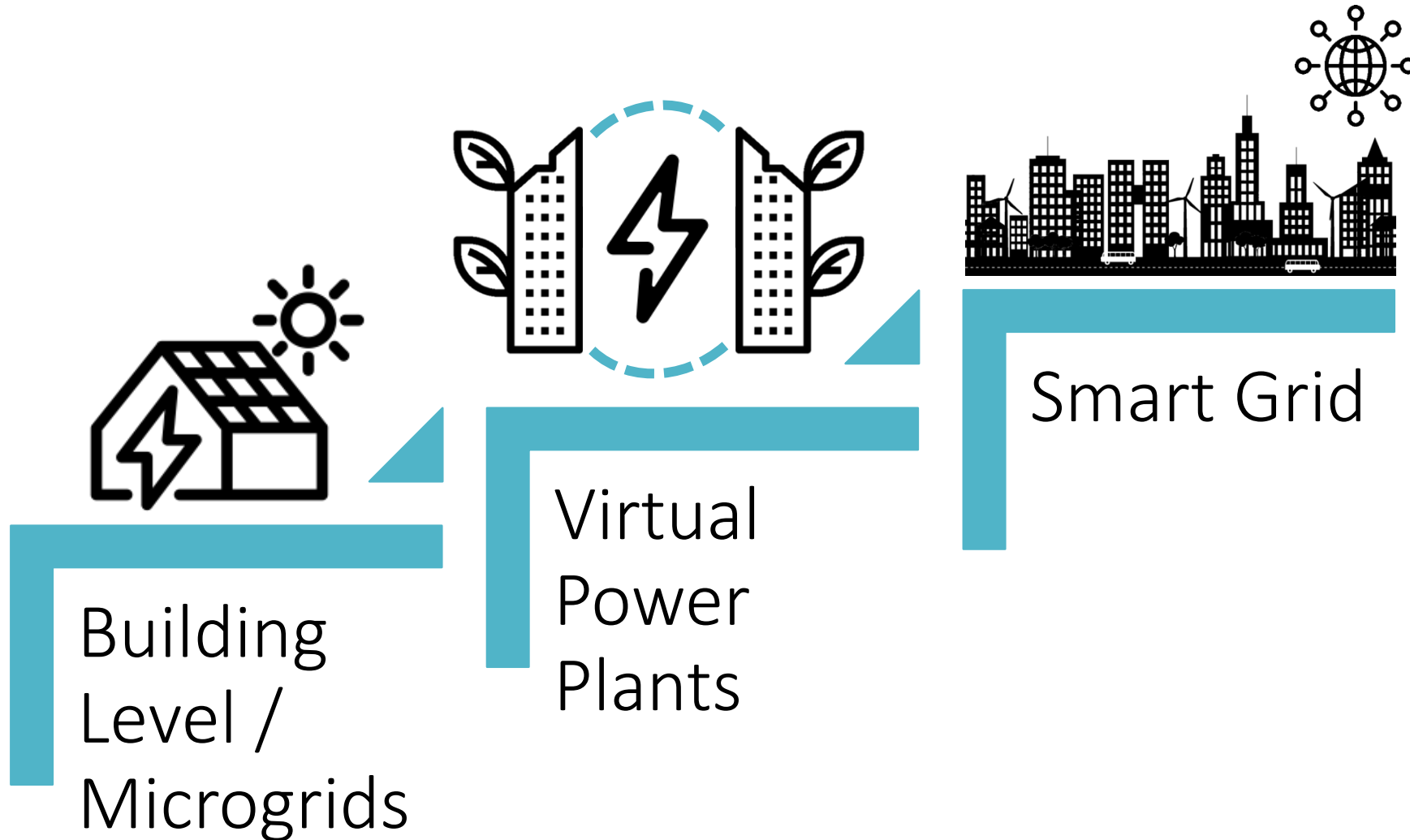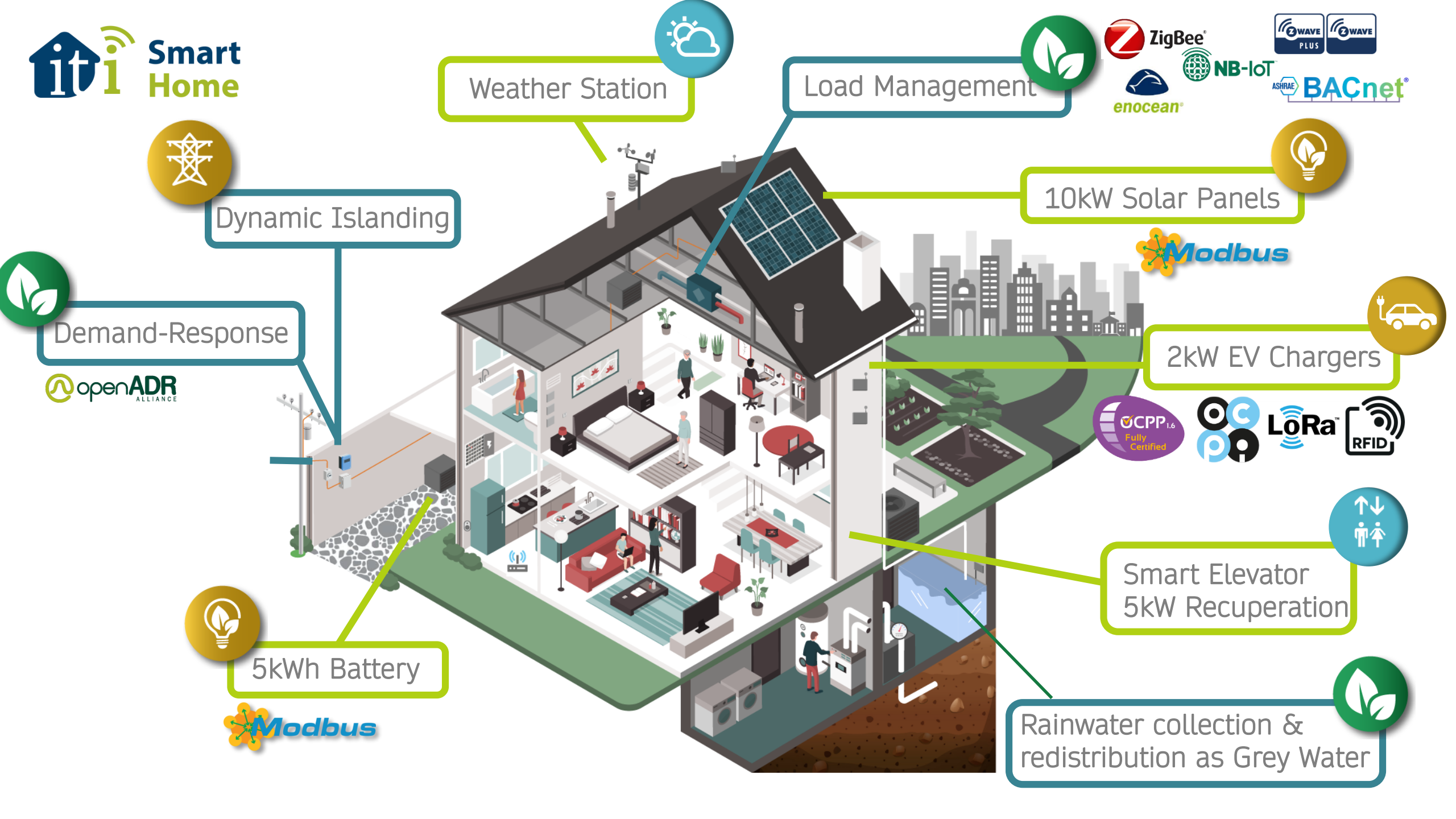Senior Researcher, Project Manager

Aris Mystakidis
Junior Researcher, Machine Learning in Power Systems

Smart Grid, VPPs & Microgrids Ecosystem

Solutions at 3 Different Levels

Building Level / Microgrids

Virtual Power Plants

Smart Grid

iti Smart Home

Weather Station

Load Management

ZigBee
NB-IoT
enocean
Z-WAVE PLUS
Z-WAVE
ASHRAE BACnet

Dynamic Islanding

10kW Solar Panels

Modbus

Demand-Response

openADR ALLIANCE

2kW EV Chargers

OCPP 1.6 Fully Certified
OCPP
LoRa
RFID

Smart Elevator
5kW Recuperation

5kWh Battery

Modbus

Rainwater collection &
redistribution as Grey Water

Infrastructure – the first grid connected microgrid in Greece

Infrastructure – smart, interoperable monitoring & control systems

➢ Light dimming

➢ HVAC full control

➢Smart, wifi-enabled home appliances

➢Multi-layered smart meters (electricity, water etc.)

➢A highly diverse (IoT) multi-sensorial & actuation network for multidisciplinary case studies (environment, energy, health, etc.)

!!! One advanced, flexible solution to unify them all: CERTH's IoT Platform
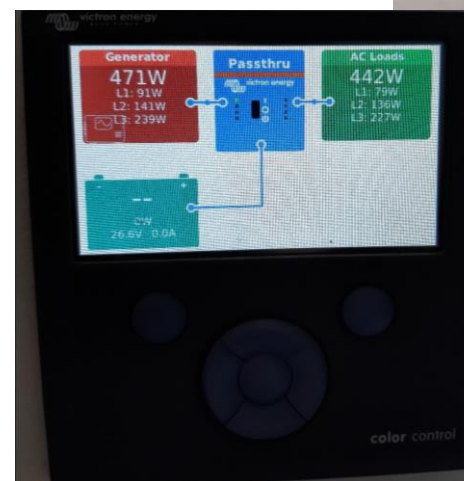
Smart House IOT platform & sensor/meter hardware

nZEB Smart House IoT Platform

Type of device	ID number	Image	Location	Connectivity	Data Access	Measuring interval
TEMPERATURE & HUMIDITY						
Plugwise Sense	-		One per each space in the main House	ZigBee HA 2.0	SmartHome IoT Platform API	15' -adjustable
Gavazzi EM340	-		One per indoor electric panel (3 ground floor)	Modbus RTU	SmartHome IoT Platform API	1 sec from device 1 min from API
Gavazzi EM270	-		Building Point of Common Coupling	Modbus RTU	SmartHome IoT Platform API	1 sec from device 1 min from API
Thermokon SR04 CO2	-		1 living room ground floor and 1 playroom first floor	EnOcean		**Measuring interval** WakeUp time = 100 sec. (default) **Transmission interval** every 100 sec. at change >0,4 K, >2,5% rH or 50 ppm, otherwise every 1000 sec.

Sensor & smart meter hardware
installed in the nZEB Smart House

11

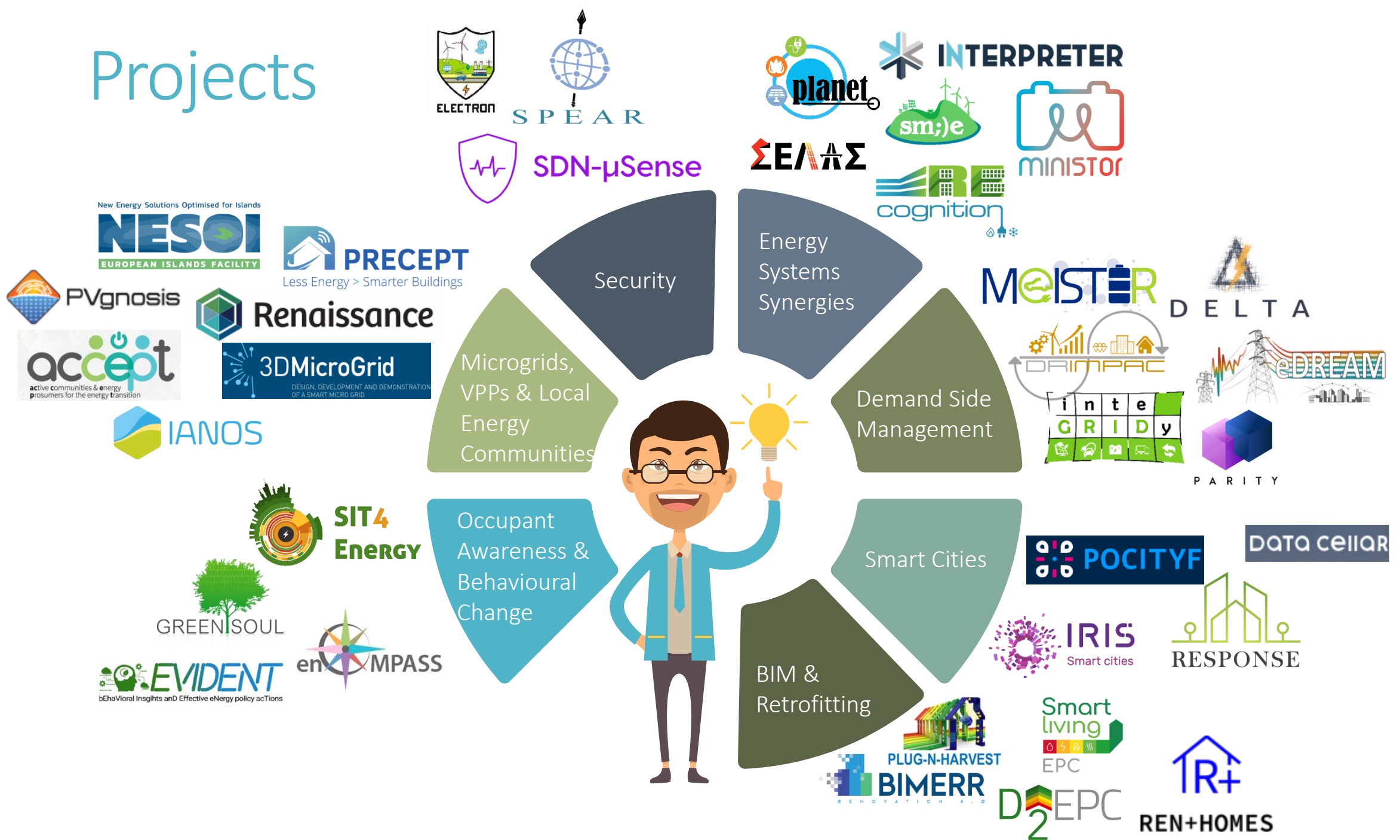RES forecasting tested in ITI Smarthome facilities and in numerous research projects

RES Power Generation Forecasting

Projects

Technologies Used

Enhanced Simulations

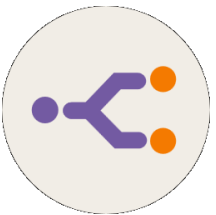Big Data

Machine Learning

Multi-Agent Systems

Internet of Things

Interoperability

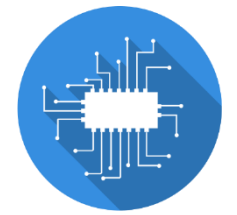Decision Support Systems

Customized Hardware Solutions

Visual Analytics

Demand Side Management

Blockchain

Artificial Intelligence

Related Project: SmartLivingEPC- Advanced Energy Performance Assessment towards Smart Living in Building and District Level

Building Energy Efficiency

About

SmartLivingEPC project aims to deliver a certificate which will be issued with the use of digitized tools and retrieve the necessary assessment information for the building from BIM literacy, including enriched energy and sustainability related information for the as designed and the actual performance of the building.

A special aspect of SmartLivingEPC will be its application in building complexes, with the aim of energy certification at the neighbourhood scale.

Who

SmartLivingEPC consortium consists of fifteen partners and two affiliated entities from twelve EU countries.
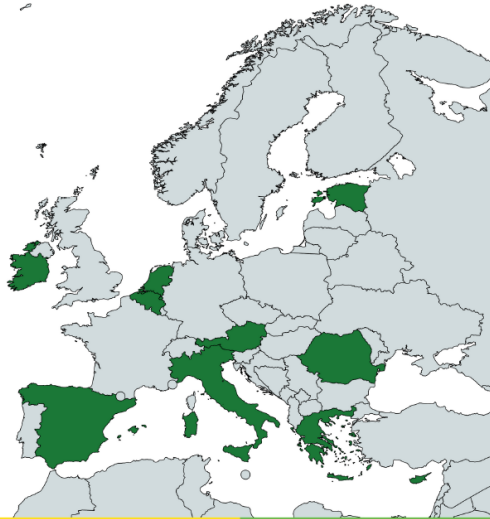
How

SmartLivingEPC concept is structured on three individual development layers, which complement each other towards achieving the project targets.

1. the development of an enhanced methodology, which will consider energy, sustainability, smartness and technical audits aspects, to deliver an enriched, enhanced rating scheme

2. the integration of digital design tools for the issuance of EPC

3. the development of the Digital Platform and AI services, which will support the user friendliness and the exploitation potentials of the SmartLivingEPC

- Operational behaviour of the building
- Life cycle performance aspects & building smartness assessment
- Compatible with digital logbooks and building renovation passports
- EPC application in building complexes

Smart living EPC

Related Project: RE-COGNITION - Renewable, Cogeneration and storage technologies integration for energy autonomous buildings

Cross-Functional Renewable Energy Sources Integration Platform

Automated Cognitive Energy Management Engine (ACEME)

Harmonizes the power generation with the power-heating-cooling demand of the building.

Building Energy Plant Planning Tool (BE-PLATO)

Allows the building stakeholders to make informed decisions on whether or not to install RES equipment on their building.
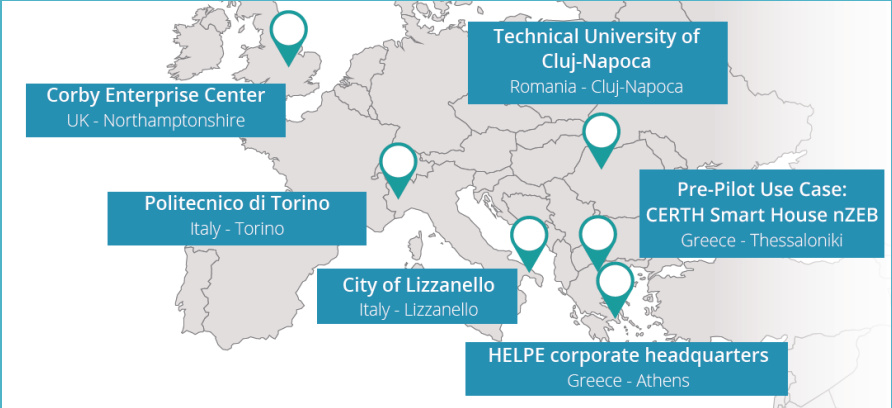
iGateway

Delivers insightful data for the connected subsystems through their embedded intelligence.

Visual Analytics Dashboard

Provides a holistic overview of the RE-COGNITION framework operation, through access to the monitored data of the developed technologies and pilot buildings.

RES Power Generation

Corby Enterprise Center
UK - Northamptonshire

Technical University of Cluj-Napoca
Romania - Cluj-Napoca

Politecnico di Torino
Italy - Torino

Pre-Pilot Use Case:
CERTH Smart House nZEB
Greece - Thessaloniki

City of Lizzanello
Italy - Lizzanello

HELPE corporate headquarters
Greece - Athens

RE cognition

www.re-cognition-project.eu

Building Energy Efficiency

Related Project: REN+HOMES - Renewable ENergy-based Positive Homes

REN+HOMES tackles the **sustainable transition** not only by reducing carbon emissions, but also resource scarcity, energy poverty and focusing on education/participation of stakeholders

Project main aims:

1. Develop a set of 23 solutions:
   - *9 hardware (e.g., geothermal walls, wireless IoT device)*
   - *7 software methodologies*
   - *7 Circular Plus Energy Homes (CPEH) methodologies*

2. Tests them in 4 large-scale demonstrators

3. Develop business models combining cost-effective deep-retrofitting, demand response and energy communities

Positive energy building (PEB): an energy-efficient building that produces more energy than it uses via renewable sources.

Given the high relevance of the building sector for emissions reduction, the concept of PEBs is gaining increasing attention.

Related Project: REEFLEX - REplicable, interoperable, cross-sector solutions and Energy services for demand side FLEXibility markets

- Developing an <u>interoperability platform</u> and <u>service catalogue</u>, the project aims to
  - Maximize the **flexibility** of distributed energy resources
  - Take into account different end-user **profiles/ infrastructure limitations**
- <u>Generate</u> a common operation market model using AI-driven intelligence services & automation systems
- Help to reduce market entry barriers, costs, encourage greater participation from energy consumers
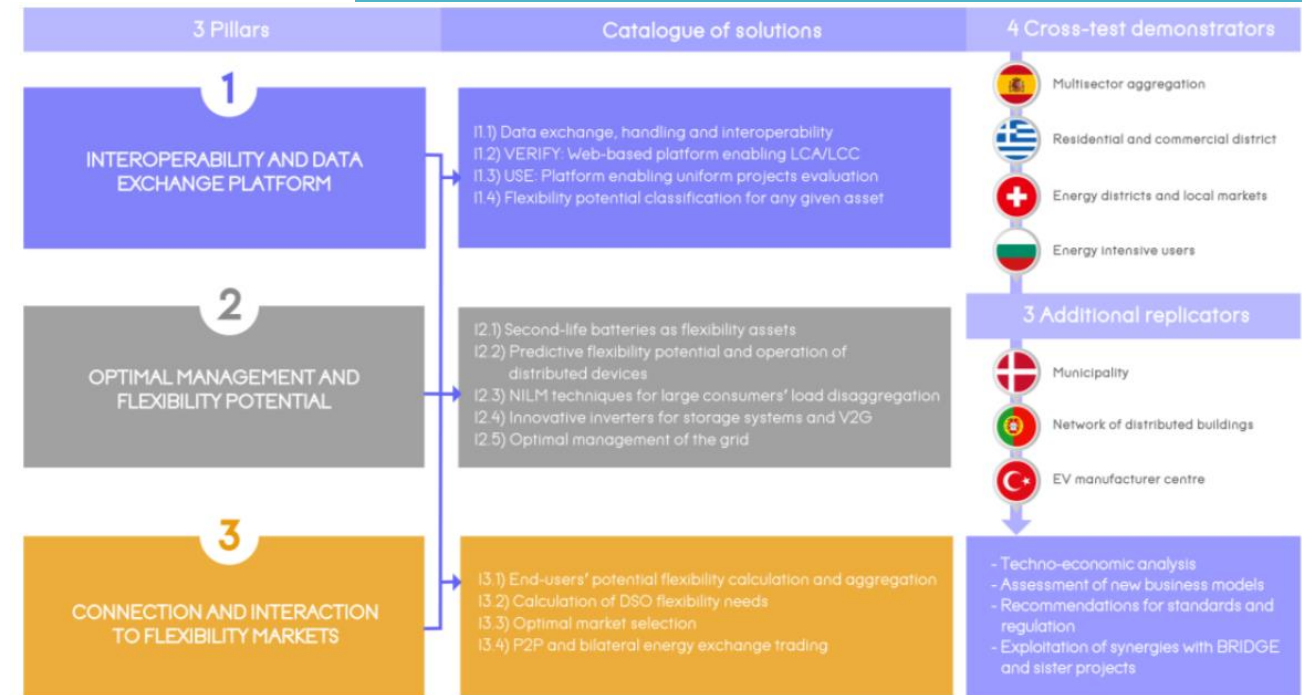
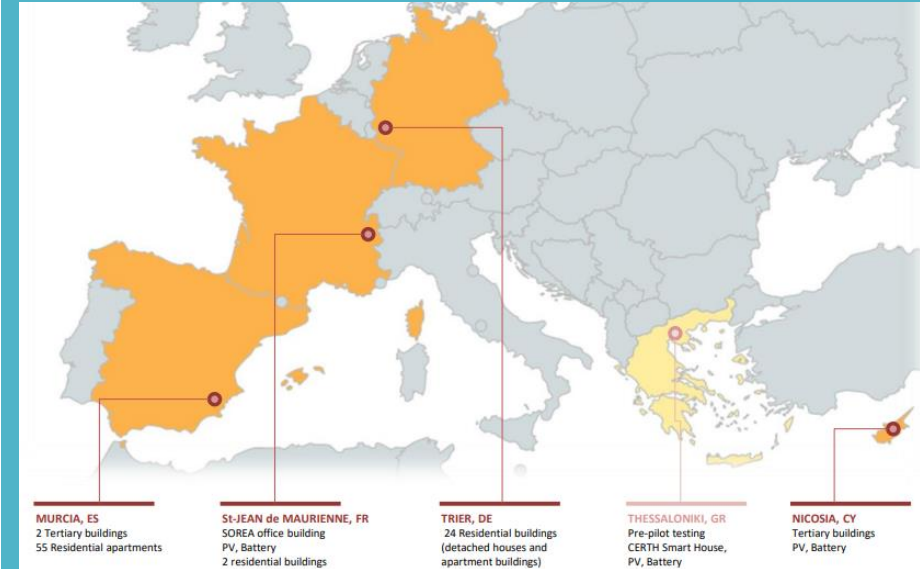## Smart Grid

Figure 1. REEFLEX overall scheme.

https://reeflexhe.eu/

Related Project: DRIMPAC - Unified DR interoperability framework enabling market participation of active energy consumers
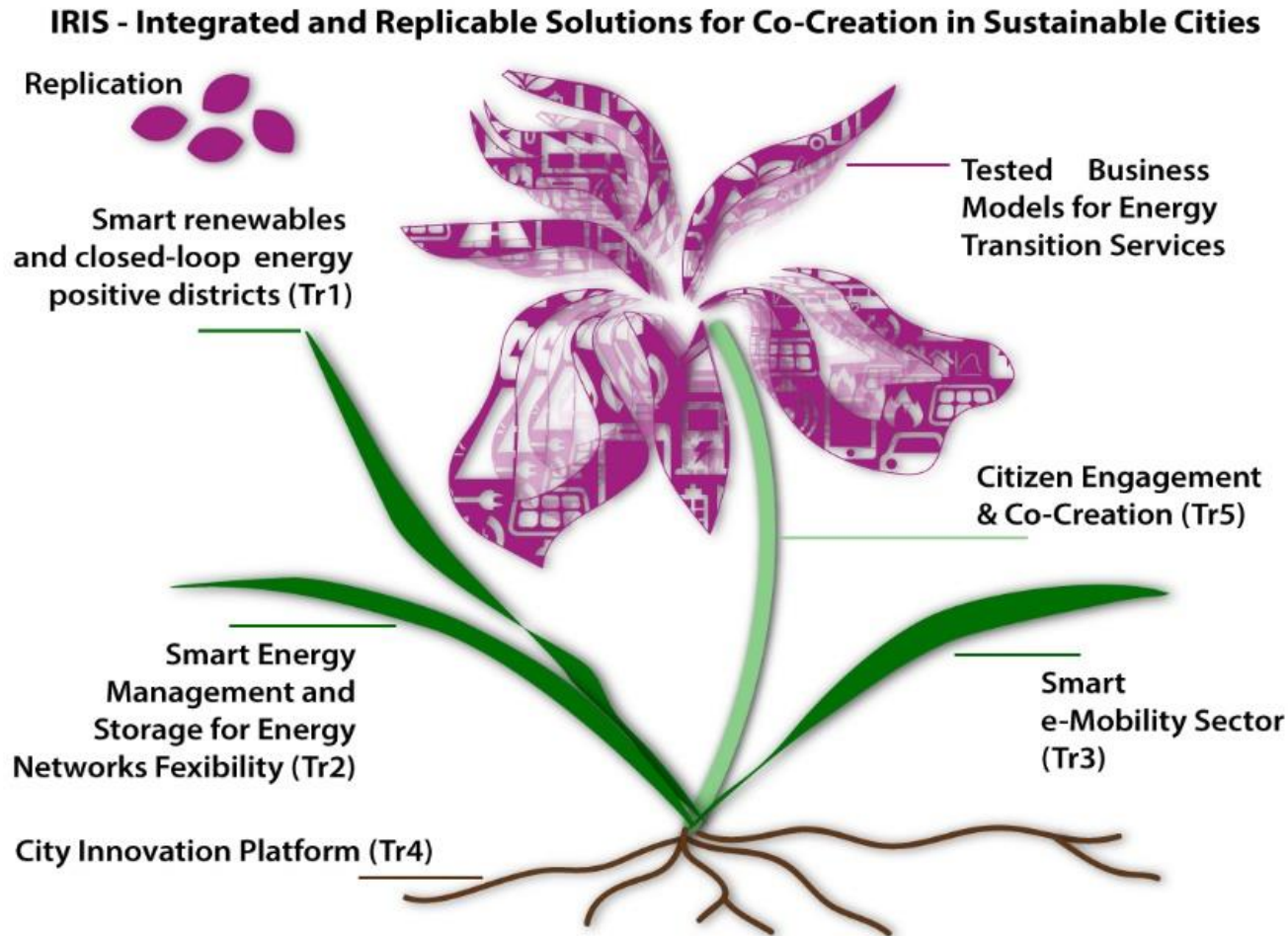
Aims:

• Develop and deliver the DRIMPAC solution as an interoperability solution for <u>small prosumer</u> Demand Response (DR)

• Define innovative <u>service offerings</u> and <u>business models</u> for energy retailers

• Demonstration via piloting and market testing on real users

• Completion of energy <u>management system</u>, smart boxes and local IoT monitoring/control system

• Testing of different innovative DR business models at the pilot sites

Grid Operators Support

MURCIA, ES
2 Tertiary buildings
55 Residential apartments

St-JEAN de MAURIENNE, FR
SOREA office building
PV, Battery
2 residential buildings

TRIER, DE
24 Residential buildings
(detached houses and
apartment buildings)

THESSALONIKI, GR
Pre-pilot testing
CERTH Smart House,
PV, Battery

NICOSIA, CY
Tertiary buildings
PV, Battery

https://www.drimpac-h2020.eu/

Related Project: IRIS - Co-creating smart & sustainable cities

IRIS - Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

- Replication
- Smart renewables and closed-loop energy positive districts (Tr1)
- Tested Business Models for Energy Transition Services
- Citizen Engagement & Co-Creation (Tr5)
- Smart Energy Management and Storage for Energy Networks Fexibility (Tr2)
- Smart e-Mobility Sector (Tr3)
- City Innovation Platform (Tr4)

Business scenarios
- Monitoring and assessment of smart city projects
- Increase of citizen <u>engagement</u> and active <u>participation</u> to promote behavioral changes

Smart and Sustainable Cities

Vaasa
Gothenburg
Santa Cruz de Tenerife
Utrecht
Focsani
Nice Côte d'Azur
Alexandroupolis
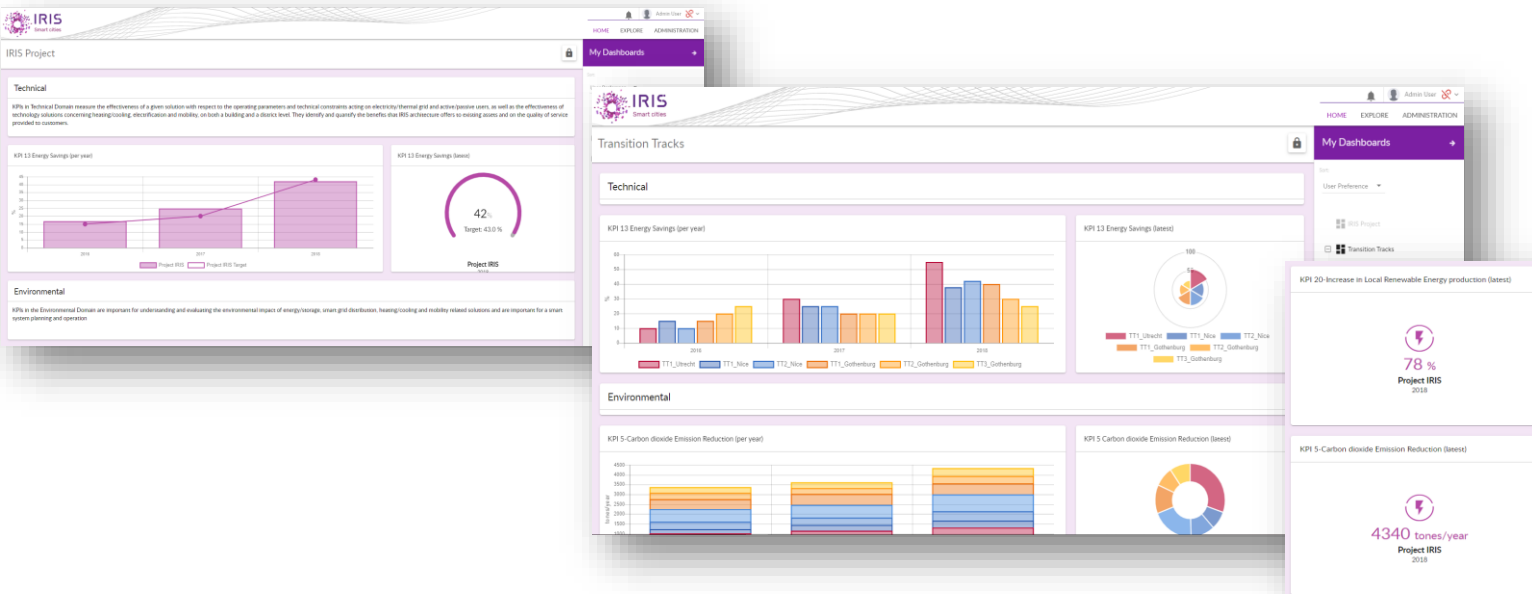

https://irissmartcities.eu/

Smart City Monitoring & Assessment Platform

Supports continuous <u>monitoring</u> and <u>assessment</u> of smart cities projects:

- Collection of monitoring data from <u>various sources through APIs</u>.

- Calculation of Key Performance Indicators (KPIs).

- Advanced <u>analytical</u> and <u>visualisation</u> techniques allowing the comparative evaluation of different projects.

Smart and Sustainable Cities

Open Data · Smart Health · Smart Grid/Smart Energy · Smart Agriculture · Internet of Things · Smart Home · Smart Mobility · Smart Retail

SMART CITY

Gamification Platform

Boosts user and citizen <u>engagement</u> through gamification:

- Introduction of gamification elements in <u>any third-party web or mobile app</u> to enhance user engagement through **a reward system**.

- Users participate in **games** that promote <u>sustainability</u> and <u>green practices</u> (e.g. reduction of energy waste, recycling, etc.) and **compete** with other users <u>for rewards</u> when completing the actions and exhibiting the desirable behaviour.

Industrial IoT and Hardware Solutions

Development and Deployment of Smart Hardware Solutions
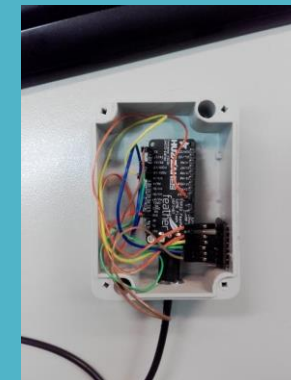
Fill level sensors for Bins' Distance Monitoring

- Indoor-bins(small bins) fill level monitoring based on **IR sensors**
- Outdoor open top containers based on **Ultrasonic sensors**
- **Low power** design

Vibration Sensors for Machine's Monitoring and Real-time Analysis

- Smart wake-up
- **Wi-Fi** connectivity
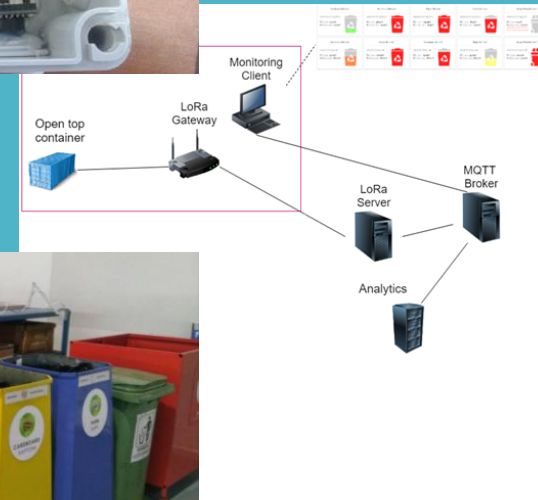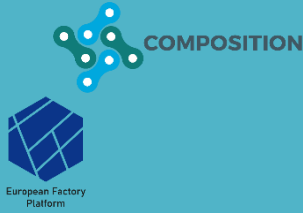
Ultra sonic & IR Sensors

Vibration Sensors

Solutions for Predictive Maintenance and Anomaly Detection

Cognitive Analytics Platform for Early Anomaly Detection
- Self-trained models
- AI & ML algorithms and boosting techniques
- Big Data Visual Analytics

Decision Support System for Predictive Maintenance
- Various approaches for <u>anomaly detection</u> and <u>advanced visualizations</u>
- Fault forecasting based on Trend Analysis (Slope Statistic Profile)
- Online and deep machine learning techniques for fault forecasting (**unsupervised machine learning** classifier for **outlier detection**)
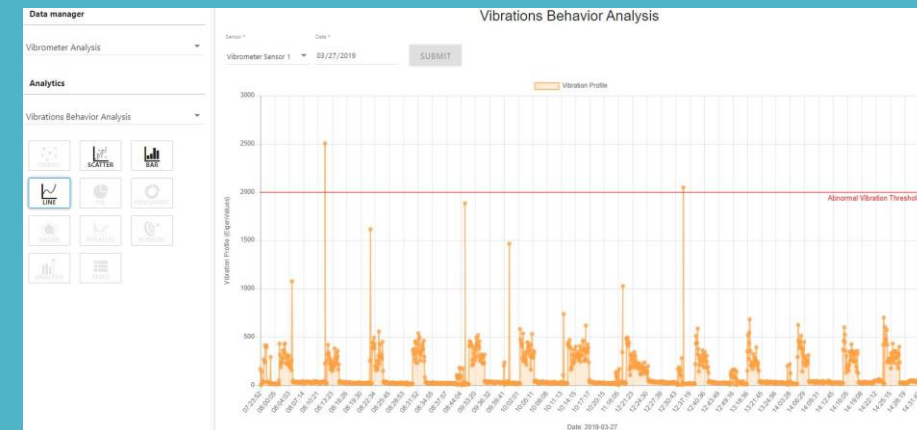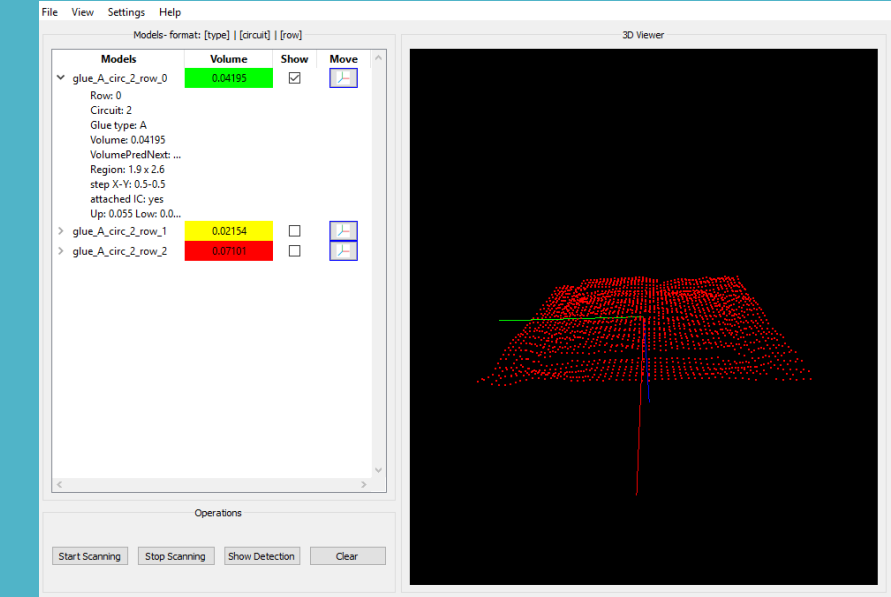
Solutions for Co-production, Collaboration and Co-creation

- **Collaborative Knowledge Services based on AR**
  - AR Glasses and AR creation toolkit (creation of AR scenarios)
  - AR presentation toolkit (presentation of scenarios at AR devices)
  - Automatic <u>object detection</u> and verification algorithms
  - Remote Assistance Support
  - A wide range of devices is offered to access the AR/VR services (webGL, Android, Hololens)
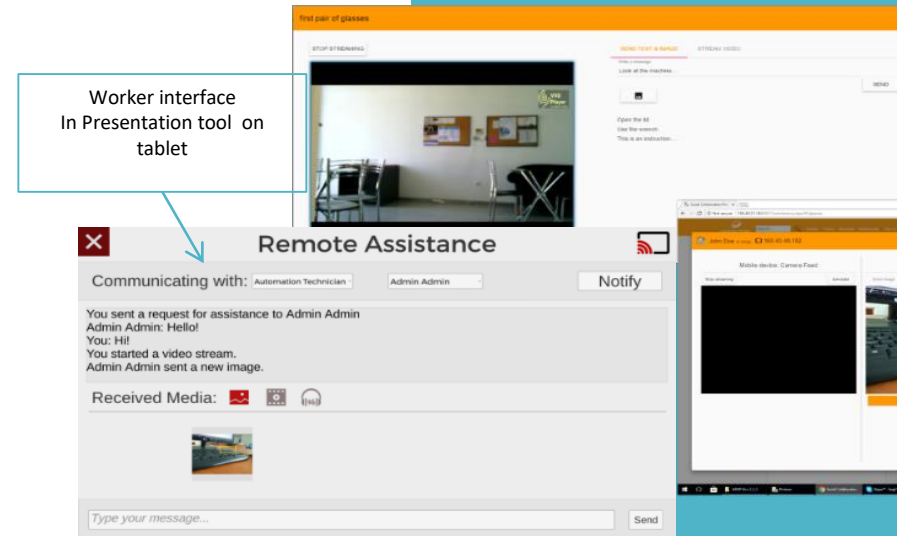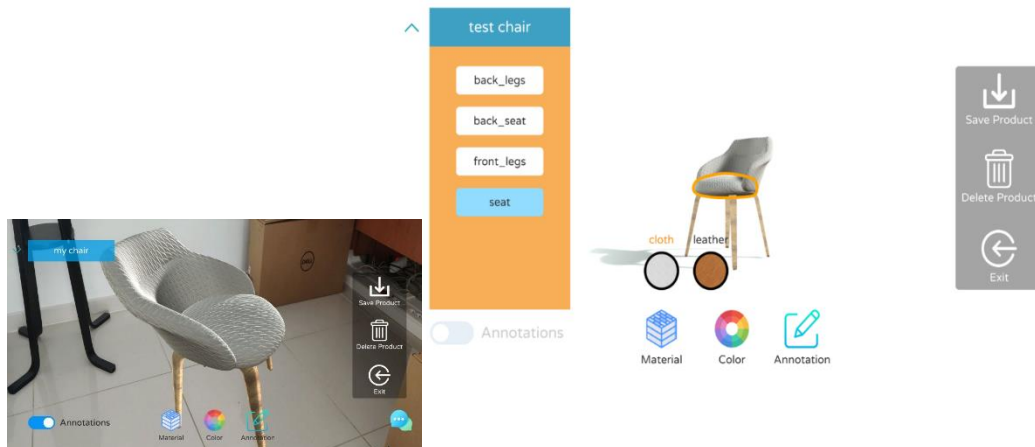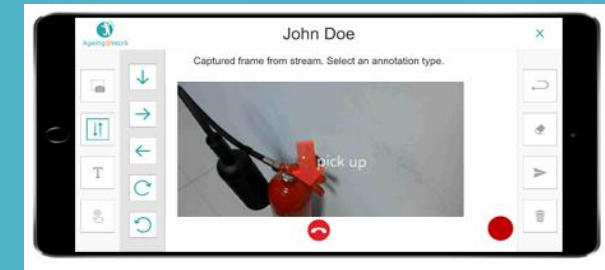
Supervisor interface to GlassUp Glasses

Supervisor interface to tablet

Worker interface In Presentation tool on tablet

Thank you

Contact:
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Researcher Grade C'
djoannid@iti.gr

Information
Technologies
Institute