The Smart Grid Interoperability Laboratory

OBJECTIVE and SCOPE

Ulrik von Estorff

Joint Research Centre
Petten

European Commission

EU Policy Background on Interoperability

- ***EU and Clean Energy for all***
- ***Horizon 2020 Calls***
- ***Transatlantic Economic Council***
- ***Mandate on CEN-CENELEC, ETSI***
- ***High level meeting: Internet of Energy***

European Commission

SGIlabs

European Commission

SGIlab @Ispra (I)

- Promote the interoperability of digital energy in smart grids and the interface with electric vehicles

European Commission

SGIlab @Petten (NL)

- Promote the interoperability of digital energy in the interface between smart homes and smart grids

European Commission

Video Clip

Clip

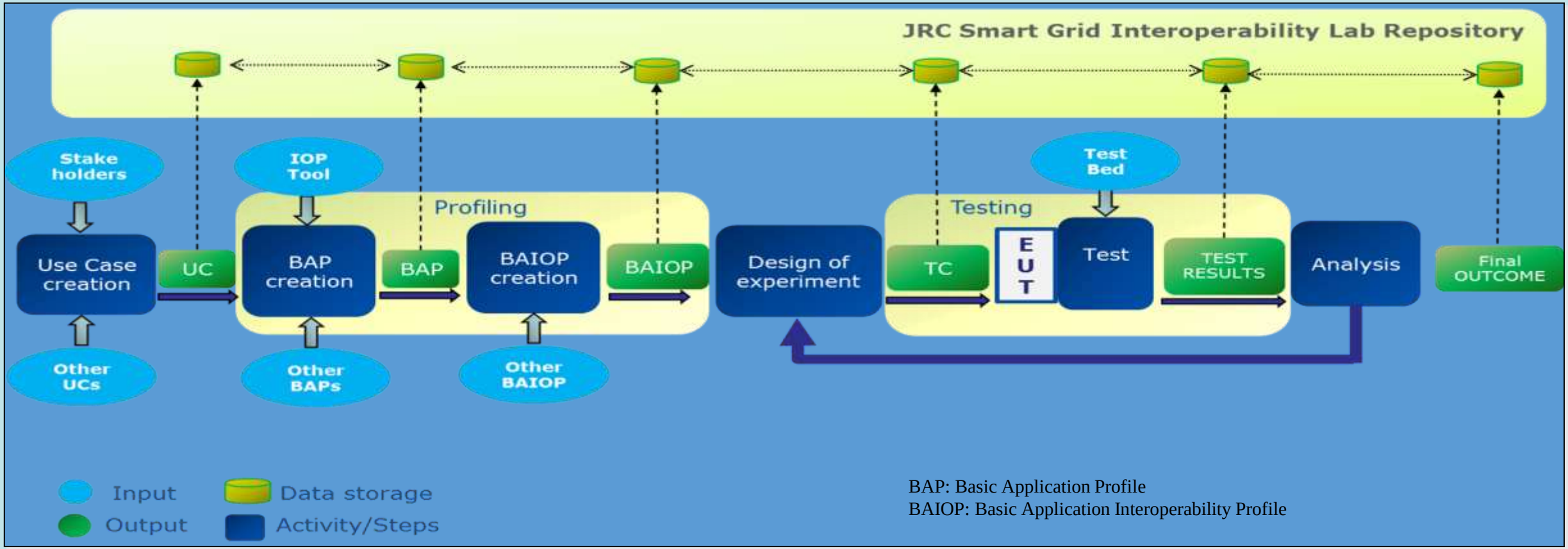
European Commission

Scope of the SGIL

- Test the Interoperablity (IoP) of solutions from the market and from research projects
- Promote the use of a common IoP testing methodology based on the CEN-CENELEC-ETSI framework
- Become a knowledge hub by disseminating processes and results of testing campaigns
- Network with European industrial actors, as well as other laboratories and research centres

JRC SGIlab: Testing Methodology

https://ec.europa.eu/jrc/en/publication/smart-grid-interoperability-testing-methodology



BAP: Basic Application Profile
BAIOP: Basic Application Interoperability Profile

- In line with CEN-CENELEC-ETSI
- Basis for a common European approach

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Who can benefit from SGIL activities

Consumers

- Access to reliable information
- Proof that new applications can participate into market
- More choices for products (certainty for plug-and-play)

Manufacturers

- Less market fragmentation
- Lower production costs due to economies of scale
- Benefits from open standards

Operators

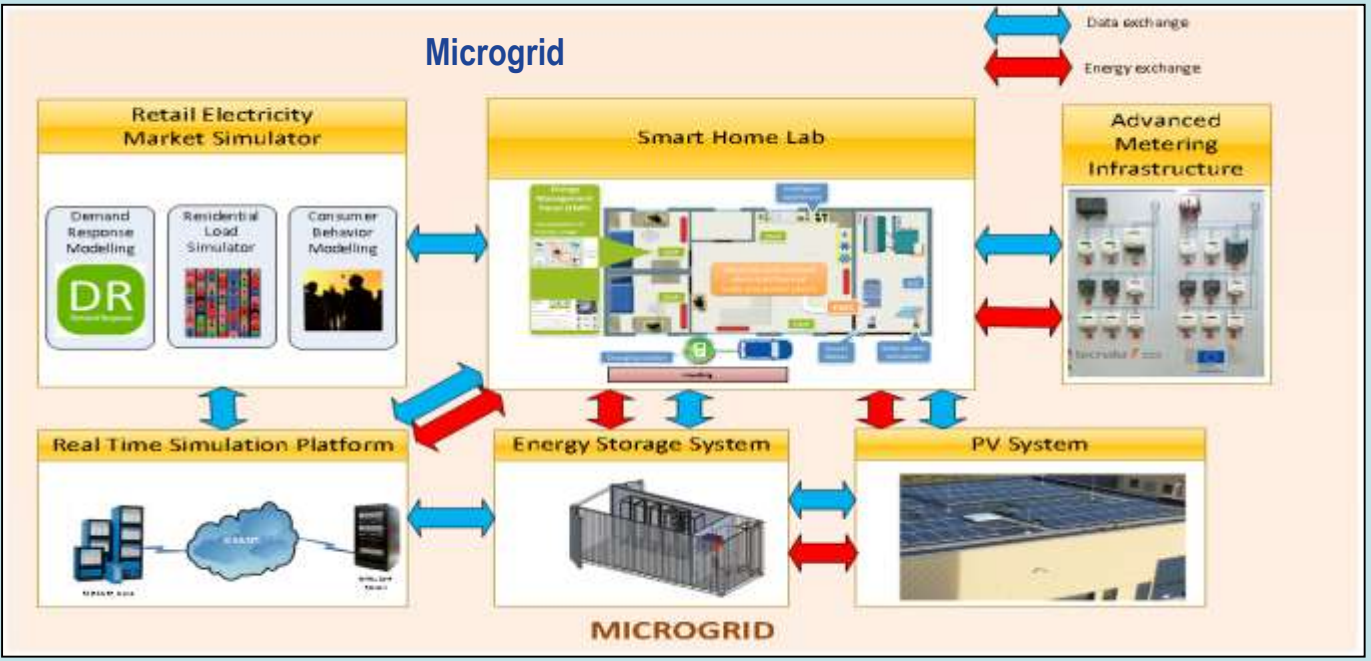
- Better integration of Distributed Energy Resources
- Opportunities for new business models and services
- More consistent approach to a comprehensive digital energy framework

Standardisation

- Identification of gaps and misalignments in current standards
- Recommendations for further global harmonisation

JRC SGIlab: integration grid-market-home

Microgrid

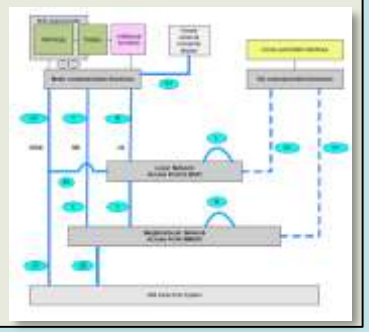


Advanced Metering Infrastructure

Test bed: HES, NNAP, LNAP… aligned with CEN/CENELEC

All interfaces and functions

Wide technological support: PLC, Wireless..



Retail Electricity Market Simulator

Aggregation of simulators

- ResLoadSim
- Demand Response Sim
- Consumer behaviour

Smart Home

Testing of IOP in home energy management test beds

Connected to AMI and retail market simulator

HEMS – open-source platform (e.g. Home Assistant)

The Smart Grid Interoperability Laboratory

THE TEST BED

Felix Covrig

Joint Research Centre
Petten

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SHORT LAB INVENTORY

- PV PANELS (SOLAR)
- MICROGRID
- ELECTRIC VEHICLES
- AMPLIFIERS
- SMART HOME APPLIANCES
- LOAD EMULATOR
- DIESEL GENERATOR
- MODERN ICT INFRASTRUCTURE
- …









Diverse manufacturers
Diverse technologies
Diverse communication protocols
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This device diversity can be found in our house / workplace / supermarket etc.

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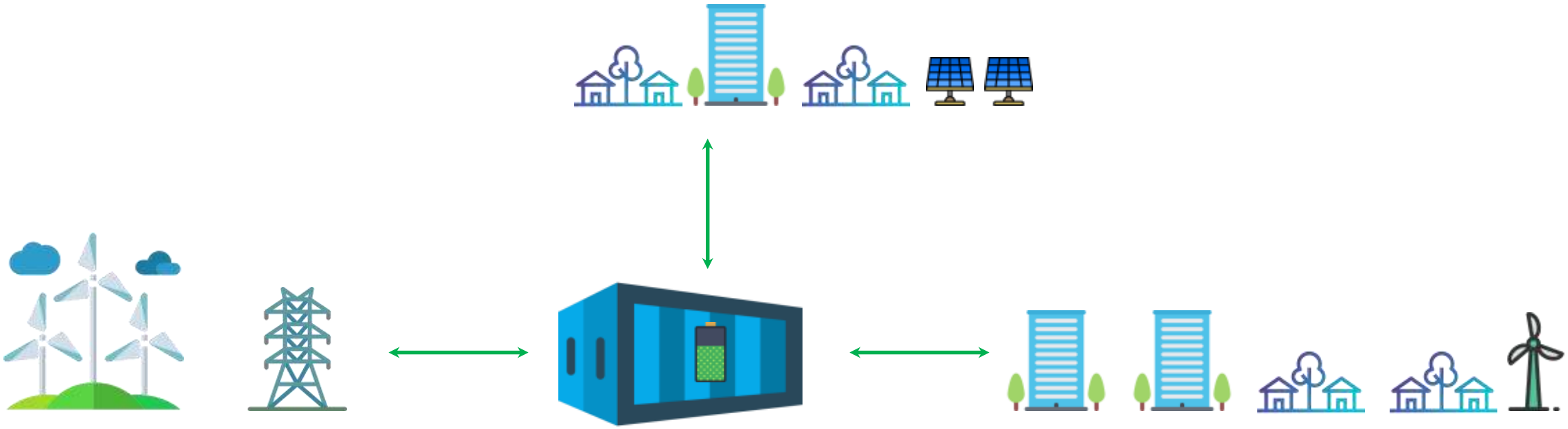
3 LARGE ENERGY STORAGE UNITS (BATTERIES)

- Power grid balancing (more renewable energy)
- Renewable energy sharing (virtual power plants)
- New business models



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V2X CAR (VEHICLE TO GRID/HOME)

- Microgrids
- Power grid balancing (more renewable energy)
- Renewable energy sharing (virtual power plants)
- New business models

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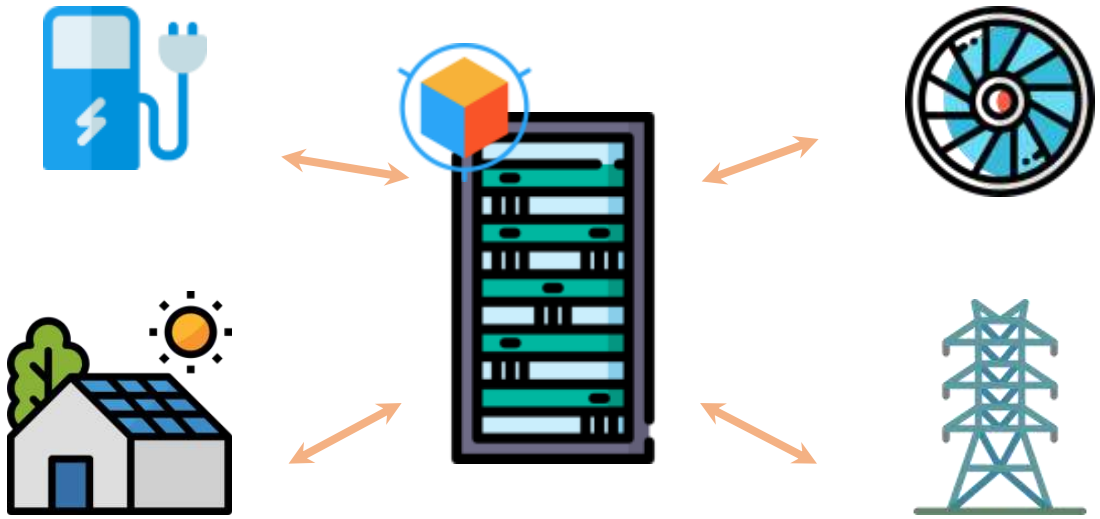
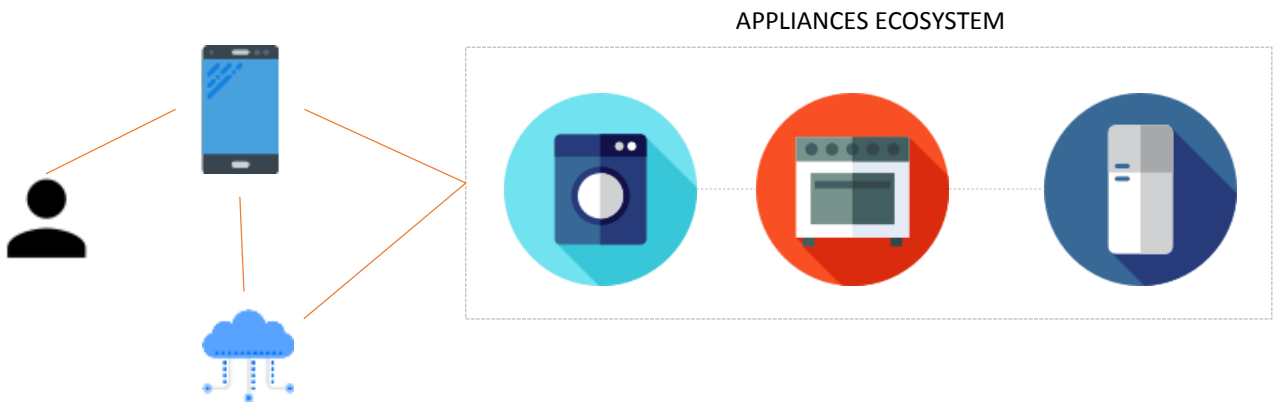
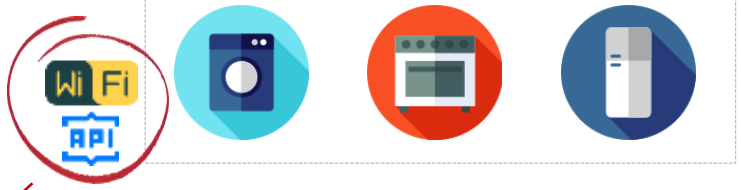
REAL TIME SIMULATION WITH HARDWARE IN THE LOOP

- Connecting models with real hardware




APPLIANCES ECOSYSTEM

APPLIANCES ECOSYSTEM



for

application programming interface (a set of clearly defined methods of communication among various components)

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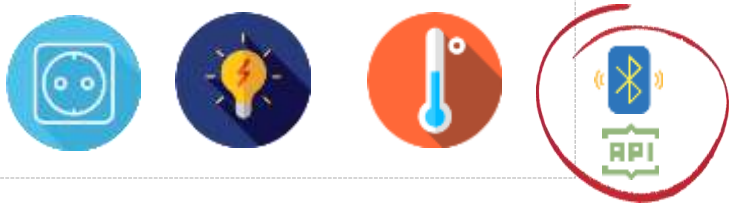
HOME DEVICES ECOSYSTEM

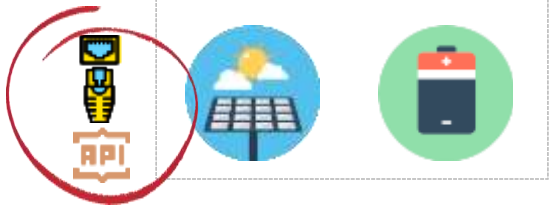


USES API3 + BLUETOOTH for CONTROL/COMMUNICATION

APPLIANCES ECOSYSTEM

GENERATION ECOSYSTEM

USES API2 + ETHERNET for CONTROL/COMMUNICATION



*API - Application programming interface (a set of clearly defined methods of communication among various components.)

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HOME DEVICES ECOSYSTEM

SMART SPEAKER

IP CAMERA

HEATER

AC

STANDALONE DEVICES

APPLIANCES ECOSYSTEM

GENERATION ECOSYSTEM

SMART METER

STANDALONE DEVICES

EV

EV CHARGER

OTHER BATTERY

European Commission

HOME DEVICES ECOSYSTEM

SMART SPEAKER

IP CAMERA

HEATER

AC

STANDALONE DEVICES

APPLIANCES ECOSYSTEM

GENERATION ECOSYSTEM

SOFTWARE MODEL

SMART METER

STANDALONE DEVICES

EV

EV CHARGER

OTHER BATTERY

e.g.

Real-time simulation (RTS)

Hardware-in-the-loop (HIL) simulation

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HOME DEVICES ECOSYSTEM

SMART SPEAKER

IP CAMERA

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AC

STANDALONE DEVICES

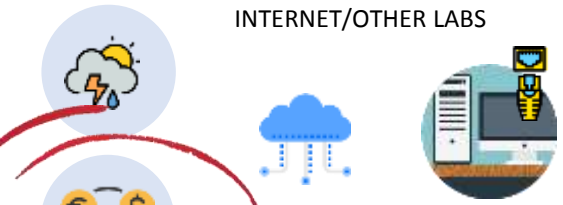
APPLIANCES ECOSYSTEM

GENERATION ECOSYSTEM

SOFTWARE MODEL

WEATHER

INFORMATION FROM THE INTERNET/OTHER LABS



PRICING

SMART METER

STANDALONE DEVICES

EV

EV CHARGER

OTHER BATTERY

European Commission

HOME DEVICES ECOSYSTEM

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STANDALONE DEVICES

APPLIANCES ECOSYSTEM

GENERATION ECOSYSTEM

SOFTWARE MODEL

COMMUNICATION PROTOCOLS

EU US AU

5GHZ

AND MORE…

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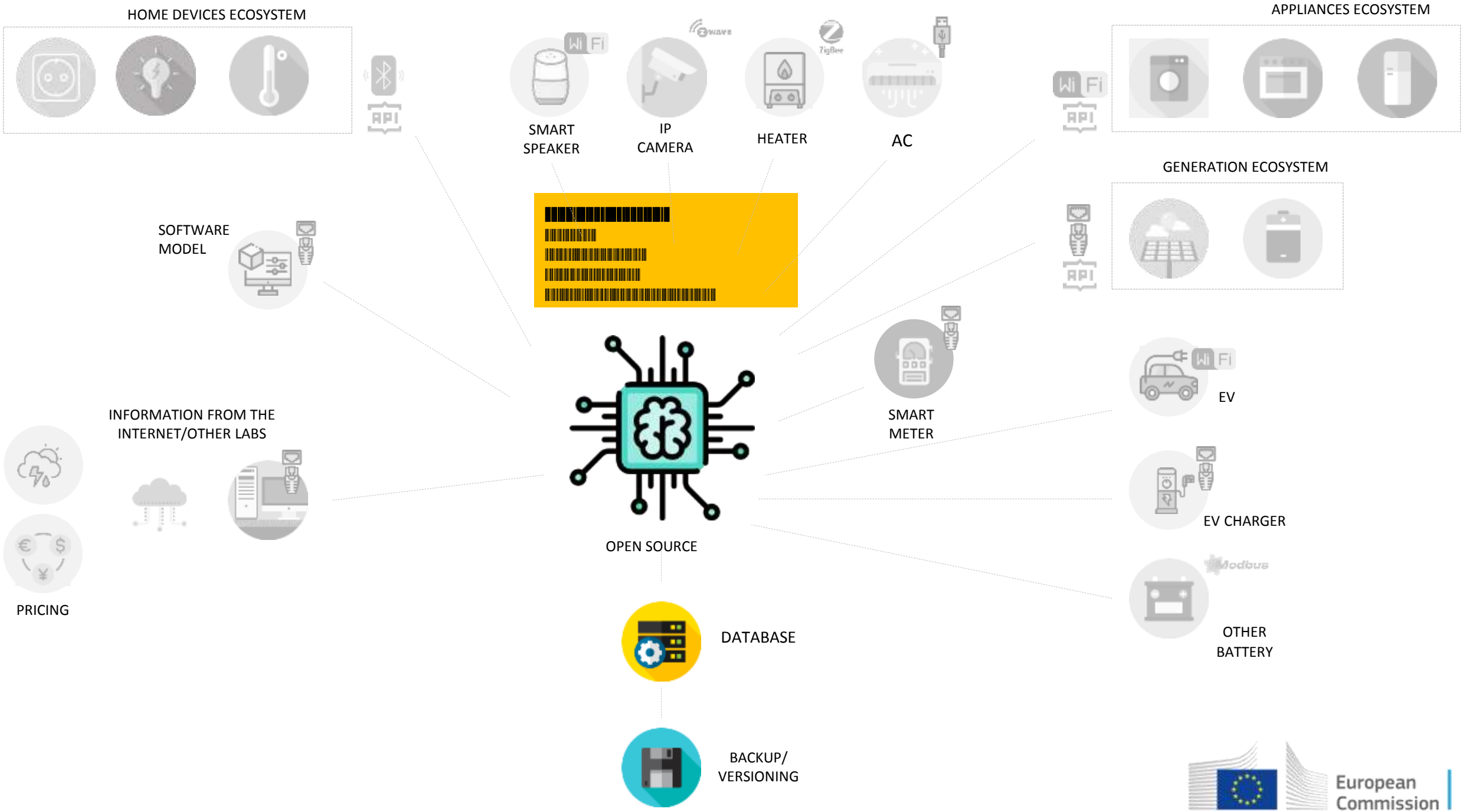
HOME DEVICES ECOSYSTEM

SMART SPEAKER

SOFTWARE MODEL

APIs, PLATFORMS

Afero	AggreGate	AirVantage	Ark	ARTIK Cloud	AT&T's M2X	AWS IoT	Axeda IoT	AXON	Ayla IoT Cloud Fabric	Beebotte
Berg	Bosch IoT Suite	Busit	Canopy	Carriots - create scenarios	CloudConnect	Combicloud	Concirrus	Connext DDS	Coversant IoT Cloud	Dashboard of Things
dataplicity	Datavenue	Deutsche Telekom's M2M	Device Connection Platform	Digi Device Cloud	DeviceHub	DevicePilot	deviceWISE	dweet.io	Electric Imp	amazon alexa
EVRYTHNG	Ecobee	Exosite	FlowCloud	Gaonic	GoFactory	Google Home	IFTTT	iMotion	Impact, from Nokia	Initial State
IoT Acceleration Platform	Hologram Cellular Platform	Apple HomeKit	AXON	IBM IoT Foundation	IoTfy	IoT lab	IoT-X	iQmenic	Kii	Lelylan
Loop	Lumata (Hitachi)	M2M Intelligence	MachineShop	mbed Device Server	Microtronics end-to-end platform	Mobius	MODE	mozaiq	Murano	myDevices
Cayenne	Nabto	Neo	works with nest	Netatmo Connect	netObjex	NetPro	Octoblu OpenMTC	OpenSensorCloud	OpenSensors	Open.Sen.se
Parse	People Power - now FabrUX	PHILIPS hue	Plat-One	PubNub	REDtone IOT (RIOT)	resin.io	Docker	restack	RuBAN	Samsung SAMIIO
SAP HANA	SensorLogic Application Enablement	SkyNet	Sine-Wave	SIMPro	SmartThings	Solair	Somfy (Tahoma)	TempoIQ	The ThingBox	thethings.iO
ThingFabric	ThingPlug	ThingSpeak	Thingsquare	ThingWorx	UnificationEngine	Verizon's M2M platform	Vortex	Waygum	waylay	Wink
			WyzBee	Xiaomi	Xively	Yaler	Zatar			


HOME DEVICES ECOSYSTEM
API
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SOFTWARE MODEL
[redacted]
SMART METER
EV
EV CHARGER
OTHER BATTERY
INFORMATION FROM THE INTERNET/OTHER LABS
PRICING
OPEN SOURCE
DATABASE
BACKUP/ VERSIONING
European Commission

HOME DEVICES ECOSYSTEM

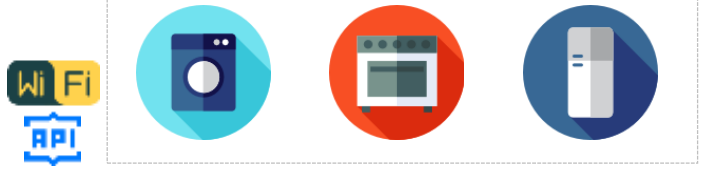
SMART SPEAKER

IP CAMERA

HEATER

AC

APPLIANCES ECOSYSTEM



GENERATION ECOSYSTEM

SOFTWARE MODEL

[redacted]

SMART METER

EV

EV CHARGER

OTHER BATTERY

WEATHER

INFORMATION FROM THE INTERNET/OTHER LABS

PRICING

DATABASE

BACKUP/ VERSIONING

END USER

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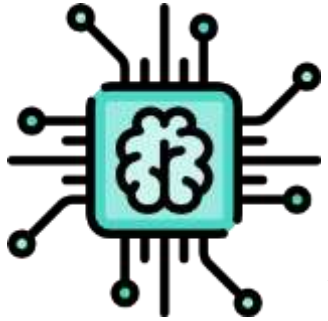
EXPERIMENT 1

BETTER INTEGRATION: SOLAR - ELECTRIC VEHICLE - ENERGY STORAGE

[redacted]

INTERCONNECTS MULTIPLE SYSTEMS/DEVICES INTO A LARGER ECOSYSTEM



DATABASE

ECOSYSTEM GENERATION

EV

EV CHARGER

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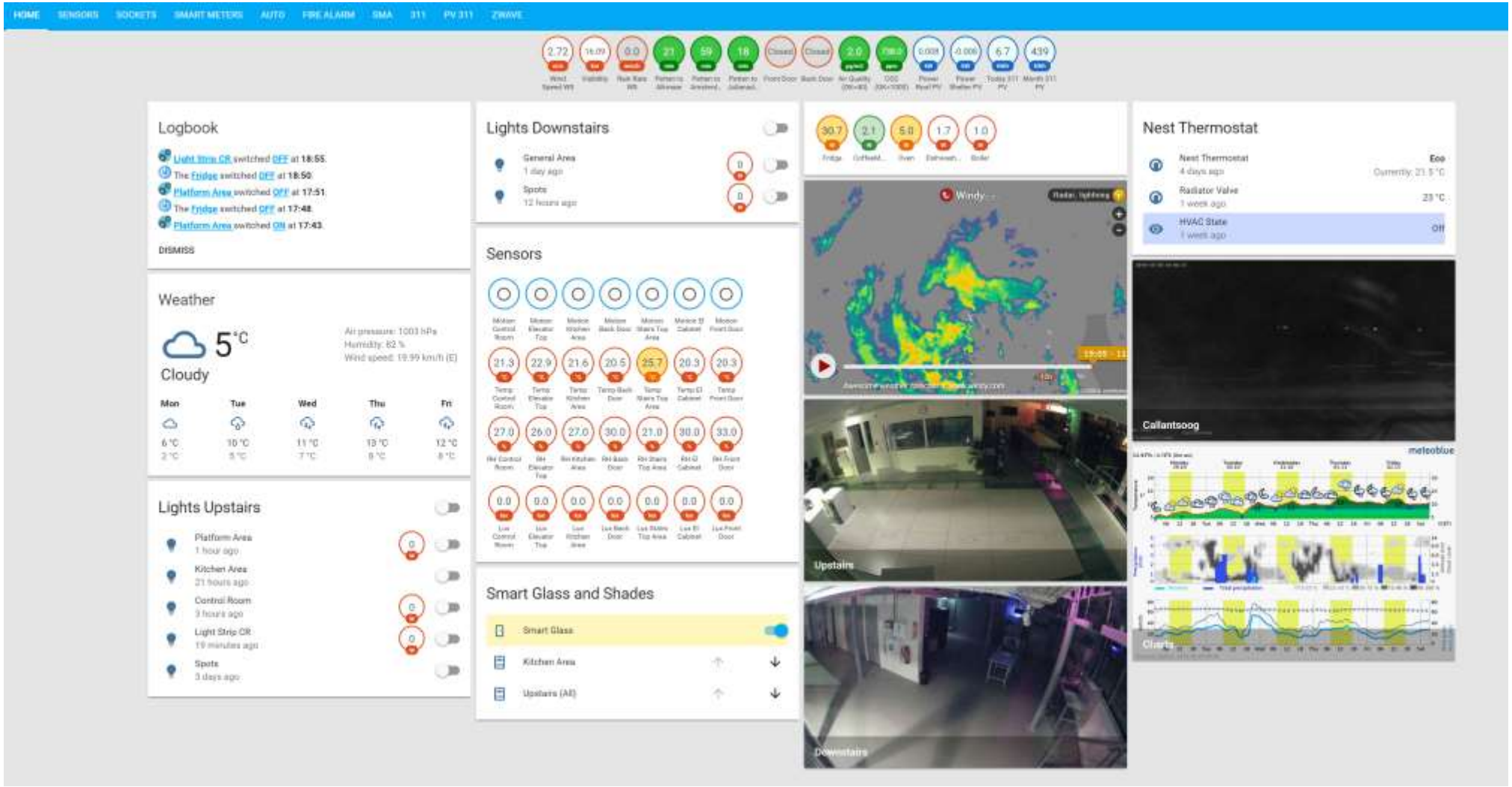

The laboratory is open and ready to partner with industry, academia and other research centres in testing interoperability

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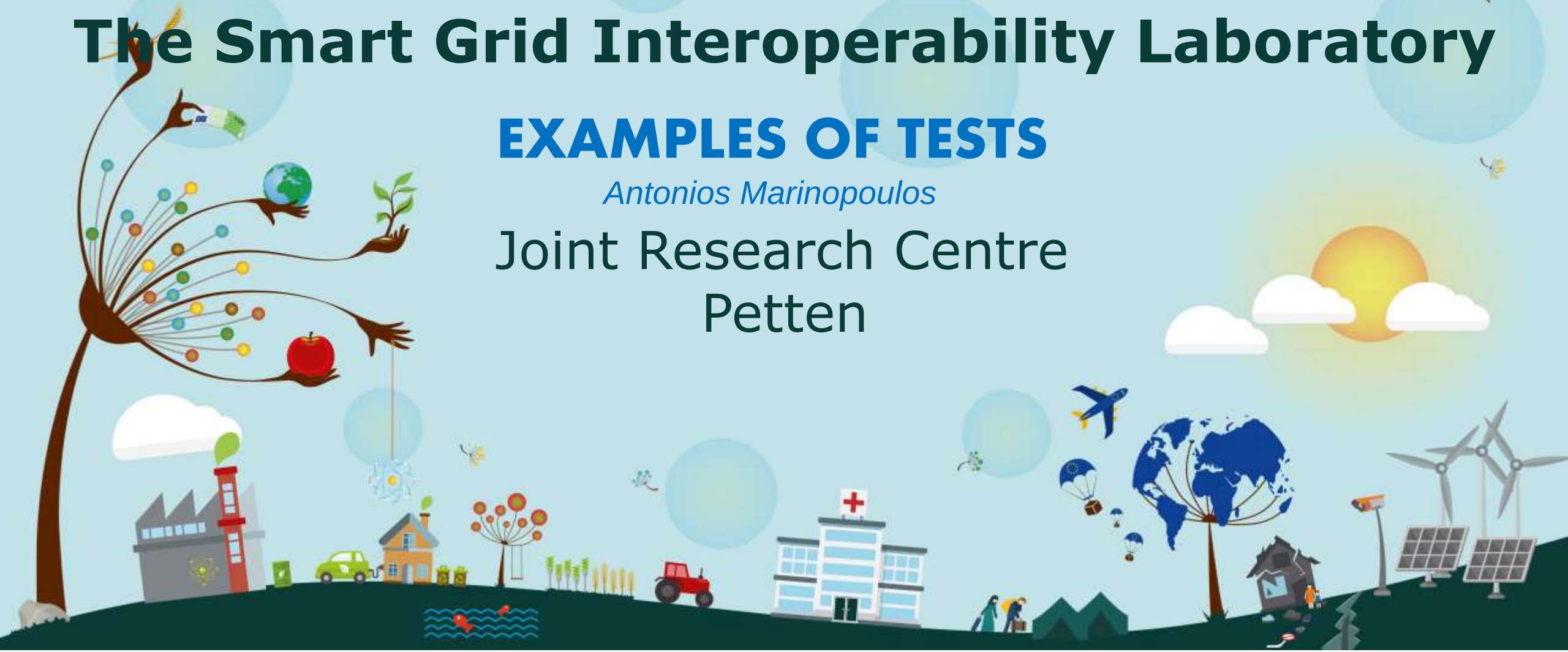
The Smart Grid Interoperability Laboratory

EXAMPLES OF TESTS

Antonios Marinopoulos

Joint Research Centre
Petten



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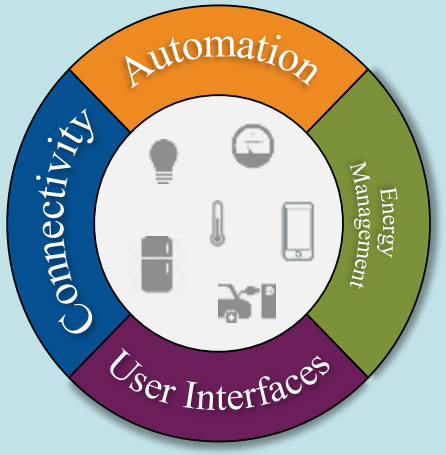
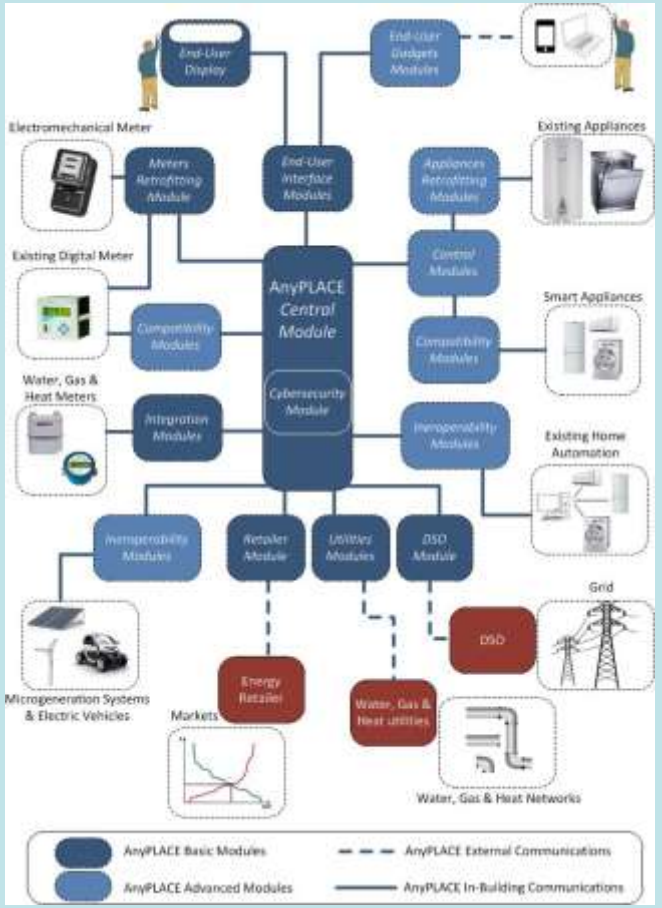
Project AnyPLACE

INTEROPERABILITY FOR SMART HOME APPLICATIONS

Low-cost, modular energy management system for home automation and grid services





Project AnyPLACE (2015-2018), http://www.anyplace2020.org/

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Project AnyPLACE

Project AnyPLACE (2015-2018), http://www.anyplace2020.org/

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Project AnyPLACE

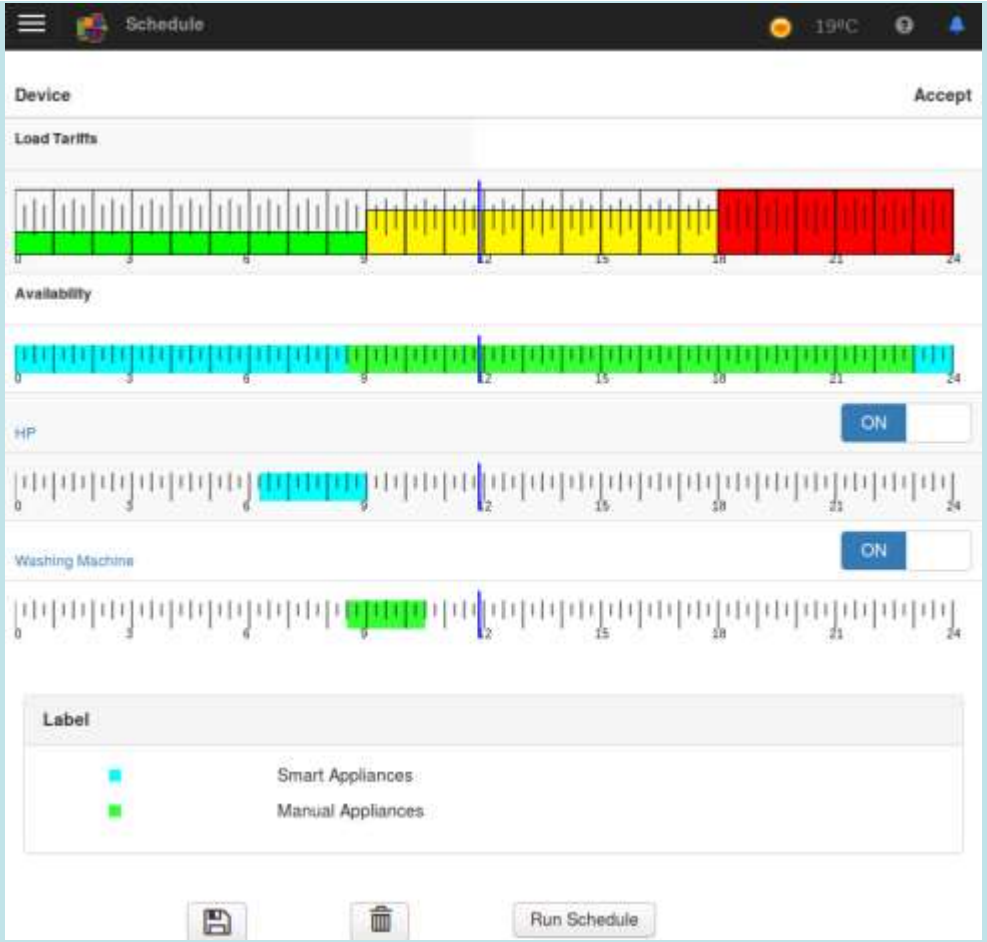
Example of optimal scheduling

Electricity price, three tariffs per day

Availability of the user for manual activation

Activation of Heat Pump in optimal time

Suggestion for operation of washing machine



Project AnyPLACE (2015-2018), http://www.anyplace2020.org/

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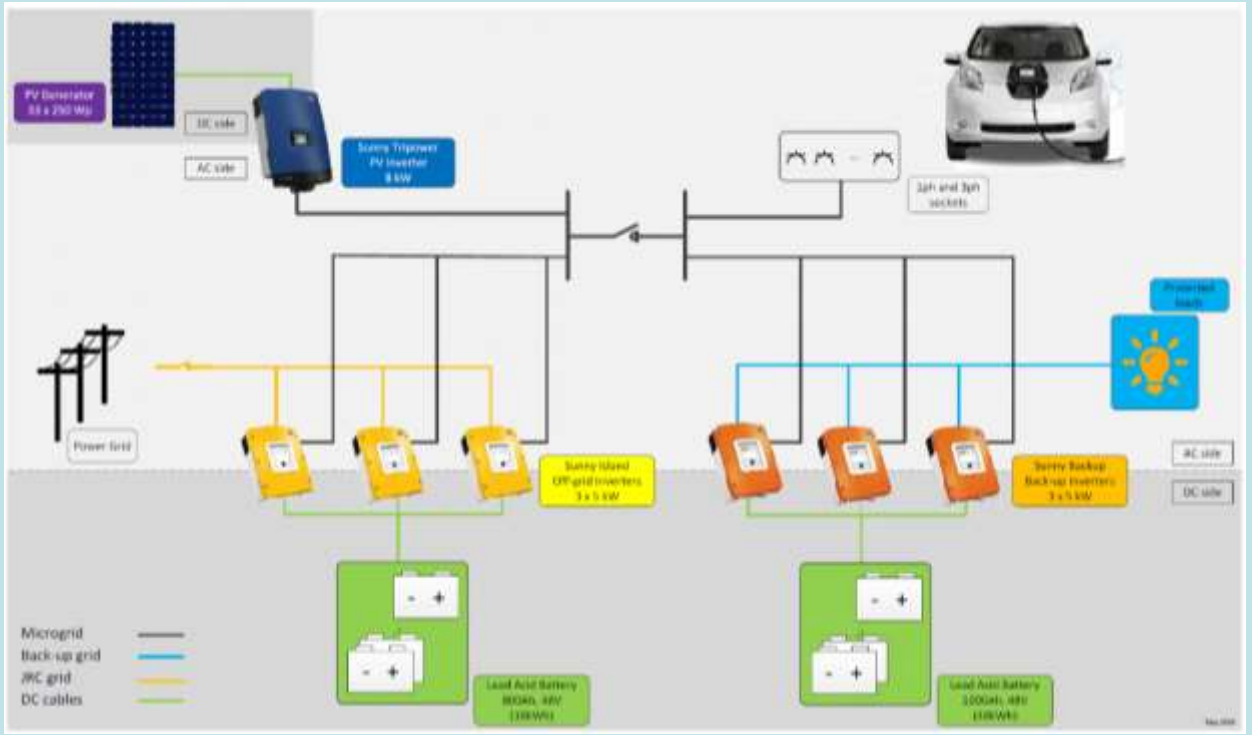
Collaboration Project with ElaadNL

Impact of EV charging on power quality of the home electricity grid

Measurements of supraharmonics (2kHz-150kHz) during charging of one or more EVs simultaneously in a home environment.

3 different EVs

Grid-connected and microgrid mode.



ElaadNL Project (2019)

European Commission

Collaboration Project with ElaadNL

Measurements at the EV-terminals of a charging station, to which different EVs are connected

Measurements at the central electrical cabinet on the conductors of the battery storage-unit

ElaadNL Project (2019)

Collaboration Project with ElaadNL

Measurements at different locations in the lab, at the connection point of several appliances

ElaadNL Project (2019)

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Collaboration Project with ElaadNL

Summary for grid-connected mode (preliminary results)

Interaction between EVs and inverters **probably present**, but it is the question whether it is significant.
Influence from laundry devices and induction cooking plate seem **negligible**, although **distortion** from the EVs is also **visible** over here.

Summary for microgrid mode (preliminary results)

Supraharmonics mainly **propagate** between the devices causing them (due to EMC-filters).
Voltage is influenced by the EVs and **affects the currents** drawn by other devices.
One of the EVs presented (for unknown reasons) difficulty with the microgrid, especially in combination with the PV-inverter. Further analysis is needed.

Contact

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European Commission