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TECHNOLOGY & SCIENCE
ASSOCIATE LABORATORY

1985
THIRTY
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FROM KNOWLEDGE
GENERATION
TO SCIENCE-BASED
INNOVATION

Electric Mobility in Future Buildings - Active Net Zero Energy Buildings -

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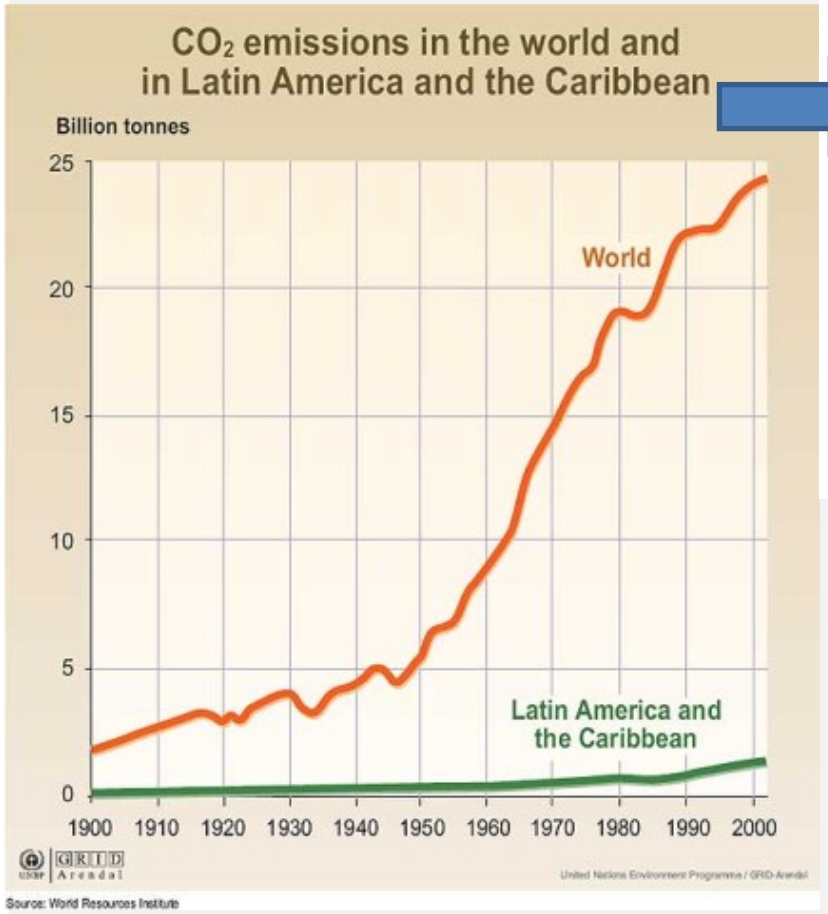
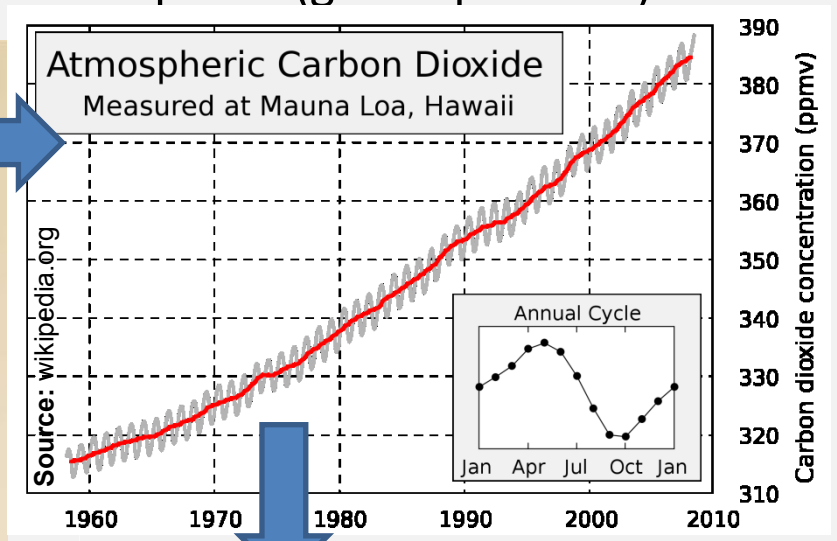
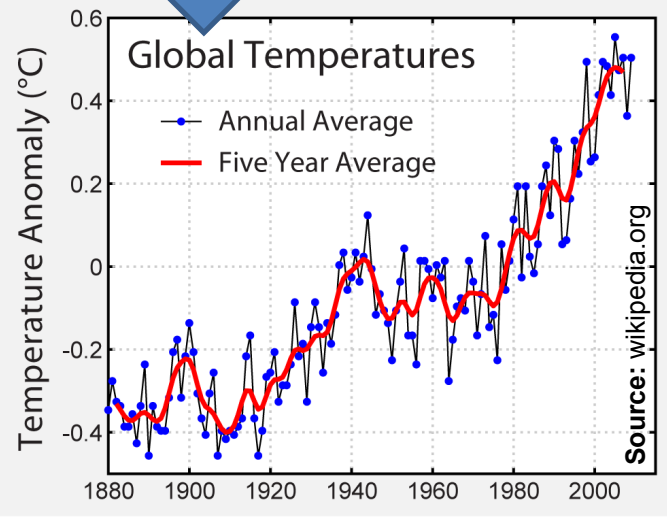
September, 2015

1. The Electric Mobility Paradigm
Motives for EV adoption

- High concentration of GHG in the atmosphere (global problem)







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1. The Electric Mobility Paradigm
Expectable benefits

- Reduction of the fossil fuel usage in the transportations sector

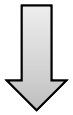
Immediate reduction of the local pollution levels
(CO_2, CO, HC, NO_X, PM)

- If EV deployment is properly accompanied by an increase in the exploitation of renewable endogenous resources

GHG global emissions will be greatly reduced → Important contribution to eradicate the global warming problematic

1. The Electric Mobility Paradigm
b) Expectable benefits

- Controlled EV charging (and V2G) together with Demand Response under the paradigm of a active net zero energy building or district, might be used to **"shape" the power demand**, avoiding very high peak loads and energy losses



- EV storage capability might be used to **avoid wasting "clean" energy** (wind/PV) in systems with high renewables integration.

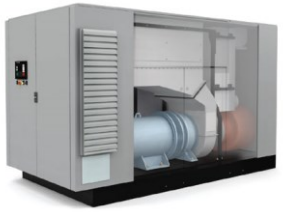
- Obtain a local balance of generation / consumed energy (at home / building, district level)

DISTRIBUTED ENERGY RESOURCES (DER)

- Distributed storage devices (static: batteries…

- DG units (wind, solar, Combined Heat and Power…)
  - Property of private promoters





- Controllable Loads (large industrial consumers and… set of domestic clients)


- Electric Vehicles (highly flexible controllable loads and possibly distributed storage devices when in V2G mode

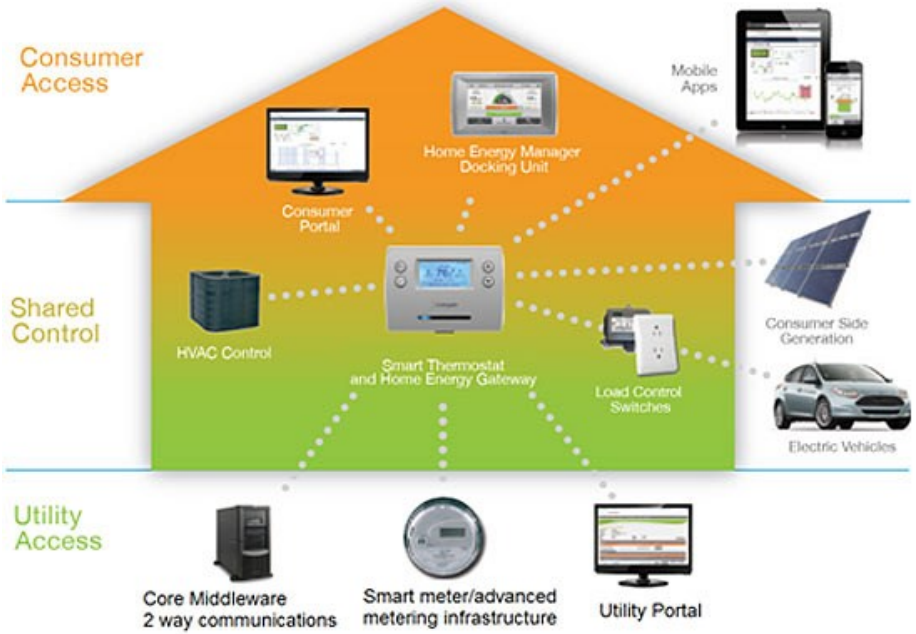
2. Smart Grid Paradigm
Active demand response

Active Loads – Implementation of demand response strategies

- Controlling loads is essential to ensure power balance
- Provide reserve to grid (terciary reserve).

➡ Active Net Zero Energy Building

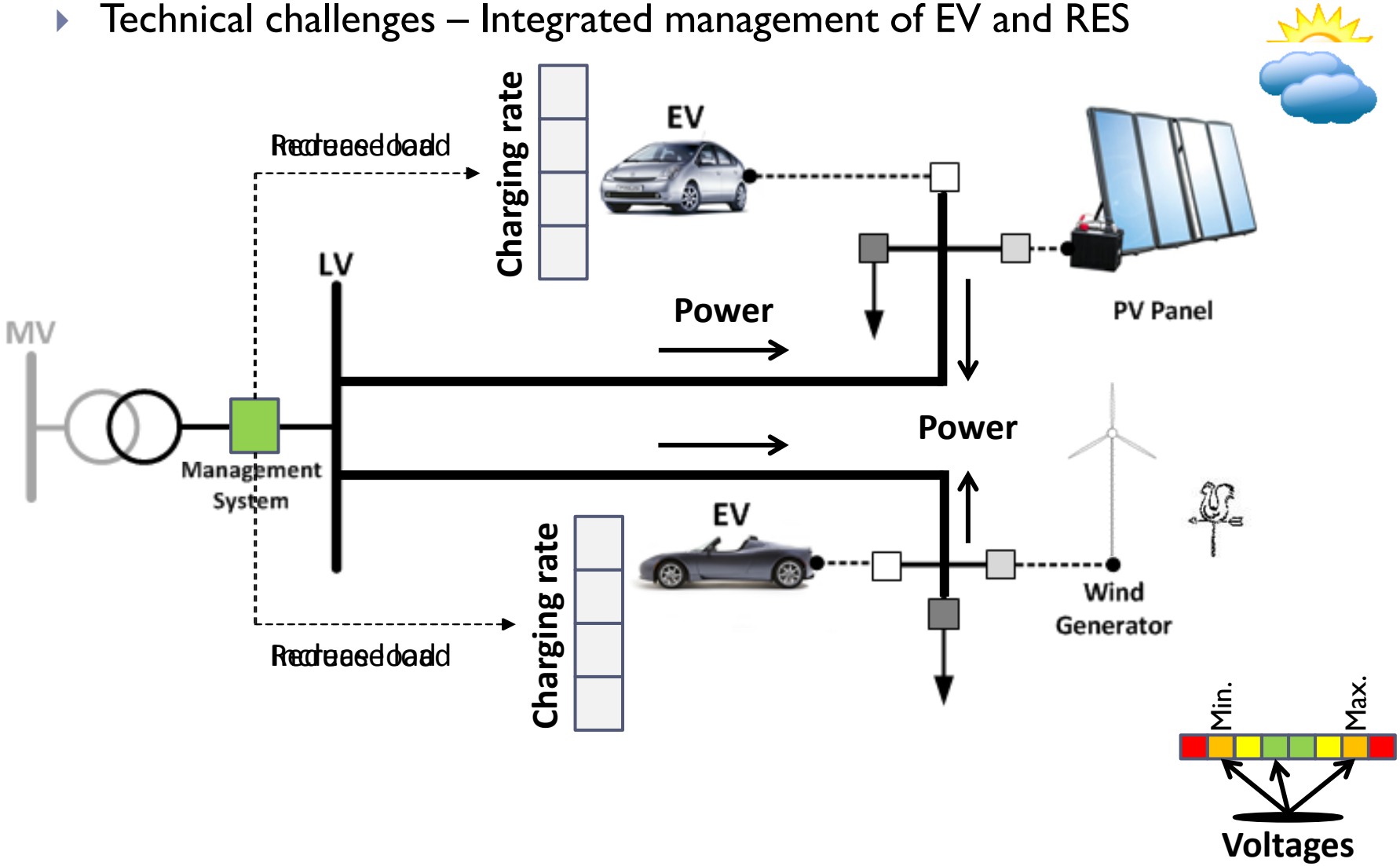
The deployment of **smart meters** and **home energy management** tools will enable the development of innovative **demand response** strategies, dedicated to LV consumers.



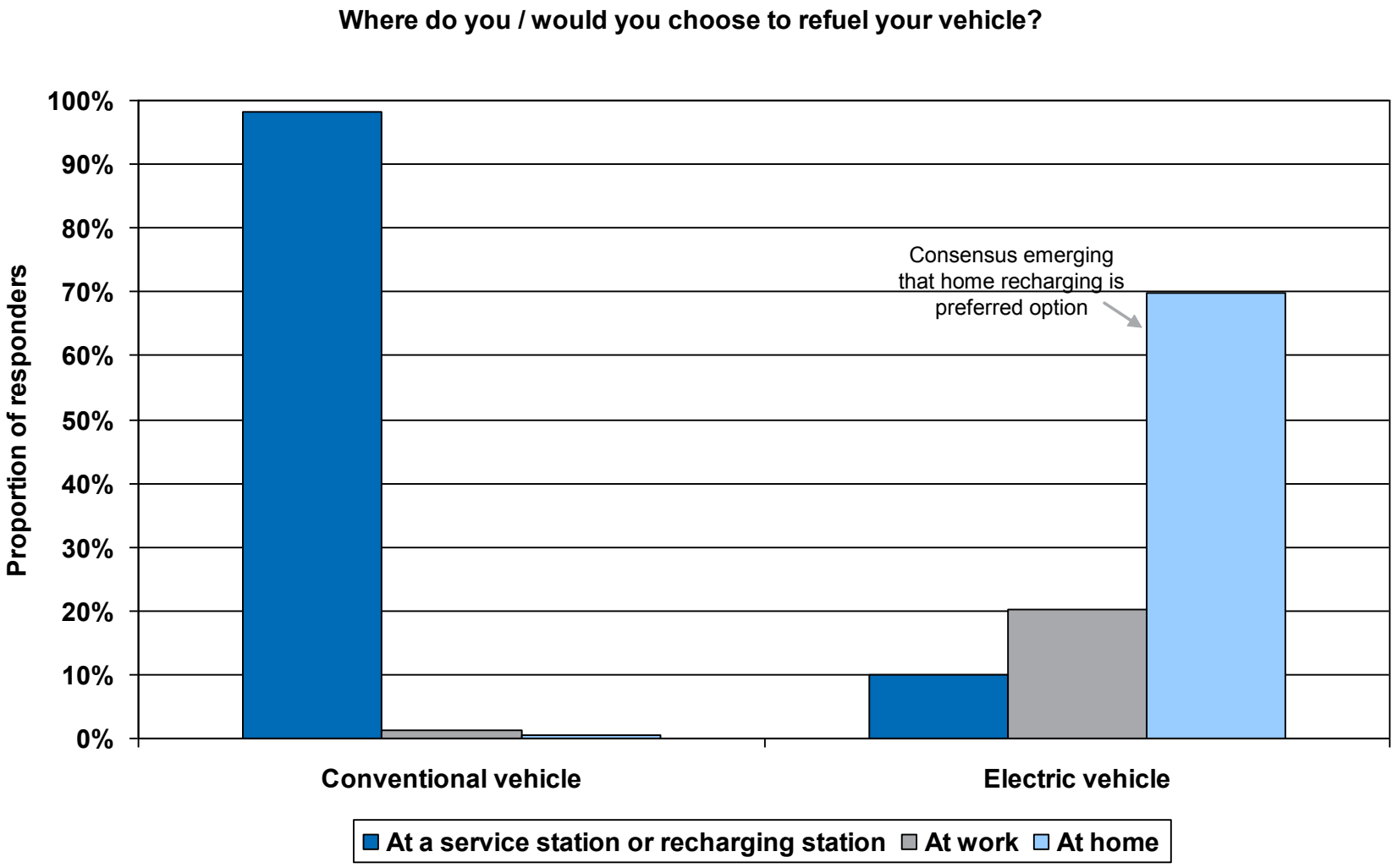
2. Smart Grid Paradigm

Foreseen problems for distribution networks resulting from EV and DG

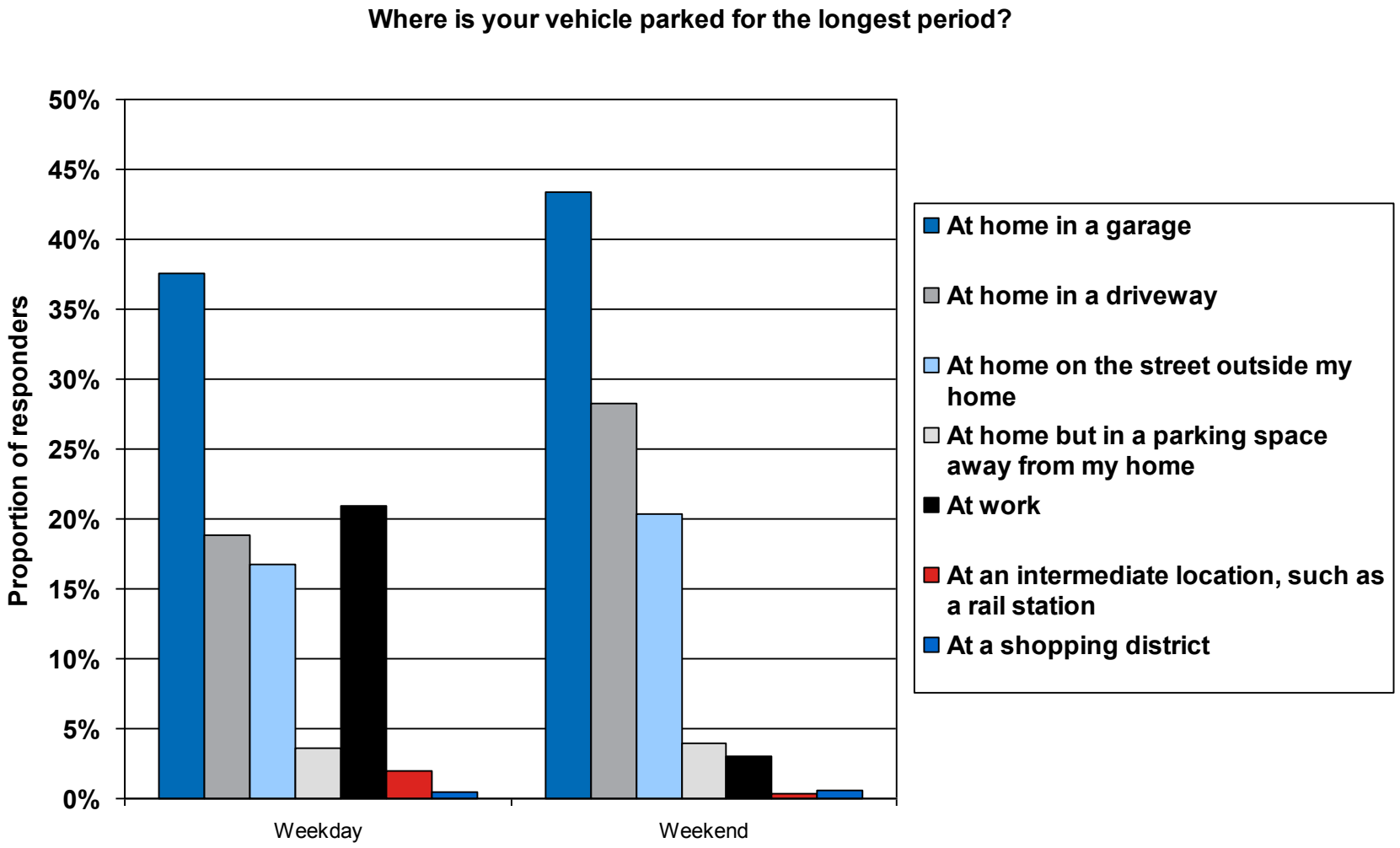
- Technical challenges – Integrated management of EV and RES



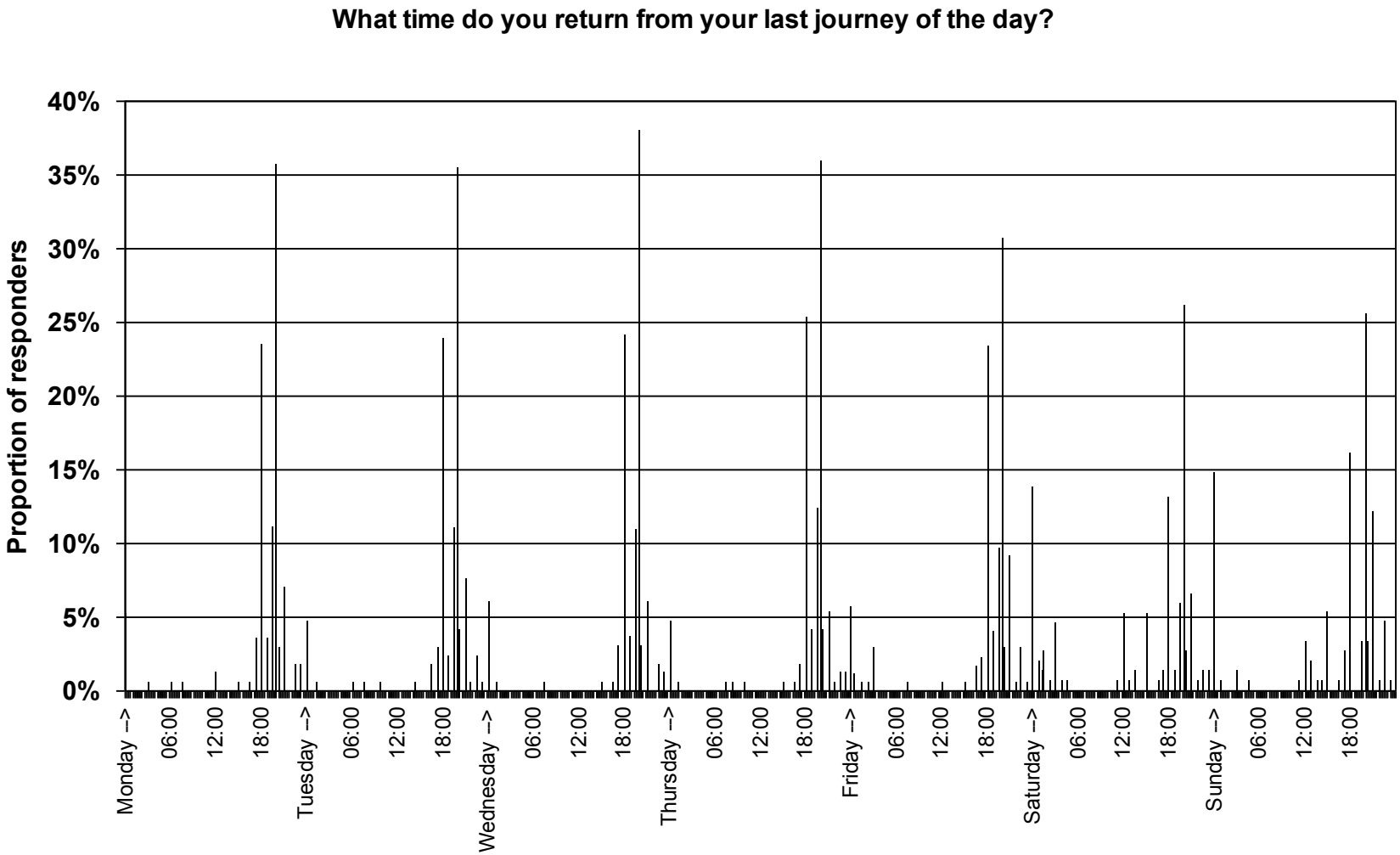
3.Refuelling and recharging location preferences



3. Location of vehicle for longest period of inactivity

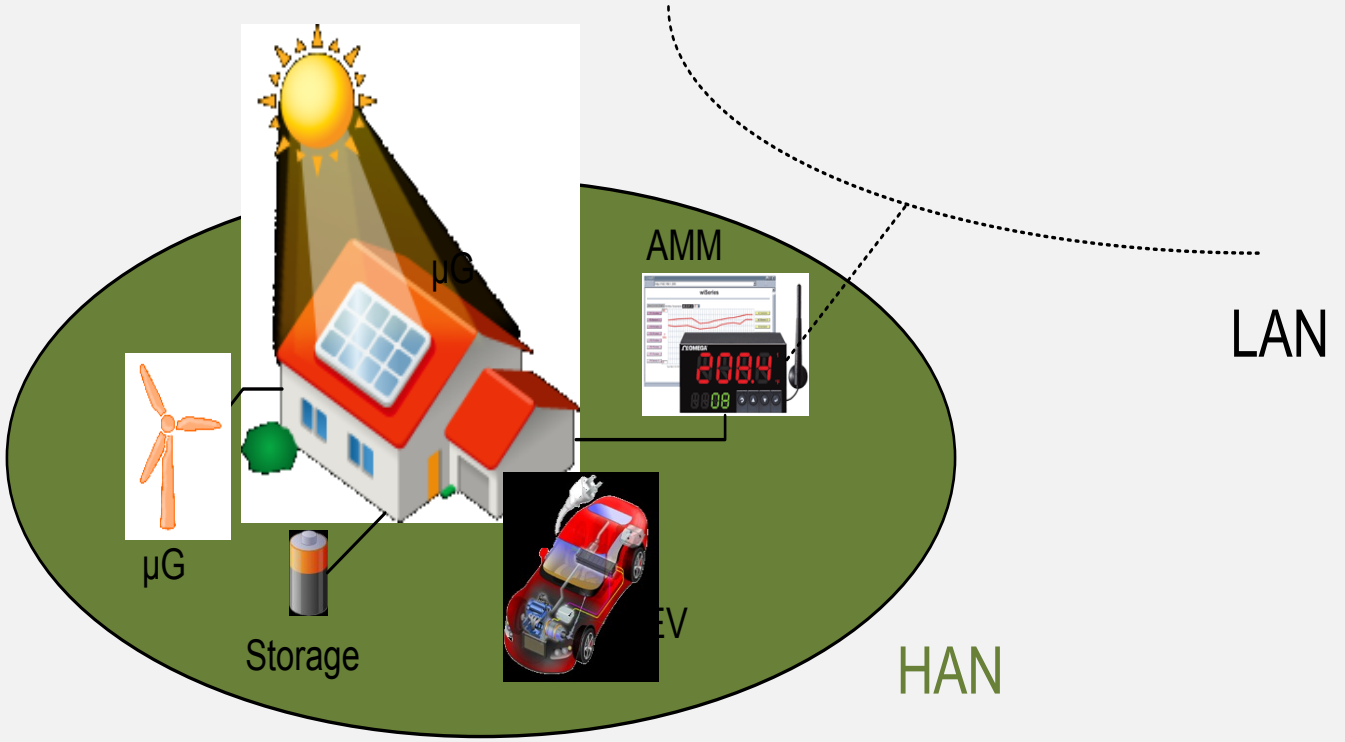


3. Profile of time of return from last journey of the day, Portugal



4. The EV integrated into a building / home

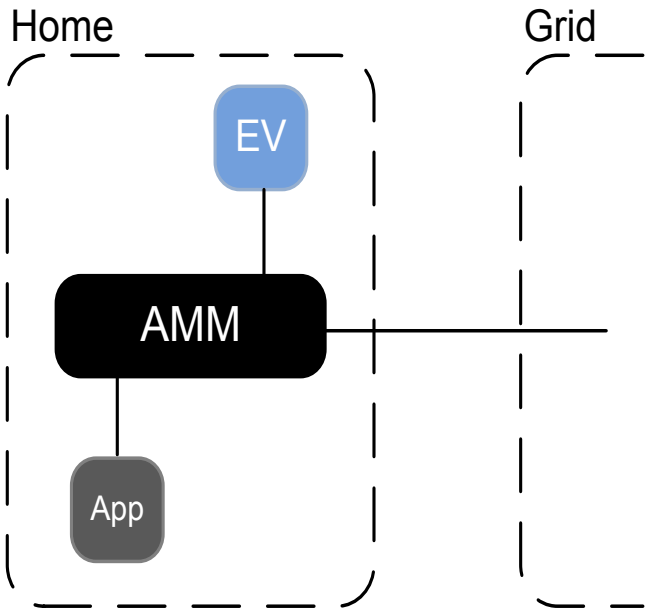
- V2H as a particular case of V2G



Active Net Zero Energy Building

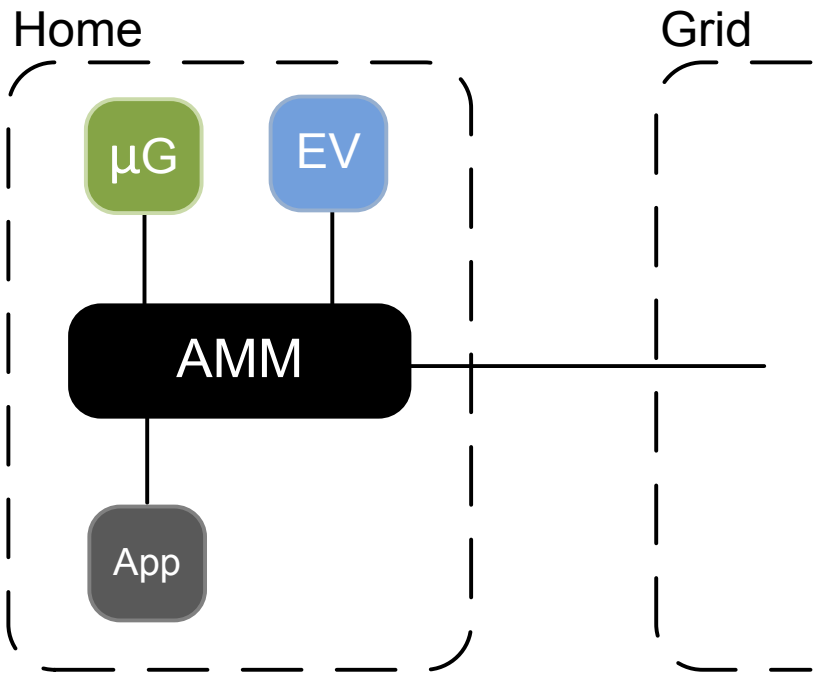
4. V2H - Use Cases

The home / building is connected to the electric grid and EV are available for energy management. The AMM is responsible for managing the EV charging/discharging along with the home appliances (App)



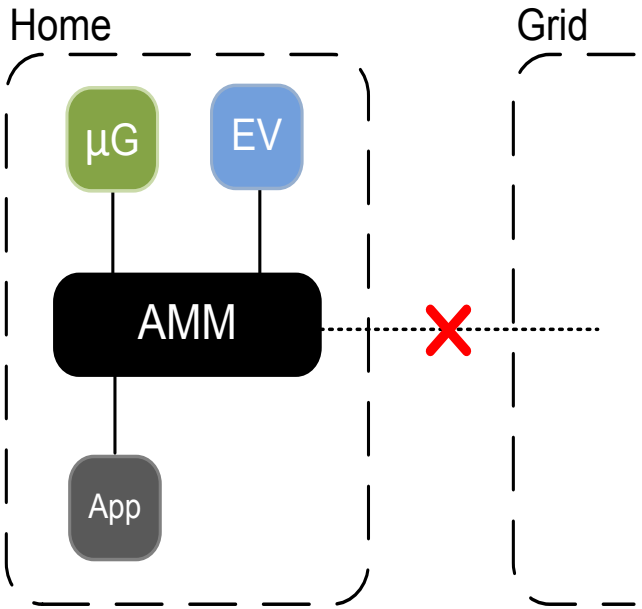
4. V2H - Use Cases

The home / building is connected to the electricity grid with EV and µG available for energy management. The AMM is responsible for managing the EV charging/discharging along with available microgeneration and home appliances



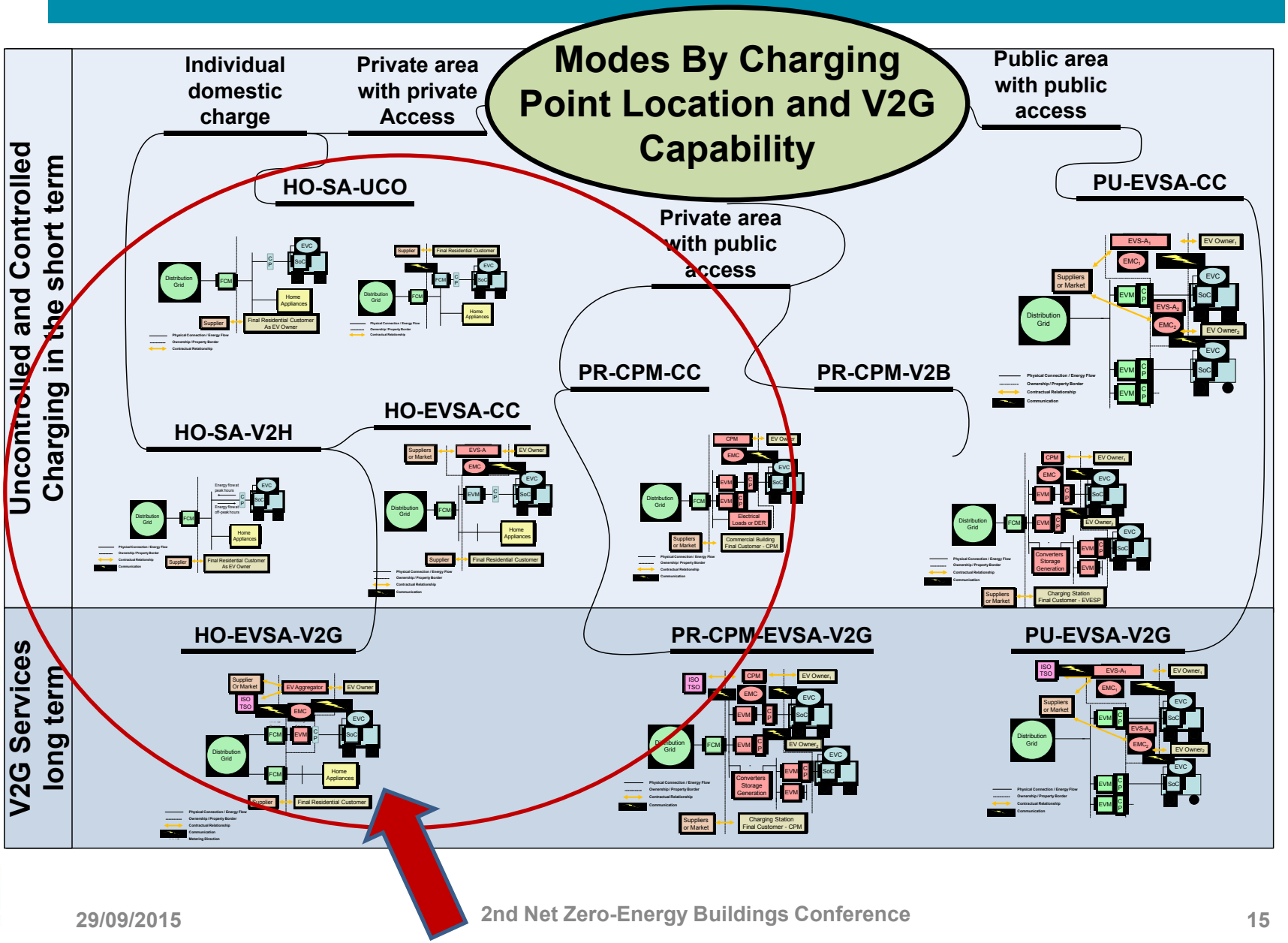
4. V2H - Use Cases

1) It is considered that AMM intentionally inhibits any energy exchange with the grid. Enough microgeneration and V2H is available to supply the consumption.
2) An emergency event or fault in the grid forces the home / building to be physically disconnected from the grid

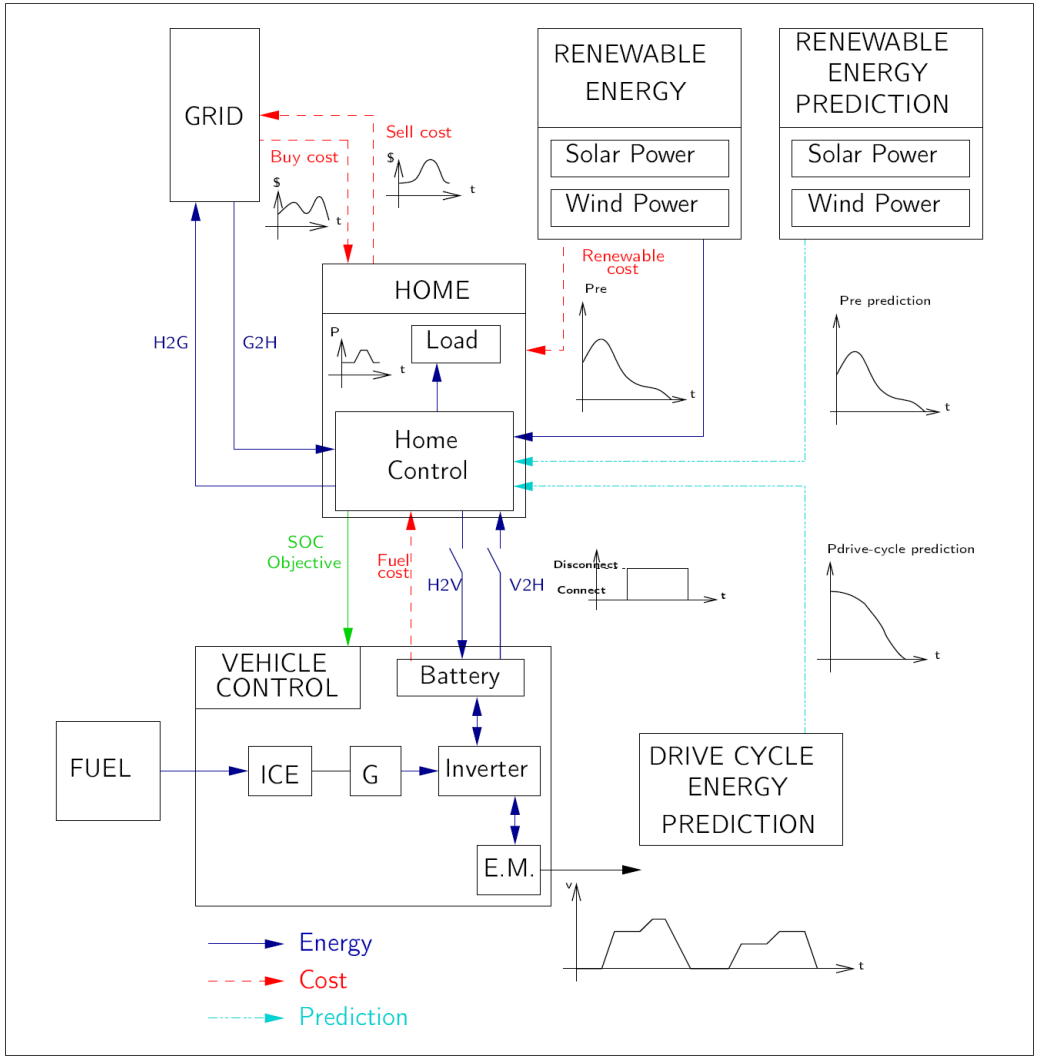


Individual microgrid <-> Active Net zero energy building

5. EV Business Models



6. Energy management control principle for homes /buildings

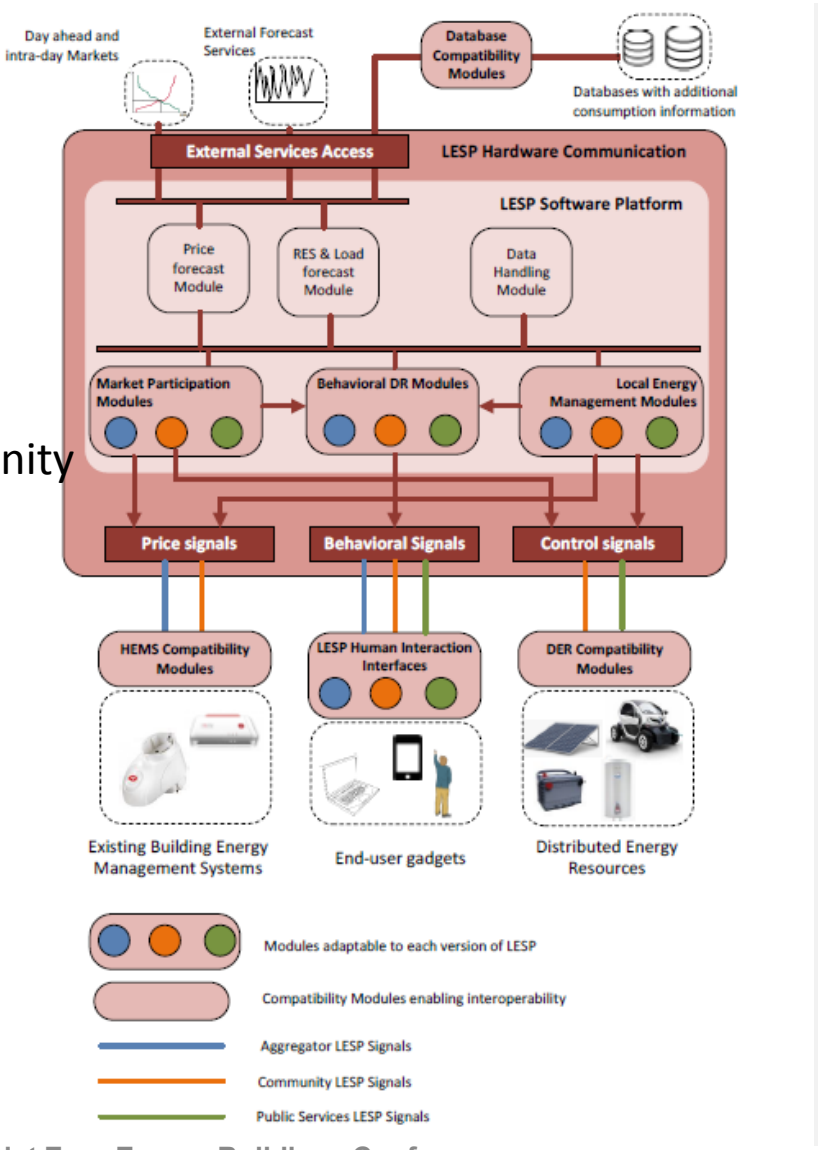


Main objective of the control strategy is to minimise the total energy cost

6. The Triple architecture

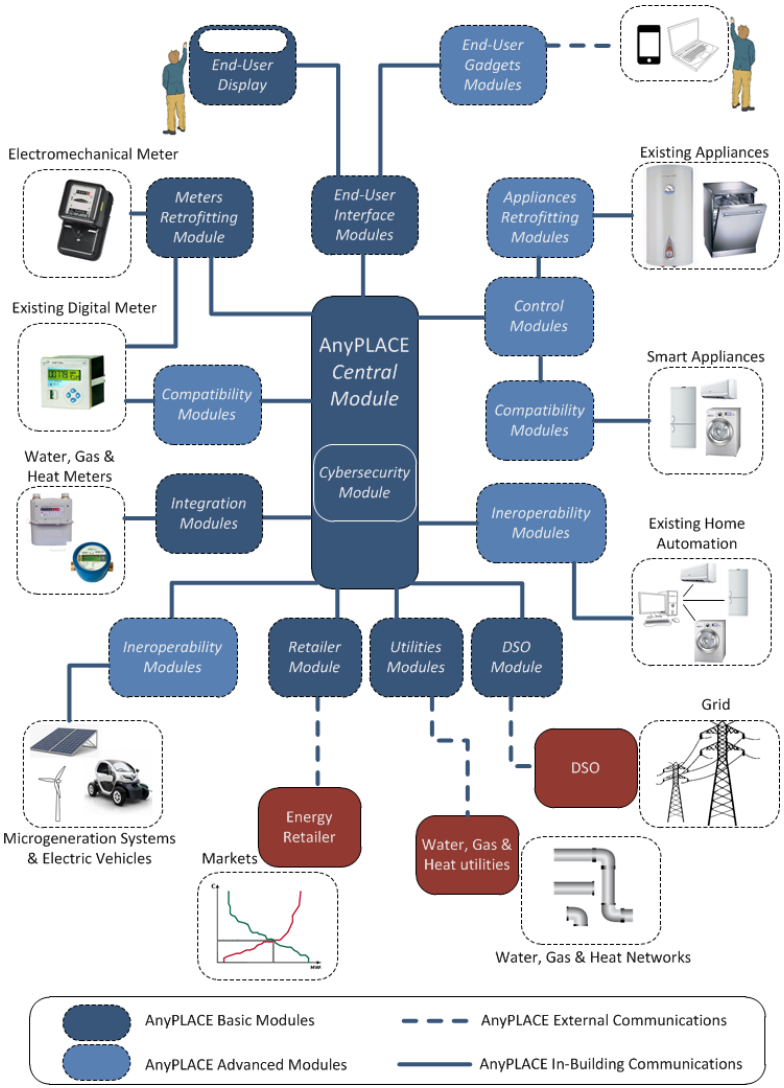
How to manage the buiding?

- Electricity price forecasts
- RES generation forecasts
- Load forecasts
- Deal with users behaviour
- Provide services to grid and comunity



6. The Any Place architecture

Home / building smart Metering platform



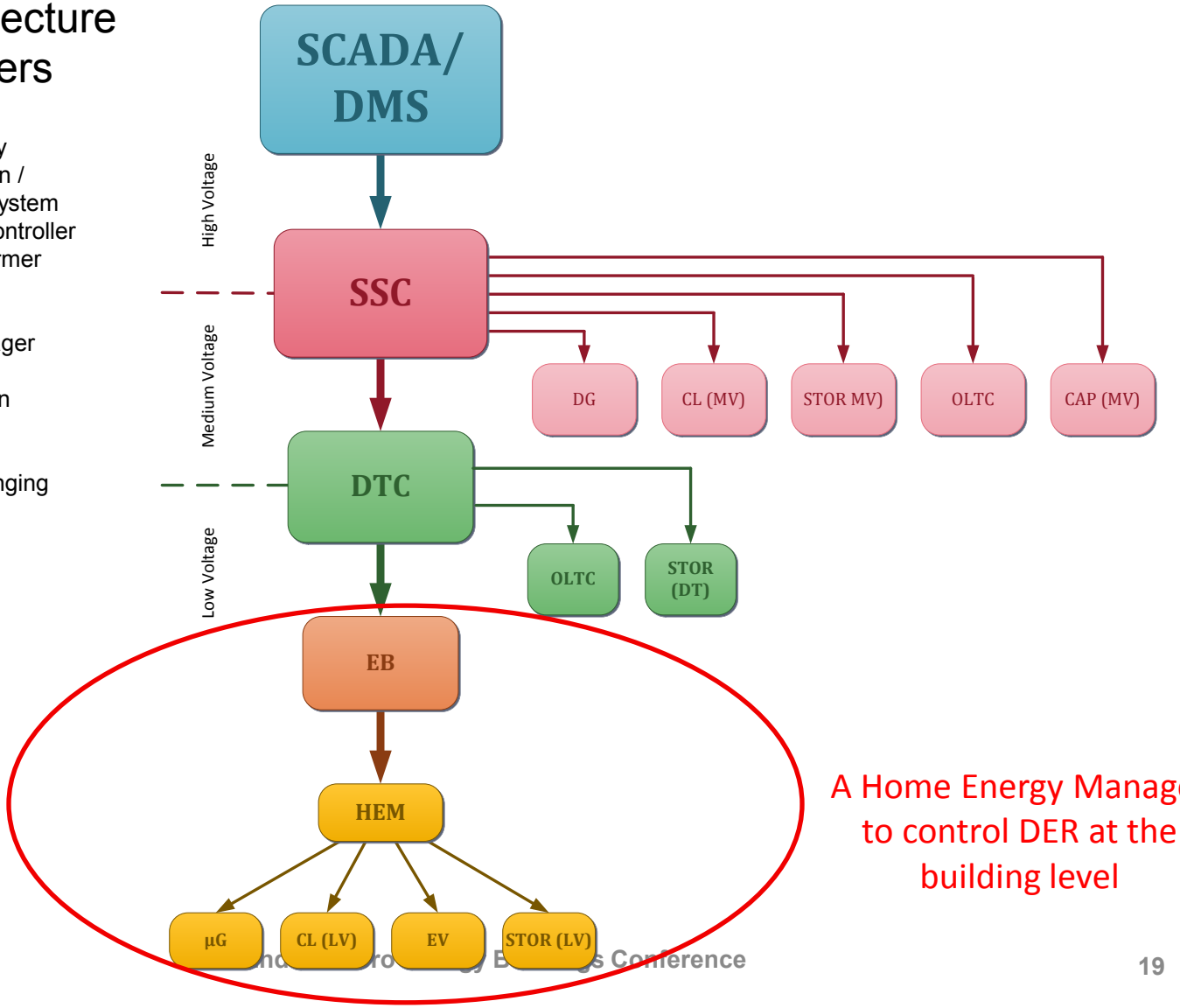
7. Advanced Grid Architectures and Control Concepts

Overall System Architecture

- Proposed Architecture and Control Layers

SCADA/DMS – Supervisory Control and Data Acquisition / Distribution Management System
SSC – Smart Substation Controller
DTC – Distribution Transformer Controller
EB – Smart Meter
HEM – Home Energy Manager

DG – Distributed Generation
CL – Controllable Load
STOR – Storage Device
OLTC – On-Load Tap Changing Transformer
CAP – Capacitor Banks
µG – Microgeneration
EV – Electric Vehicle



A Home Energy Manager to control DER at the building level

8. System Operator under SG paradigm -
The New Role of the Distribution System Operator

- The role of the DSO is evolving and emerging with the development of the smart grid concept and its associated technologies (smart metering, intelligent sensors, Active NetZero Buildings)

- Consequently, DSOs will have to change their focus by developing new business activities and diversifying their business model

- This is especially important since the change of the operational philosophy into an active network management approach will enable overcoming the challenges that arise form an increasing penetration of DER (specially at the LV level)

- New Functionalities:
  - state estimation,
  - forecasting tools (generation, load)
  - Coordinated voltage control
  - Predictive and prescriptive control solutions to be extended to the distribution grid (LV included)

New combined profiles need to taken into account

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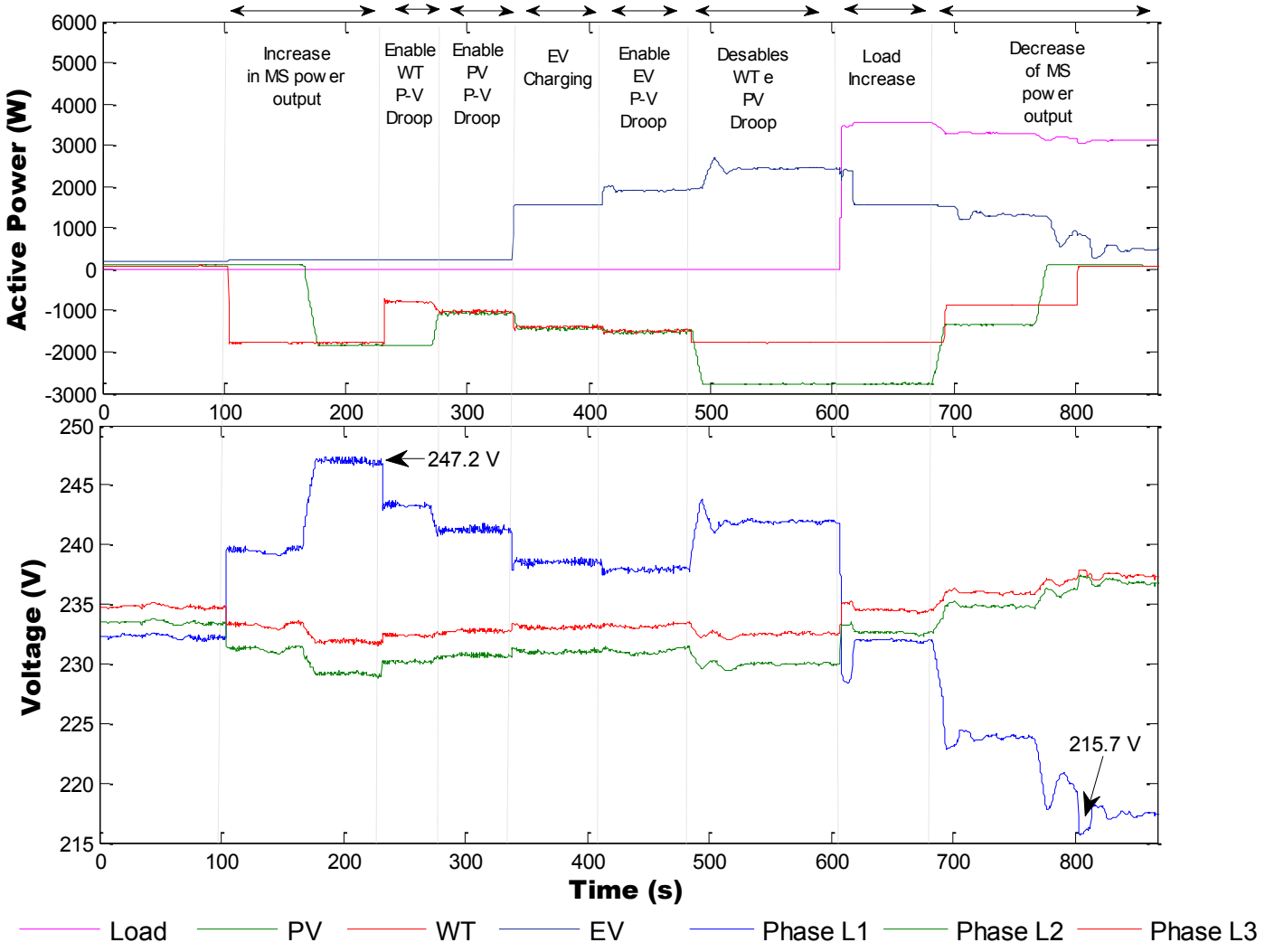
9.Managing building resources in Island mode of operation

Laboratorial tests



10. Conclusions

- Microgrid: the building block for future power distribution system allowing to facilitate and take full advantage of DER (demand response, thermal loads and EV with renewable resources, storage) connected at LV and MV levels
- Buildings (Active NetZero Buildings with EV connected) will behave as a Microgrid
- The wide deployment of smart meters with enhanced capabilities (bidirectional communication, information storage and processing) as well as ICT creates the infrastructure for management of the distribution grid of the future
- NetZero Buildings integrated in communities of buildings forming large microgrids will allow LV grid islanding operation and will provide self healing capabilities and increase global resilience of the grid.