POLITECNICO DI MILANO

Smart Grids Plus
ERA-Net





Scoping Workshop, Malmö 2015

Storage needs in the future energy system

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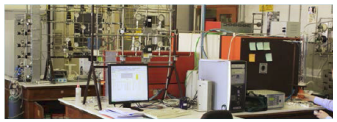
The Department of Energy - Education

- BSc & MSc in **Energy Engineering** (500 BSc and 290 MSc students enrolled in 2013)
- MSc in **Nuclear Engineering** (35 MSc students enrolled in 2013)
- PhD on "**Energy and Nuclear Science and Technology**"
- PhD on "**Electrical Engineering**"

Five Department divisions

1. Chemical Technologies and Processes and NanoTechnologies Division

- Catalysis and Catalytic Processes
- Micro and Nanostructured Materials



2. Electrical Division

- Electric Systems for Transportation
- Electrical engineering
- Power Systems

3. Nuclear Engineering Division

- Radiation Measurements and Detection
- Nuclear Reactors
- Reliability and Risk Analysis of Nuclear and Industrial Components and Systems

Five Department divisions

4. Fluid Dynamic Machines, Propulsion & Energy Systems Division

- Fluid-dynamics of turbomachines
- Group of Energy COnversion Systems (GECOS)
- ICEGroup - Internal combustion engines
- Propulsion and combustion

5. Thermal Engineering & Environmental Technologies Division

- Applied Thermal Engineering
- Buildings' Environment and Energy Systems
- End-use efficiency (eERG)
- Heating, Ventilating, Air Conditioning and Refrigeration Systems and Components
- Mono and Multiphase thermo-fluidynamics

Research Group
Relevant Projects (2010-2015)

"Internal" Research Project

LIVREA: ***Voltage Regulation with inverter***

PRESTO: ***Primary Regulation with STOrage***

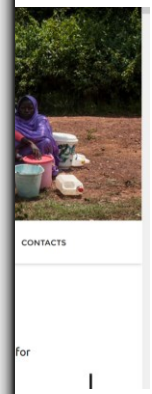
ENERGY4GROWING: ***Microgrid for Emerging Countries***

"Private" Research Project

Smart Grid: ***Scientific/Technical advisors for five «official» (Italian Resolution Arg/elt 39/10) SMART GRID Deployment project***

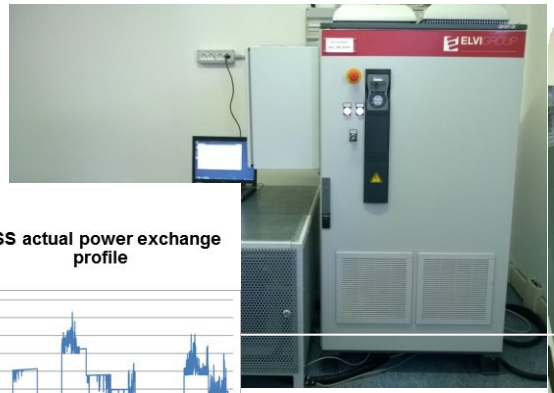
STORAGE: ***Lab activities in cooperation with national/international companies***

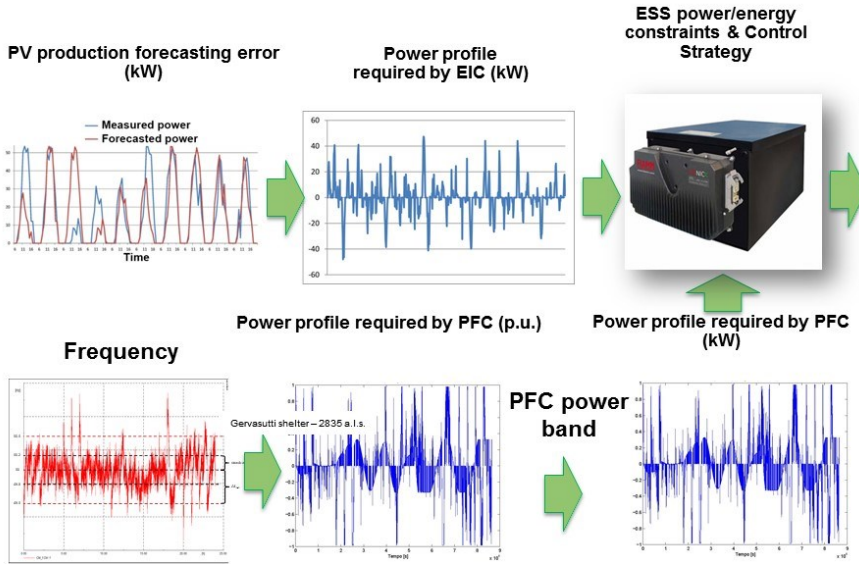
RENEWABLES MANAGEMENT: ***Lab activities in cooperation with national/international companies***



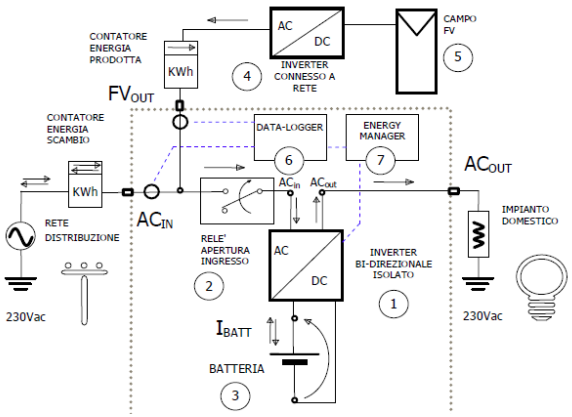
- **SoNiC: FIAMM**
  - **Research project PRESTO**

  Primary Regulation of STOrage

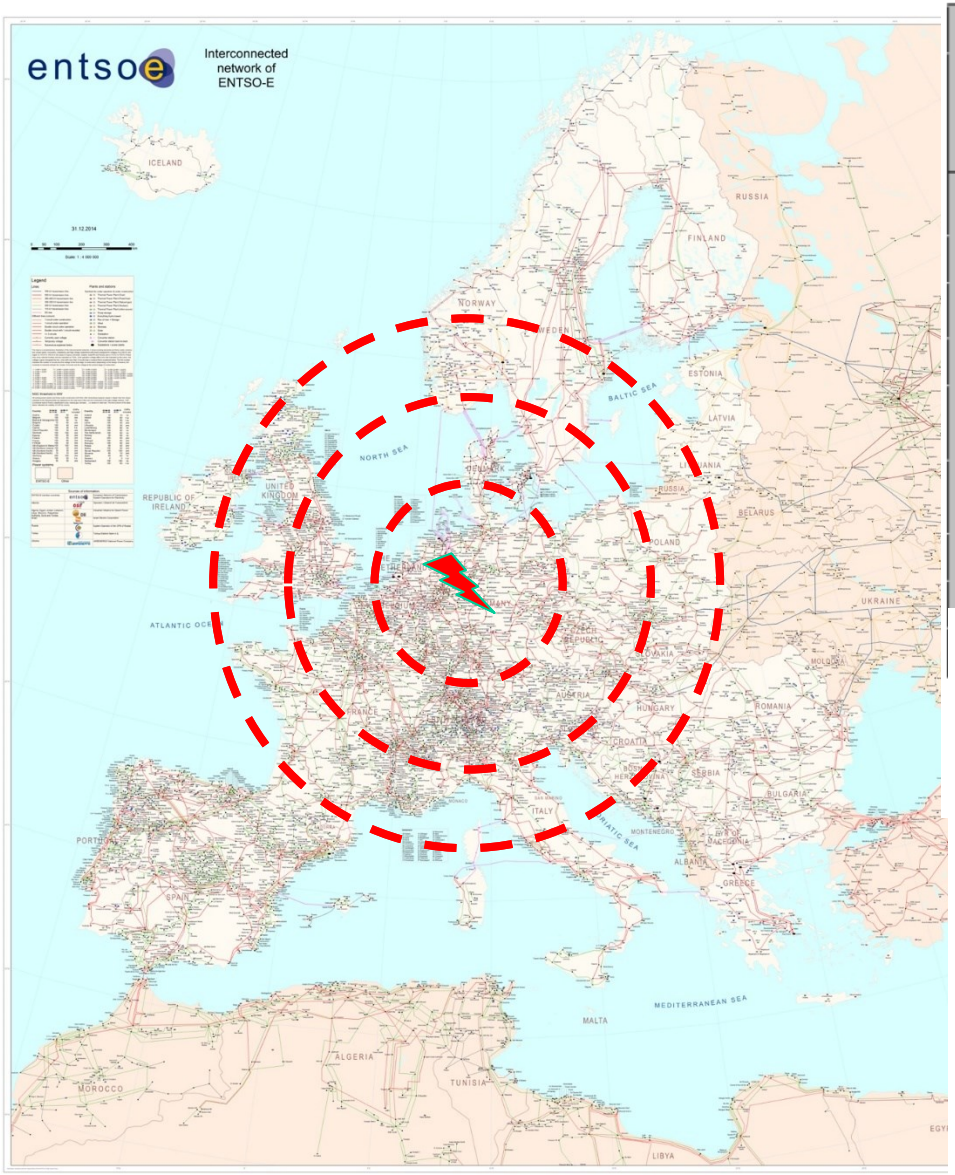




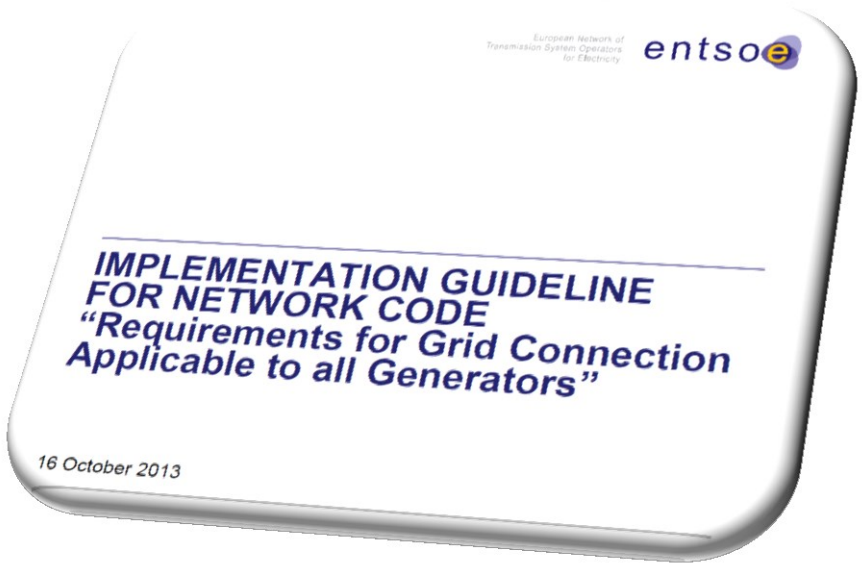
- **Lead Acid: LV PV + Storage**



Europe is one single entity (!?)

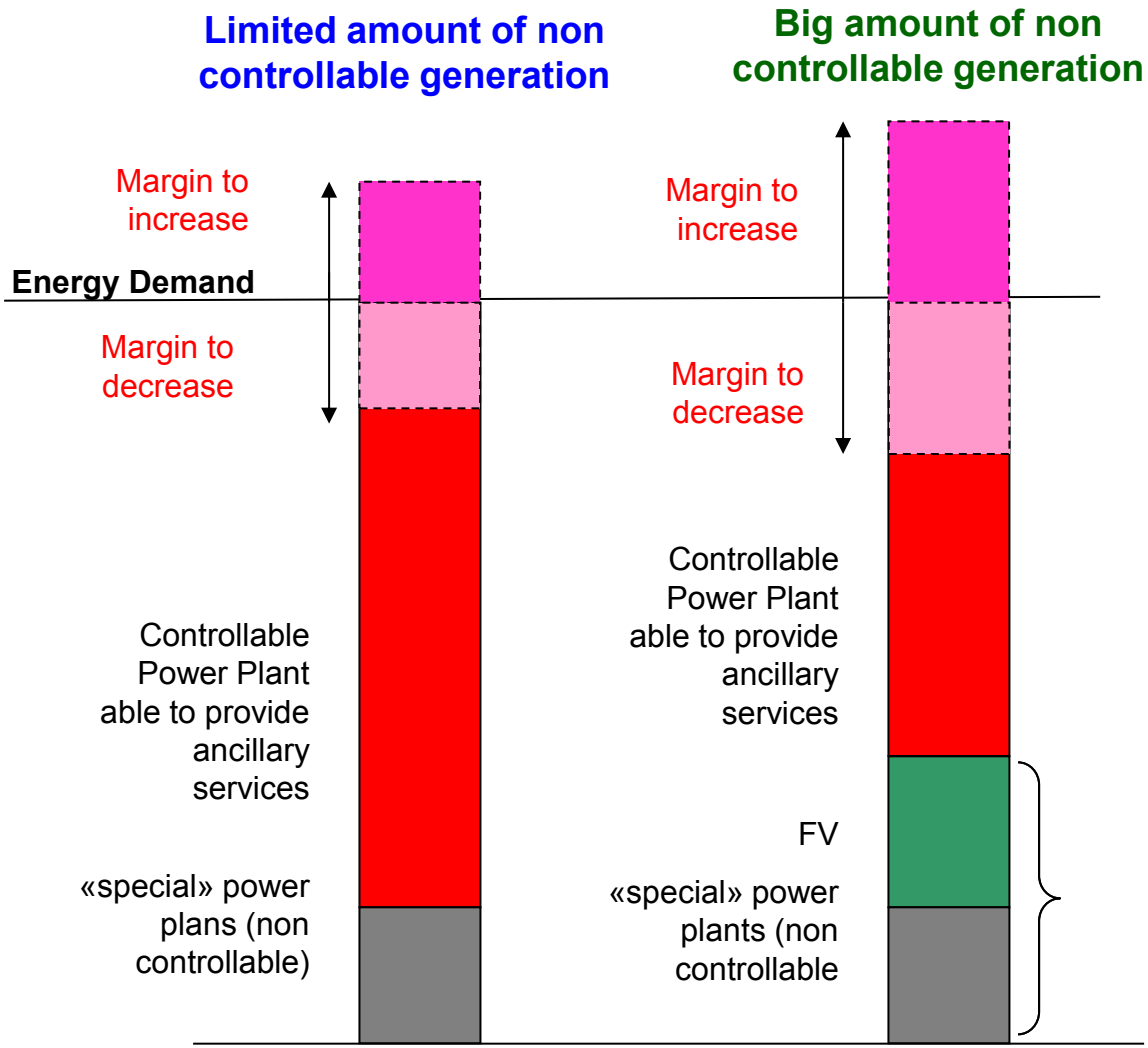


Country	Installed capacity in CE TSOs	Disconnection Settings 50,2	50,3 Hz	50,5 Hz	New installations compliant?	Retrofitting program?
Germany	14000	14000			yes	yes
Italy	11500	0	11500		from 1 April 2012**	yes
Spain	3900	0	0		yes	no
France	2500	2500	0		under preparation	no
Czech Republic	1900	950*	950*		no	no
Belgium	1600	960	0		yes	no
Greece	600			600	no	no



The challenge we have today

Ancillary Services: grid security and stability

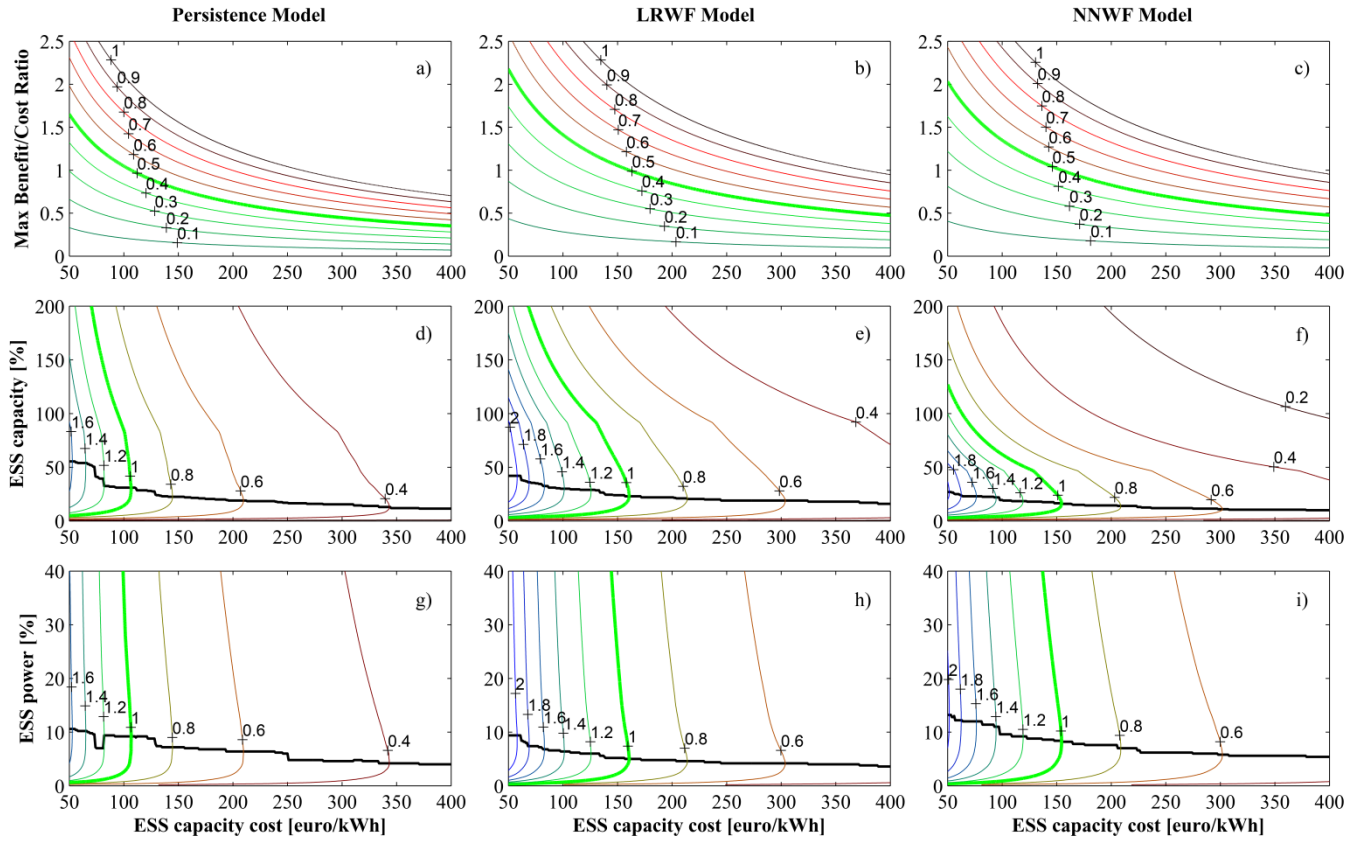


"BUT"

- «REAL LIFE» figure are, sometimes, far from theoretical one
- There is a lack in the technical regulation **IEC TC – 120** (www.iec.ch)
- Grid Codes have to be unified **ENTSOe**
- Market structures have to be updated
- We need "real life" tests (few cases so far)
- SOCIAL PROBLEMS

Storage needs/role in the future E.S.: numerical simulations/examples

STORAGE to improve the predictability (reduce umbalances) of FER (PV)

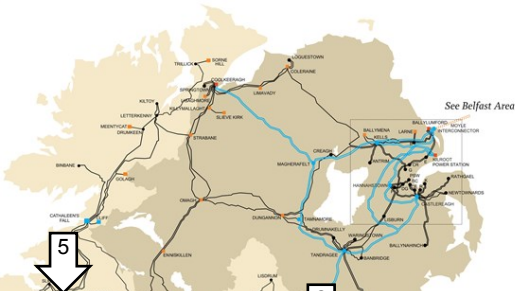


The results obtained with the simulations depict that, under the assumptions of the study, the STORAGE becomes an effective solution to reduce RES imbalances with costs lower than 160 €/kWh. The situation changes considerably at an increase in the imbalance penalties, the break-even cost increases to 289 €/kWh.

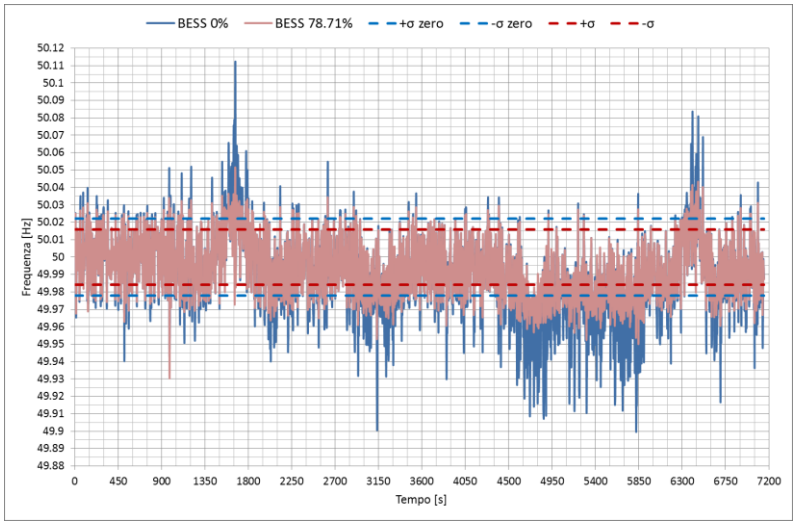
Storage needs in the future energy system: numerical simulations/examples

EIRGRID SONI

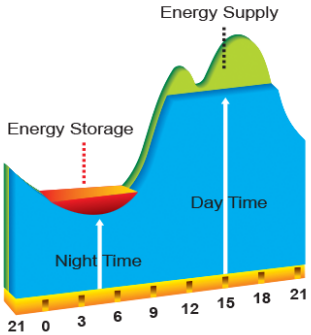
TRANSMISSION SYSTEM 400, 275, 220 and 110kV



STORAGE for primary and secondary frequency control

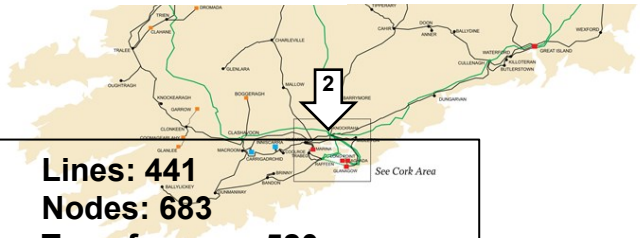


There's much more than the classical Peak Shaving:

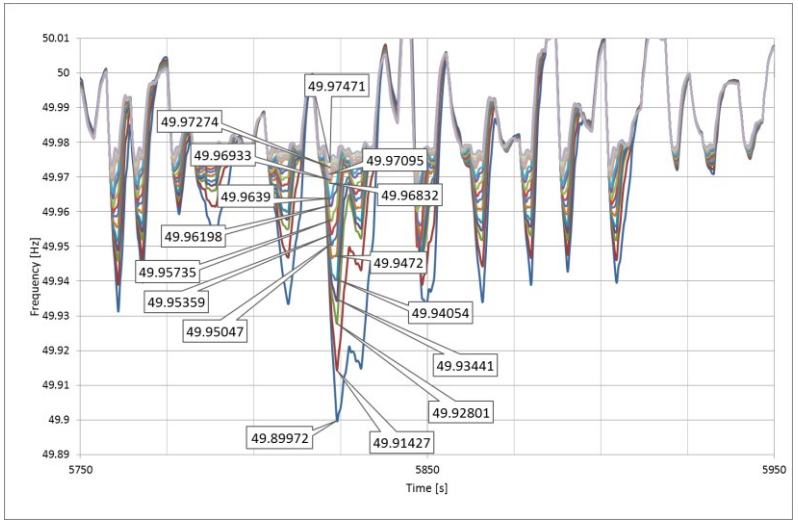


Ancyllary Services !

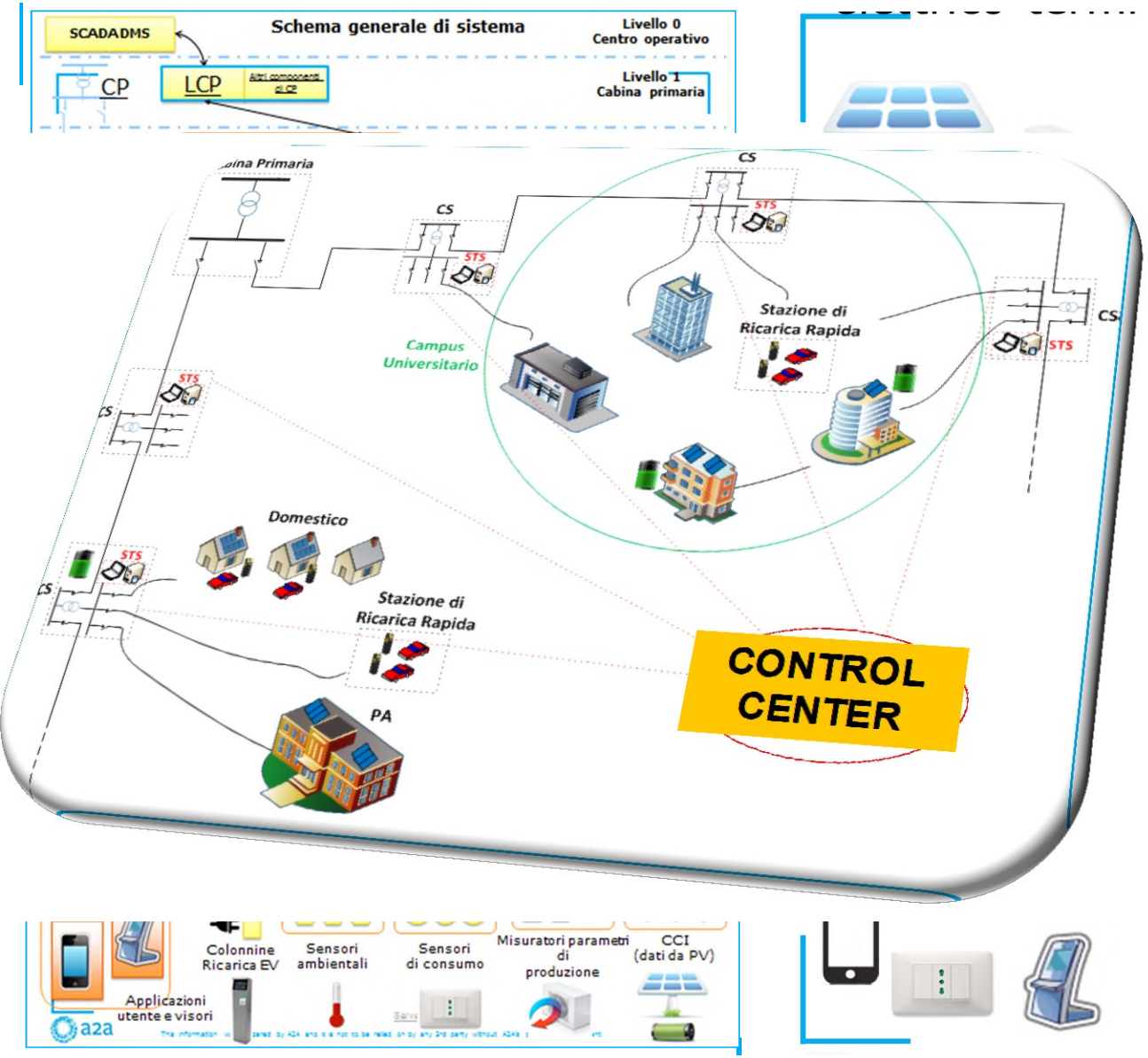
- *Fast (real) power control*
- *Reserve (real) power control*
- *Voltage (reactive power) control*
- *Stability control*
- *Black Start*
- *etc*



- **Lines: 441**
- **Nodes: 683**
- **Transformers: 520**
- **Termo generators: 31**
- **Hydro generatores: 48**
- **Wind power plants: 163**



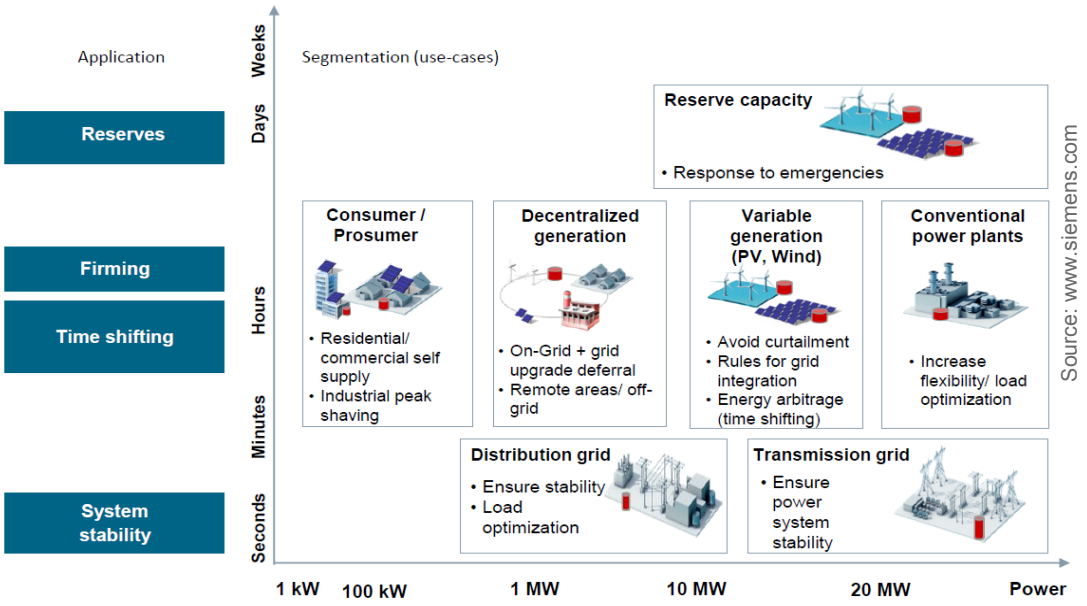
Project SCUOLA
a possibile study case example



- PV + Storage (building like)
- Building Energy (electric + thermo) management (trigen machine in place)
- Smart e.car recharge
- ICT & TLC for interaction with the final users
- Everything is linked to and managed by the DSO (Distribution System Operator)

Open Questions:

- *What are we looking for*
  - *Renewables?*
  - *Economics?*
  - *Security?*
  - *Quality?*
- *What is our benchmark?*
  - *Today quality of service in*
    - *Gemany?*
    - *Italy?*
  - *Other Metrics?*



- *What is the Electric System structure more suitable for the future challenges:*
  - *TSO/DSO Pubblic/Private?*
  - *ESS Pubblic/Private?*
- *What should be the «final user» role in this picture?*

On top of that:

<u>Real life tests are “almost” mandatory</u>

<u>Willingess to “use” this new energy econosystem is a key factor</u>

Really a tough goal: let's move our mind

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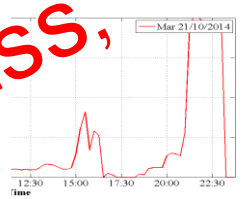
have a look to



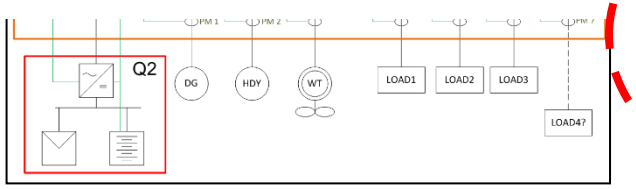
able energy behaviour

uency oscillations

ctor (effectiveness)

n for a LAB !!!

... BUT AT THE END PEOPLE, WILLINGNESS, IS THE MAIN DRIVER ...



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