Control and Flexibility

from the System Operator point of view

2nd Net Zero-Energy Buildings Conference

New Challenges for NZEB in Smart Cities

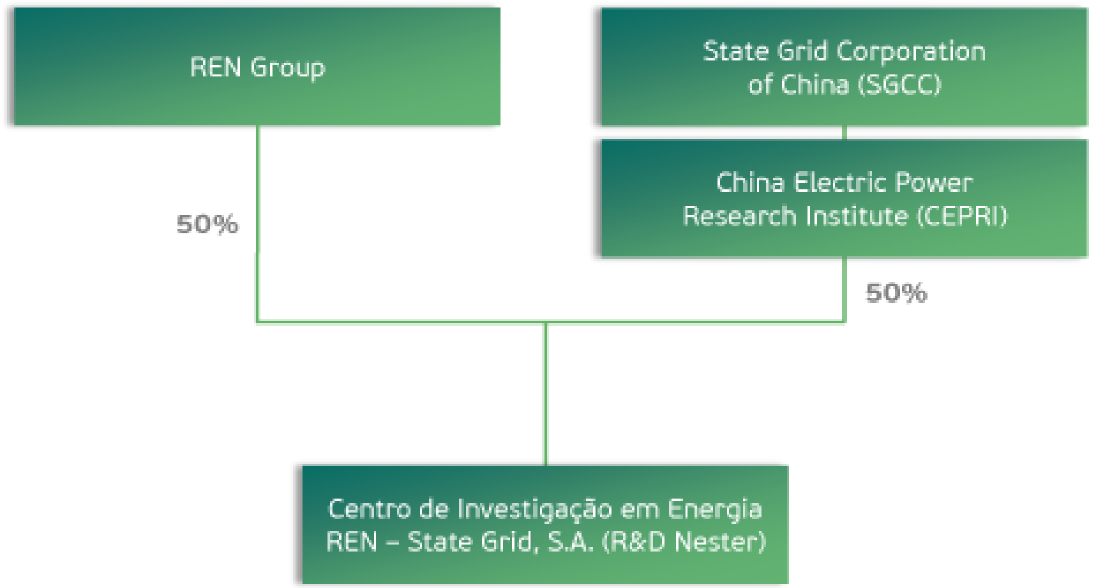
Energy Flexibility and Buiding to Grid interaction

September 2015

- R&D Nester, a research and development center incorporated in **May 2013, in Lisbon**

- Shareholders
  - REN (Redes Energéticas Nacionais – Portuguese TSO)
  - SGCC (State Grid Corporation of China),

    via CEPRI (China Electric Power Research Institute)



Initial projects portfolio

Renewable Energy Dispatch Tools

Substation of the Future

Network Planning in the presence of Energy Storage

Real-Time Simulation; Planning and Operation of large AC/DC Power Grids with Renewables; TSO/DSO cooperation

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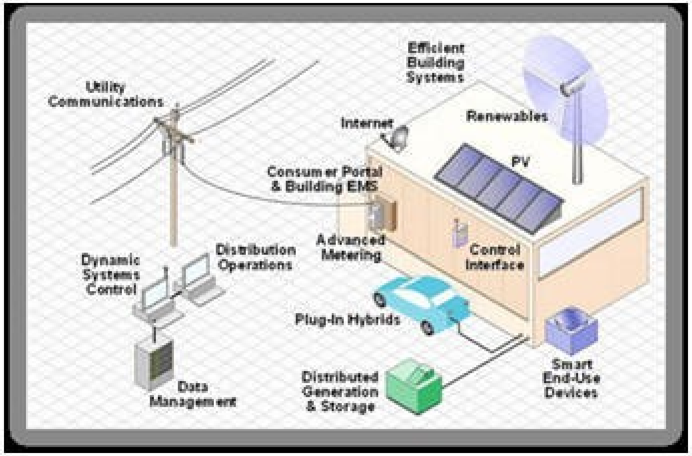
NZEB expected to bring many new elements to the network and the overall system

- Building integrated solar systems
- Heat pump systems
- Combined heat and power
- smart predictive controls that reduce/shift peak demand
- Storage equipment (electric, heating/cooling)
- Electric Vehicles charging devices
- short-term and seasonal thermal storage
- …



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These elements pose new challenges

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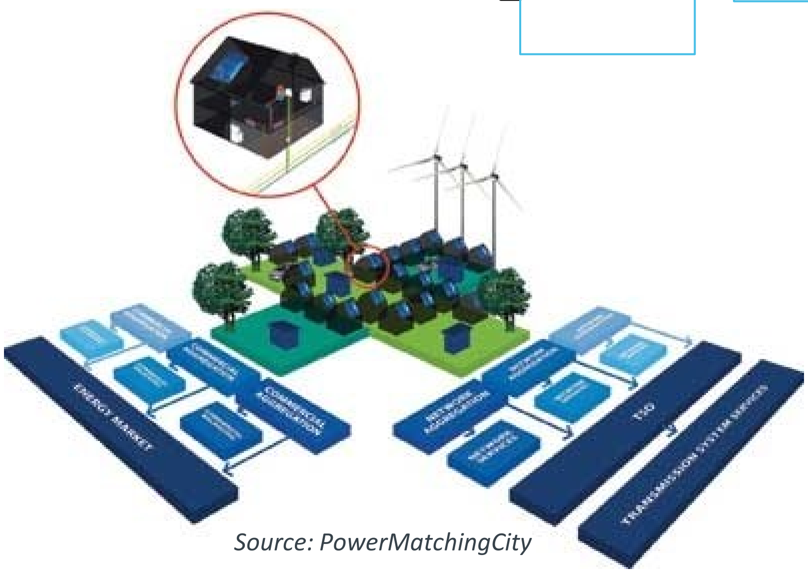
Characteristics, typology and volume, dependent on eco-system level

- Building level
- District level
- Aggregator level
- City level
- Community level
- Aggregator level



Source: PowerMatchingCity

Smart Cities and Communities concept

Need of coordination

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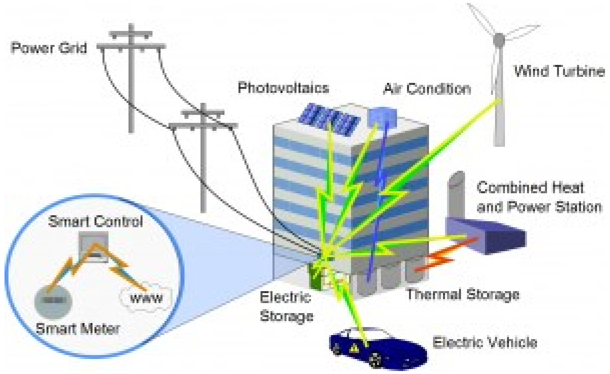
- *New and multiple stakeholders*
    - *Building Manager, District Manager, City Manager, Aggregator, …*

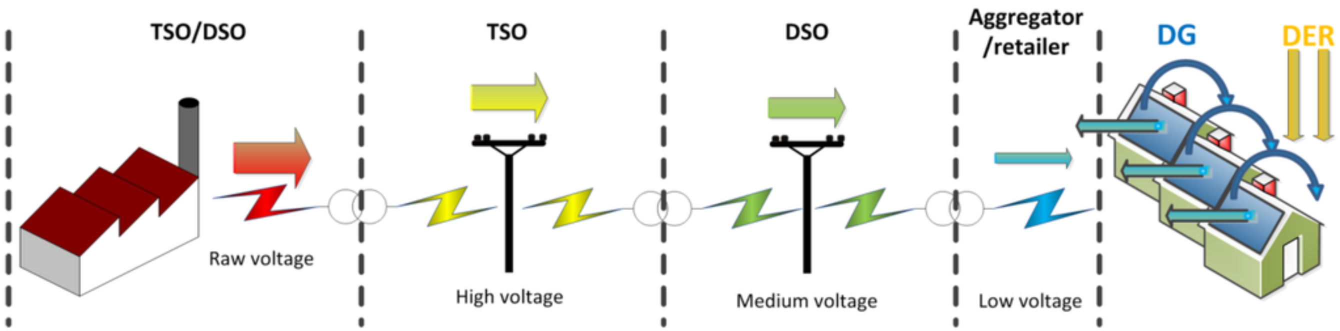
- *Need to manage multiple levels of protection, stability and availability of the grid*

- *Need to manage multiple intelligent agents*

- *Buildings Data (big data) allows New Services and Technical / Economic Optimization*



- *Need to have more coordination between TSO and DSO*
- *Information between TSO and DSO*
  - *Real-time data*
  - *Structural data*
  - *Scheduling data*
- *Integrated response TSO/DSO*



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New approaches needed:

Automatic network reconfiguration:

- optimization of network operation to meet demand in the most efficient way; **network controllers** receive information on grid topology, generation and demand and have algorithms capable of integrating this information and activating grid hardware to reconfigure the grid if necessary; this includes **self-healing** capabilities

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- as energy generation capacity becomes more distributed and power flows across the grid cease to come from large, centralised plants, it will become harder to detect and locate faults; future protection systems will be equipped with i**ntelligent electronic devices which communicate with other protection systems and sensors**, and will have a strong need for **real-time** knowledge and **forecasts of grid states**

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Energy storage technology:

- necessary to assume penetrations of storage in load flow analysis, as well as in models simulating transient and stable grid operation; technologies providing storage allow the movement of electricity over the grid to be controlled and make the grid more flexible if the storage units can be controlled; storage can contribute to **grid stability** in grids and compensate for fluctuating generation on different timescales

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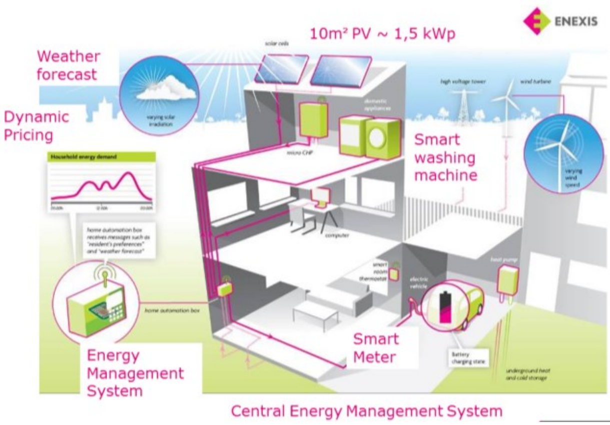
Models and simulation will need to take these new approaches into account

Demand-side forecasting

- As electric vehicles (“EVs”) are introduced and heat pumps become more common, **forecasting demand** will have to evolve as these changes will happen gradually but have to be incorporated into **demand forecasting models**
- Exposure of a large number of consumers to **real-time electricity prices**, and more automation that activates loads in response to those prices or other signals can make demand harder to model
- The huge potential of **industrial demand-side management** is not well understood
- Necessary to distinguish between short-term **reactions to price signals** and medium- and long-term reactions from the industry and buildings to highly volatile or even negative energy prices
- Potential systems which incentivize or mandate **frequency control** from appliances in households or industry or EVs (the operators of the power grid must be able to include the effect of this policy in modelling, simulations, operation)
- More **data on consumer behaviour** in response to price and other signals must be gathered to make models and simulations reliable



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Grid Status Monitoring

- Grid calls for robustness at all levels
- High penetration of fluctuating generation from RES requires **novel control methodologies** based on **multiple integrated control systems** to ensure the **security of supply** (both coarse and fine-grained levels)
- Controlling the power balance and frequency requires **multiple control loops** handling different power markets to always match generation and consumption both at transmission and distribution level
- Usage of measurement devices as PMU's (Phasor Measurement Units) for enhanced online and **real-time data measurement** and a WAMS (Wide Area Measurement System) with intelligent software processing of the huge amount of data opens new system awareness and even an early warning approach for the **control systems at all levels in the grid**

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- *Optimizing generation + loads + storage*
- *Critical to properly define the priority of energy storage between grid services (for instance to define the priority between grid outage and energy arbitrage, or between frequency response procurement and energy arbitrage)*
- *Need to manage assets flexibility; including ICT*
- *Need to handle DSM/DR; reaction to dynamic tariffs, dynamic pricing*
- *Development and use of communication protocols for DR in Buildings*
- *Balance production according to consumption; ancillary services*
- *Ability to ramp (presence of high levels of RES)*

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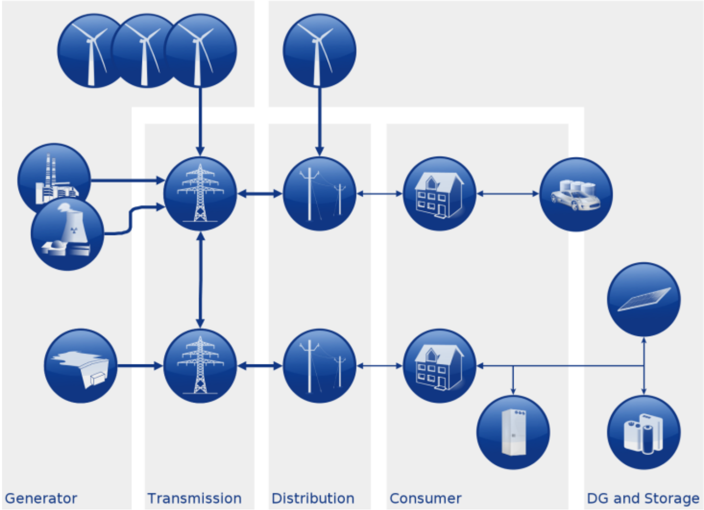
- *NZEB as participants of ancillary services / balancing / flexibility markets*

- *Need to garantee the existence of the mechanisms that allow the cooperation between NZEB and TSO/Grid/System Operator*

Source: csnc.ch



NZEB can contribute to the role Grid and System Operator; Grid and System Operator can benefit from the capabilities of NZEB; jointly contributing for a sustainable and reliable energy system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