Demand-Response
Let the devices take our decisions

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From Devices to Automata

How from a device could we create something smart?

When a new device is plugged into the grid. The Smart House needs a numeric representation to control it. See "From devices to automata".

Some devices can't take part in a DR program, but still can be stimulated in order to increase or decrease its consumption. For example, a smart light reacts to brightness sensor or presence sensor output.

Others build an automaton following rules:
- to take one criterion in each set {cyclic, acyclic}, {internal parameters, external parameters}, {with batteries, without batteries}, {producer, consumer, both}

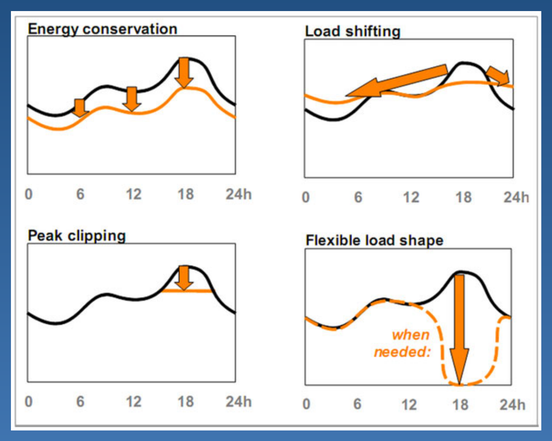
- to take some parameters depending of the previous combination

- to define DR programs which can be followed by the device

- to build an automaton, a flowchart that describes its behavior in function of criteria, parameters and DR programs.

Consumption's Schemes

The set of strategies includes basic consumption and DR programs such as:



A Decision tool for Microgrids

Strategies of consumption

A strategy is a combination of a DR (or basic consumption) programs for each device in the smart house.
If the smart house owns three devices with 3, 4, 5 programs, then the smart house makes 3*4*5=60 strategies.

Strategies from producers

Depending of local production, smart contract and routing, producers send their strategies of distribution to each microgrid.

Finding a consensus

For each smart house, a game is created, including all smart house's strategies of consumption and strategies sent by producers to the microgrid.
A Pareto equilibrium, i.e. a consensus between supply and demand, is found and forms the decision.

From devices to automata

No DR programs	With DR programs			
Cyclic	Cyclic	Internal and external parameters	Batteries	Producer
Acyclic	Acyclic	Internal parameters	No Batteries	Consumer
Sensors				Prosumer

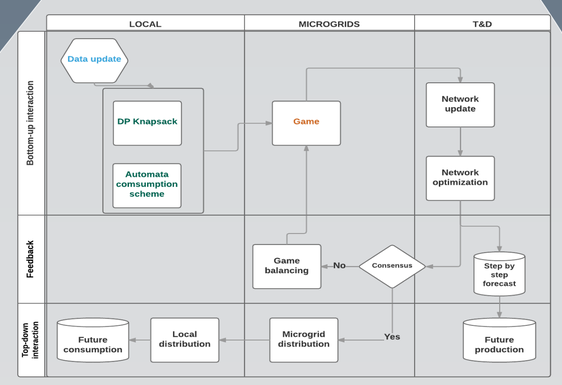
Choose at most one per category

- Plug a new device
- It defines its own DR programs
- It defines its own parameters
- Automaton is created in function of previous choices

Price	User's behavior	Sensor Environment	Internal Machine
Time T	Preference Time	Temperature	Concumption Cycle, Time
δT	Preference of scheduling	Humidity	Inertia
	Desired Set of values	etc	etc

Smart home

Overall process



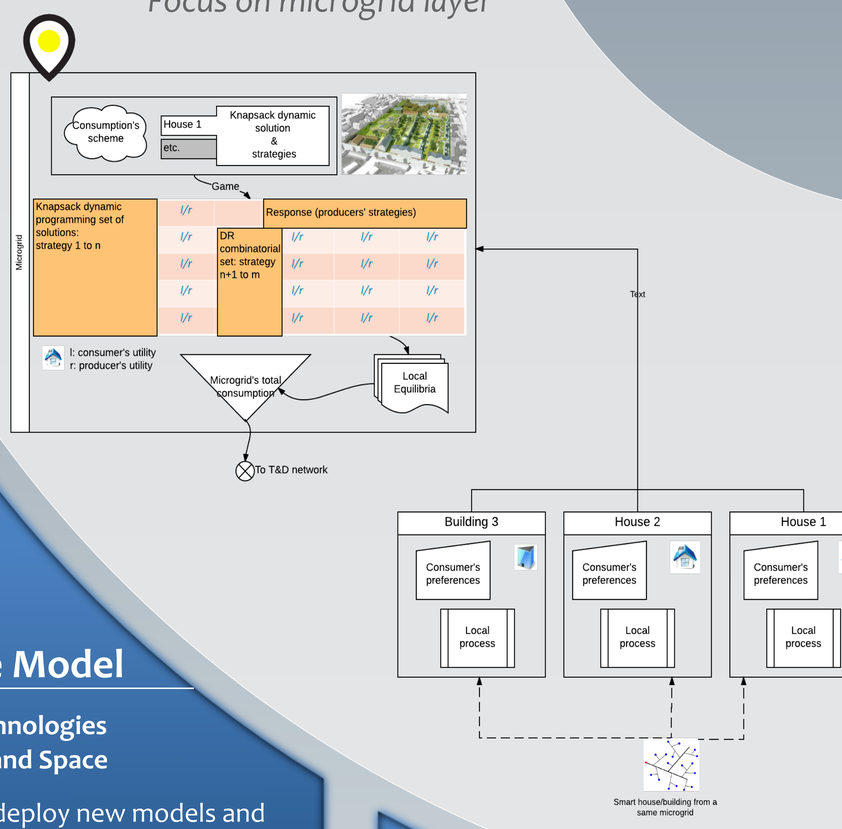
Dark blue bookmark: at the beginning of a new iteration, devices and automata are updated, smart homes create their strategies then send them to the microgrid

Green bookmark: strategies of consumption are made from automata and from a knapsack problem

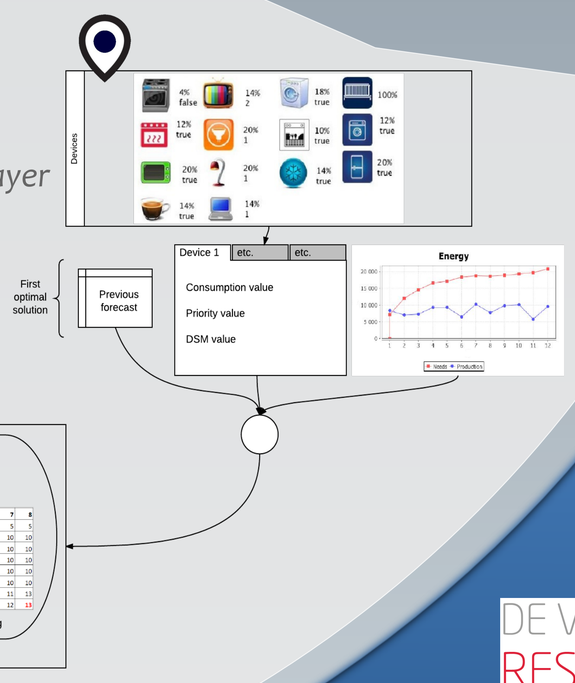
Yellow bookmark: microgrid groups both consumption's and producer's strategies and chooses a Pareto equilibrium

The rest of the process is described in reference [1]

Focus on microgrid layer



Focus on local layer



Step by step process

Context-free Model

Suitable for all technologies
Evolution in Time and Space

There is a need to deploy new models and algorithms that can capture the following characteristics of the emerging smart grid. It is a current and active field that will give birth to many innovations and technologies.

The needs to build an efficient and flexible smart grid are known, and it becomes an urgent matter.

The presented model provides some simple and useful tools for a generic model of smart grid. This decision making tool can be used to test existing or future technologies in a smart grid design.

See the following references [2,3] for more information.

What does Demand-Side Management consist of?

Demand-Response

It includes all intentional modifications to consumption patterns of electricity to induce customers that are intended to alter the timing, level of instantaneous demand, or the total electricity consumption

Sustainable Energy

It includes all permanent changes in equipment or improvements in the physical properties of the system.

Change Management

It is a set of incentive programs and social programs in order to create responsible behaviors, like sorting the wastes in the late 90s.

References

[1] Ahat, M., Amor, S. B., Bui, M., Bui, A., Guerard, G., and Petermann, C. (2013). Smart grid and optimization. American Journal of Operations Research.

[2] Amor, S. B., Bui, A., & Guerard, G. (2014). A context-free smart grid model using complex system approach. In Proceedings of IEEE/ACM.

[3] Ramchurn, S. D., Vytelingum, P., Rogers, A., and Jennings,N. (2011). Agent-based control for decentralised demand side management in the smart grid. In The 10th International Conference on Autonomous Agents and Multiagent Systems.

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