

Smart Grid services for promoting demand side management

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Deployment of Smart Grids for system flexibility

The recent changes in the power system

- Increasing exploitation of non programmable RES, in particular Distributed Generation (DG)
- New usages of electricity (es., e-mobility, heat pumps, electric cooking)
- Active end-user involvement in the electricity market (cfr. 3° Energy package)

Taking into account the objectives of the

Network operator

- System adequacy/security
- Access to the network for all the users
- Quality of service
- Investment protection

Enabling factor

A new model of the grids
"smart grids"

Enabling factors

Setting up an effective

Legislative framework

- New regulatory framework (the electricity grid is a regulated asset)
- Economic efficiency (avoiding unnecessary costs for the user)

Smart grid enabling factors

- New technologies
- Technical standards



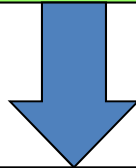
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Distributed generation is the driving force of Smart Grids

.... and Demand Response is taking advantage of SG deployment

Outstanding growth of Distributed Generation



Distribution grid evolution from "passive" to "active" grid in order to control DG.
Distribution grid integrated with broad and low cost ICT layer allowing a two-ways interaction with the users.
("active distribution network" – smart grid)



Distributed Generation installed at the consumer premises
New controllable domestic electricity usages



Consumers become "active subjects" of the electricity market
(interactive and flexible users)

Prosumers

Demand side management for residential and service customers

Present and future opportunities for the active consumers

- 1. Improving efficiency in energy consumption (energy saving)**
(obtaining the same services with less energy)
“Stand alone” Customer Energy Manager
- 2. Exploitation of time varying electricity prices**
Customer Energy Manager + Energy price signals
- 3. Providing new services to the electricity market** (e.g. participation of demand response in balancing, reserve and other system services market)
Customer Energy Manager + Demand Response
- 4. Novel “added value services” for the domestic electricity consumers made available by the Smart Grid**
Customer Energy Manager + added value Smart Grid services

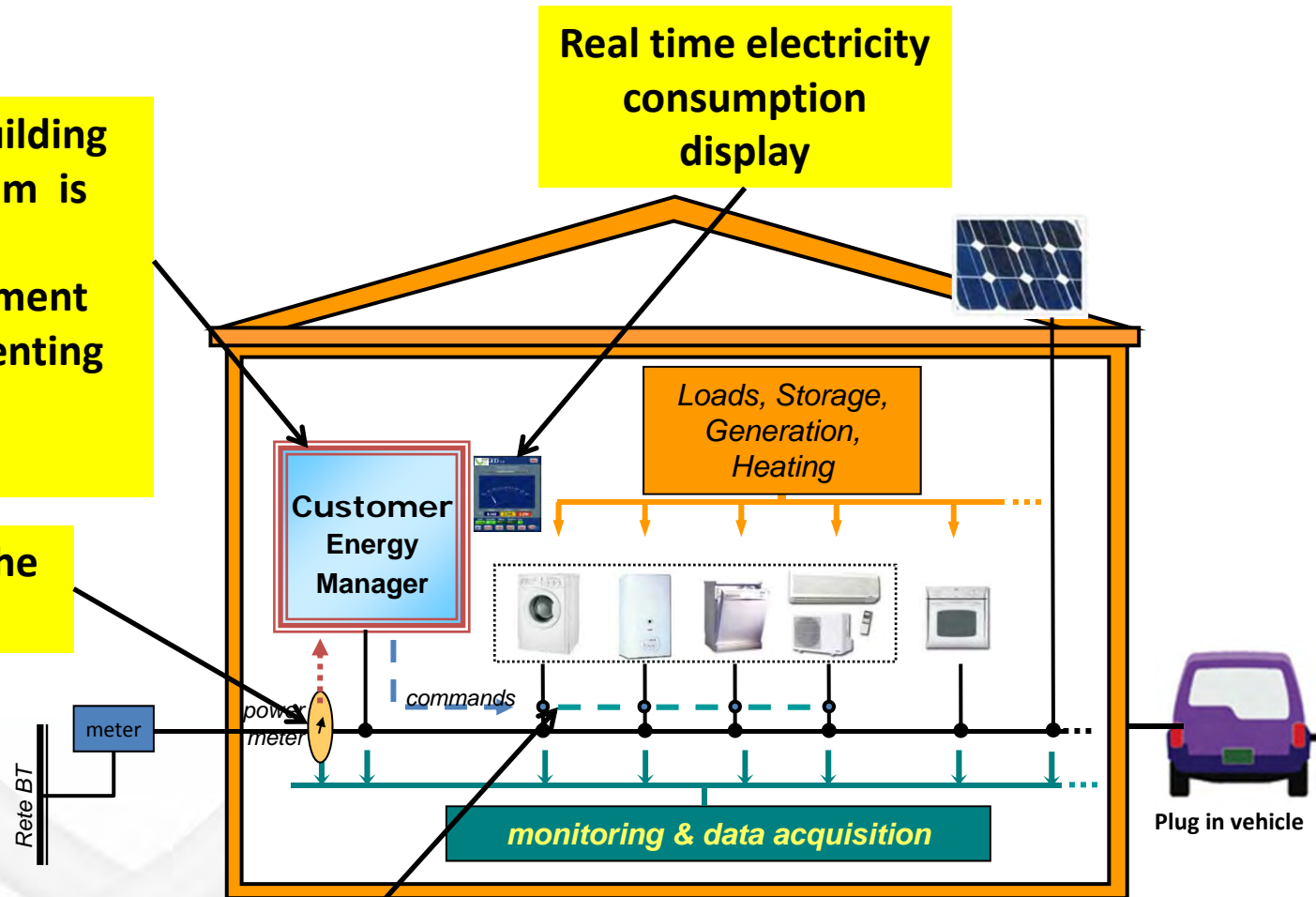
“Stand alone” customer energy manager

The home and building automation system is integrated with a «energy management system» implementing energy efficiency algorithms

Input data from the electricity meter

Communication with the home appliances

Wireless sensors for usage information and command actuation

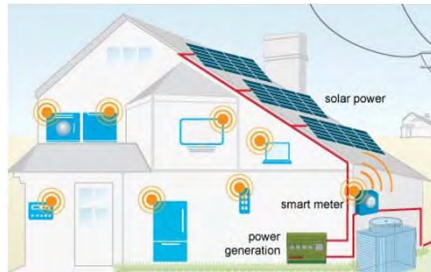


“Stand alone” customer energy manager

Main functions

- **Improve consumer awareness of her/his electricity usage**
 - Real time data visualisation
 - Correlation of multi source data to give the consumers powerful insights about their energy use
- **Optimisation of electricity consumption**
 - Profiting by the availability home and building automation devices
 - Detection of appliance malfunction/performance degradation
- **Containment of the contractual power rate (avoiding disconnections when exceeding the contractual power)**
 - Management of shiftable / interruptible loads (water heater, A/C, washing machine, dishwasher)
- **Matching domestic generation (eg. PV) and energy usage (increasing self consumption)**
- **Optimising space heating (eg, exploitation of a “dual fuel” solution – combining heat pump and gas fired boiler)**

“Stand alone” customer energy manager - enabling technologies -



Wireless Home Area Network (standardisation of communication protocols)



Energy management algorithms

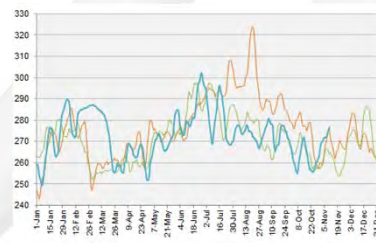


2° generation Smart meter (two-ways communication)



Smart appliances

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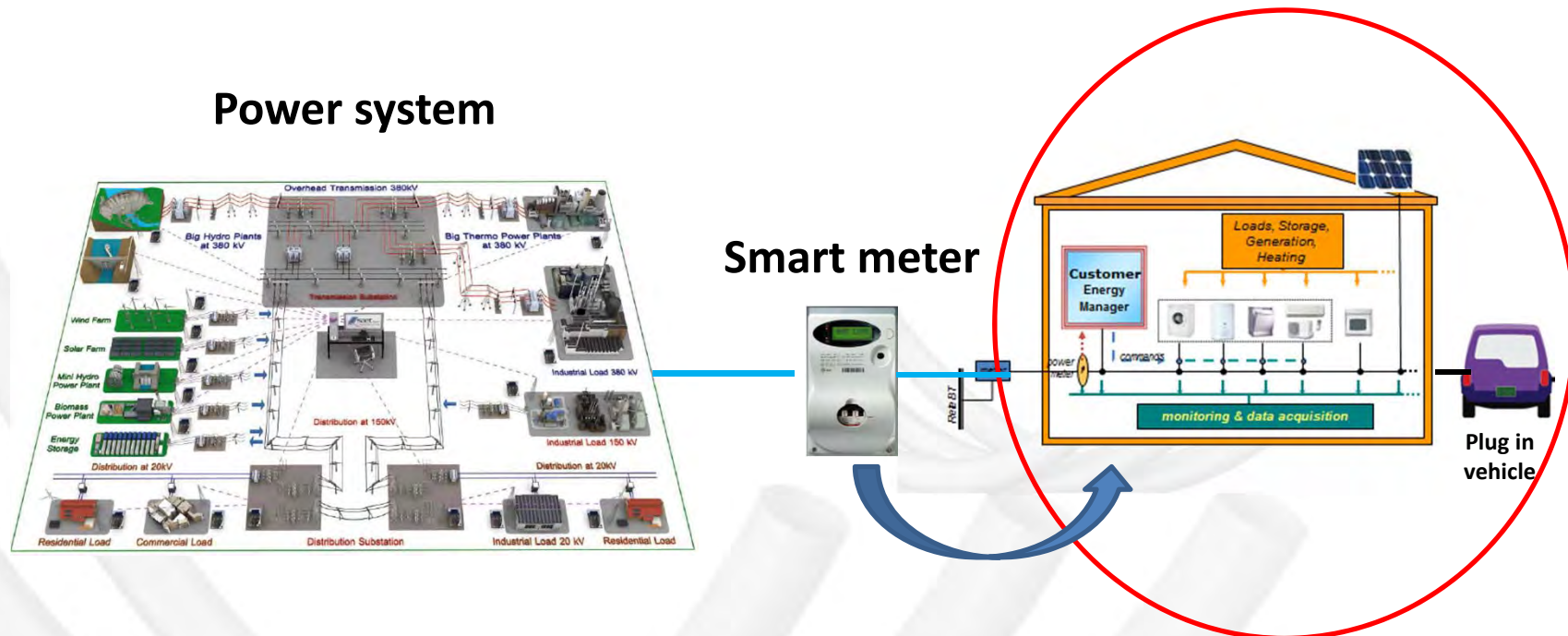


Electricity demand and production forecasting



Real time consumer display

“Stand alone” customer energy manager - Interaction with the power system -



The **smart meter** is the only interface between the smart home and the power system. It has to make available a **two-ways communication** with the home devices. The **smart meter** delivers data to the Demand Side Manager.

No direct information exchange with the power system.
Smart grid functions are not exploited in this model.

Customer energy manager + Energy price signals

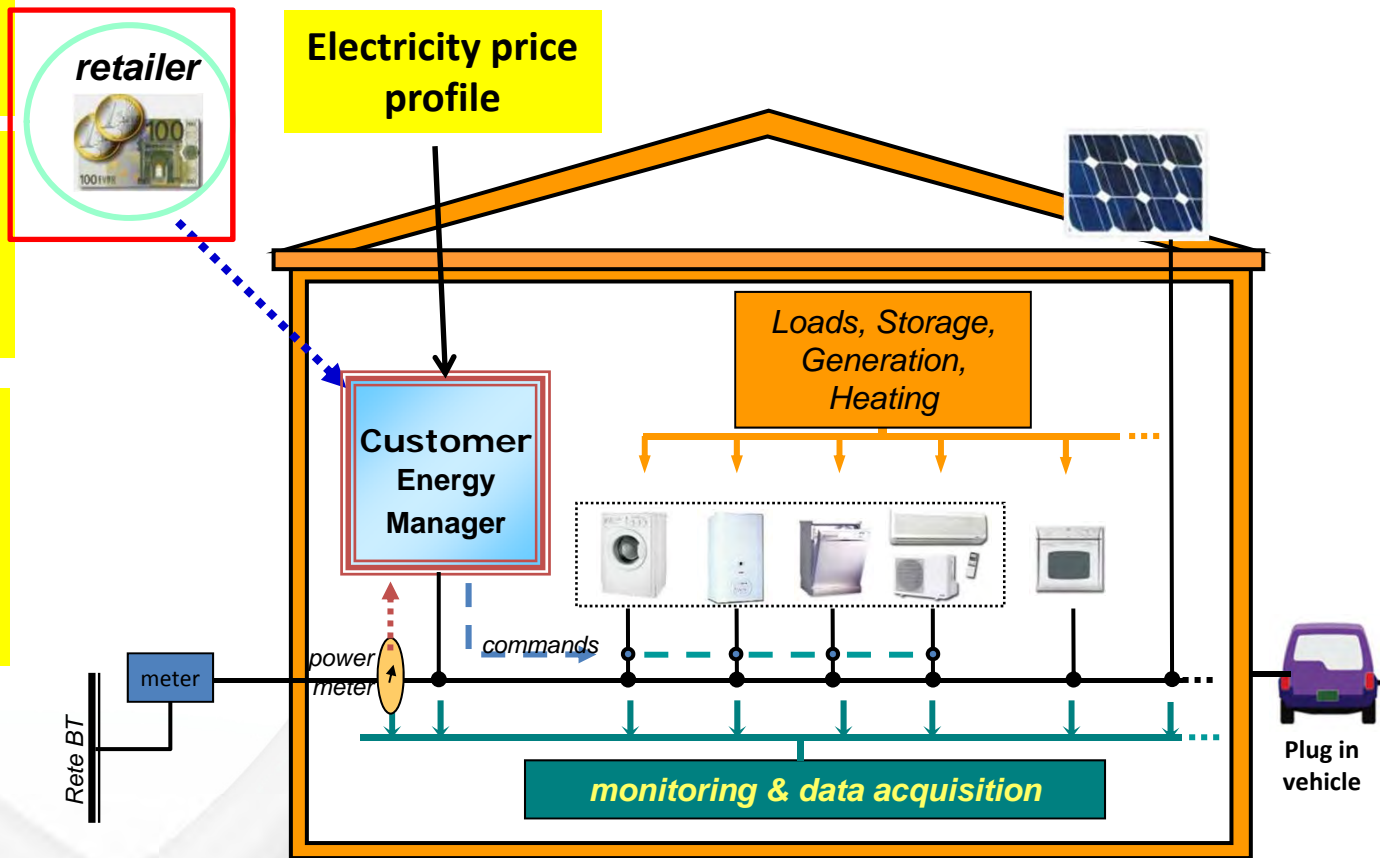
From energy/power quantities to energy prices

Energy price signals

Time varying energy prices

- Static TOU tariffs (peak, off peak hours)
- Dynamic, real time prices
- Critical peak pricing

The consumer decides/modifies his/her electricity consumption according to the energy price signals.



Closer relation between the retailer and the consumer.

Customized offers, innovative pricing formulas, increased customer engagement, group comparison – To give customer access to his/her data.

Energy price signals

- effects on the consumer behavior -

Energy price signals
(*opportunity signals*)

- The price reflects the energy cost in a given time period
- The consumer decides whether to consume or not according to the value he/she gives to the energy in that moment
- Energy prices: a stimulus for the customer to exert demand flexibility (load profile modification)
- As much effective as the value reflects the real time cost of energy

Energy price signals have a positive impact on the overall power system (eg., system adequacy, mitigation of the wholesale electricity price)

Customer energy manager + energy price signals - enabling technologies -

Wireless Home Area Network

Energy Management

2^o generation Smart meter (two-ways communication)

Energy management algorithms

Smart appliances

Real time consumer display

The same technologies as the stand alone customer energy manager



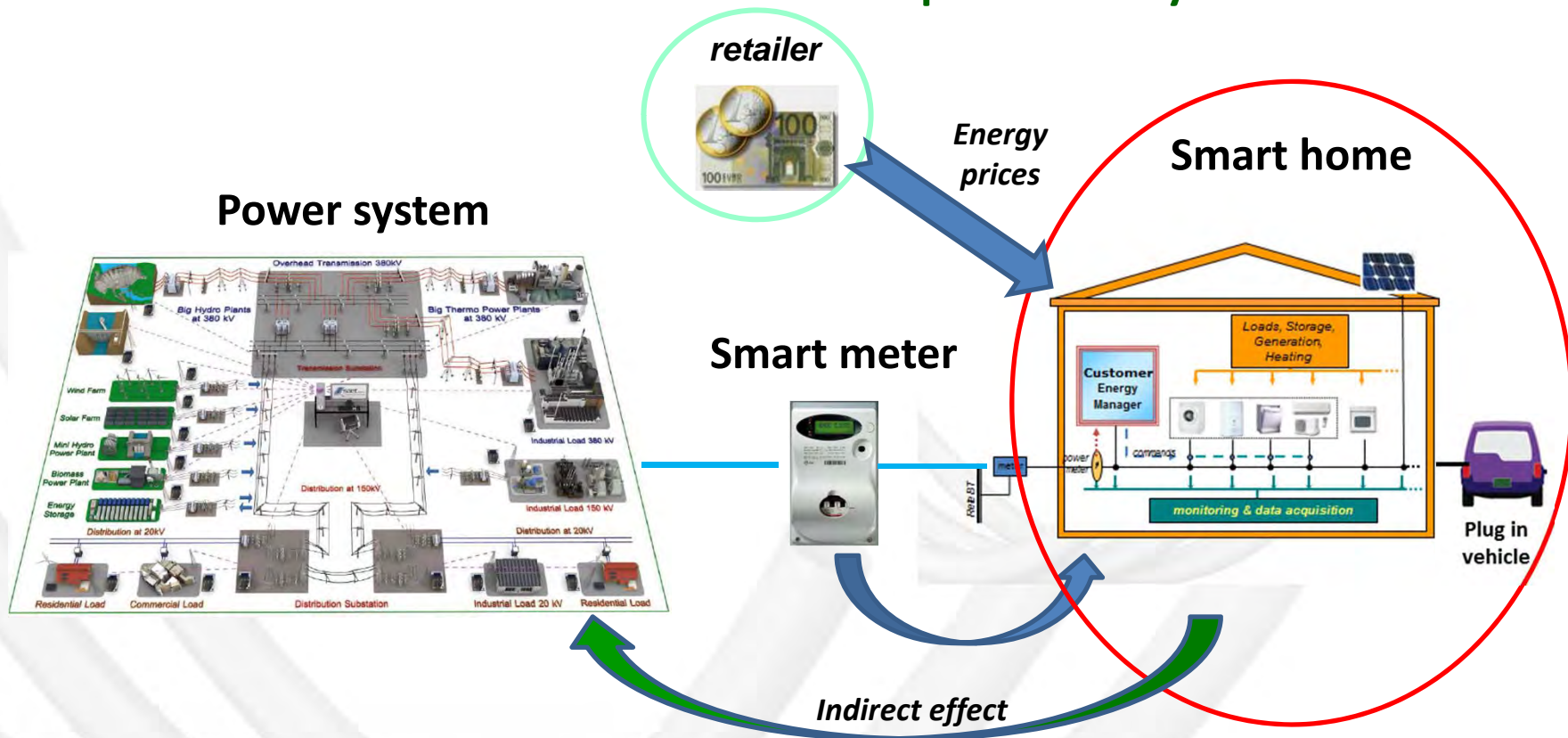
Wide Area Network



Data mining of electricity consumption (eg. comparison with the reference user class)

Customer energy manager + energy price signals

- Interaction with the power system -



The electricity usage in a smart home is influenced by the dynamic energy price

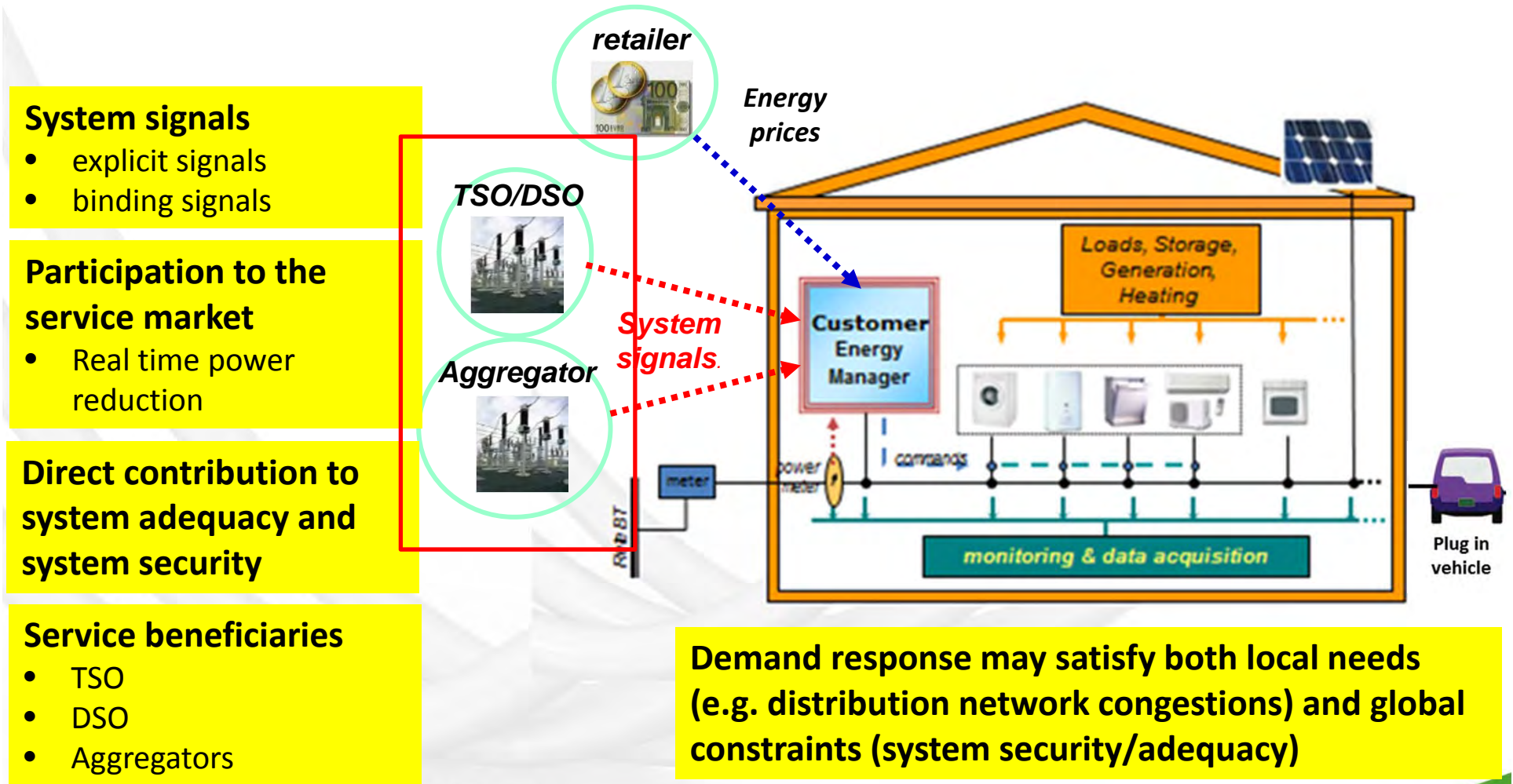
The smart home behavior has an indirect positive effect on the power system

Initial exploitation of the Smart Grid functions

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Customer energy manager + demand response

The Smart home sells services to the power system



Demand response

- effects on the consumer and the power system -

The consumer is an “active user” of the power system.

The power system relies on the services provided by the demand response

Obligations and rewards for the customer

**System signals
(direct signals)**

- Direct (binding) signals to the consumer
- The customer is providing services to the power system.
- A specific contract rules the relation between the customer and the service beneficiary (eg., DSO, TSO)
- The customer is remunerated for modifying his/her electricity consumption

Energy price vs. system signals

Energy price signals (*opportunity signals*)

- The price reflects the cost of energy in a given time period.
- The consumer decides whether to consume or not according to the value he/she gives to the energy in that moment.
- Energy prices: a stimulus for the customer to exert demand flexibility (load profile modification).
- As much effective as the value reflects the real time cost of electricity.

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Demand response in Directive 2012/27/EU

Directive 2012/27/EU on energy efficiency (EED) puts a great emphasis **on demand response** (in particular, *distributed demand response*).

National Regulatory Authorities must encourage **demand side resources**, such as demand response, to participate alongside supply in **wholesale and retail markets**. Establishing a **level playing field** for all the flexibility resources (i.e., generation and consumption).

The EED (Article 15.8) provides that Member States must require National Regulatory Authorities, or TSOs and DSOs, to promote **participation of demand response in balancing, reserve and other system services markets**.

- To allow for and encourage **demand response participation, operational and participation rules** are needed.

Demand response in Directive 2012/27/EU

EED explicitly refers to specific energy market actors such as **demand service providers** and '**aggregator**'.

Aggregator: *demand service provider that combines multiple short-duration consumer loads for sale or auction in organised energy markets.*

TSOs and DSOs must treat **aggregators** and other demand response providers:

- in a nondiscriminatory manner,
- on the basis of their **technical capabilities** in meeting requirements for balancing and ancillary services

Demand participation in service market

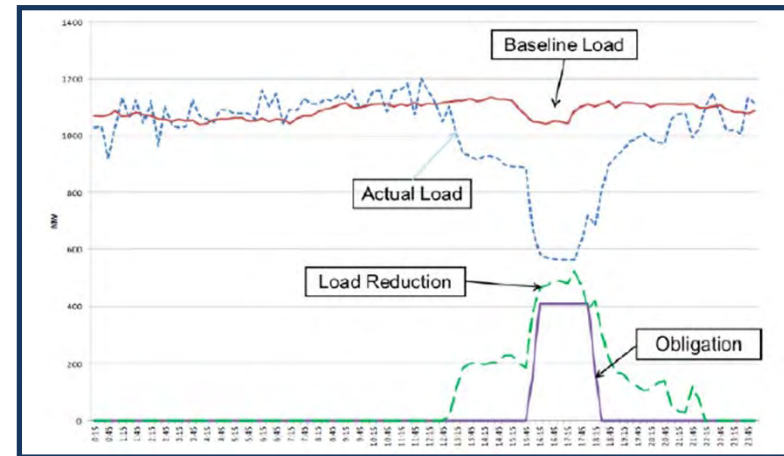
– **Specific contractual requirements for demand side participation in service markets have to be defined, eg.:**

- **minimum required capacity,**
- **notice time for activation,**
- **timing and duration of demand response activation,**
- **frequency of demand response activation,**
- **the option to bid on positive or negative capacity.**

in a way that is appropriate for demand side participation

Standing problems for distributed demand response

- How to measure the «baseline» consumption?



- Relation between the aggregator and the retailer (in case they are different subjects)
 - Aggregators may cause unbalances to the electricity sold by the supplier in the electricity market
- Local vs. global service market
 - Congestion management in the distribution network
 - Peak shaving, balancing market

Customer energy manager + demand response

- enabling technologies/factors -



Communication with the aggregator/DSO/TSO

Wireless Home Area Network

Energy Management

Energy management algorithms

2° generation Smart meter (two-ways communication)

Smart appliances

Real time consumer display

Wide Area Network

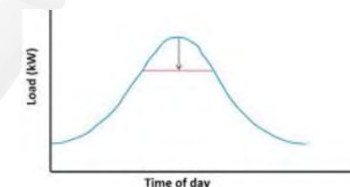
Data mining of electricity consumption (eg. comparison with the reference user class)



electricity storage



Electric car



Electricity curtailment algorithms

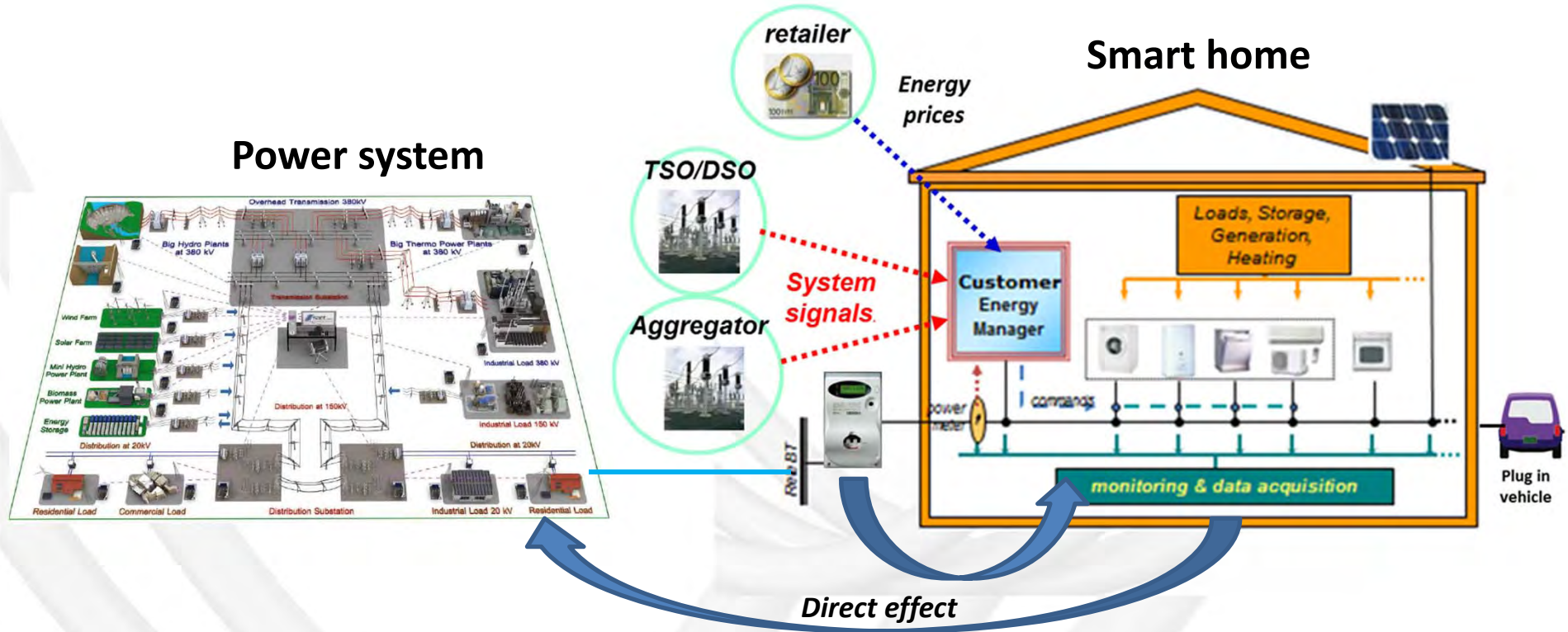


Advanced service markets

The same technologies as for the «stand alone» customer energy manager + energy price signals

Customer energy manager + demand response

- Interaction with the power system -



The Smart home is modifying its consumption according to energy and system signals.

The smart home is providing services to the power system, supporting adequacy/security.

Full exploitation of the Smart Grid functions.

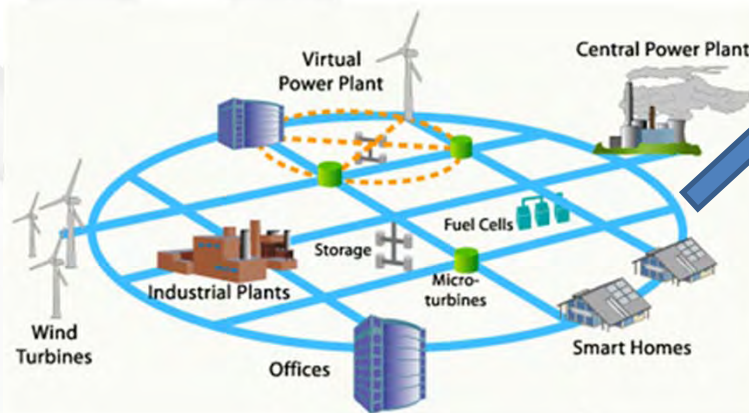
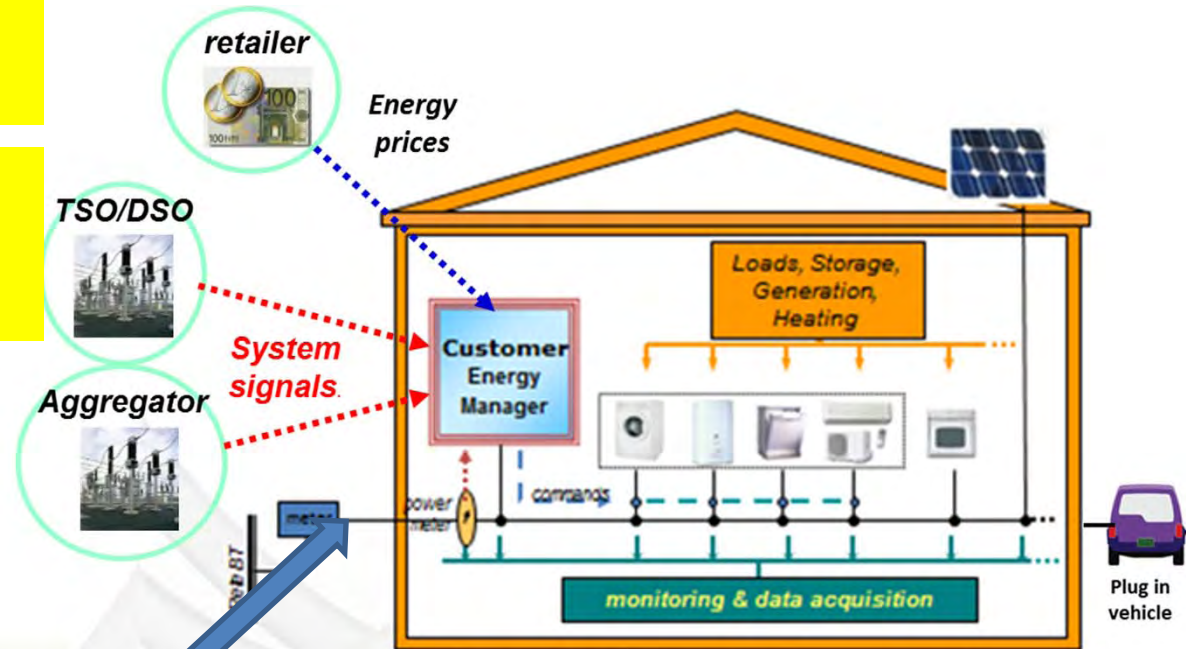
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Customer energy manager + added value Smart Grid Services

New added value services provided by the Smart Grid to the Smart home

In this model, the Smart Grid makes available additional services to the prosumer...

... while in the previous model the prosumer provided remunerated services for the Smart Grid.



“Added value” services provided by the Smart Grid to the prosumer

Added value services for the consumer: what do we mean?

– Possible added value services made available by the Smart Grid to the consumers

- Temporary increase of the contractual power (e.g. for a home party during the week-end) – Service provided by the DSO.
- Customized T&D tariffs (e.g. for energy efficiency promotion).
- Special offers for energy consumptions in specific time periods.
- Special condition for the domestic recharging of the electric vehicle.

Conclusions

- A multi step trajectory is needed for making the small/medium electricity consumer an «active user».
- The EU legislation is strongly supporting this design
 - New actors
 - New market rules
- The 2° generation smart meter plays a key role in the consumer involvement.
 - Making the detailed consumption data available to all the interested subjects is the preliminary condition for consumer participation
- The new usages of electricity will ask for demand side management
 - Additional opportunities with the spread of thermal and electricity storage



*Thanks for your
attention*

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