Intelligence

Smart grids : Buzzword or new paradigm?

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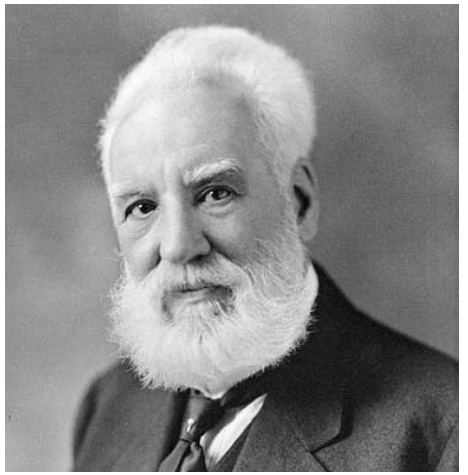
France-Israël dialogue on sustainable energy options

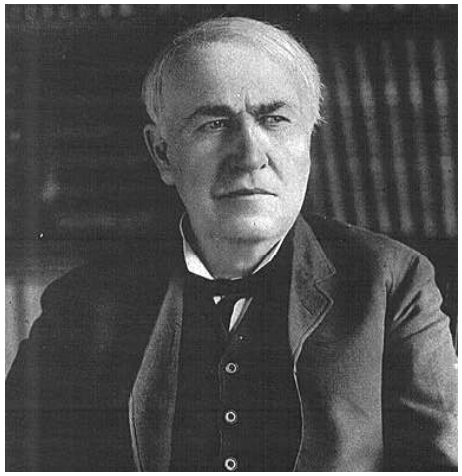
5 July 2010

The Case for Revitalization

The anecdote goes like this:
If Alexander Graham Bell were somehow transported to the 21st century, he would not begin to recognize the components of modern telephony...



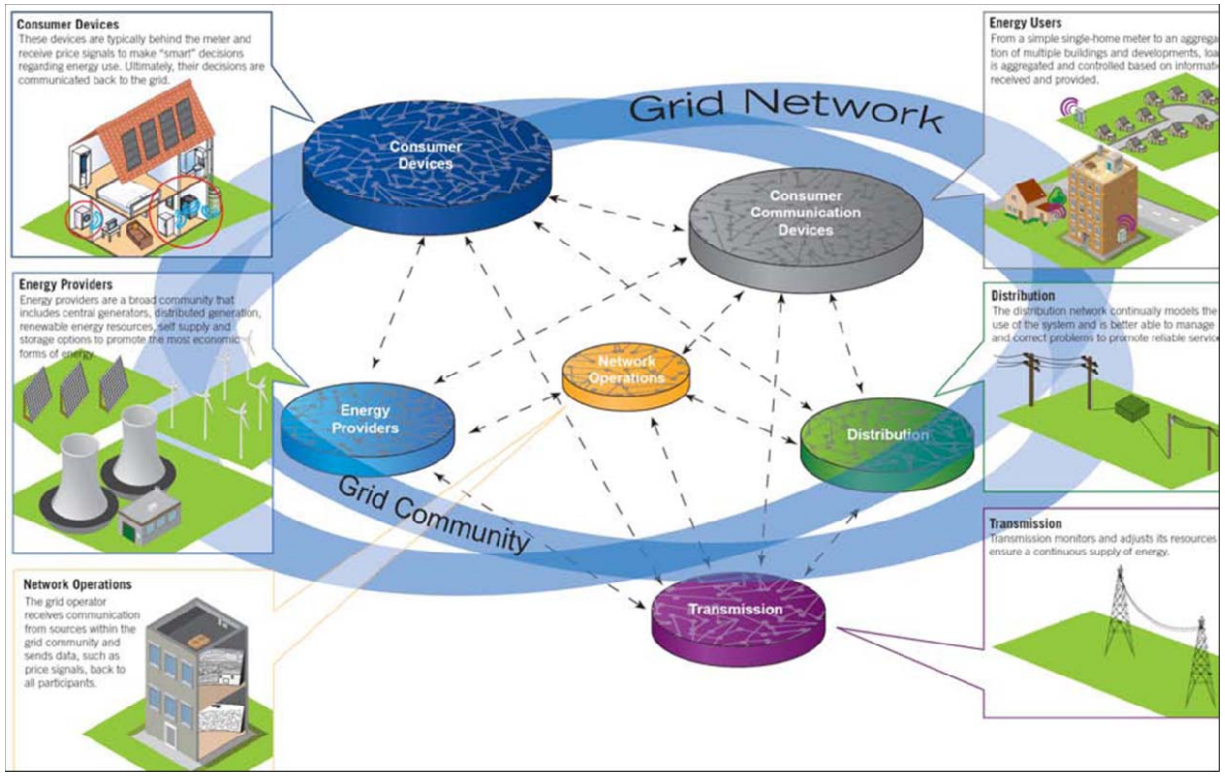
While Thomas Edison, one of the grid's key early architects, would be totally familiar with the grid.



Source: "Smart Grid: An Introduction" U. S. Dept. of Energy

The concept of « smart grid »

➢ Integration of digital computing and communication technologies and services with the power-delivery infrastrucure



➢ Bi-directional flows of energy and two-way communication and control capabilities

➢ Power grid + Information network = Smart grid

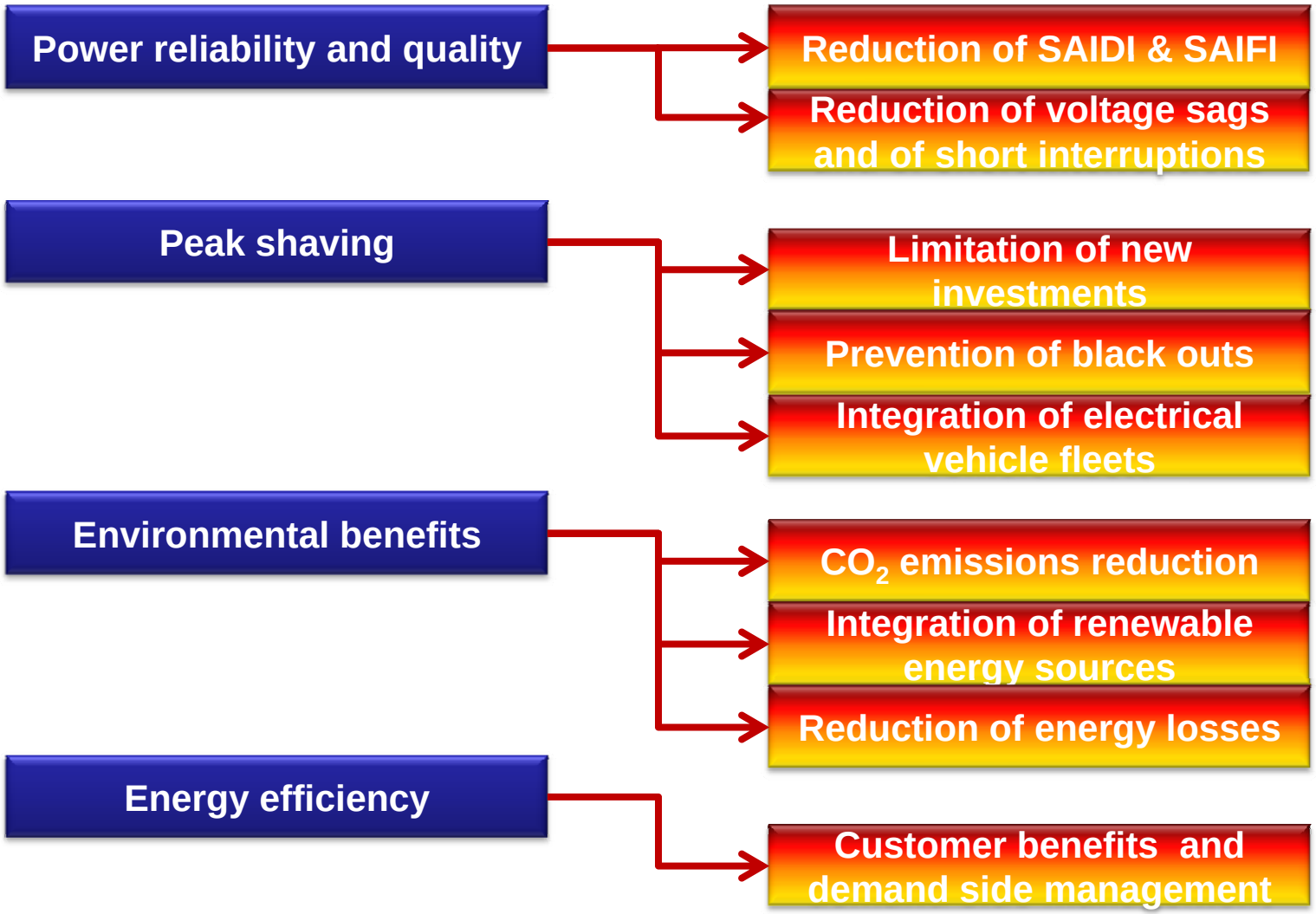
➢ Advanced metering infrastructure is a key part of smart grids but overall objectives are far more ambitious

Smart grid definition

- The term “Smart Grid” refers to a modernization of the electricity delivery system so it monitors, protects and automatically optimizes the operation of its interconnected elements – from the central and distributed generator through the **high-voltage network and distribution system**, to industrial users and building automation systems, to energy storage installations and to end-use consumers and their thermostats, electric vehicles, appliances and other household devices.
- The Smart Grid will be characterized by a **two-way flow** of electricity and information to create an automated, widely distributed energy delivery network. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level.

Source : Independence and Security Act of 2007

The main drivers for smart grids

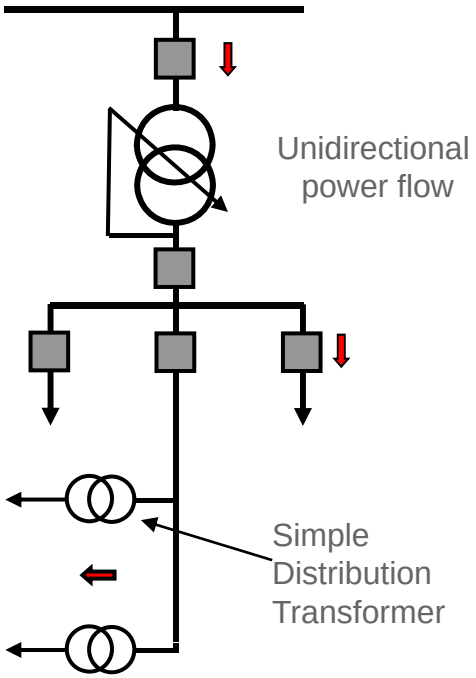


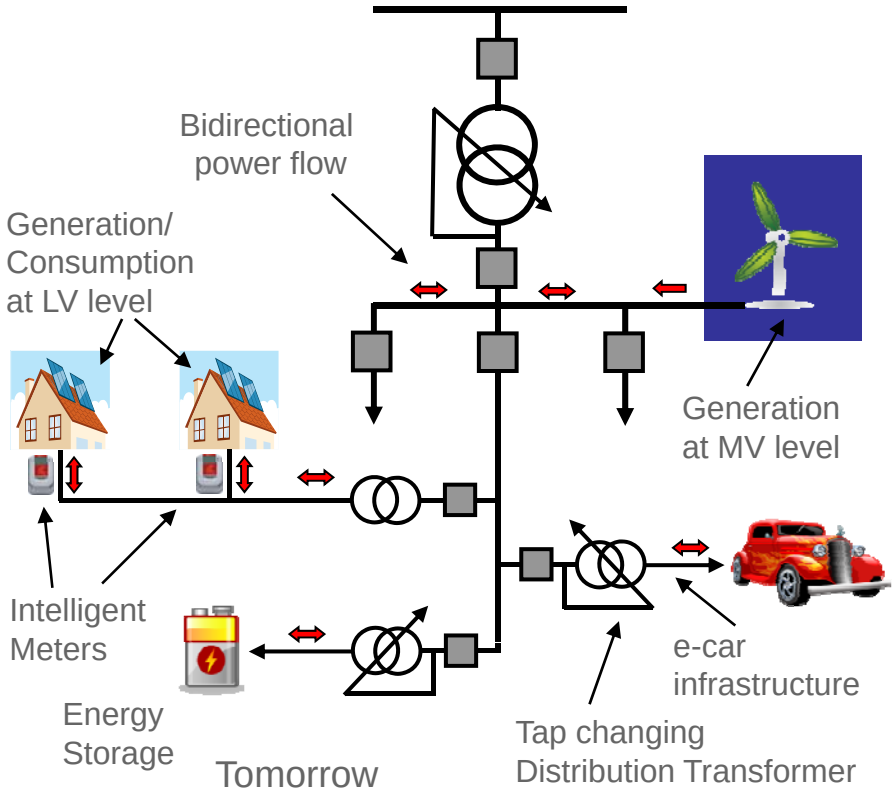
Not all the countries have the same priorities

- In the USA, grids are generally old and in a poor condition. Reduction of average duration of interruptions is the priority.

- In France, three major drivers :
  - Integration of renewable and distributed energy sources
  - Customers education / Demand side management
  - Integration of electrical vehicles fleets

Integration of Distributed Energy Resources





Today

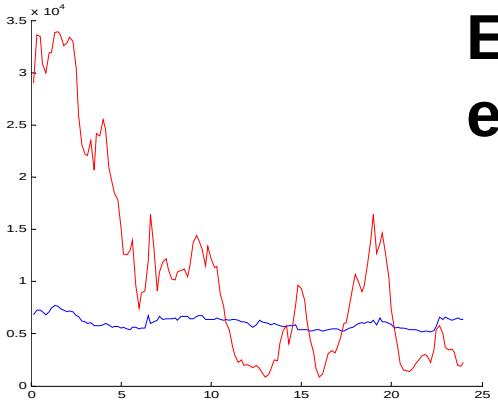
- Passive radial system & no generation
- Unidirectional static power flow
- Open loop operation
- Simple non directional Protection
- Simple or no automation
- Simple or no communication

Tomorrow

- Active system with integrated DERs
- Bidirectional dynamic power flow
- Closed loop operation
- Adaptive directional Protection
- High degree of automation
- Bidirectional communication

Source : Siemens

Integration difficult because of discrepancy between local demand and local production

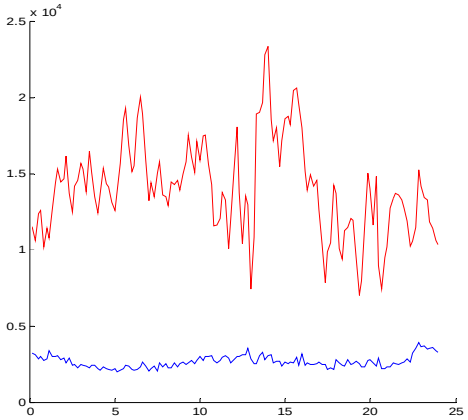


January

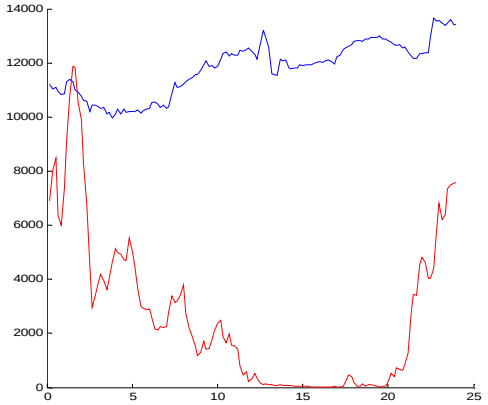
Example : high voltage station with wind energy production (Champagne)

Demand

Production



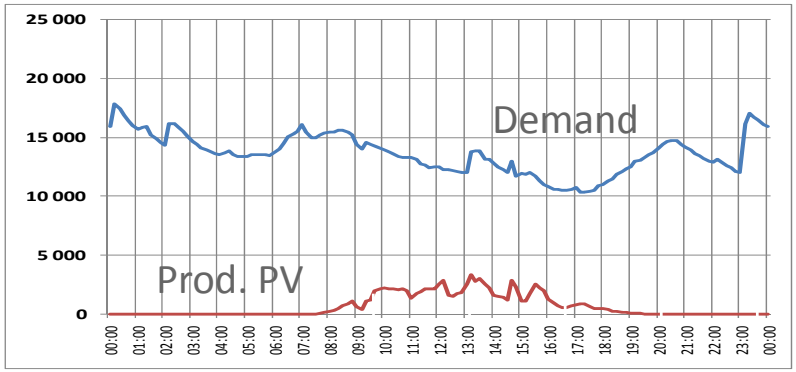
July



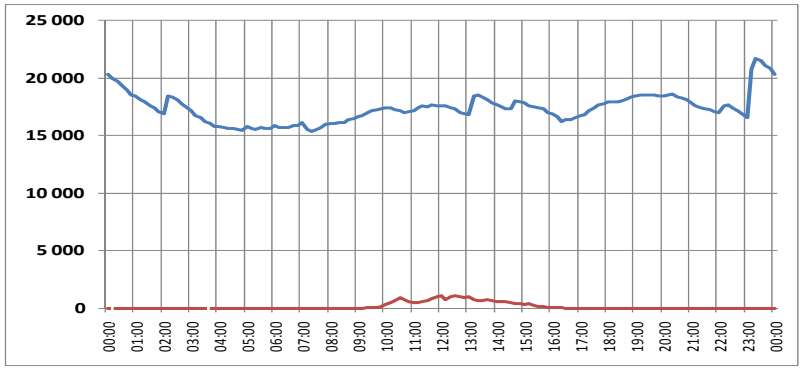
December

Source ; EDF

Medium voltage station with photovoltaics production

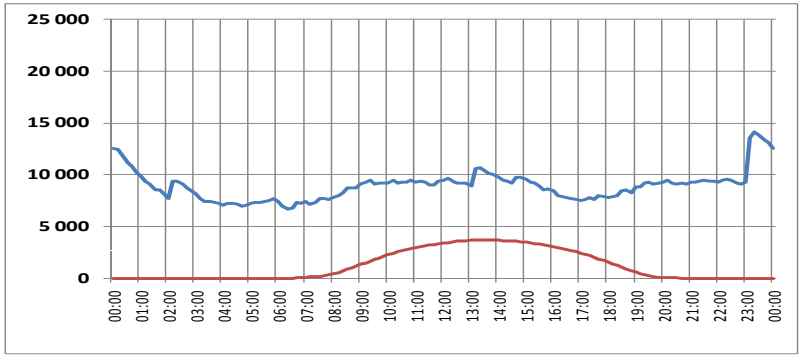


31 March 2009

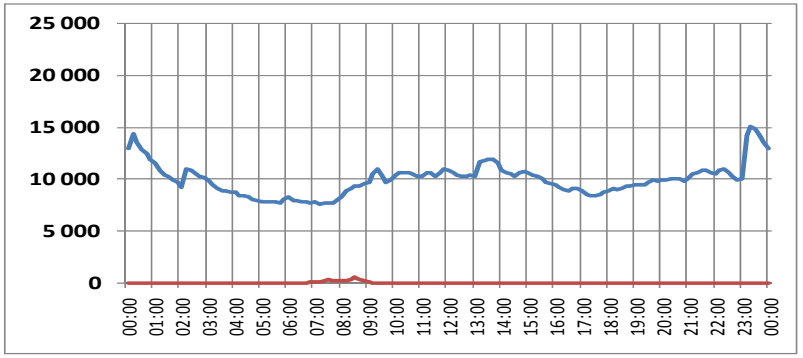


26 December 2009

P (en kW)



30 May 2009

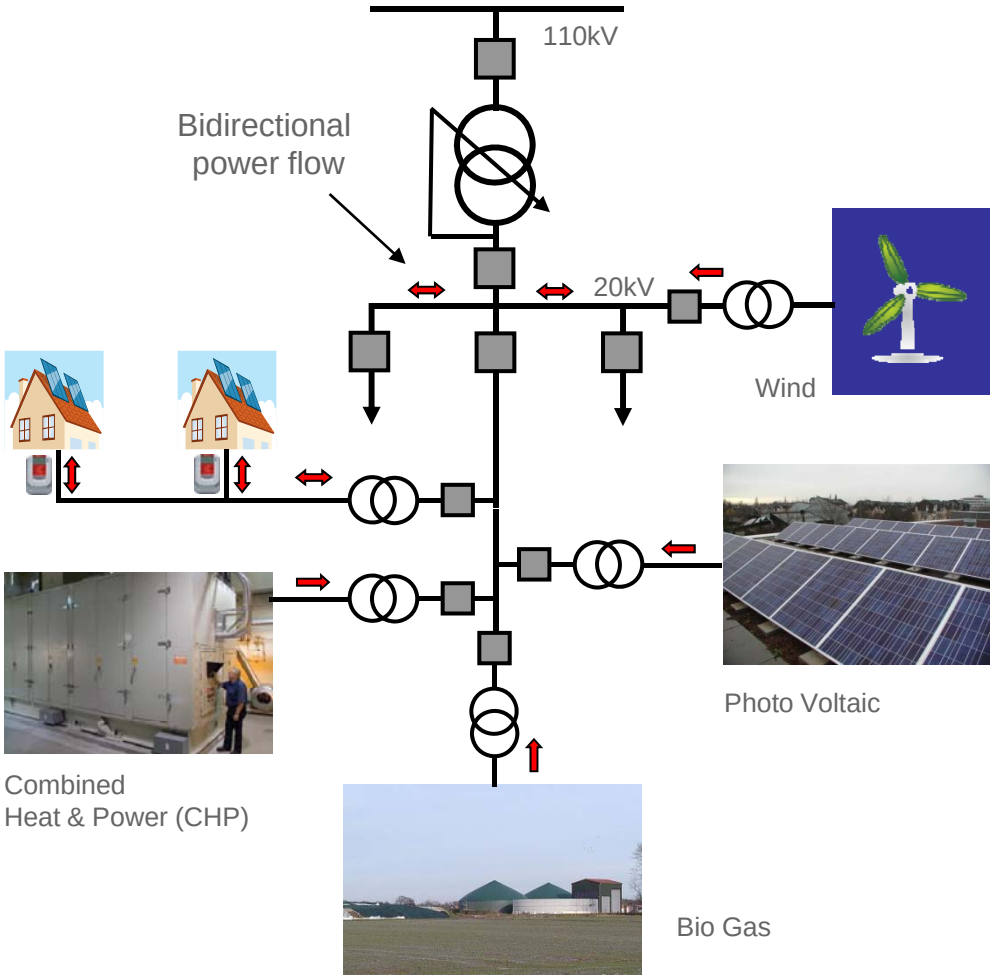


Hour

2 August 2009

Source ; EDF

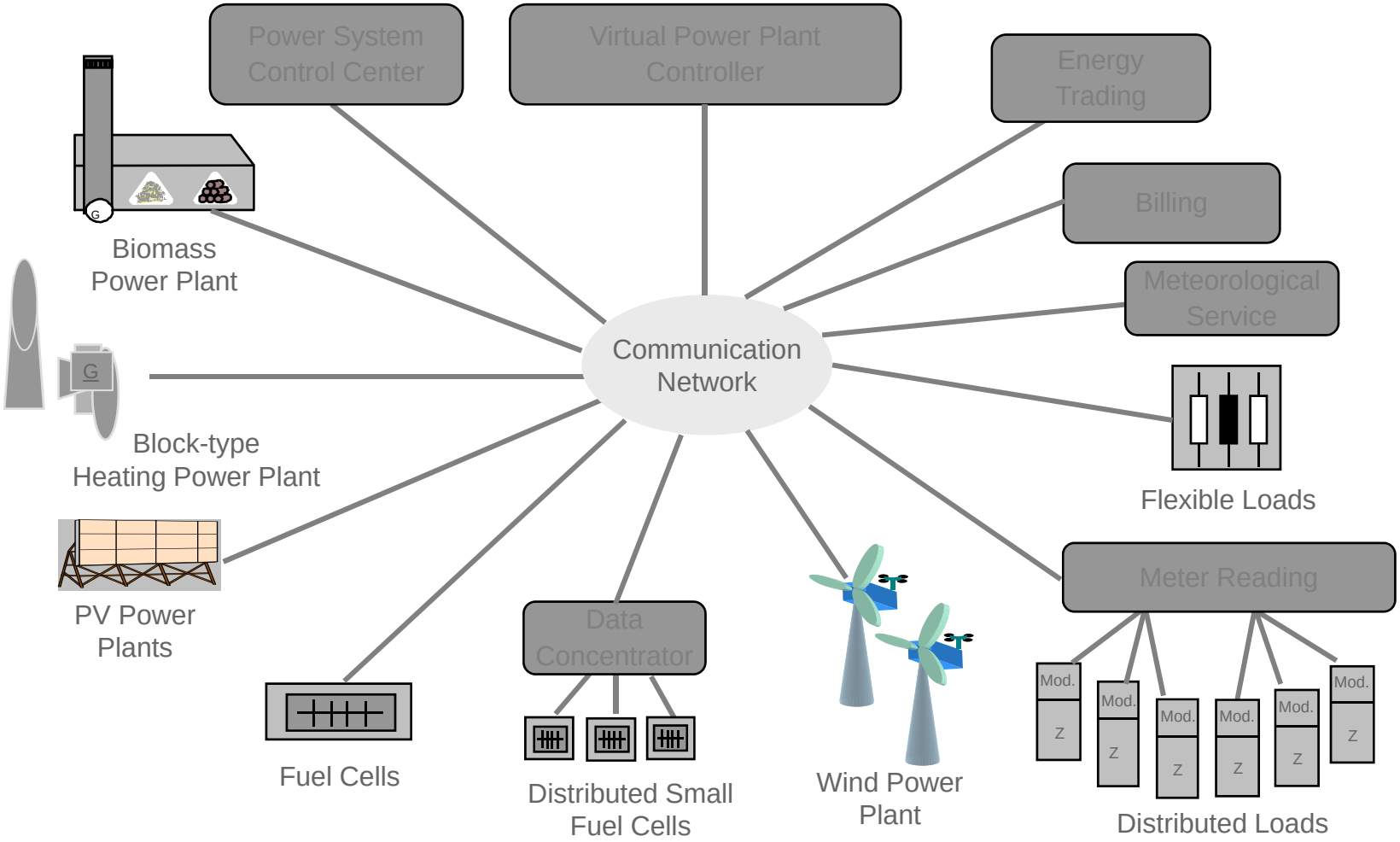
Today's DER integration concept: Connect and forget !



- ❑ Voltage and Frequency stability maintained by large generators connected at transmission level
- ❑ DERs are too small (100kW…10MW) to participate at energy market
- ❑ Most DERs are switched off in case of system disturbances
- ❑ DERs boost voltage level
- ❑ Negative energy values are no more unusual during certain periods

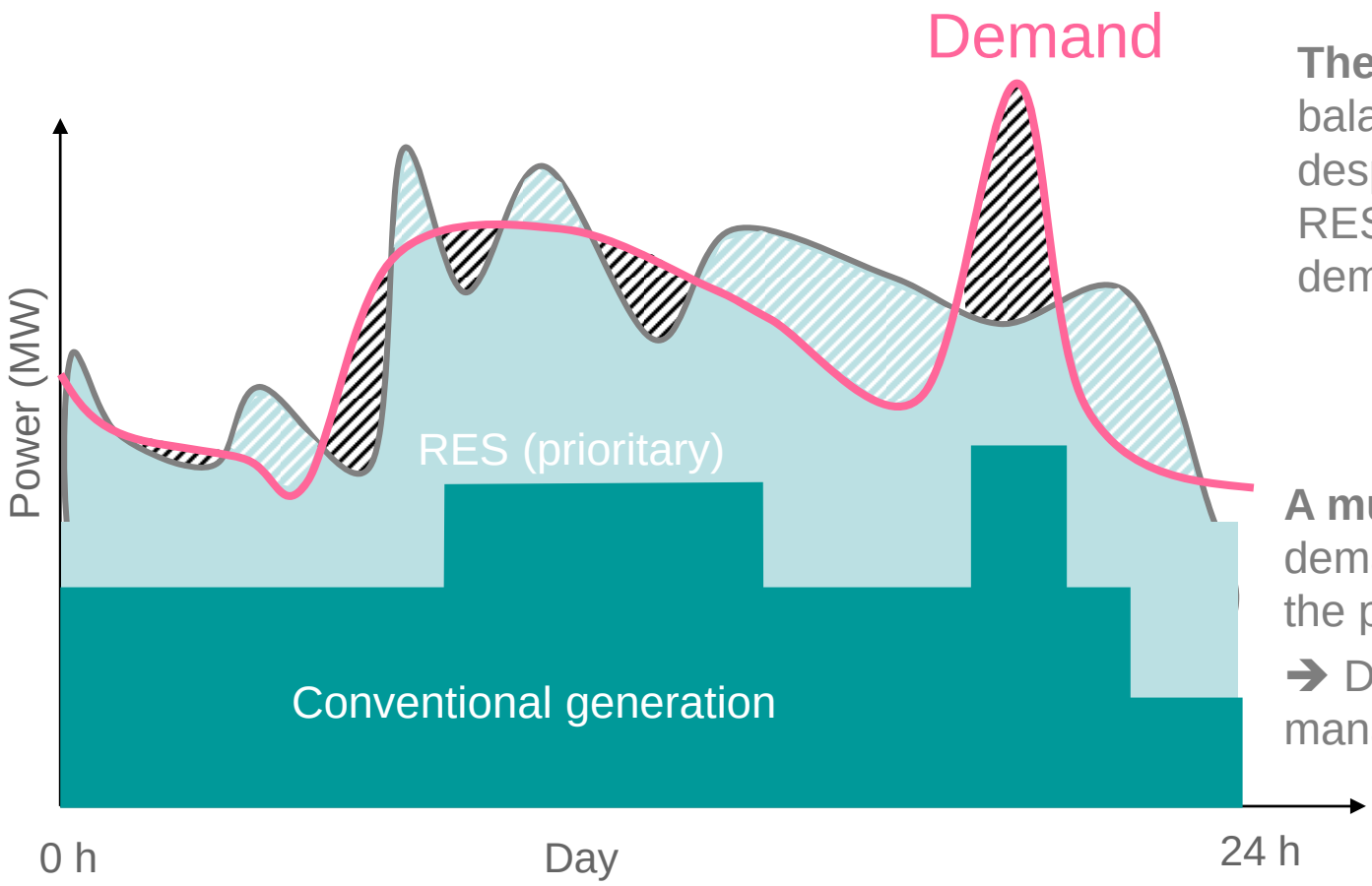
Source ; Siemens

The smart grid solution : a Virtual Power Plant Controller (VPPC)



Source ; Siemens

In the absence of mass storage solutions, demand side management is a must

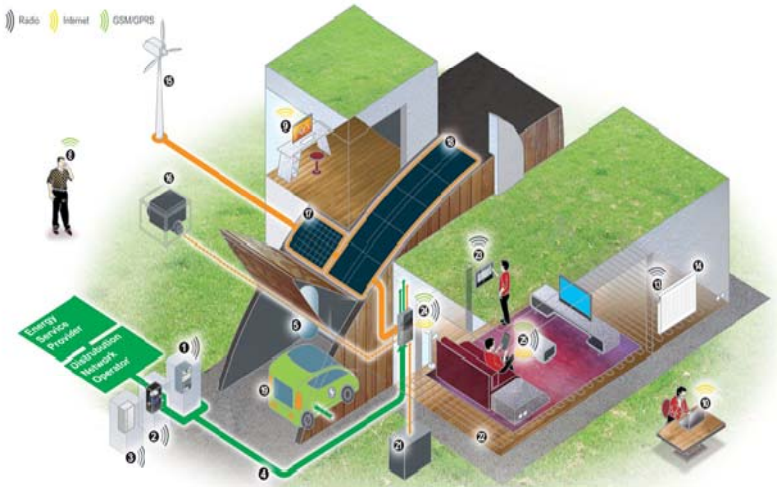


The challenge: balance the loads despite intermittency of RES and volatility of demand

A must: manage the demand according to the power availability

➔ Demand side management

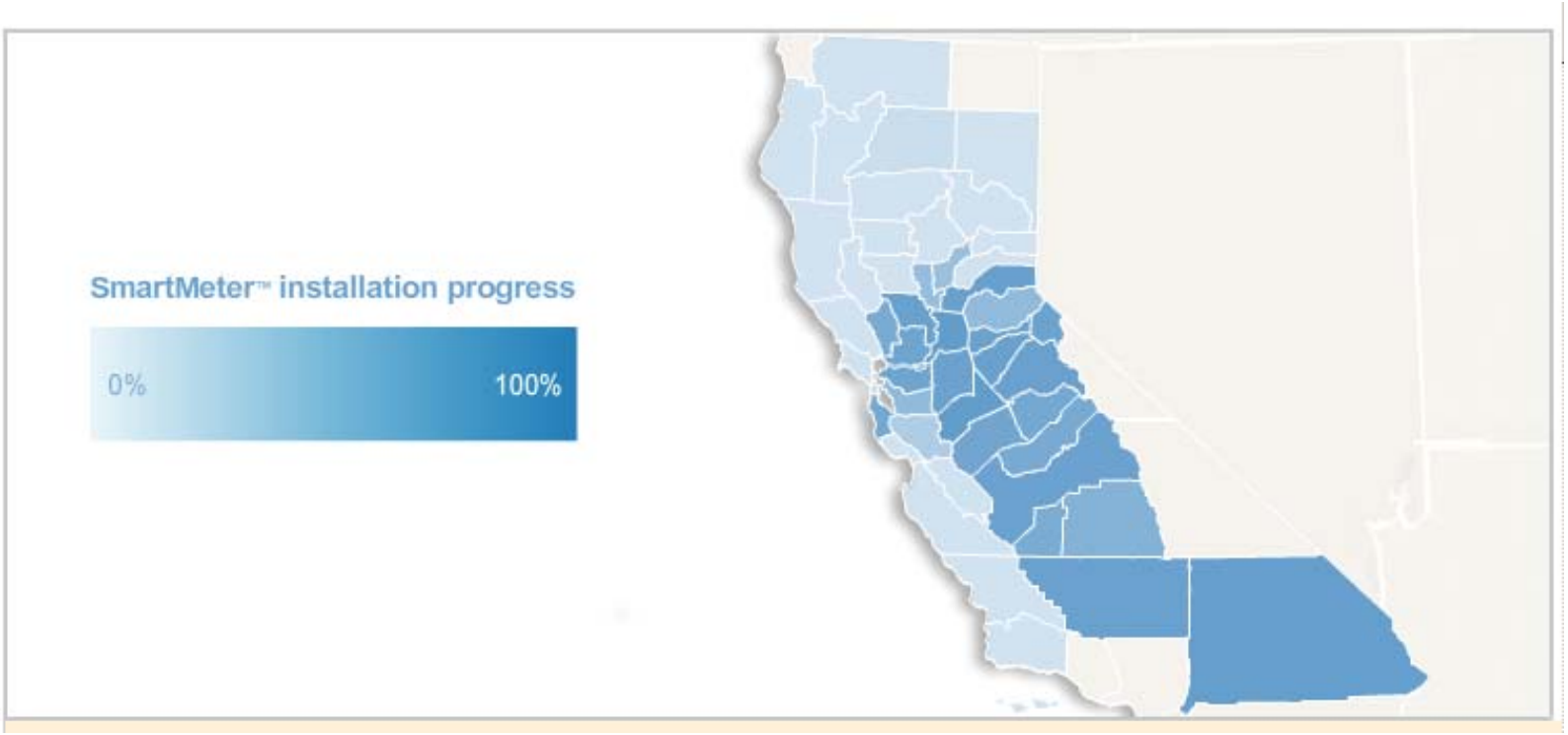
The cost effective solution will result from a combination between active energy management and remote energy management



- **Active Energy Management :** Price and usage visibility allow customer to adapt consumption behavior by reducing energy usage while securing comfort
  - Lighting Monitoring
  - Space Heating and Hot water heating management
- **Remote energy management :** Shaving of peak loads and shifting of energy usage by smart control of certain energy uses : water heating, household appliances (washing machines)

Demand side management necessitates advanced metering infrastructures

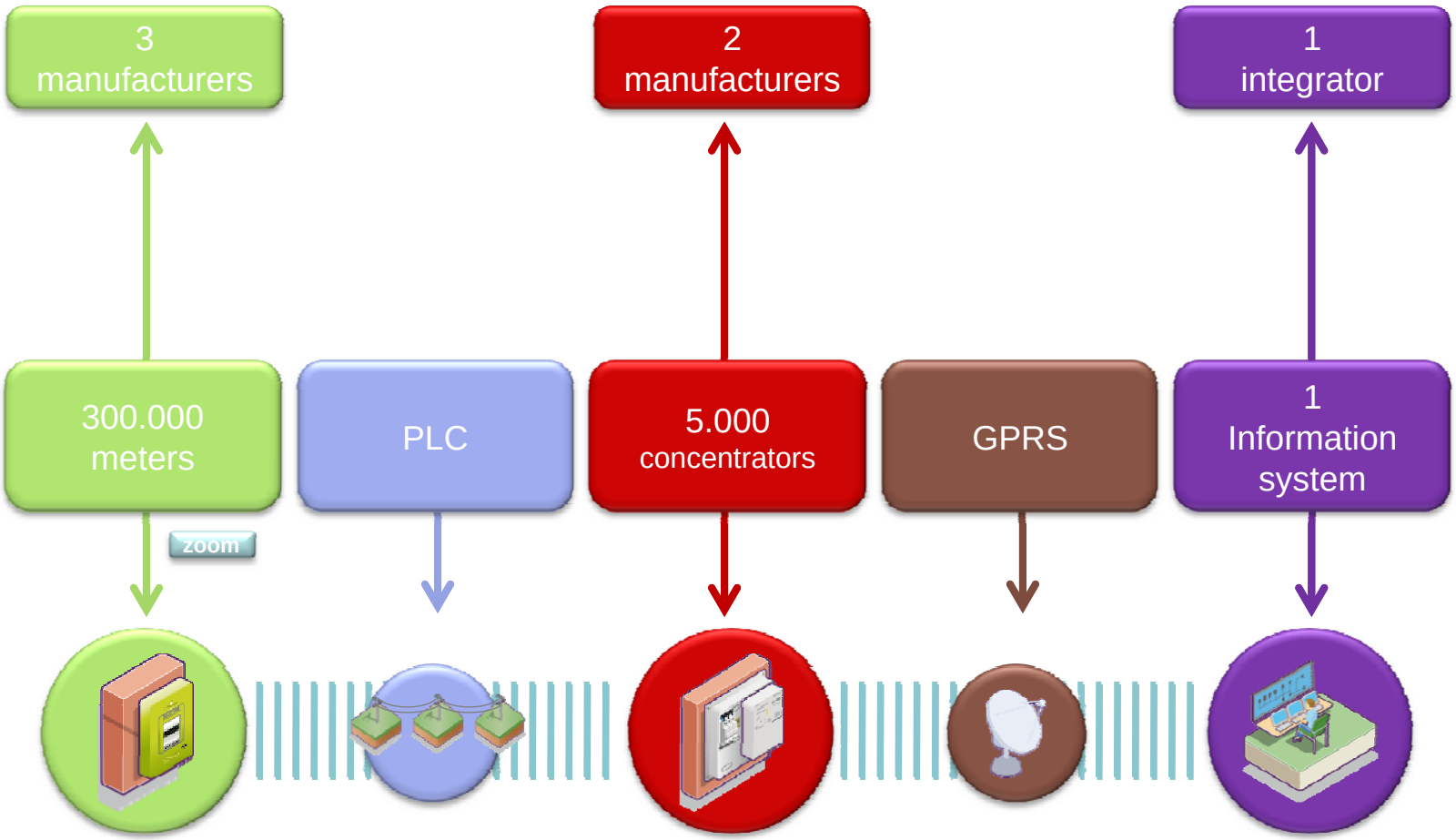
Smart meters in California: 6 000 000 as of June 2010



Source : PGE

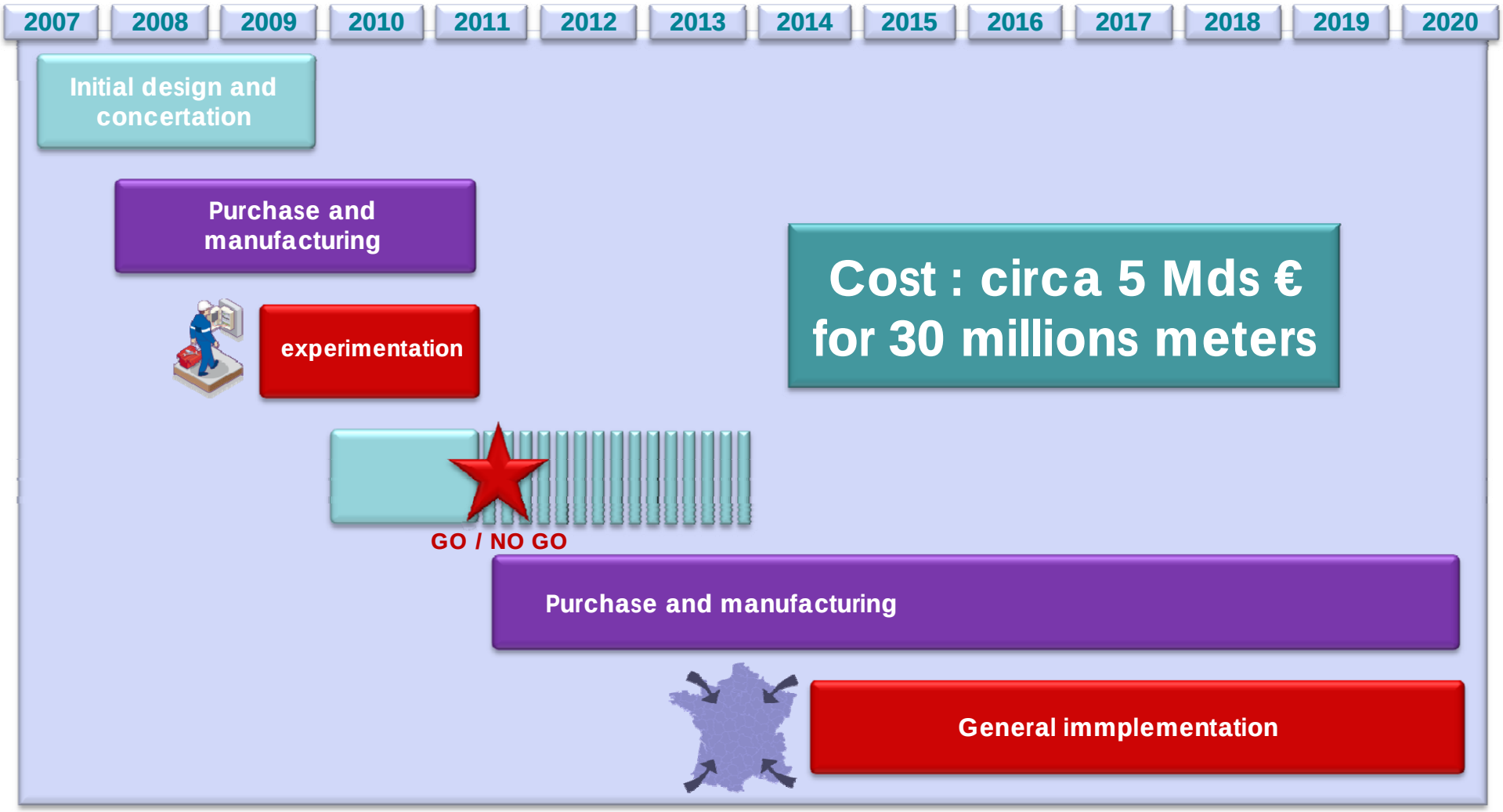
Nota : Circa 80 000 000 smart meters installed around the world (Italy, Japan, Canada, australia etc.)

Tle Linky project in France : more than a meter



Source ; ERDF

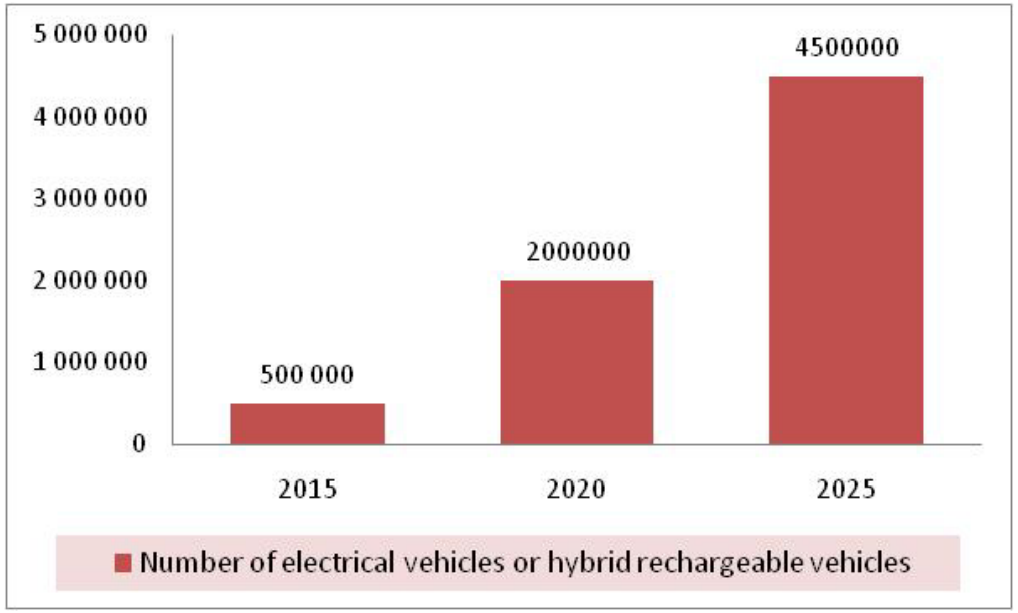
Time schedule



Source ; ERDF

Electrical vehicles

- French government has announced in October 2009 ambitious targets



- Three kinds of charging stations :
  - 3 kW (home or work) : complete recharge in 8 hours
  - 24 kW (semi rapid) : 5 minutes for 10 km
  - 40 kW (rapid) : special situations

Two main issues

- How to integrate the charging stations in the grid ?

Full recharching of an electrical vehicle in	requires an electrical power equivalent to
8 hours (3 kW)	A water heater
1 heure (25 kW)	A building
3 minutes (600 kW)	A district in a city

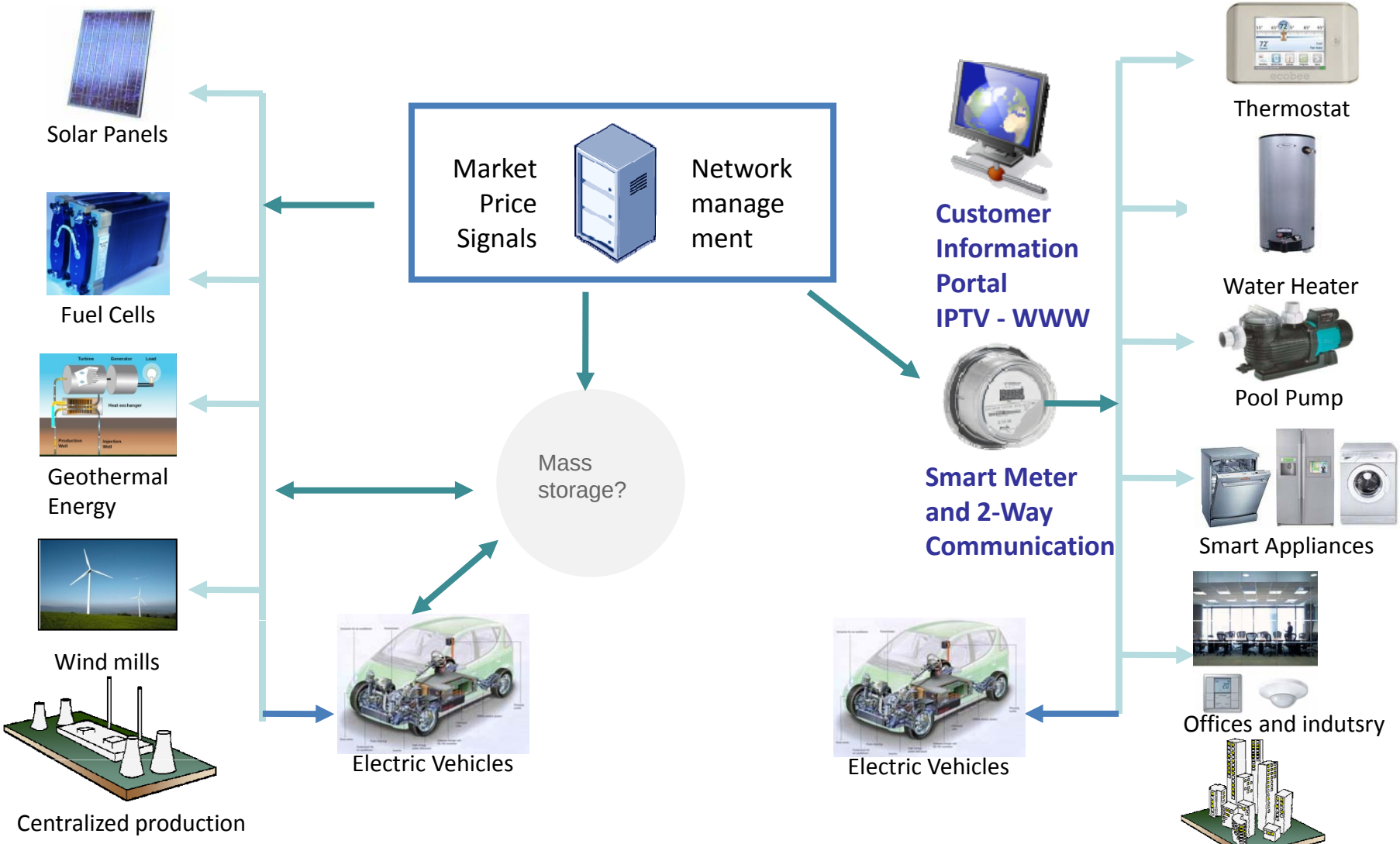
- An electrical vehicle will consume, in average, 3 MWh per year i.e.6 TWh per year for a fleet of 2 millions of vehicles

How to be sure that these 6 TWh will correspond to

- Off peak power
- CO_2 free energy

➔ The answer : maybe “smart grids” but how?

Smart grids: the ultimate objective



A lot of issues remains to be addressed

Technical

- General architecture : hierarchy of network management and corresponding algorithms
- Modelization, forecasting tools and control of intermittent resources
- Smart meters : low cost, accurate, reliable, easy to use
- Dynamic line rating (depending on weather conditions)
- Power electronics devices : HVDC lines (for deep off shore), FACTS
- Infrastructures for electrical vehicles and strategies of management
- Communications (see next slide) and cyber-security

Regulations and tarification

- Flexible pricing : mandatory or voluntary (customer dependant)
- Clear delineation of the role of operators

Standardization

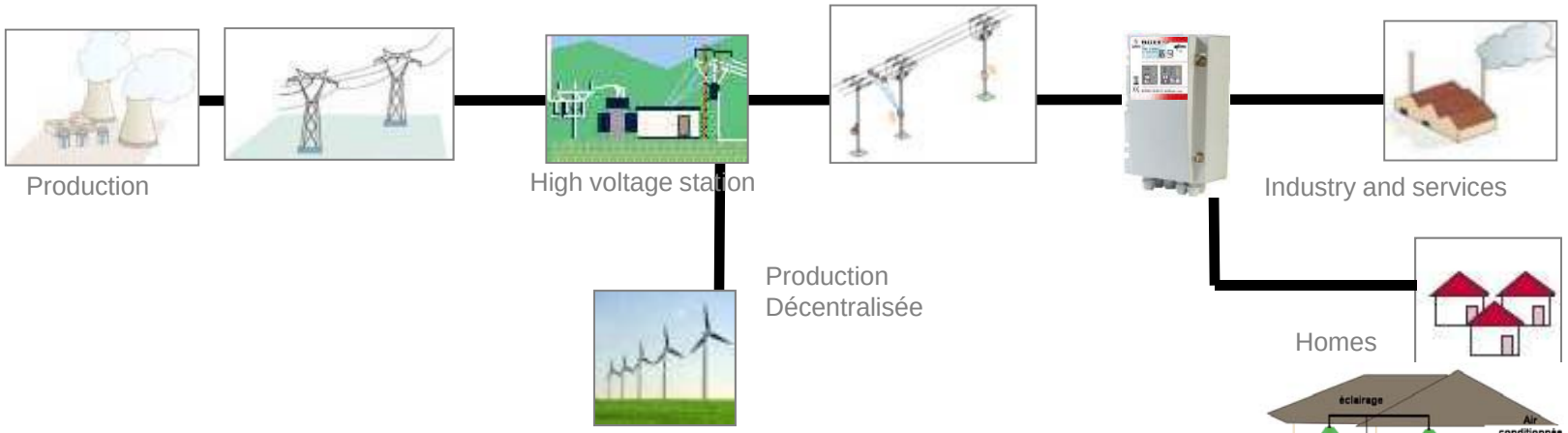
- Interoperability/Interchangeability of devices

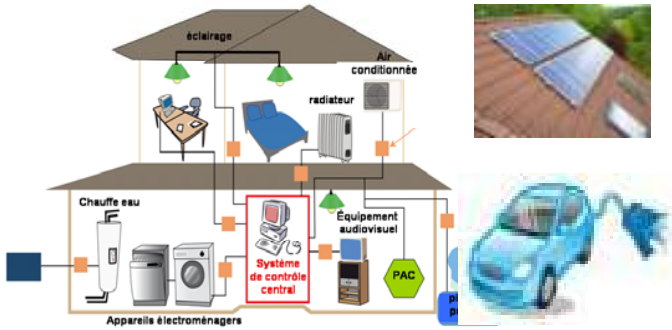
Finance

- Cost efficiency; burden sharing of the investment

Sociological acceptance

Which communication solutions will enable smartgrids?





Availability, robustness, cyber-security, throughput are key issues (in normal & crisis situations)

4 segments

Production & transmission
- Optical fibers
- WiMax
- LTE

Distribution after concentrators
- Optical fibers
- WiMax
- LTE
- GPRS

Distribution before concentrators
- PLC
- WiMax
- 3G
- GPRS

Inside « Pro-sumers »
- Wireless (ZigBee, ISA100)
- PLC

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Thank you for your attention

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