More electricity for less CO2

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EDF's Chairman and CEO
scientific advisor
Member of the french
Academy of technology

LEADING THE ENERGY CHANGE

More electricity for less CO2

Introduction : the trend

1 On the demand side

1.1 - At home

1.2 - On the road

1.3 - In the industry

2 The "smart" electrical system

2.1 - The smartmeter

2.2 - The smartgrid

2.3 - The electrical mix

Conclusion : the need for…

LEADING THE ENERGY CHANGE

EDF Group at a glance

China

Figlec
(100 % EDF Laibin power plant)
Installed capacity : 720 Mwe
Shandong Zonghua Power Company
(EDF 19, %)
Installed capacity : 3000 MWe

France

Capacity: 98.4 GW
(63 GW nuclear)
Gas: 3 Gm³
Clients: 30 million
Networks: 1,380,000 km

United Kingdom

EDF Energy (100%)
No. 1 distributor
British Energy (96.44%)

Germany

EnBW (45%)
No. 3 electricity utility

USA (49%)

Partnership with Constellation Energy

Italy

Edison (50%)
No. 2 electricity utility

EDF Trading

Volumes handled

Electricity: 745 TWh
Gas: 116 Gm³
Fuels: 237 mt
Oil: 141 mb

Sales: €64.3 billion
Net profit: €3.4 billion
Global customer base: 38.1 million
Employees worldwide: 161,000
Installed capacity: 128.2 GW
Output: 610 TWh

Many electric end-uses since Thomas Edison

Lighting bulbs — 1880

1890 — Electric locomotive, London underground

First electric railroad in Europe — 1889

1906 — Vacuum cleaner

Washing machine — 1920

1935 — TV set

Integrated space heating — 1971

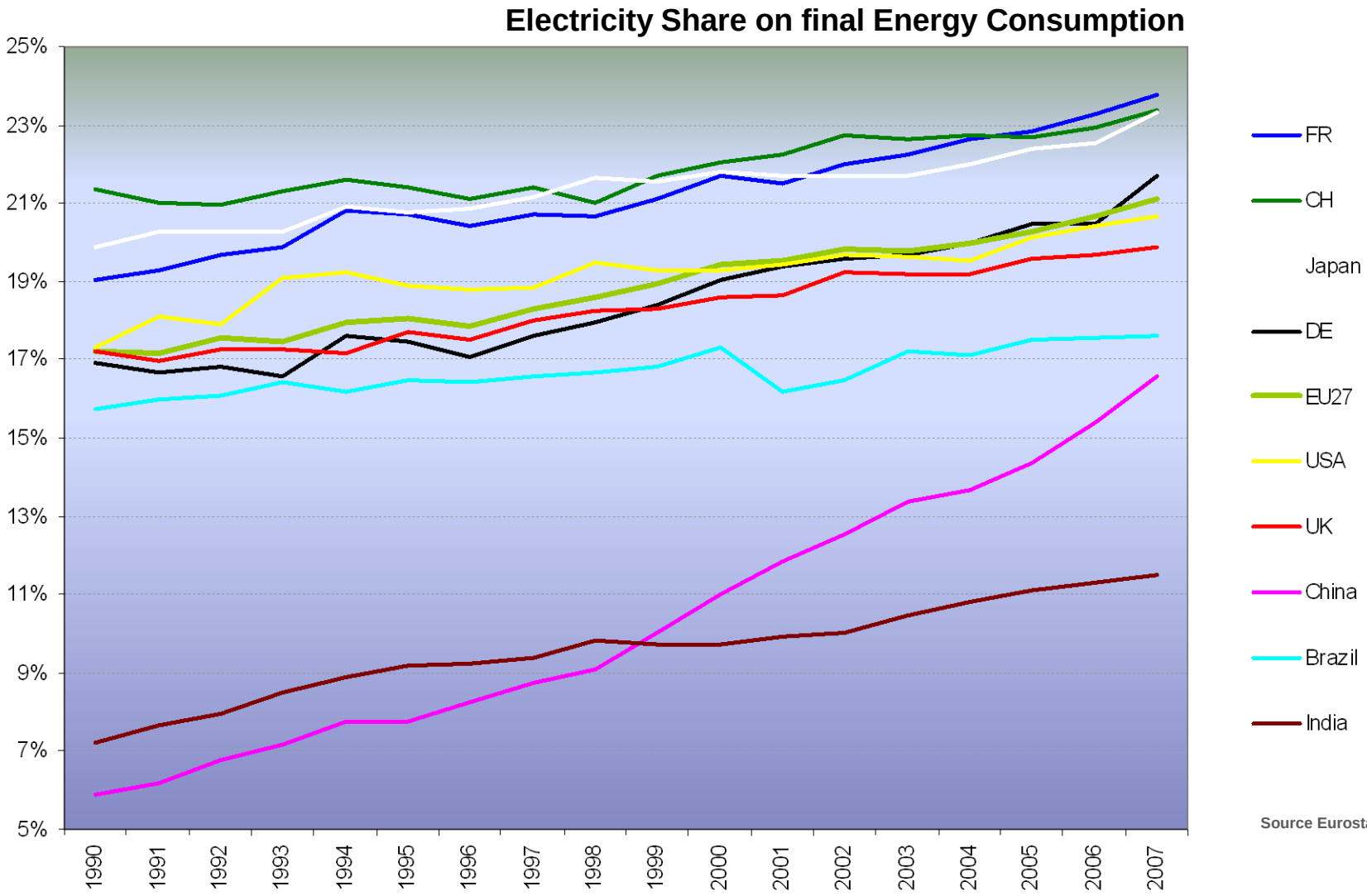
1985 — PC

Geothermal heat pump — 1990

2003 — Digital photo frame

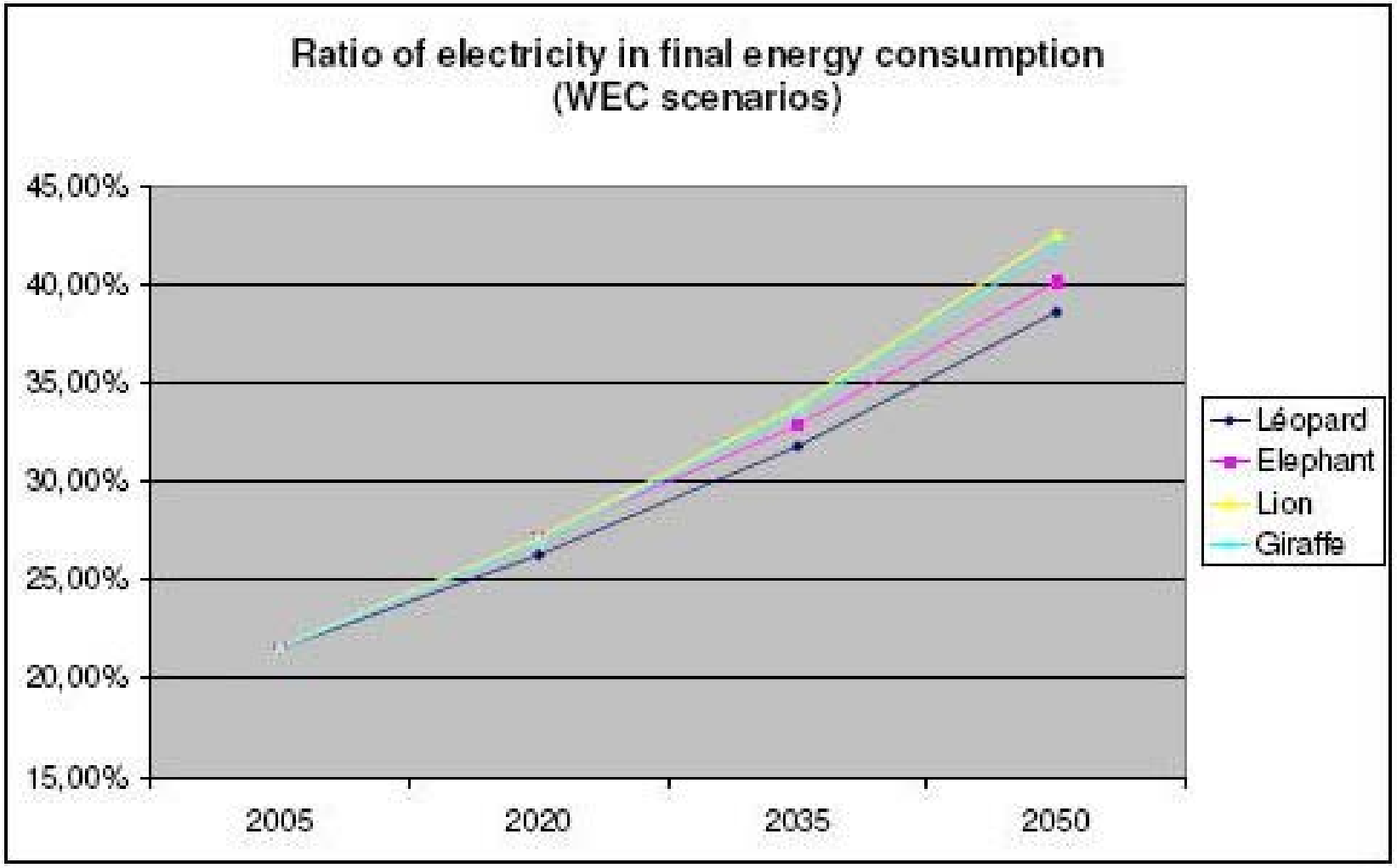
PHEV — 2011 ?

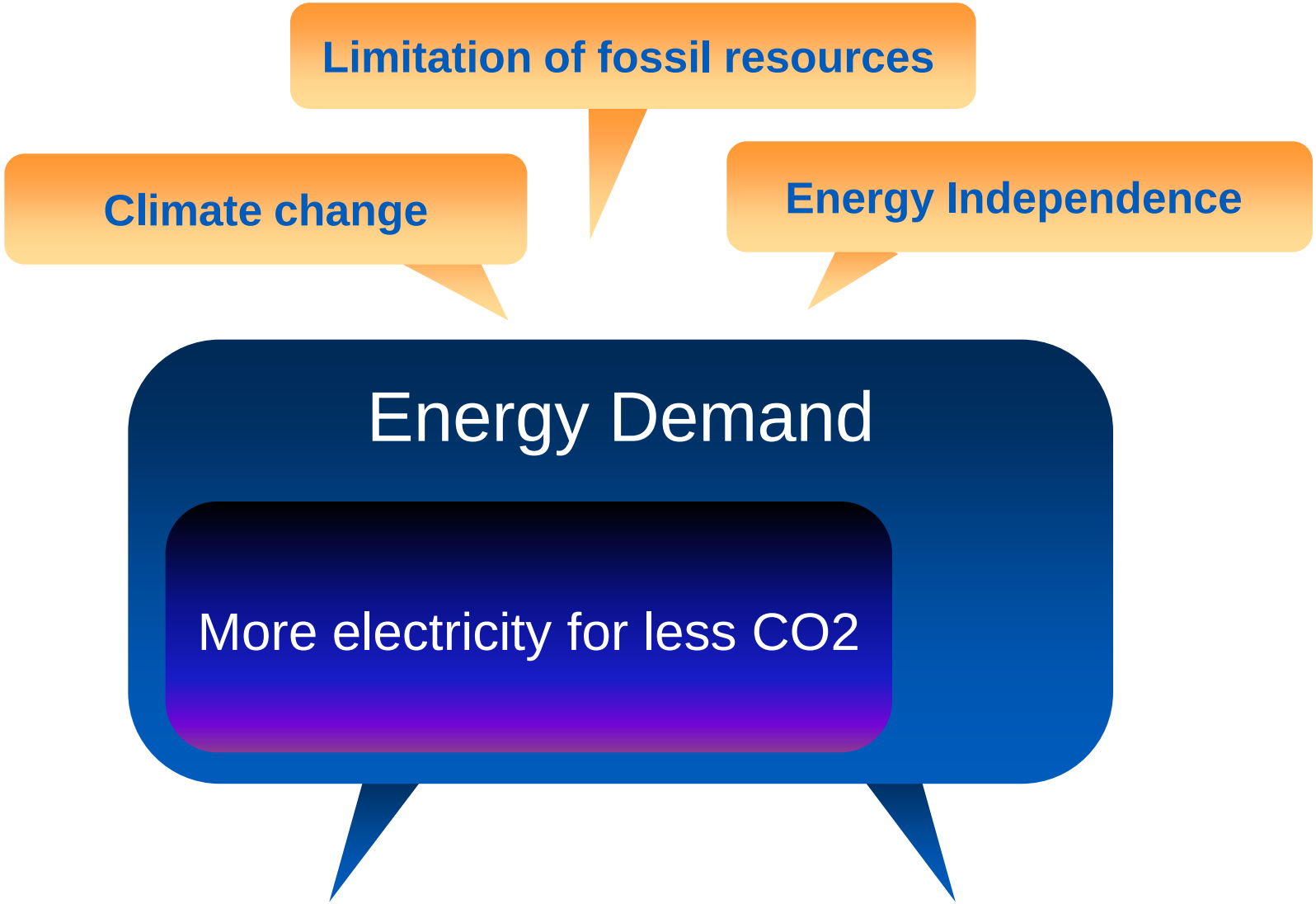
A visible and clear trend…



Source Eurostat et Enerdata

More electricity for less CO_2…





The “right” energy quantity for all human beings

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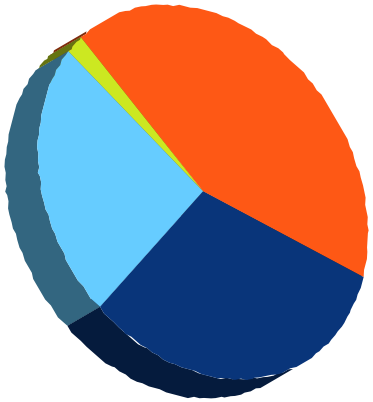
LEADING THE ENERGY CHANGE

Buildings : the first energy use in France…

Final energy consumption

Buildings	**42%**
Agriculture	2%
Industry	24%
Transport	**32%**

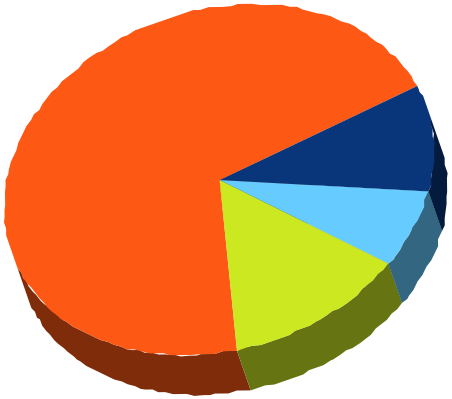


CO2 emissions

Buildings	**28%**
Agriculture	19%
Industry	23%
Transport	**30%**

2/3 of total energy used for space heating and hot water in residential and commercial buildings

Residential buildings (France)



70% Heating

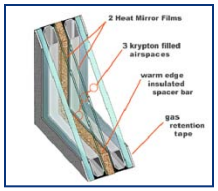
10% Hot water

7% Cooking

13% Lighting / appliances

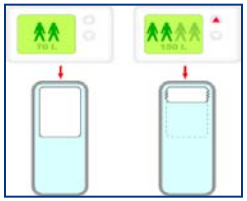
Four steps towards energy efficiency in buildings

1 – Reduce energy demand



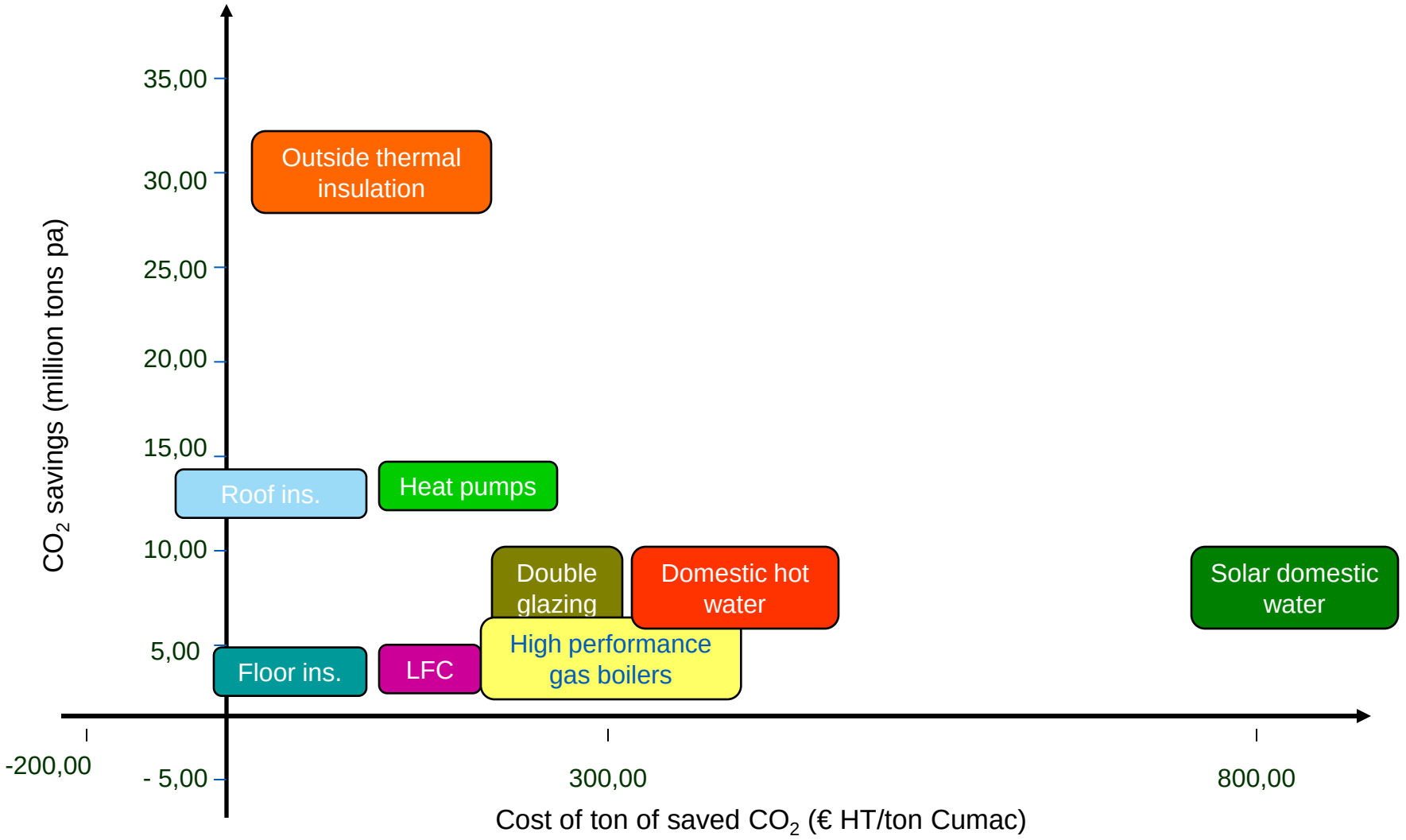
2 – Produce heat with renewables

3 – System control



4 – Produce electricity with renewables

Estimated possible CO_2 savings versus costs



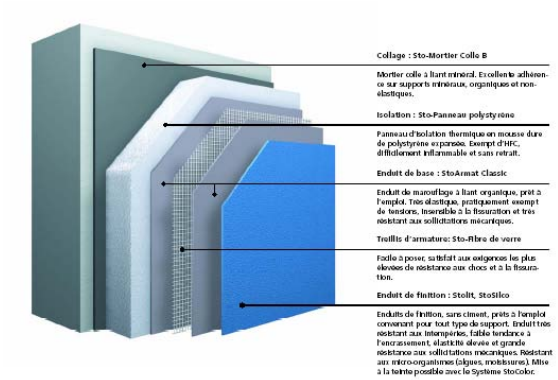
Innovation for retrofitting → Thin insulation panel & External insulation

Wall internal insulation

Issue : to develop thin insulation panel for wall & ground floor internal insulation (vaccum insulation panel,…)

Wall external insulation

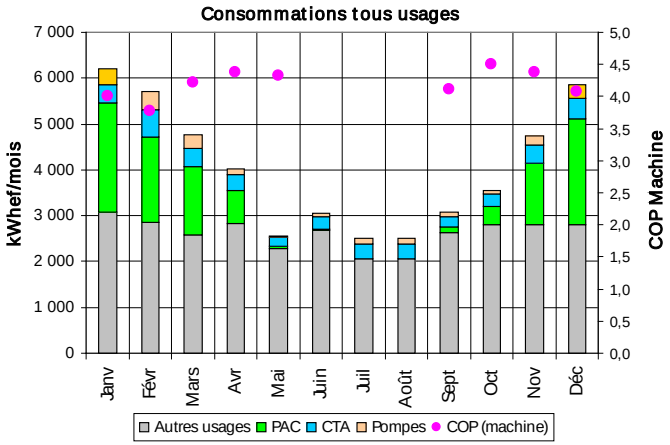
Issue : to reduce installation cost to be able to take advantage of every facade restoration to insulate

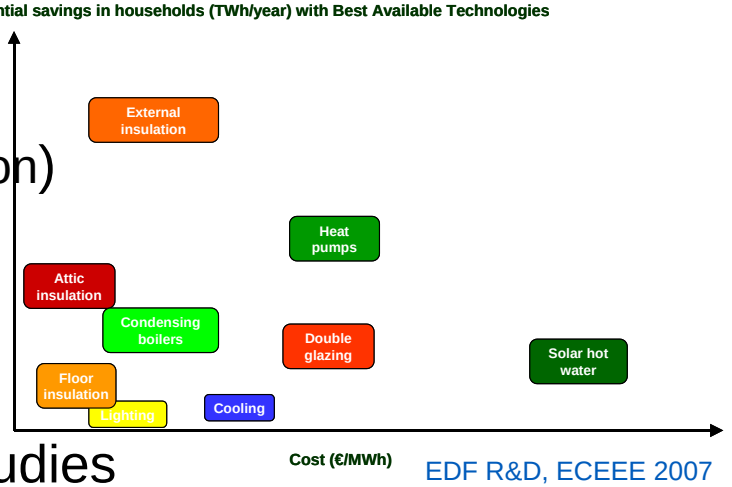


Consumption analysis and forecasting : examples

Energy saving potential evaluation >

(or CO2 emissionpotential reductions evaluation)

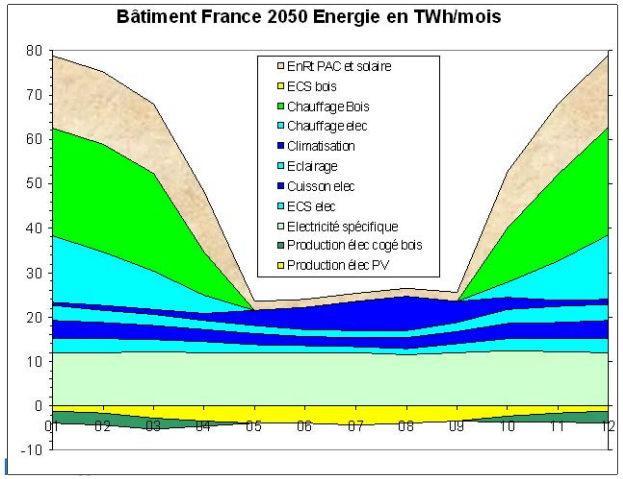




< Field studies

EDF R&D, ECEEE 2007

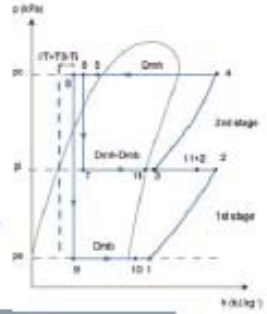
EDF R&D (2000 m2 office renovation with a geothermal heat-pump)



< Forecasting scenarios

High Performance Heat Pump (Air to Water)

- Need :
  - Replacement of oil Boiler in exiting single houses heated with radiators
- Specifications
  - Capacity of 14 kW producing Water à 75°C, under –15°C of outdoor
  - 100% thermodynamic (no electric backup)
  - Single phase, easy to install (plug and heat)
- Development
  - Modeling (Thermodynamic Cycle, Performances),
  - Computer Aided Design
  - 3 prototypes built, 3 patents applied, Laboratory test
  - Field test

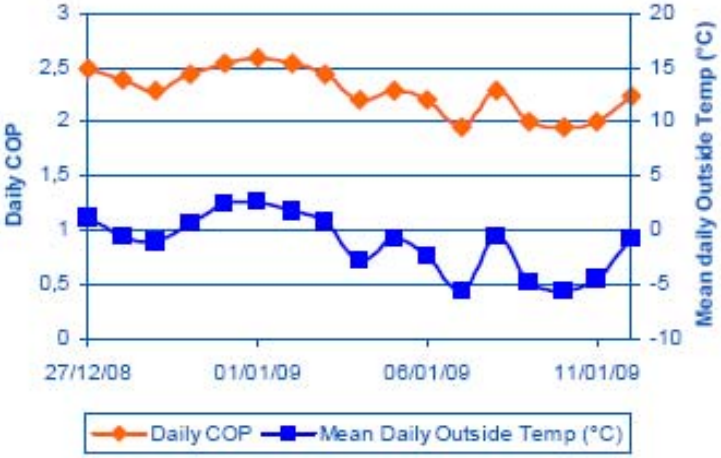


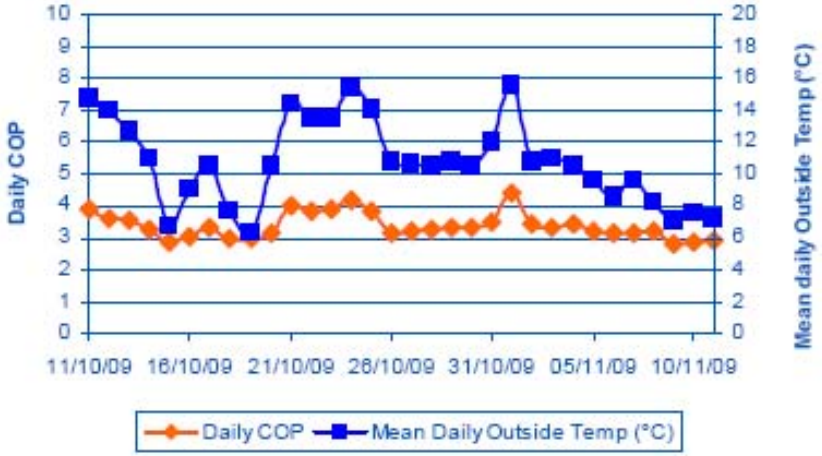
High Performance Heat Pump (Air to Water)

- Industrialisation with European manufacturer

- Tool Development for Sales Forces :
  - House Description : Localisation, Insulation, Radiators..
  - Training Session

Field Test Results



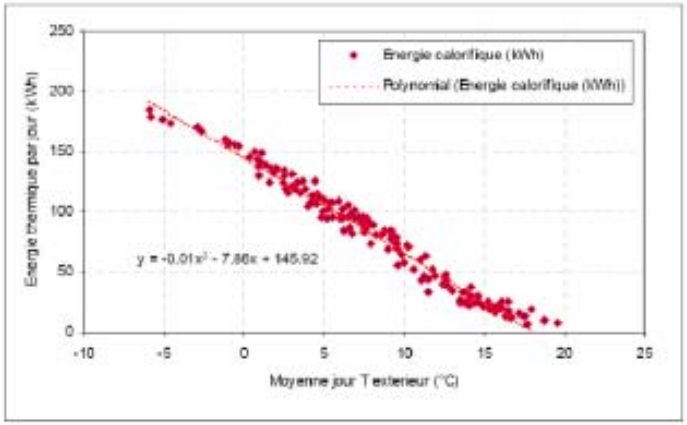


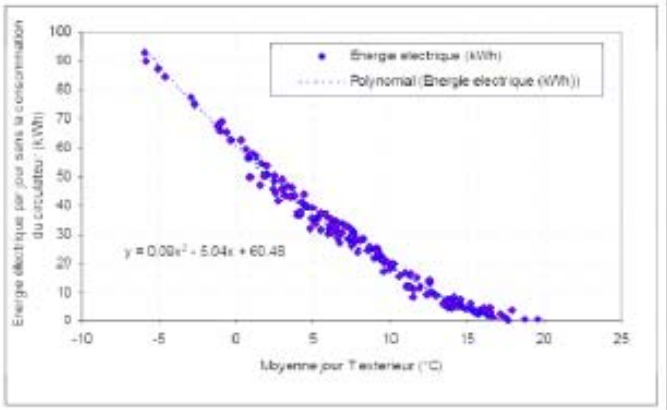
- Coldest Week of Winter 2008/2009 :
  - Mean daily Temp down to –7°C, Daily COP >= 1.9
  - Minimum Outside Temp –14°C

- Autumn 2009
  - Daily COP >= 3,
  - Lower Mean Outside Temp >= 6°C

Estimated SPF according Climatic conditions

- Calculation of Provided Thermal Energy and required Electric Power from field test results



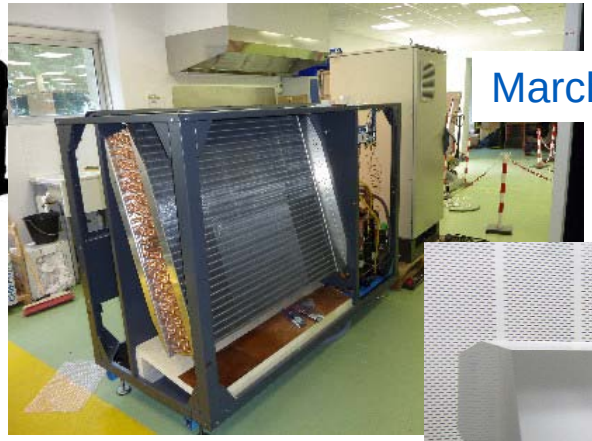


- Estimation of SPF depending on Region

Climatic Zone	H2c	H2d	H2b	H1c	H1b	H3	H2a	H1a
Town	Agen	Carpentras	La Rochelle	Macon	Nancy	Nice	Rennes	Trappes
Coldness (DJU)	2227	2132	2095	2609	2986	1525	2313	2692
Estimated SPF	**2.89**	**2.90**	**3.01**	**2.75**	**2.59**	**3.34**	**2.92**	**2.75**

From idea to Field-Test

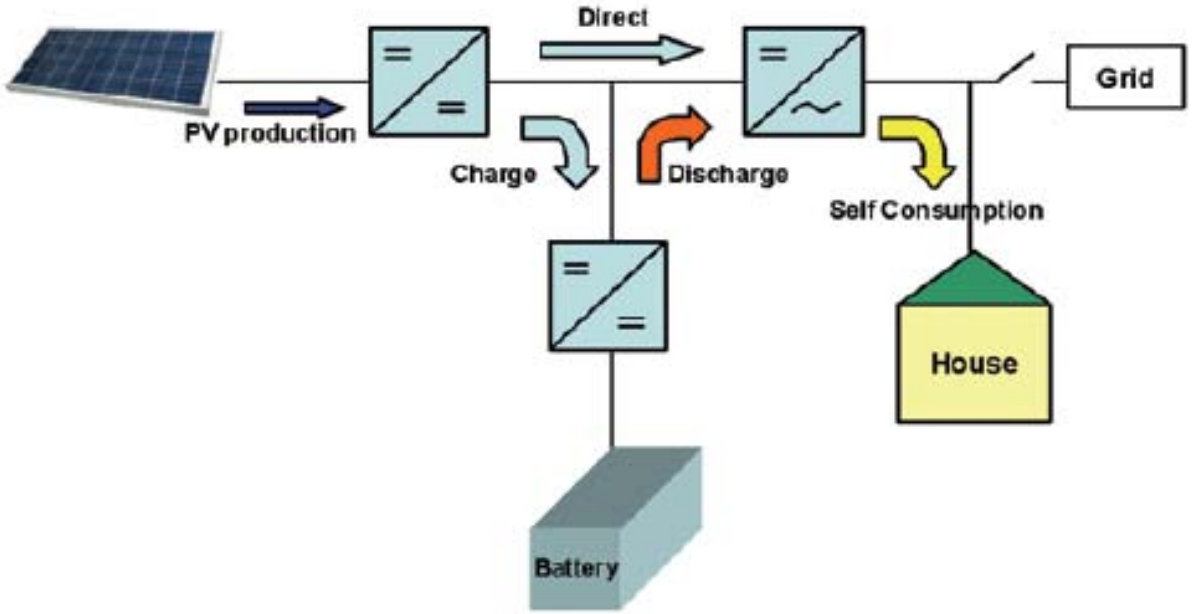
September 2008 : Specification and
Beginning of Computer Aided Design



March 2009 : Prototype Assembly

May 2009 : Laboratory test

January 2010 : Field test Installation

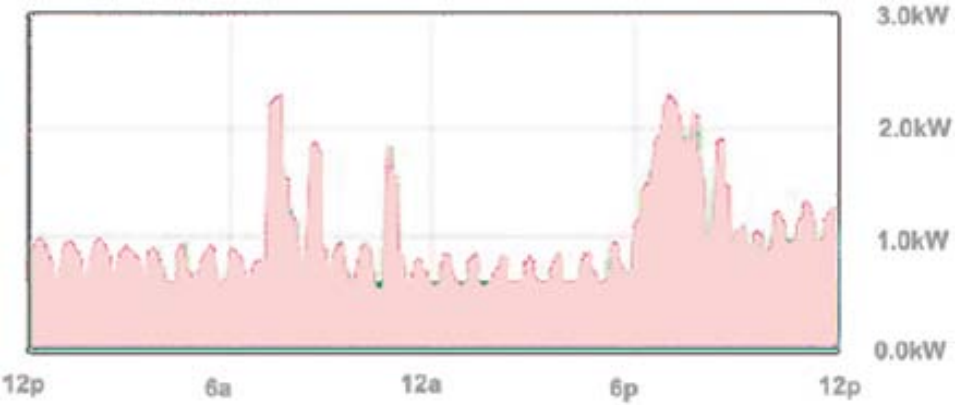


BYD PV Module

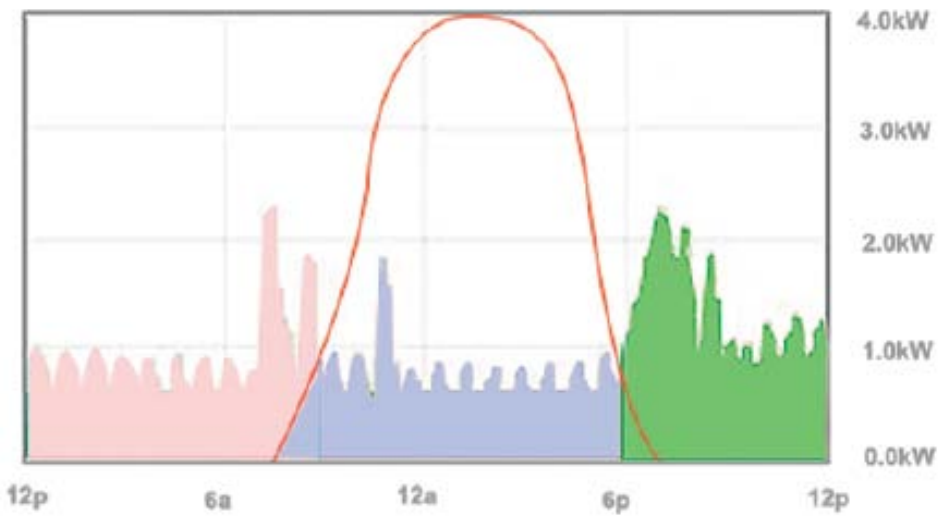
BYD LED Lighting

BYD Energy Storage System

Daily electricity used



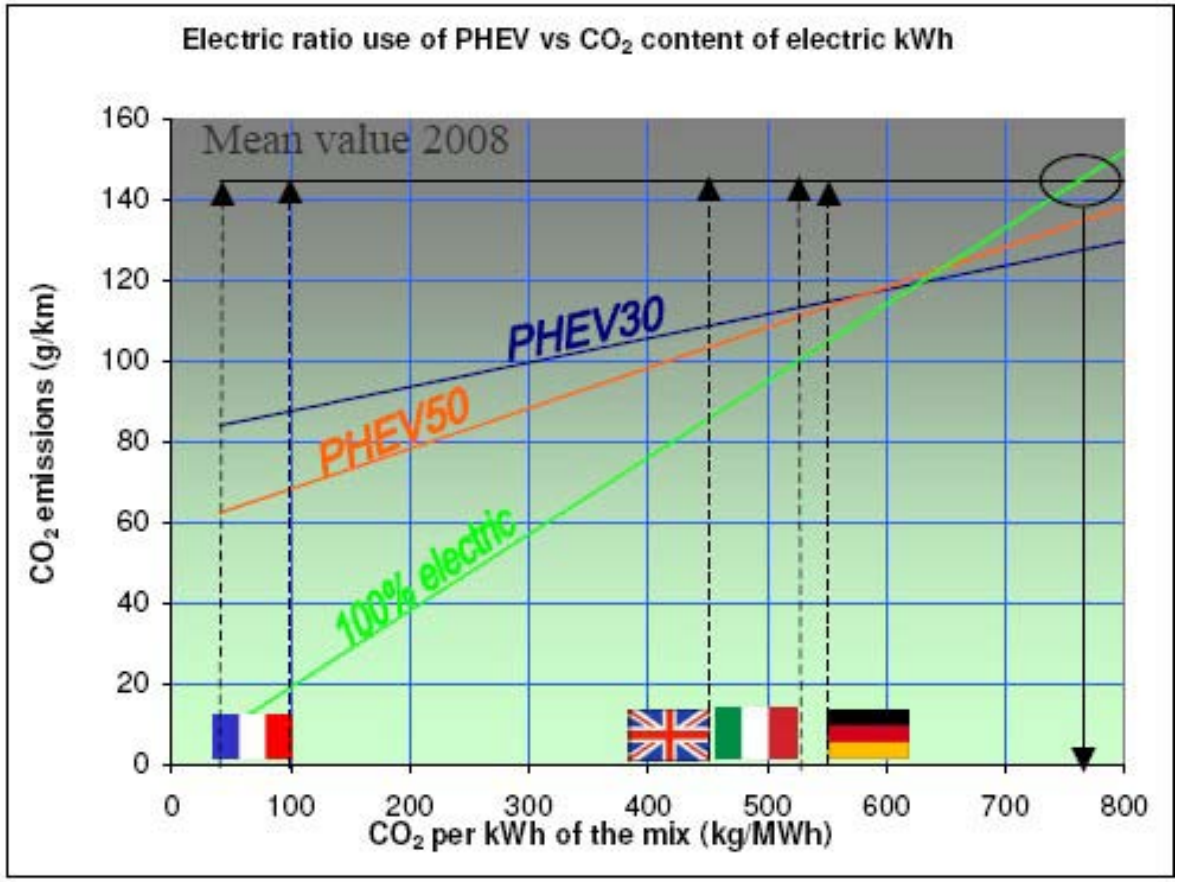
Green House Daily electricity used



NEW ENERGY MIX

Annual Energy Mix

Plug-in hybrid electric vehicles: an effective answer to CO_2 emissions for transports



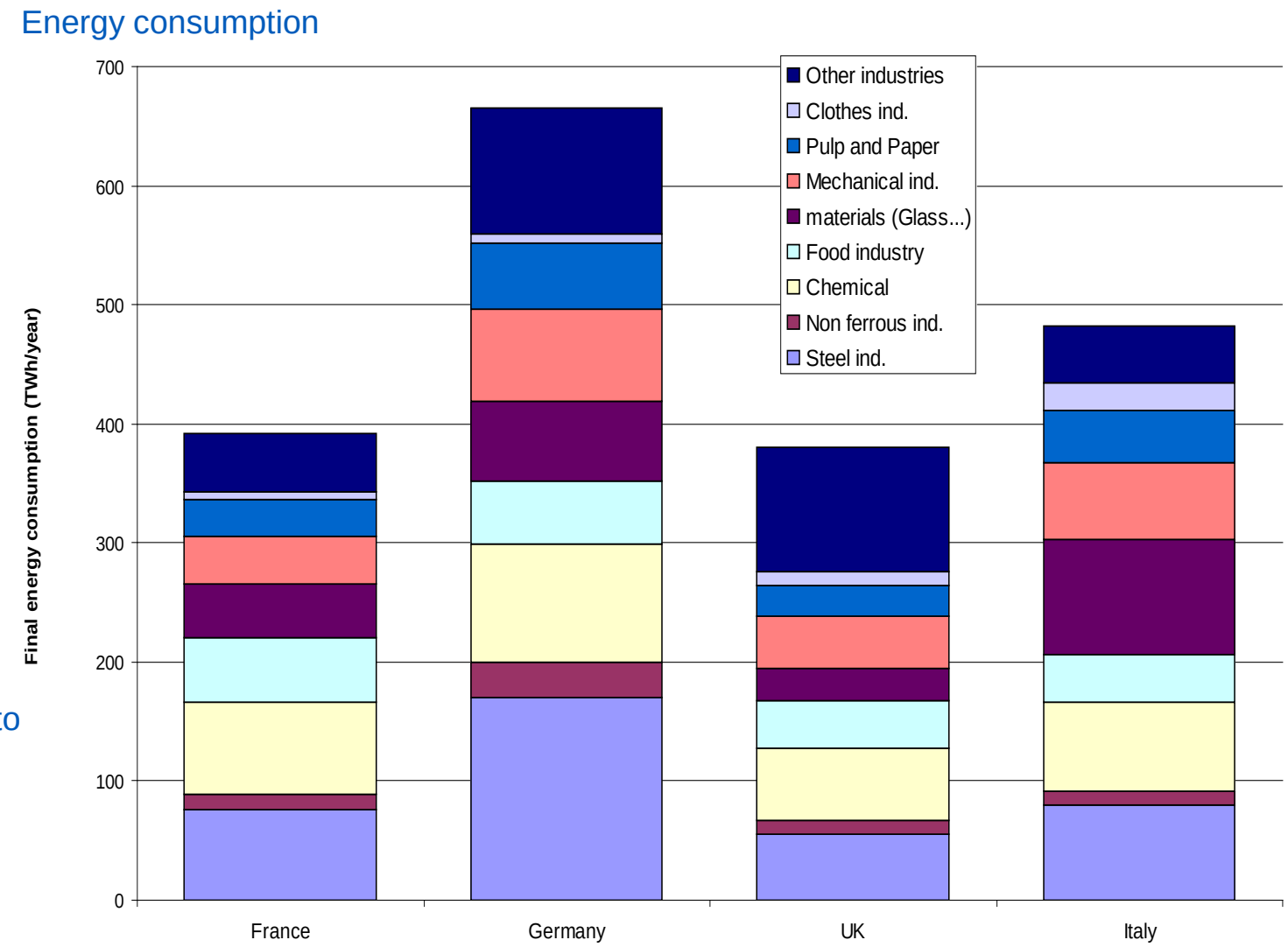
1 million PHEV @50% in France in 2020 ➲ -1 Mt CO2 and -0.5 Mtep oil

Industry : 25% to 30% of energy consumption

1/3
Of electricity

2/3
Of fossil energy

70%
Of energy used to produce heat



Main consumers: steel industry, chemical industry and food industry

Energy Efficiency in industry

Potential savings

		Emissions CO2/year	Fossil Energy /year	Electricity /year
1 –Better energy management and equipments with higher efficiency	Fossil	-11 Mt_{CO2}	-34 TWh	-
	Elec.	- 0,8 Mt_{CO2}	-	-16 TWh
2 –High temperature heat : induction heating Foundries, mechanical industry., heat treatment, food, Para chemical		-1,5 Mt_{CO2}	-7 TWh	+3 TWh
3- Low temperature heat : Heat pump to recover lost heat Food, chemical, paper industries, …		-7,3 Mt_{CO2}	-31 TWh	+10 TWh
4- Other substitutions Motors, electric furnaces, …		-2,8 Mt_{CO2}	-13 TWh	+8 TWh
		-23 Mt_{CO2}	-94 TWh	+5 TWh

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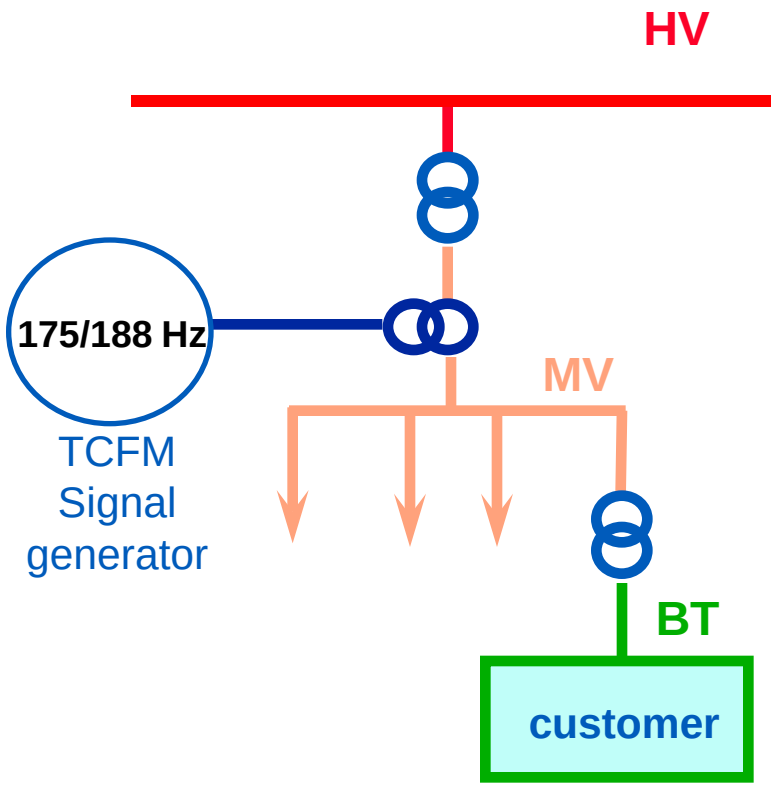
LEADING THE ENERGY CHANGE

Ancient times : Power Line Current (PLC) gen. 0

- **1955**: EDF decides to deploy « TCFM »: central remote control via musical frequency.
- For **tariff modulation** (off-peak hours, day/night).
- For **load-shifting**:
  - ✓ 10 million water heaters automatically switched on at night hours.
  - ✓ Day-ahead notice on prices and day-ahead customer withdrawal during 22 peak days a year.



ERDF's Linky project

The Linky pilot

Linky is the name of ERDF's complete Advanced Metering Management system

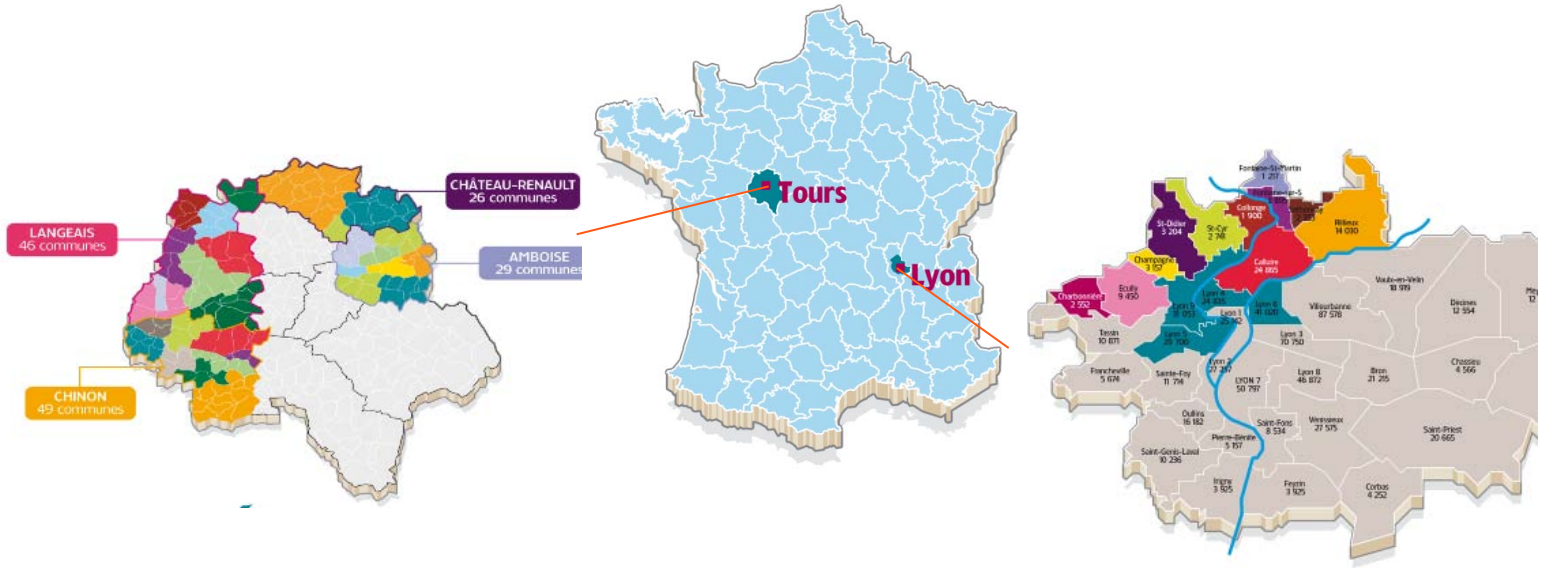
The main project goals are:

- Design an easily maintainable & adaptive system
- Equipment from all vendors must be interoperable & interchangeable
- Security guaranteed at all levels
- Robustness, availability & performance
- 20 years service life of meters & data concentrators
- Highly integrated & flexible information system

System design must guarantee scalability to 34 millions meters & 700 000 data concentrators

The pilot roll-out status

- Figures of September 4th, 2010
  - 123.000 meters rolled out today
  - 300.000 meters rolled out at the end of 2010
  - 5000 concentrators roll-out almost complete



Rural : Touraine

105 000 electricity customers

150 towns

4 800 concentrators

Urban : Lyon

190 000 electricity customers

4 arrondissements + 11 towns

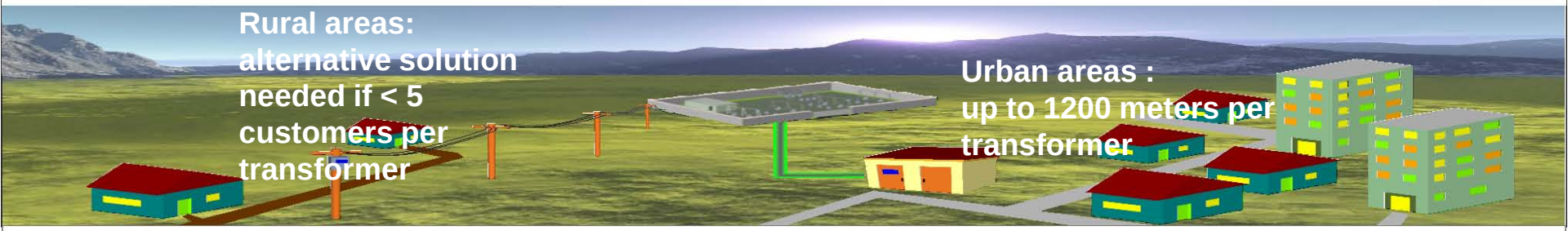
1 200 concentrators

Functionalities of Linky

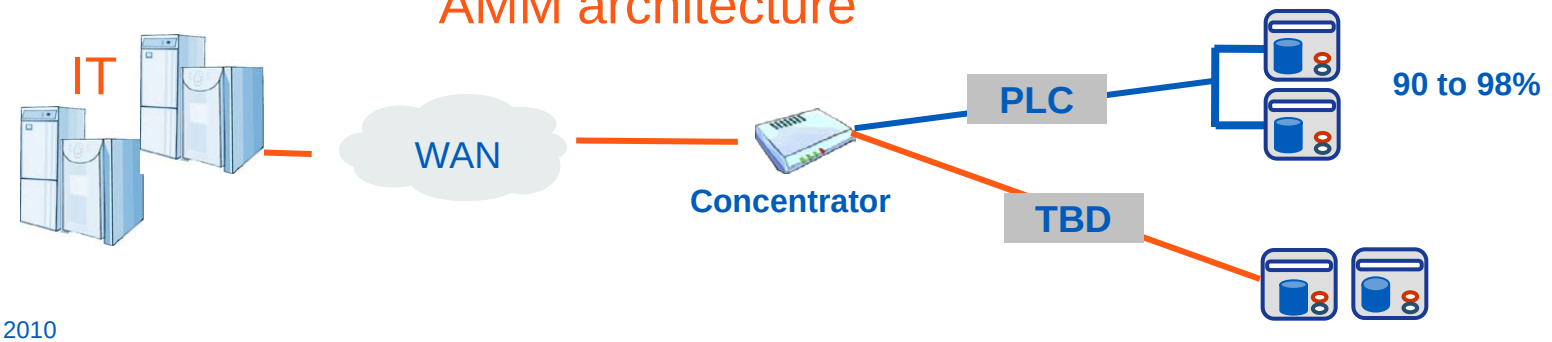
- Support of EDF historical tariffs and new TOU tariffs
- Active energy load profile
- 4 quadrant metering
- Unidirectional interface for in-home displays and energy-managers on USB connector
- Power quality monitoring
- Subscribed power level managed remotely by integrated load switch
- Overvoltage protection of client installation
- Integrated PLC modem

Photo shows single-phase version
a three-phase version also exists

A three-tier architecture with 2 communication media



AMM architecture



About the benefits of smartmeters (Automated Meter Reading)

Distribution operators :

- Reduction of O&M costs
- Improved performances and state estimation of the network
- Monitoring local production and DSM (defer investment and play a new role in the electrical system)
- New services to market operators

Customers/users :

- Simplified contractual relationship
- Better knowledge of their habits
- New energy services and tariffs
- Enabling energy management and savings

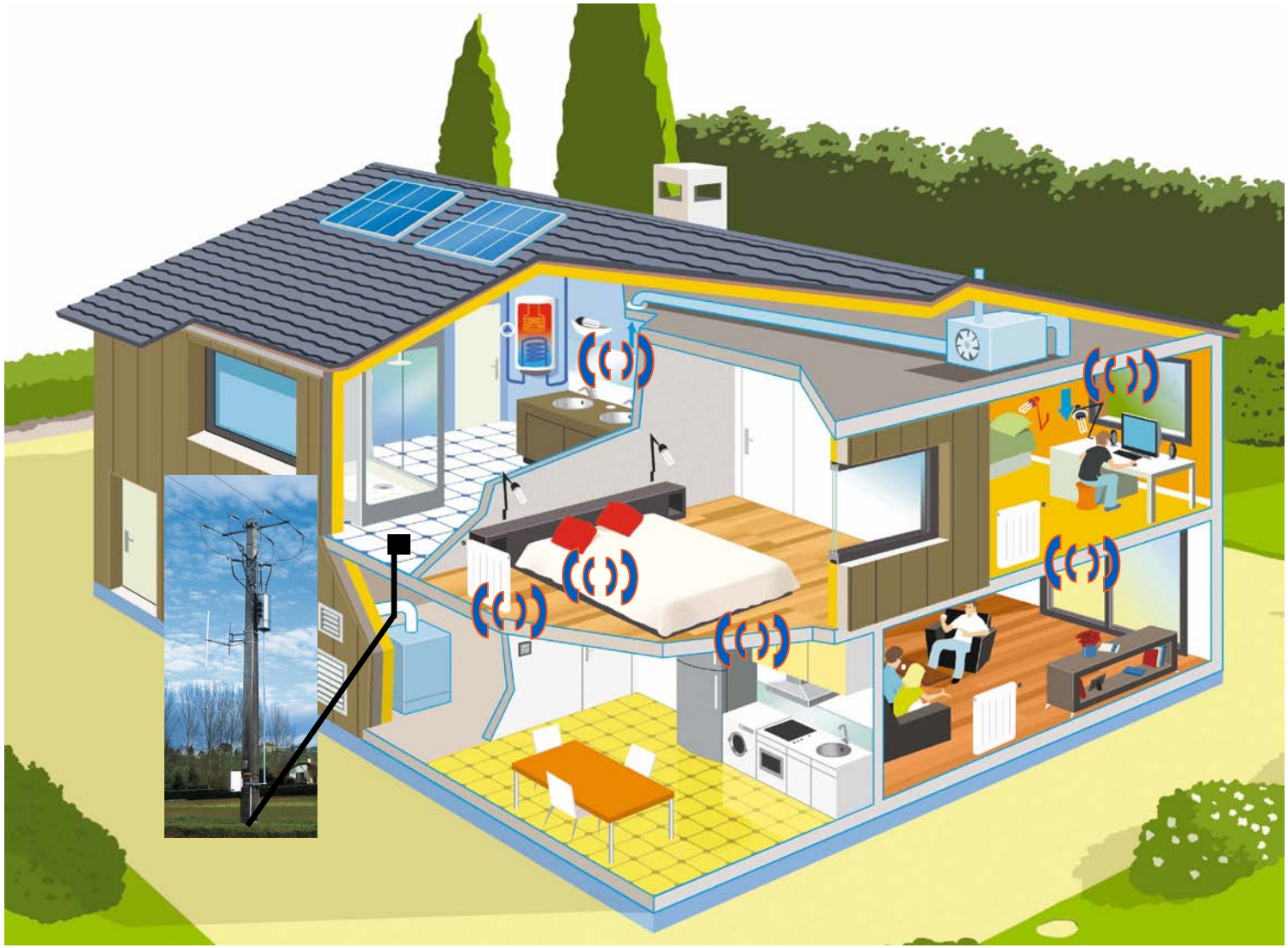
Producers and balance responsible party :

- Reduce peak production and increase CO2 savings
- Easier aggregation of renewable energy in their portfolio
- Better ability to forecast load and DER production

Retailers :

- Better knowledge of customers needs and habits
- Innovative tariffs and offers and energy services

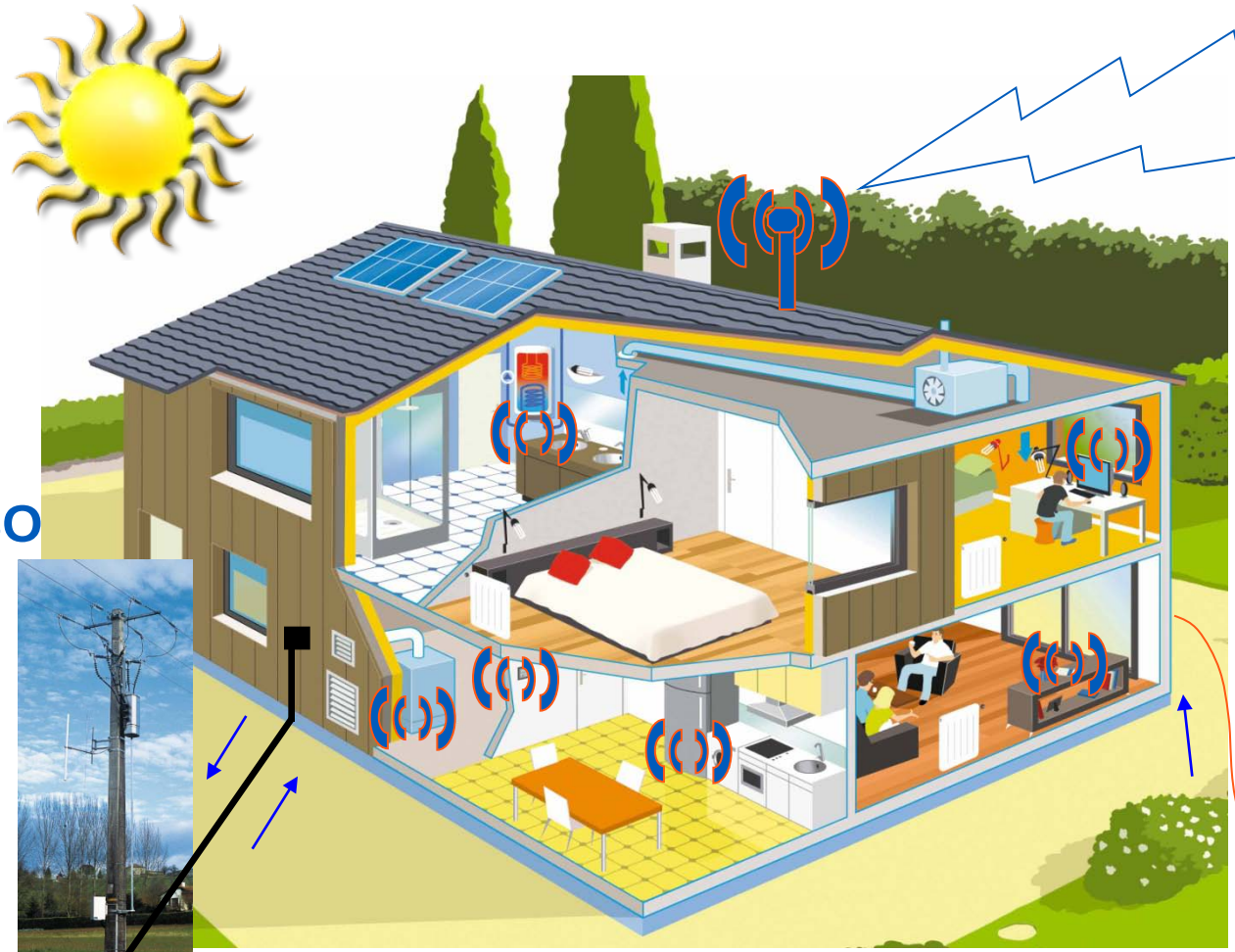
Towards a Home Area Network (HAN) for energy efficiency …
or the devil is in the details !



Towards a Home Area Network (HAN) for energy efficiency

Energy provider
Vendor
Agreggator

Towards a Home Area Network (HAN) for energy efficiency



Energy provider
Vendor
Agreggator

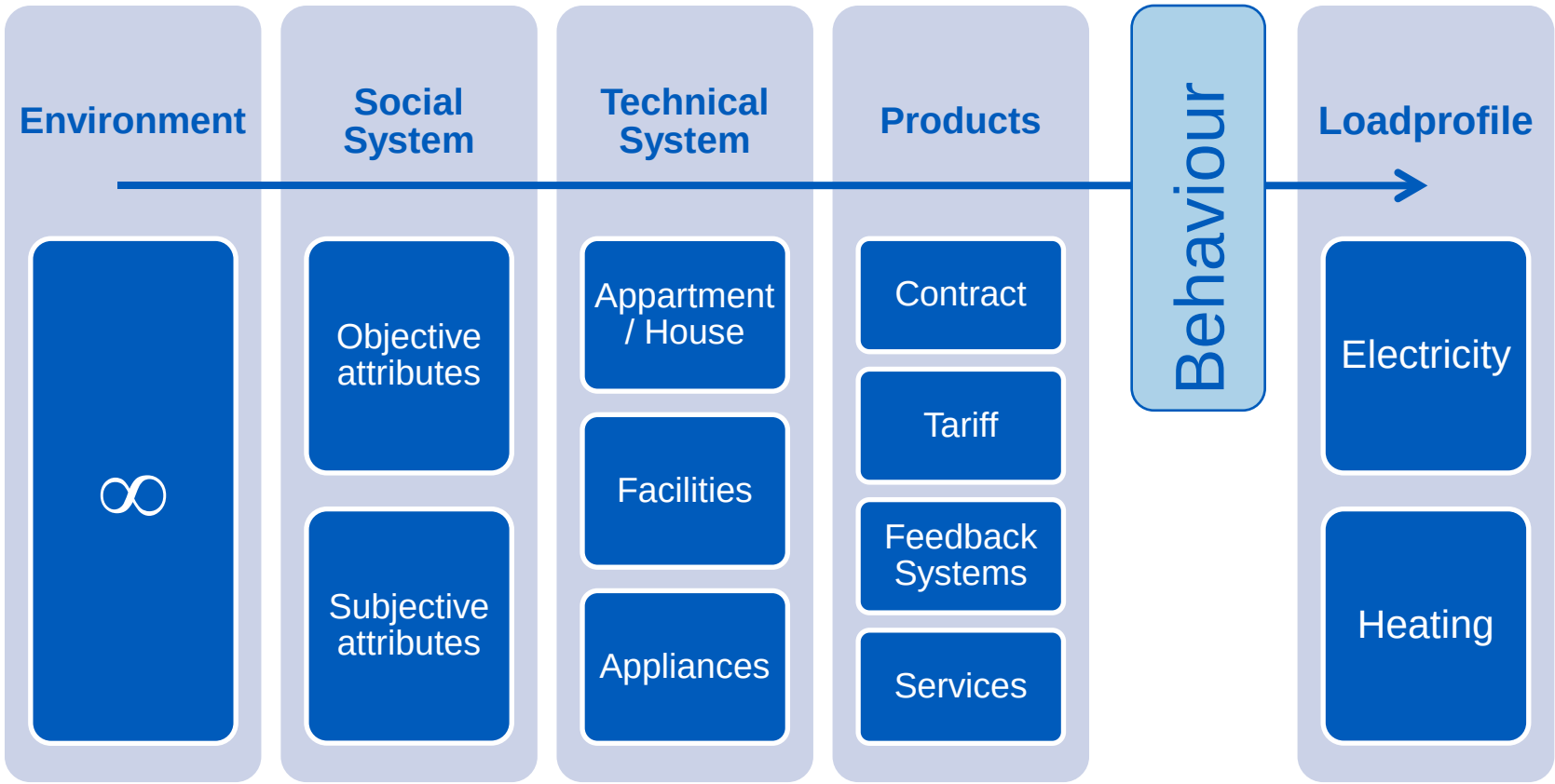
DSO

Towards a circulation grid !

Who is the user?

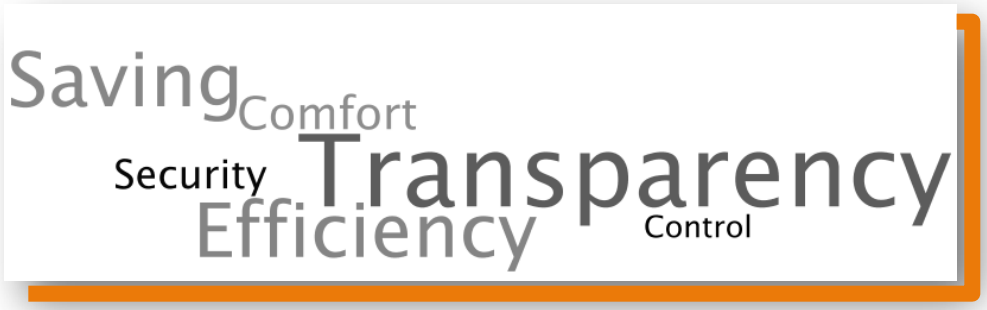
- The customer?
- The contract owner?
- The energy consumer?
- The energy producer or „storer“?
- The citizen?
- The household?

Household



(Source: EnCT 2010)

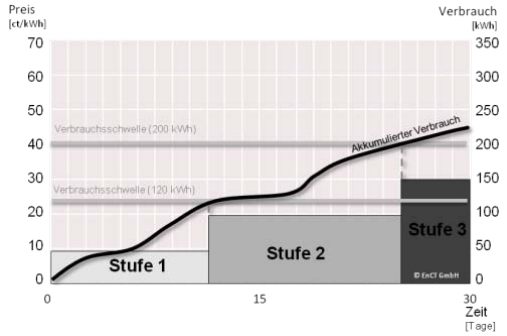
Customer Needs/Priorities



(Source: EnCT 2010)

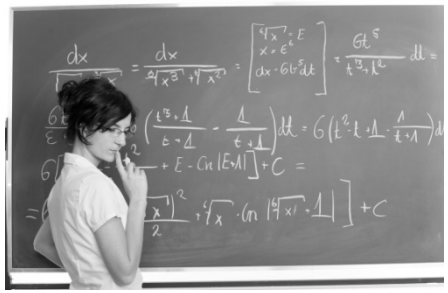
Source : T. Kukuk – EnCT GmbH

Smart Metering or Innovations in Tarifs and Services



Tariffs

- Time of Use Pricing (ToU)
- Critical Peak Pricing (CPP)
- Real-Time-Pricing (RTP)
- Direct Load Control (DLC)
- Time of Sale Pricing



Services

- Information / Advice
- Warning / Alarm

Source : T. Kukuk – EnCT GmbH

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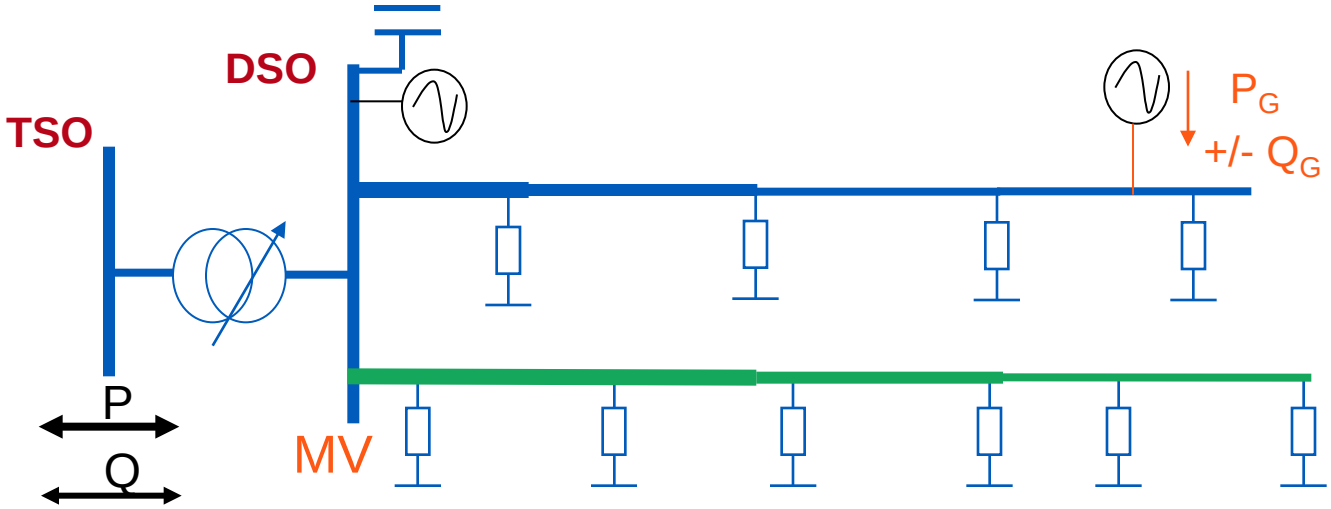
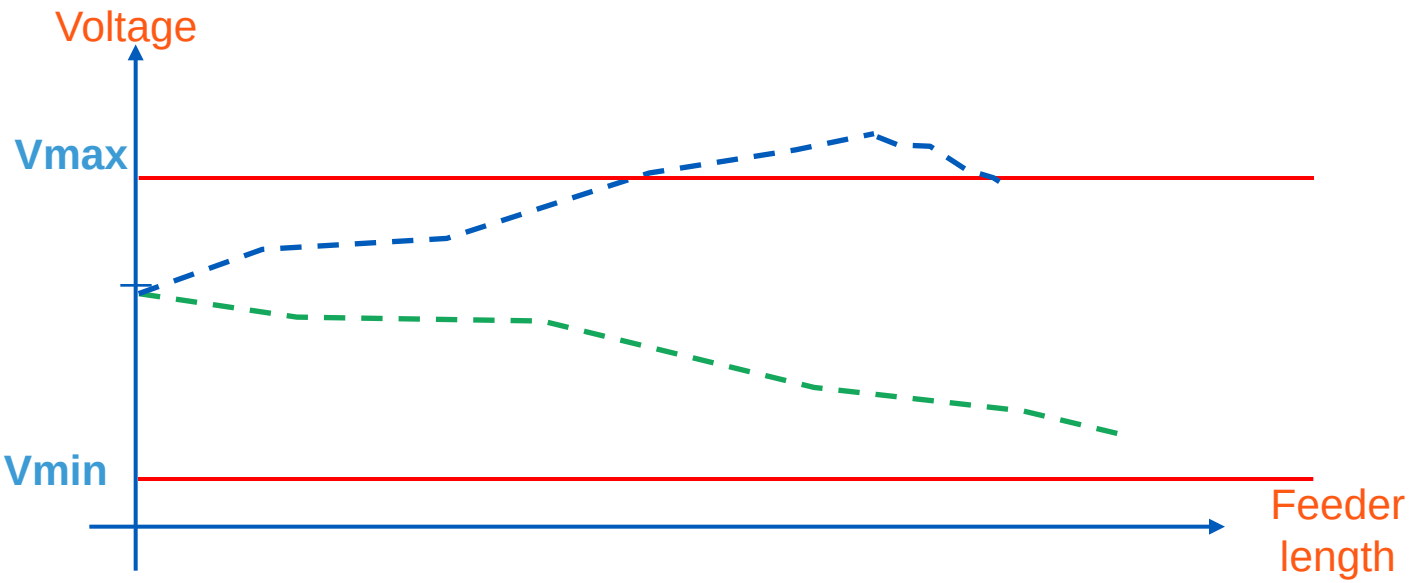
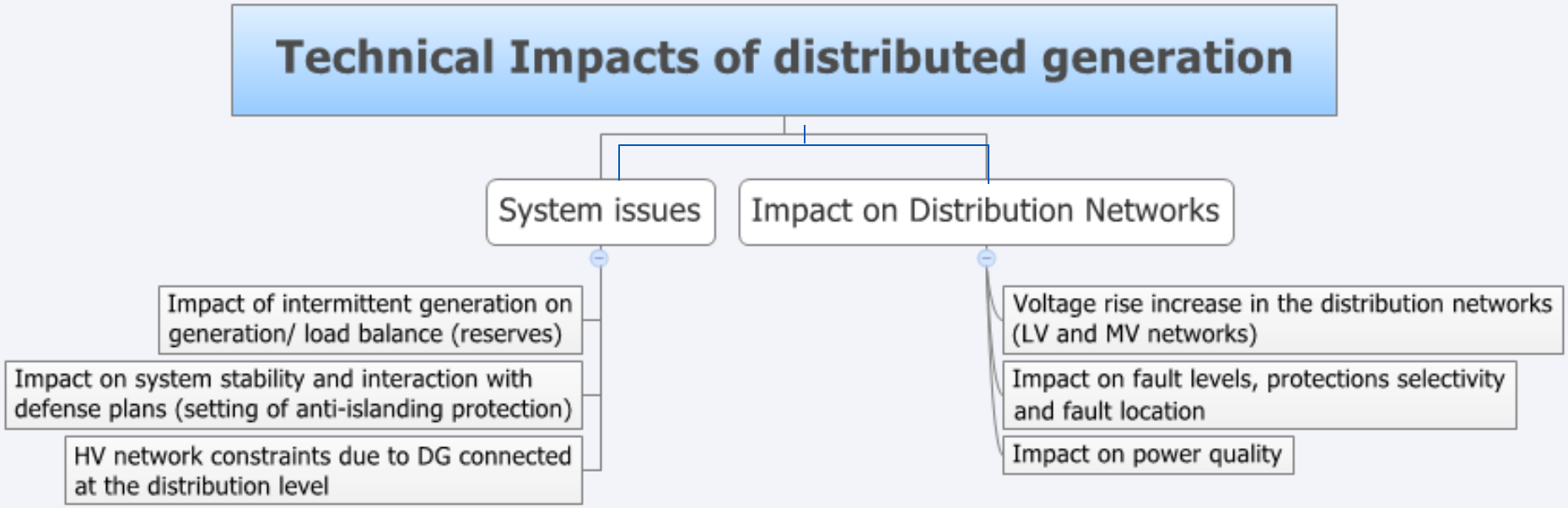
LEADING THE ENERGY CHANGE

The Voltage and VAr control issue in MV networks





Technical Impacts of distributed generation



Technical solutions/innovations to enable sustainable DG integration

1) Observability of distributed generators

- Medium size DG: Real-time measurement and H-1 to D-1 renewable production forecast
  - Example: IPES project in France
- Small DG: forecast of production aggregation

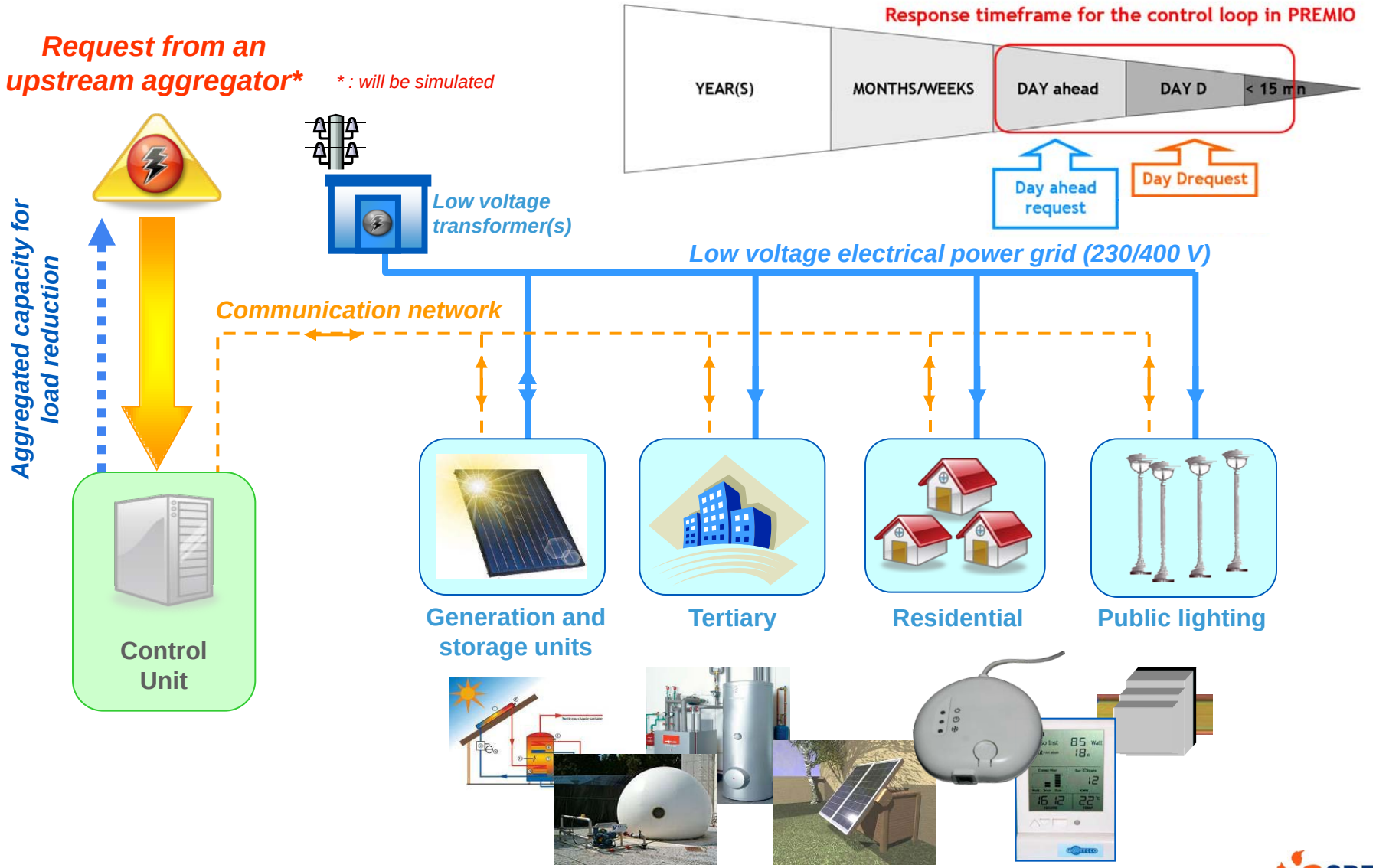
Observability for both TSO and DSO

2) Controlability of distributed generators

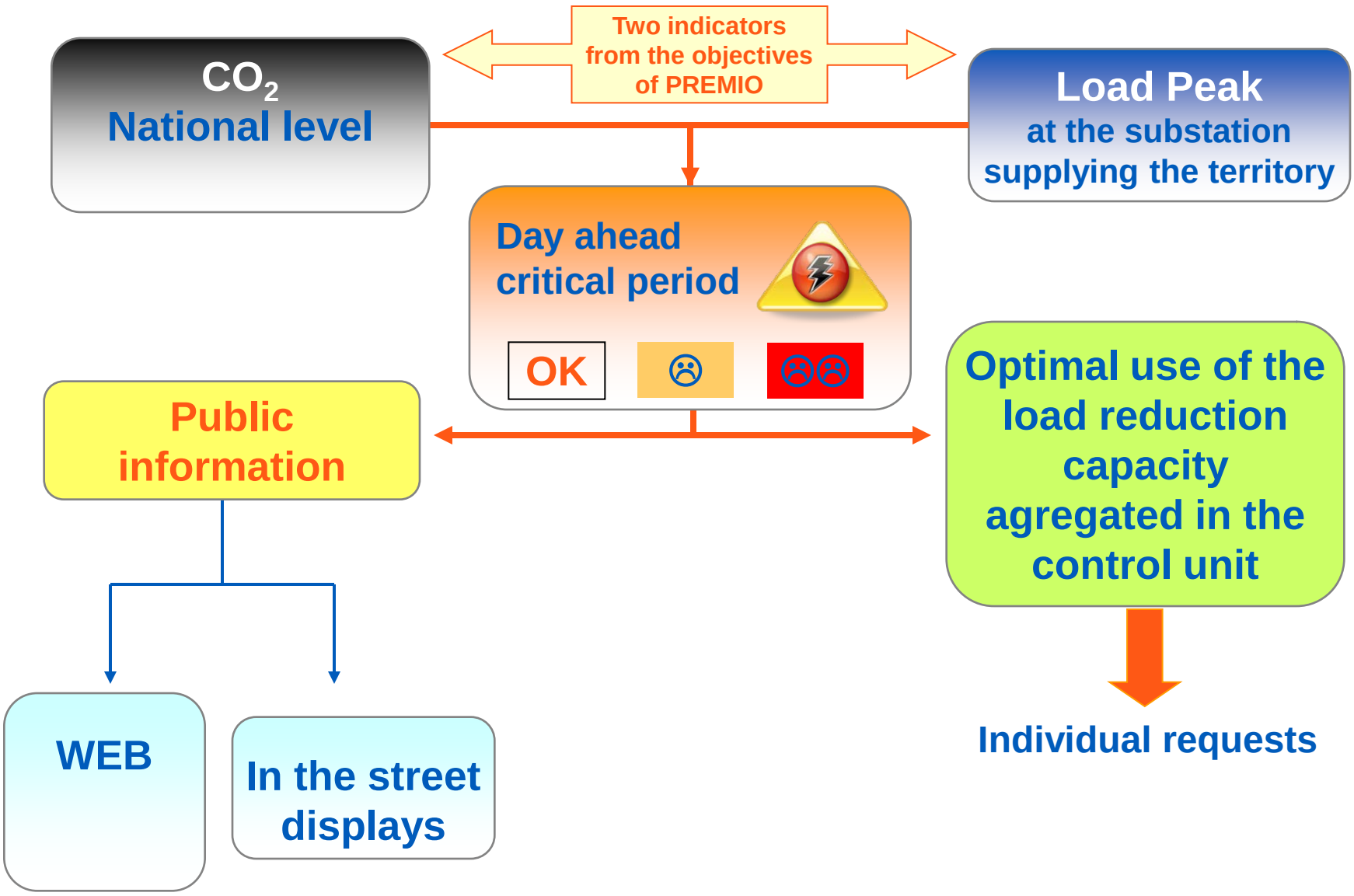
- Active power controlability to solve power balancing issues
- Reactive power controlability to solve local voltage issues and TSO's reactive power requirements
- Controlability through new centralised automation functions using controlability of DG
- Local control for small DG

Which interactions between actors for the controlability?

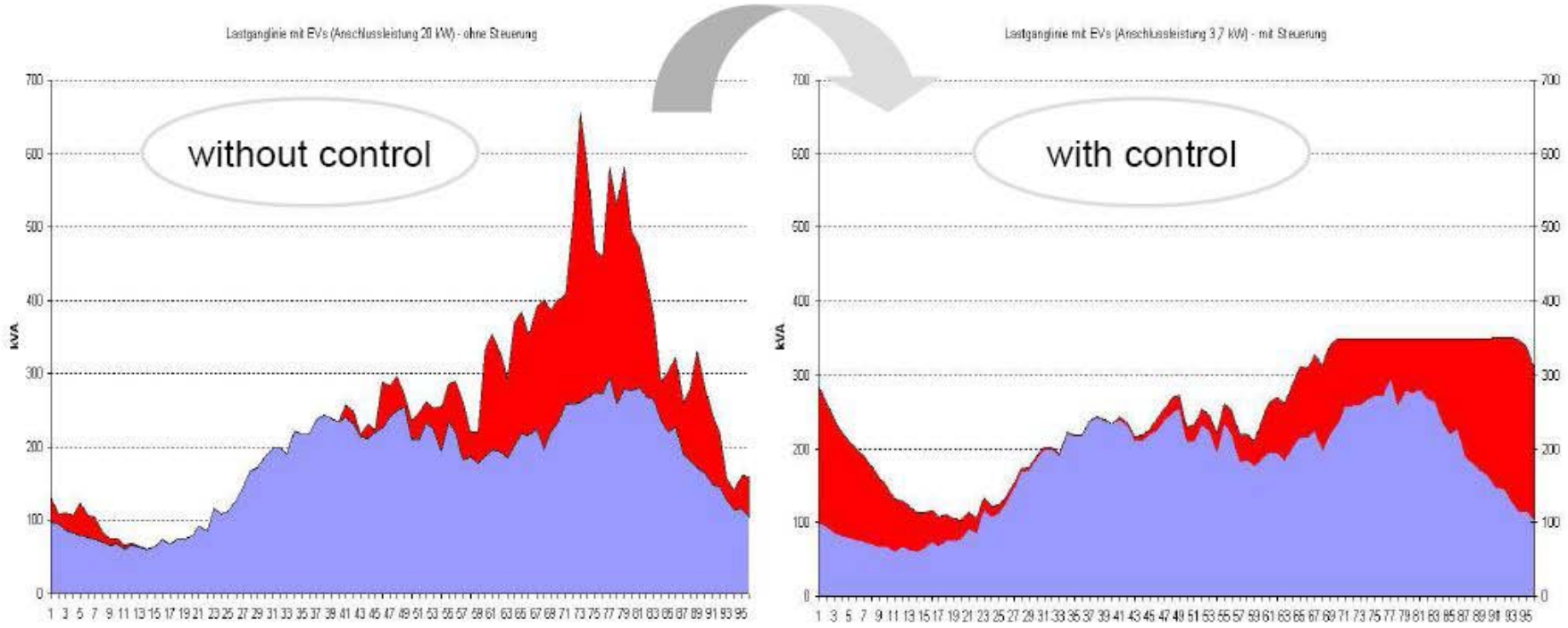
PREMIO's plateform design



Day ahead critical periods are simulated



Smartgrid ,storage and central load control (for EV)

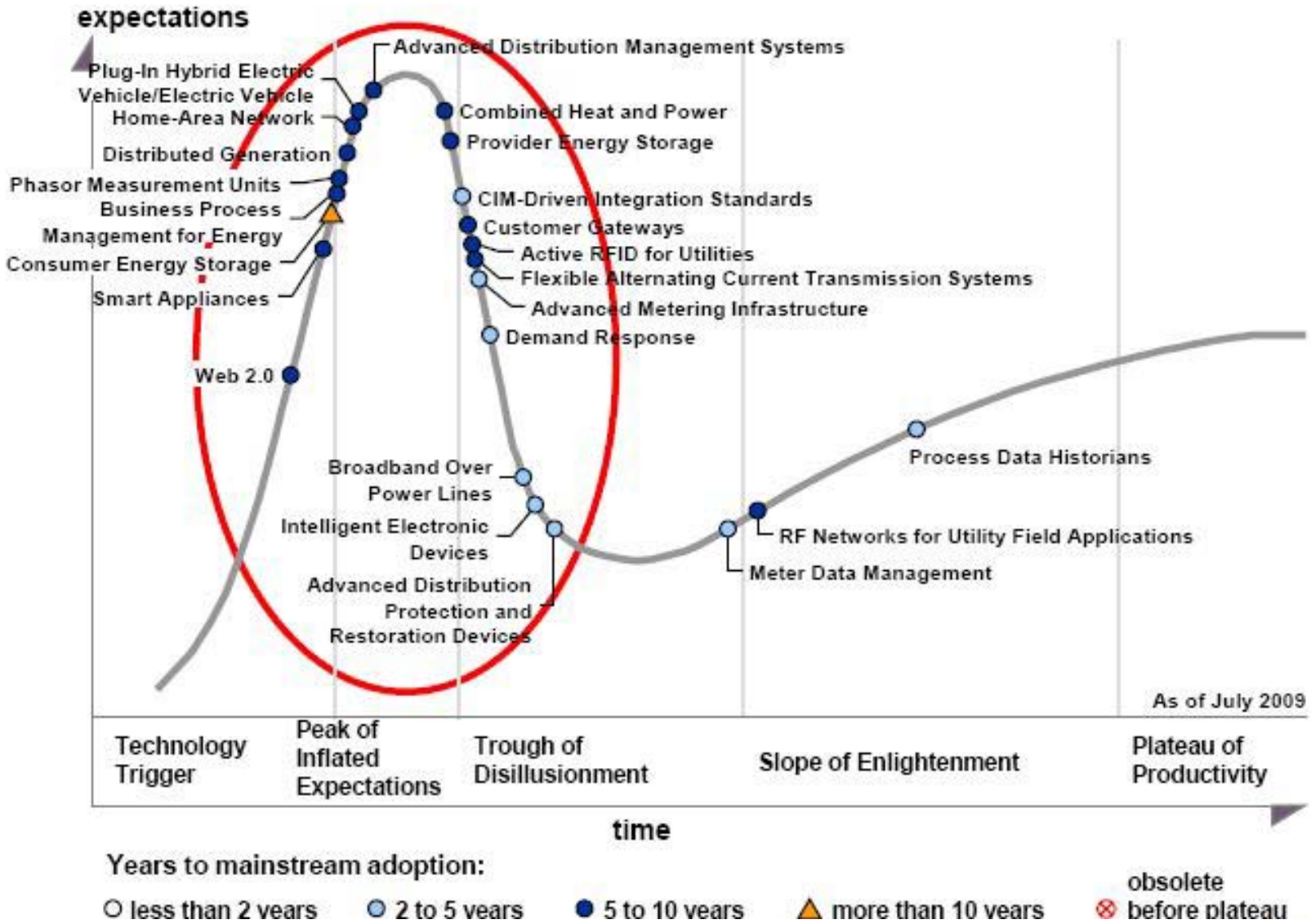


example (resolution: 15 min)

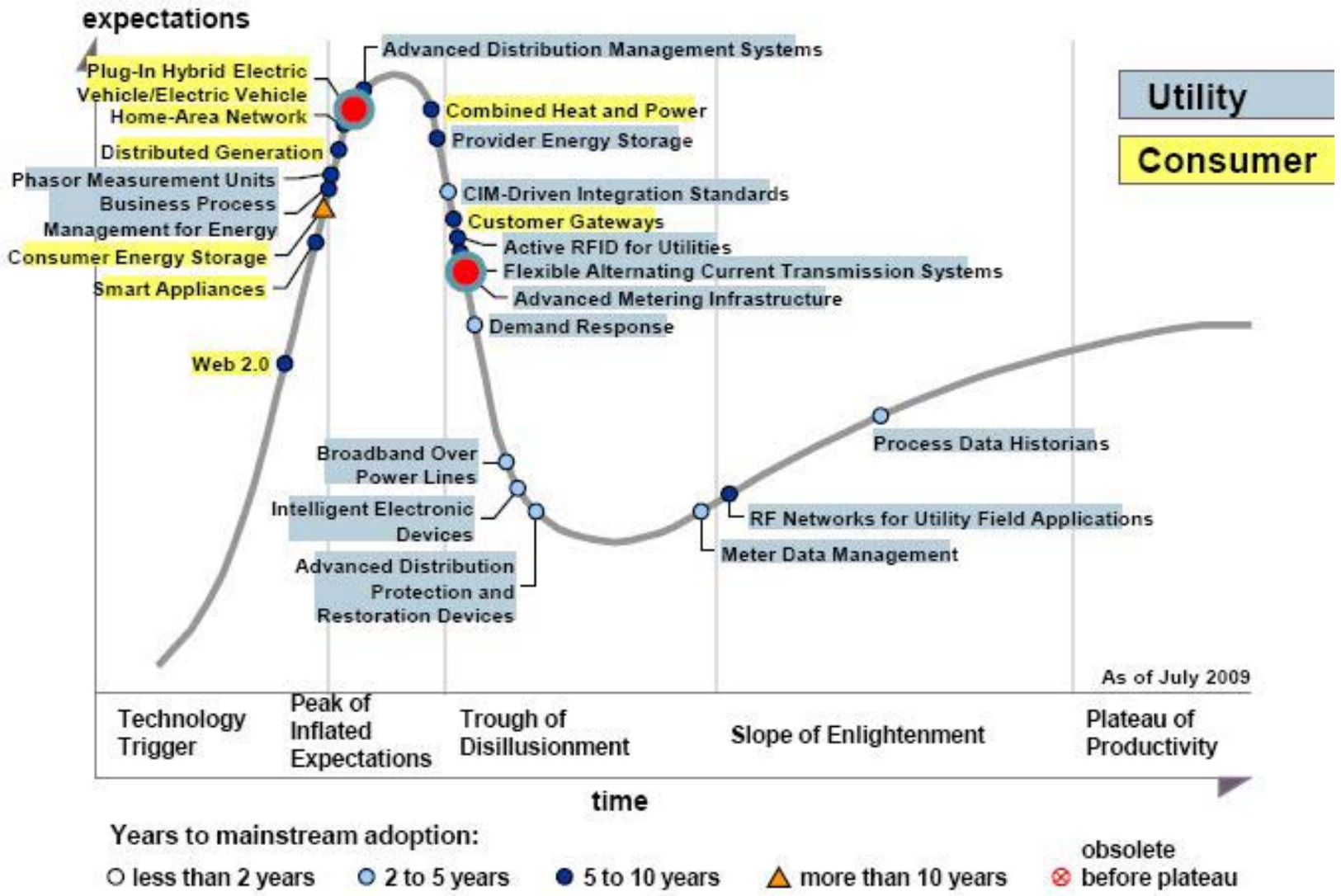
- load at secondary substation
- penetration rate of 80% EVs
- batteries 35 kWh, 18 kWh & 16 kWh
- different kind of driving behaviour

- blue = without EVs, red = with EVs
- deutliche Reduzierung der Lastspitzen
- Vergleichmäßigung der Tagesganglinie

Source : T. Dederichs - RWTH Aachen University



Source : Gartner



Source : Gartner

More electricity for less CO2

Introduction : the trend

1 On the demand side

1.1 - At home

1.2 - On the road

1.3 - In the industry

2 The "smart" electrical system

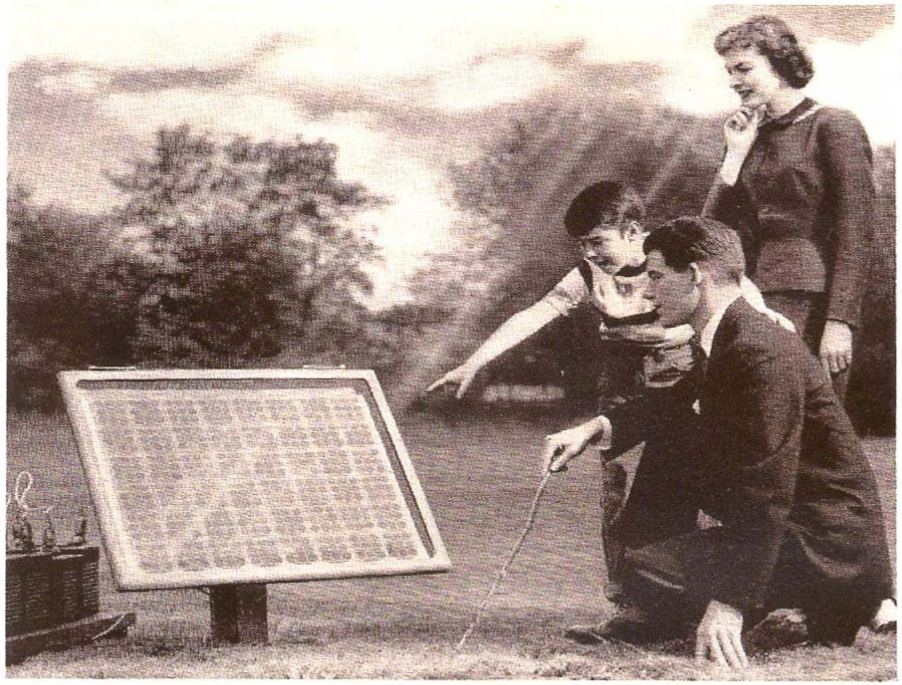
2.1 - The smartmeter

2.2 - The smartgrid

2.3 - The electrical mix

Conclusion : the need for…

LEADING THE ENERGY CHANGE



Something New Under the Sun. It's the Bell Solar Battery, made of thin discs of specially treated silicon, an ingredient of common sand. It converts the sun's rays directly into usable amounts of electricity. Simple and trouble-free. (The storage batteries beside the solar battery store up its electricity for night use.)

Bell System Solar Battery Converts Sun's Rays into Electricity!

Bell Telephone Laboratories invention has great possibilities for telephone service and for all mankind

Ever since Archimedes, men have been searching for the secret of the sun.

For it is known that the same kindly rays that help the flowers and the grains and the fruits to grow also send us almost limitless power. It is nearly as much every three days as in all known reserves of coal, oil and uranium.

If this energy could be put to use — there would be enough to turn every wheel and light every lamp that mankind would ever need.

The dream of ages has been brought closer by the Bell System Solar Battery. It was invented at the Bell Telephone Laboratories after long research and first announced in 1954. Since then its efficiency has been doubled and its usefulness extended.

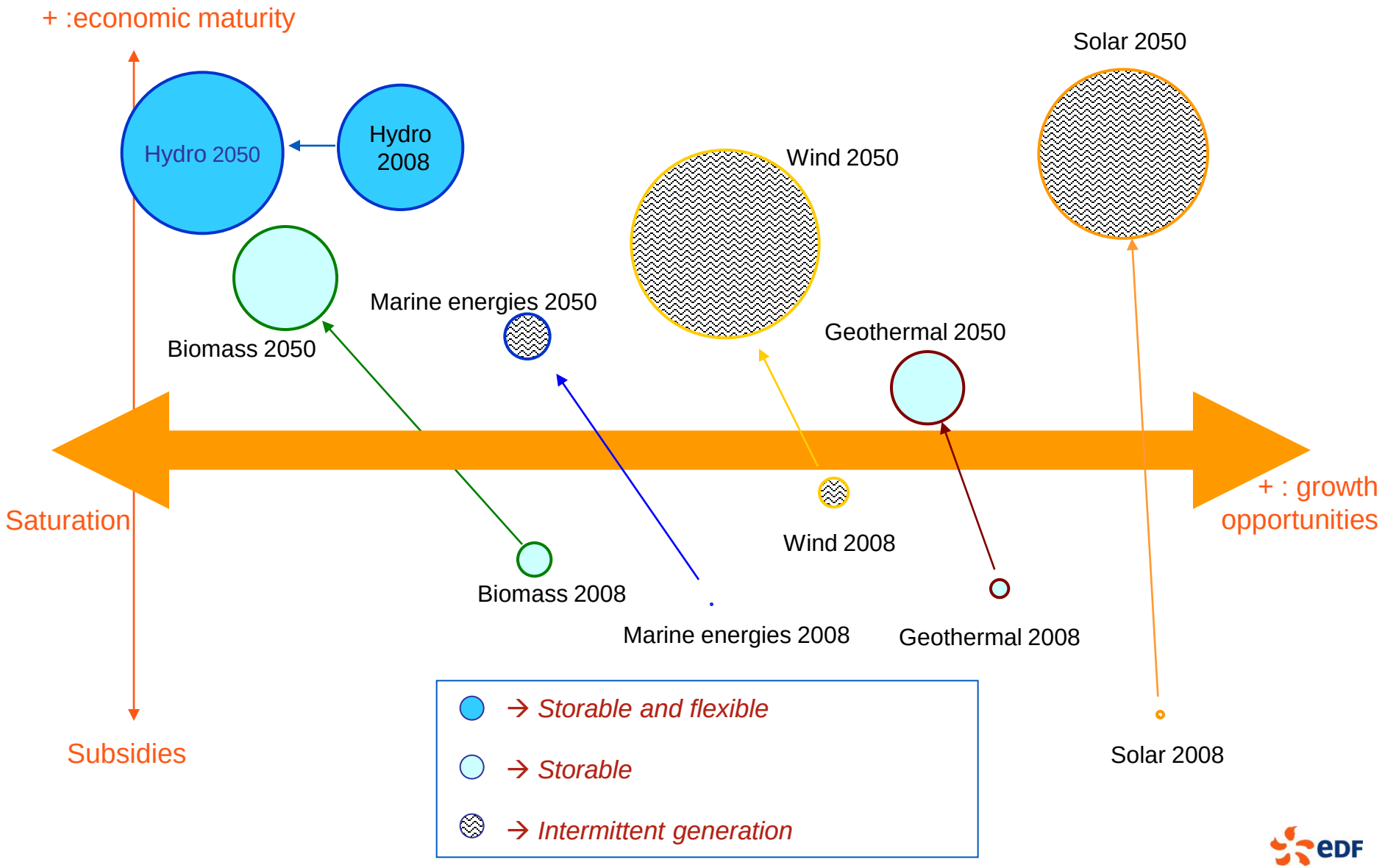
There's still much to be done before the battery's possibilities in telephony and for other uses are fully developed. But a good and pioneering start has been made.

The progress so far is like the opening of a door through which we can glimpse exciting new things for the future. Great benefits for telephone users and for all mankind may come from this forward step in putting the energy of the sun to practical use.

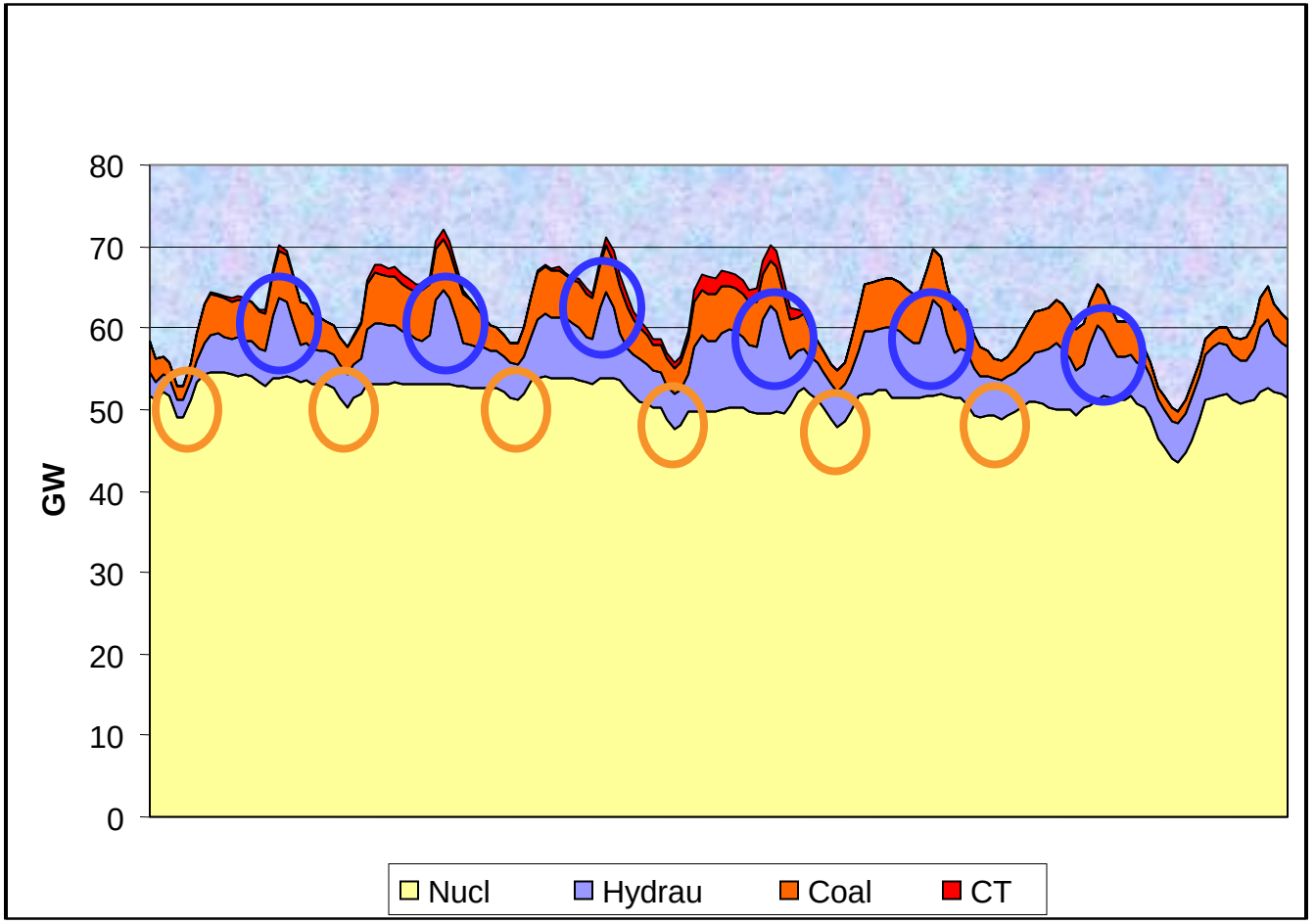
BELL TELEPHONE SYSTEM

An advertisement published in the US National Geographic Magazine, Washington DC, August 1956

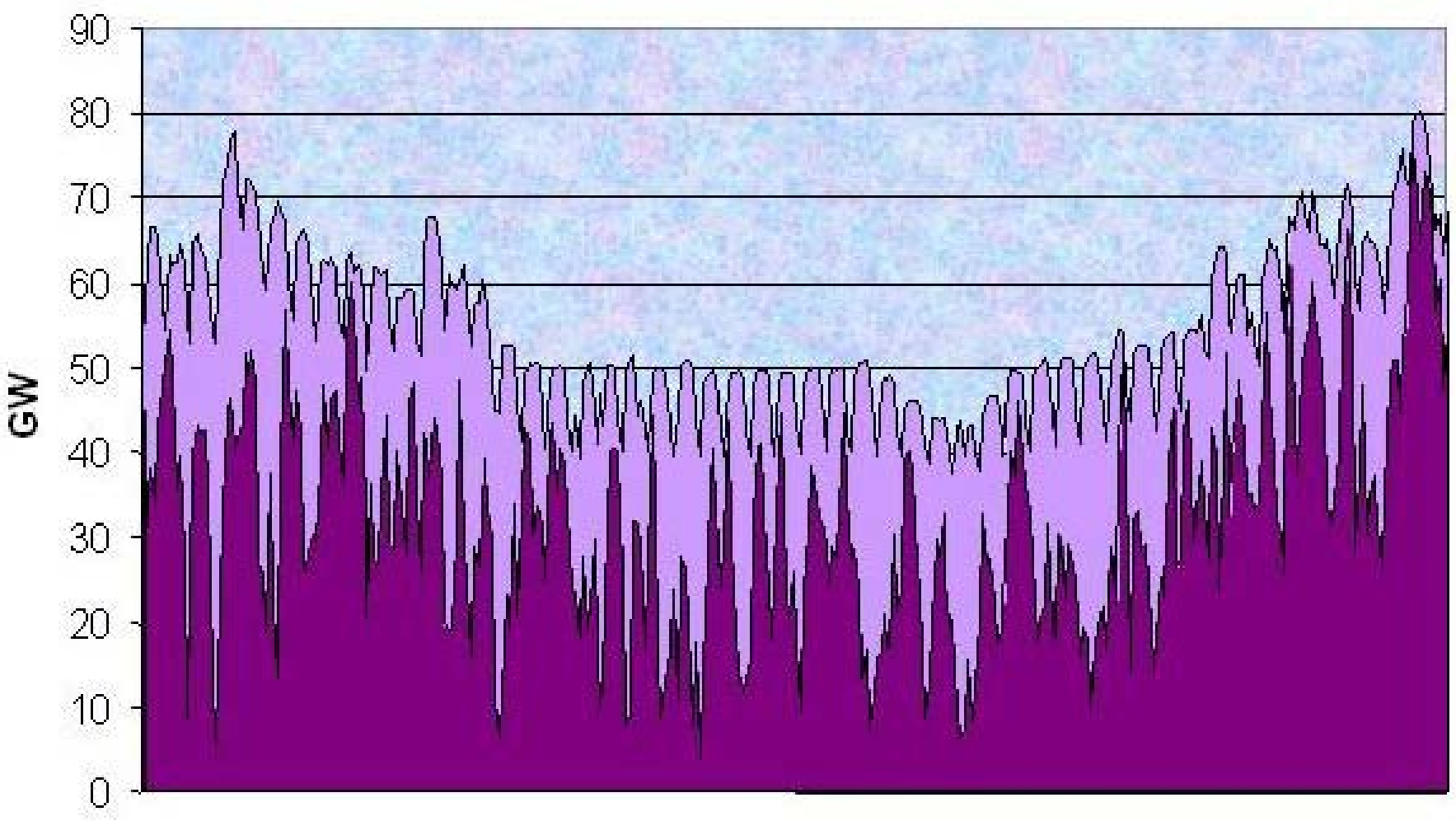
Power from Renewable energy sources : Opportunities versus costs ?



How is the demand satisfied in France?

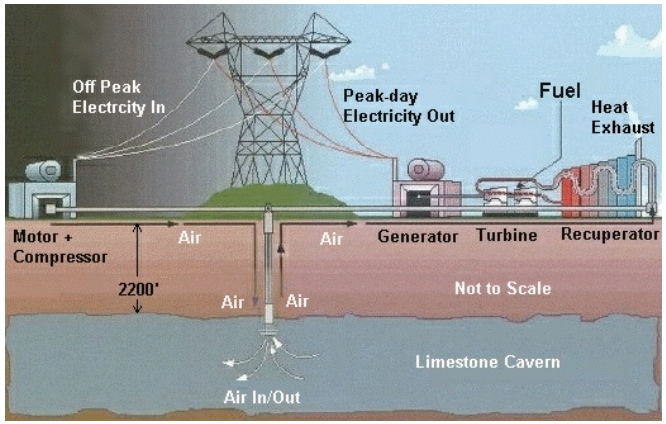


How to optimize the system while integrating intermittent renewables ?



Storage at every scale will « disturb » business as usual

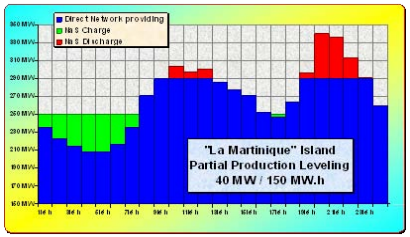
Demonstration projects for CAES
(Compressed Air Energy Storage)



Nant de Dranse 600MW pumped storage project

Swiss operators to sell peak load to Europe ?

NaS batteries

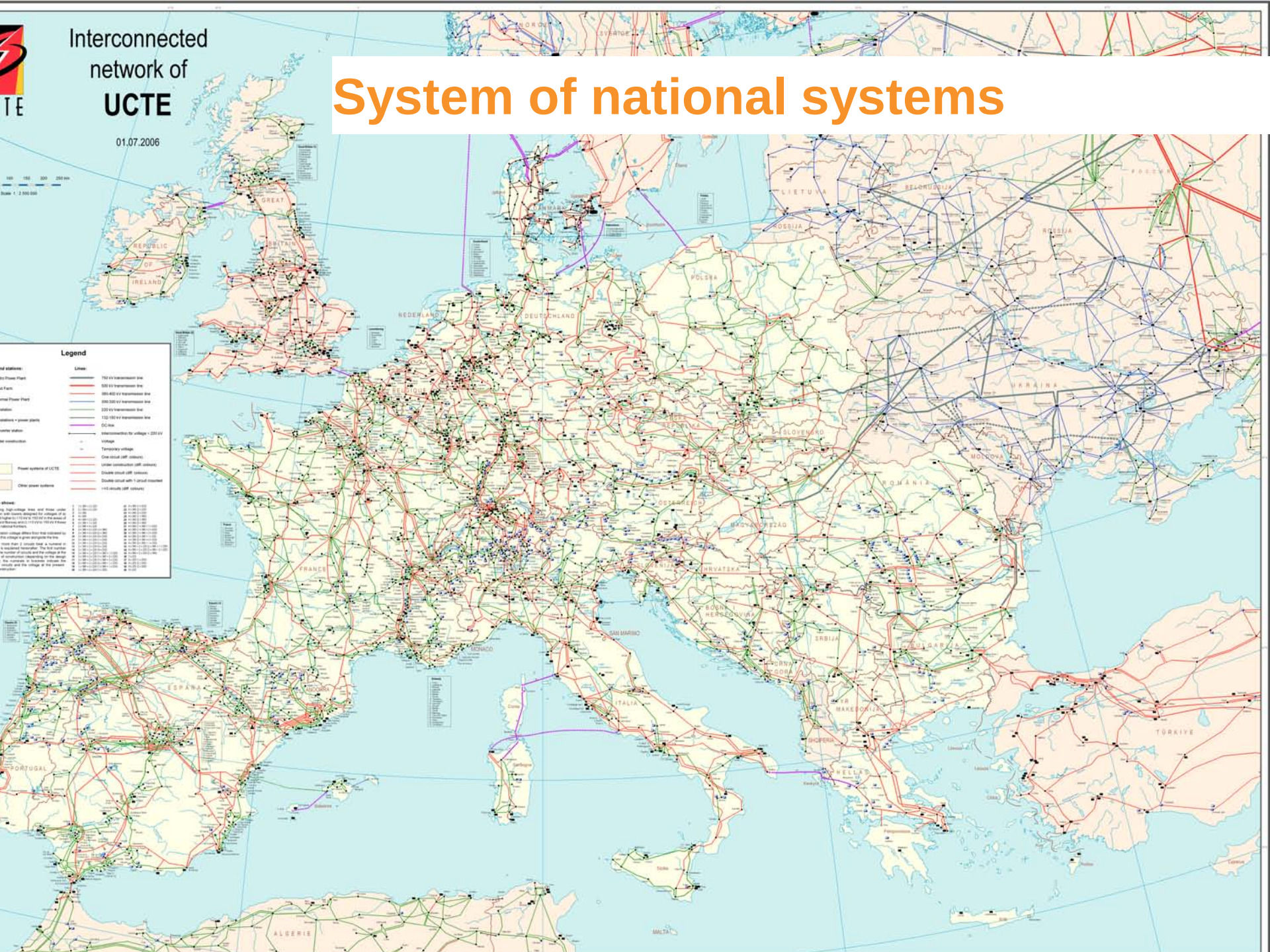


Sites in La Réunion (France) and hundred sites in Japan, more than 150 MW

Ota City (Japan)

Houses with PV, 2MW in total

System of national systems



Conclusion 1: the need for….

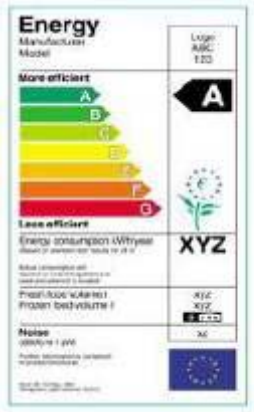
smart stable regulations

which implies

*systemic research

**and* smart politicians…

Conclusion 2 : more electricity for less CO_2 for sustainable development



Energy efficiency

Renewable energies

Nuclear energy

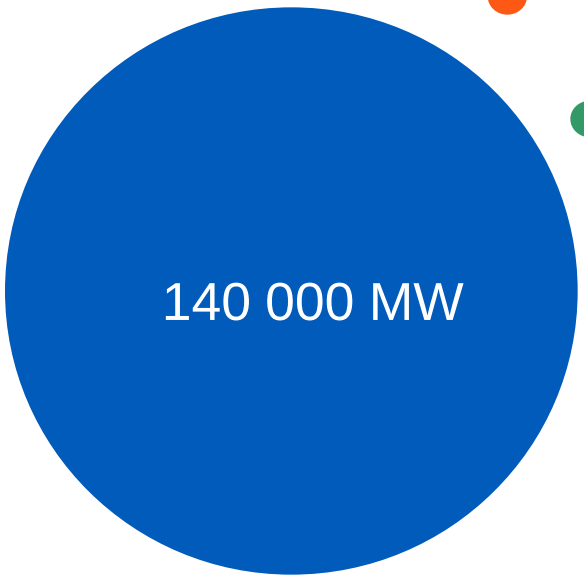
Thank you
for your attention !

yves.bamberger@edf.fr

Le stockage d'énergie sur les réseaux électriques dans le monde.

Station de transfert d'énergie par pompage de Grand-Maison 1680 MW

Salle des machines d'un barrage



- Stockage d'air comprimé et turbine à gaz: 477 MW
- Batteries Sodium Soufre: 400 MW
- Batteries Plomb acide: 125 MW
- Batteries Nickel Cadmium: 40 MW
- Batteries Lithium ion: 15 MW
- Batteries redox flow 10 MW

Source Fraunhofer Institute, EPRI, EDF R&D