SMART GRIDS

An opportunity to modernize the development of distribution network ?

Alain DOULET

MACEIO, November 8th, 2011

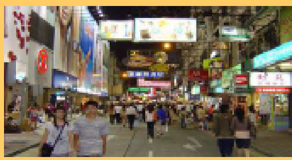
Contents

MAJOR CHANGES IN THE CONTEXT

Challenges in power transmission and distribution also require innovative automation concepts and technologies…

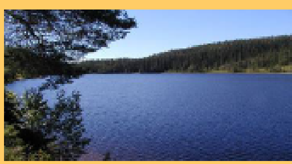
SIEMENS

Need for more energy

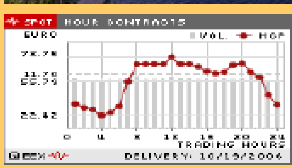


Urbanization

Scarcity of natural resources



Environmental awareness

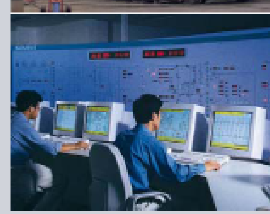


Open markets

Increased use of distributed and renewable energy resources

Capacity increase and bulk power transmission over long distances

Distribution within congested areas / mega cities



Goal: reliable, flexible, safe and secure grids

© Siemens AG 2006

A fundamental change

Till now, the system was balanced by adjusting production to demand .

To morrow, acknowledging inevitably intermittent generation means adjusting demand to production

Yesterday, energy management was the job of electrical utilities

To morrow, all customers must be involved in their own energy management

WHAT ARE SMART GRIDS?

Smart grids

- Converging technical opportunities
  - convert the traditional network into a system assuring end-to-end continuity from generation equipment, through the network to customer installations
  - switch from a simple electrical network to a system that uses both the traditional network, services from telecommunications networks and the services offered by mass data processing
  - take advantage of the services provided by “smart meters”

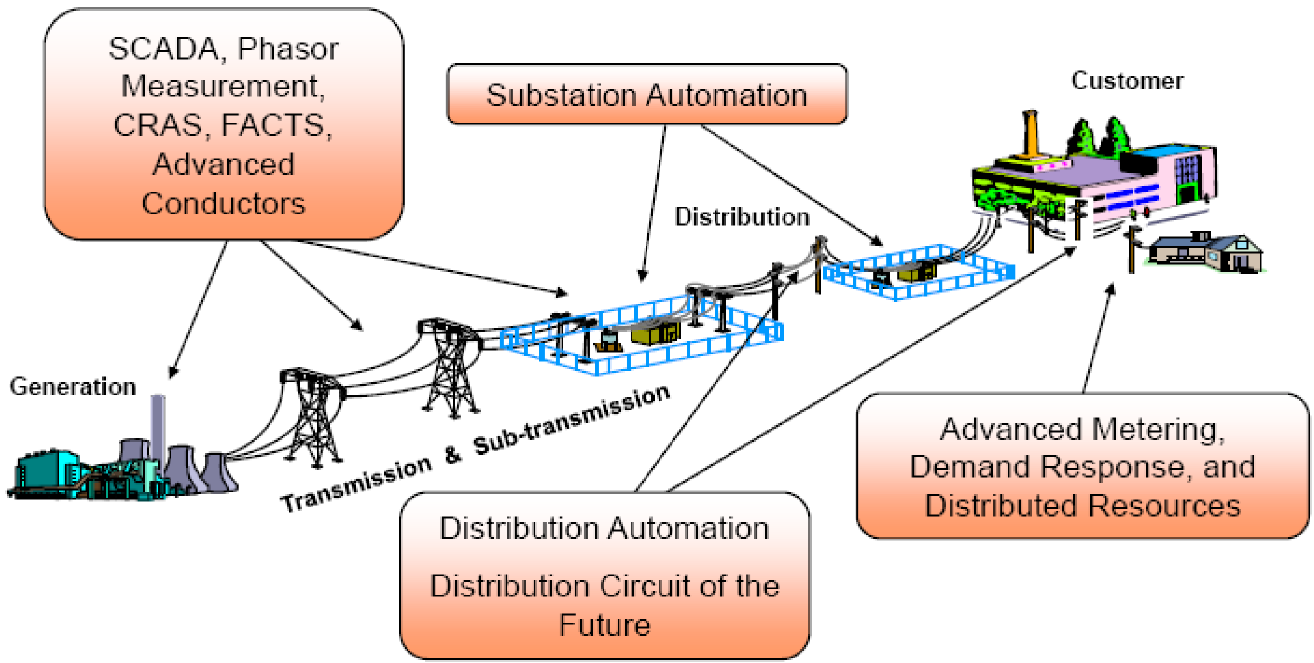
Smart grids

- And the emergence of new needs:
  - integration of decentralised production, often connected to the distribution network, not originally designed for this purpose, often intermittent
  - management of the power demand and involvement of the end customer in the management process
  - Connection of new uses like electric vehicles
  - Better asset management
  - quality of supply improvement

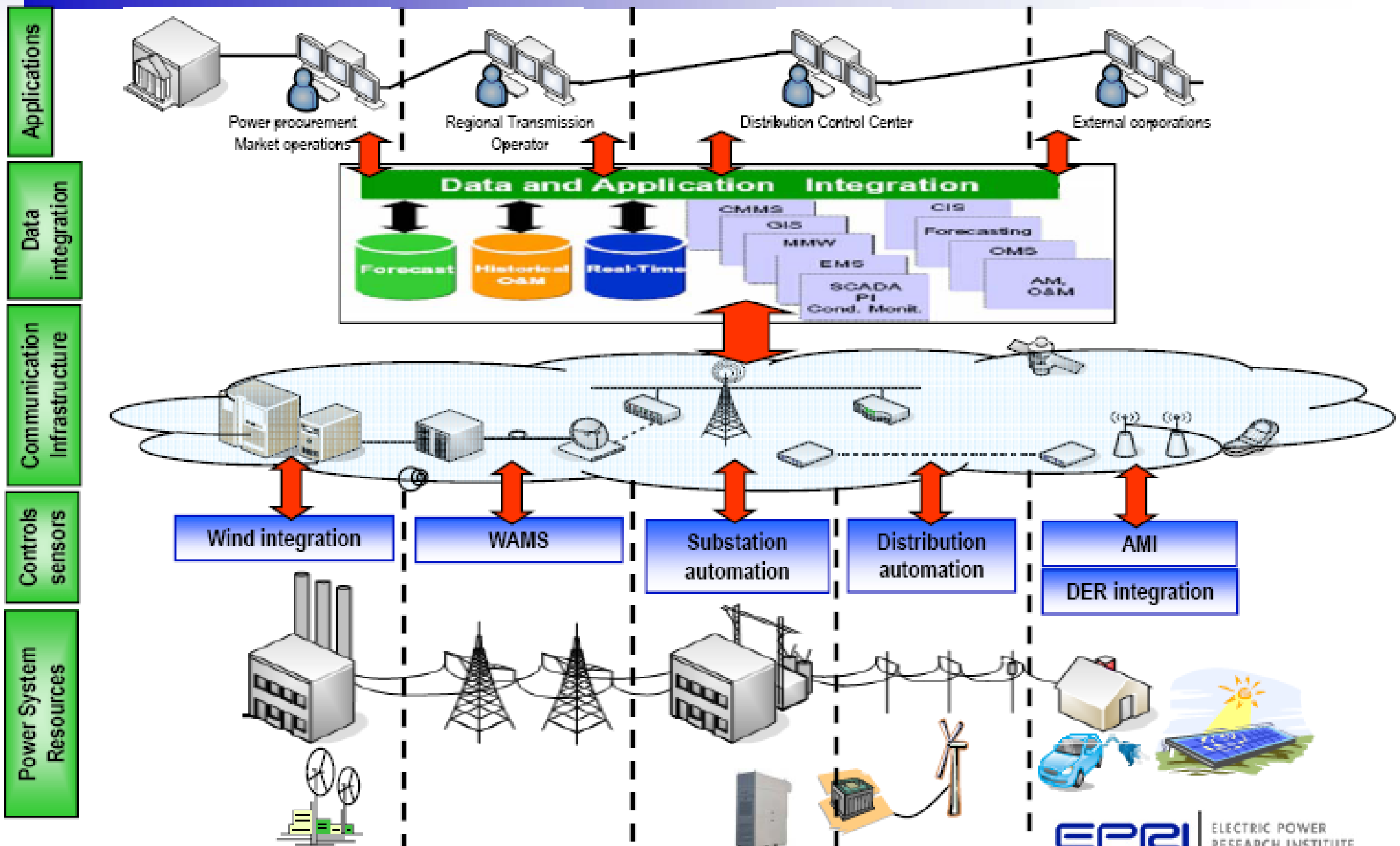
Smart grids

- Insertion of intelligence into the transmission network began long ago
  - The high cost of transmission equipment justified the inclusion of intelligent systems: sensors, power electronics, etc.
  - Telecommunications services have already been used in the operation of control systems
- The new services expected:
  - Consideration of decentralised production
  - Management of demand from the customer perspective affecting first the organisation of the distribution network and the links between the transmission and distribution networks.

SCE Smart Grid Activities



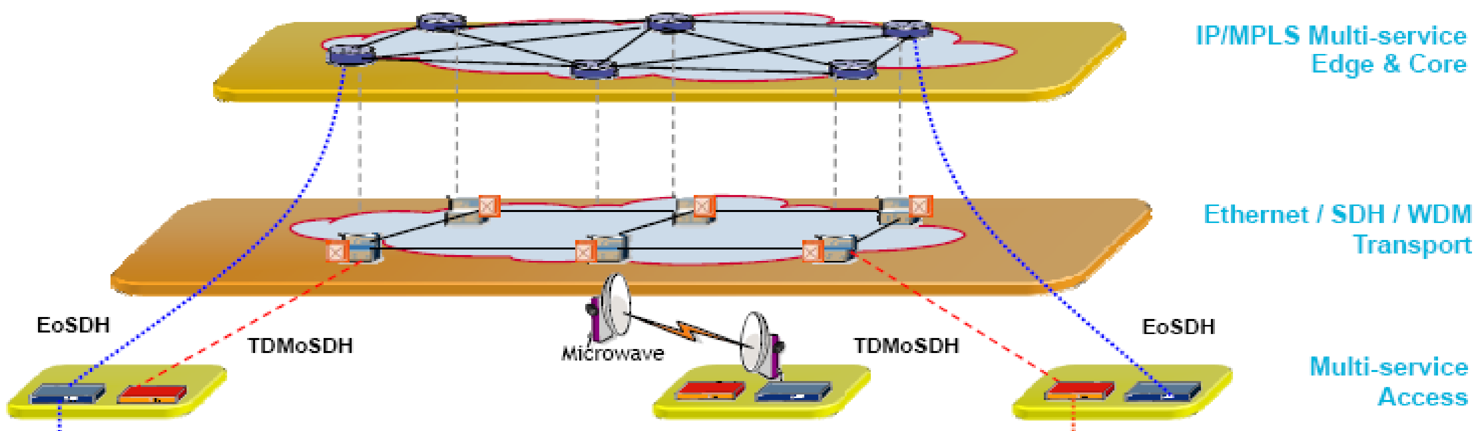
Smart Grids



© 2006 Electric Power Research Institute, Inc. All rights reserved.

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Smart Grid communications architecture: new generation networks



IP-based services, eg
- SCADA
- Voice
- LAN/WAN
- etc

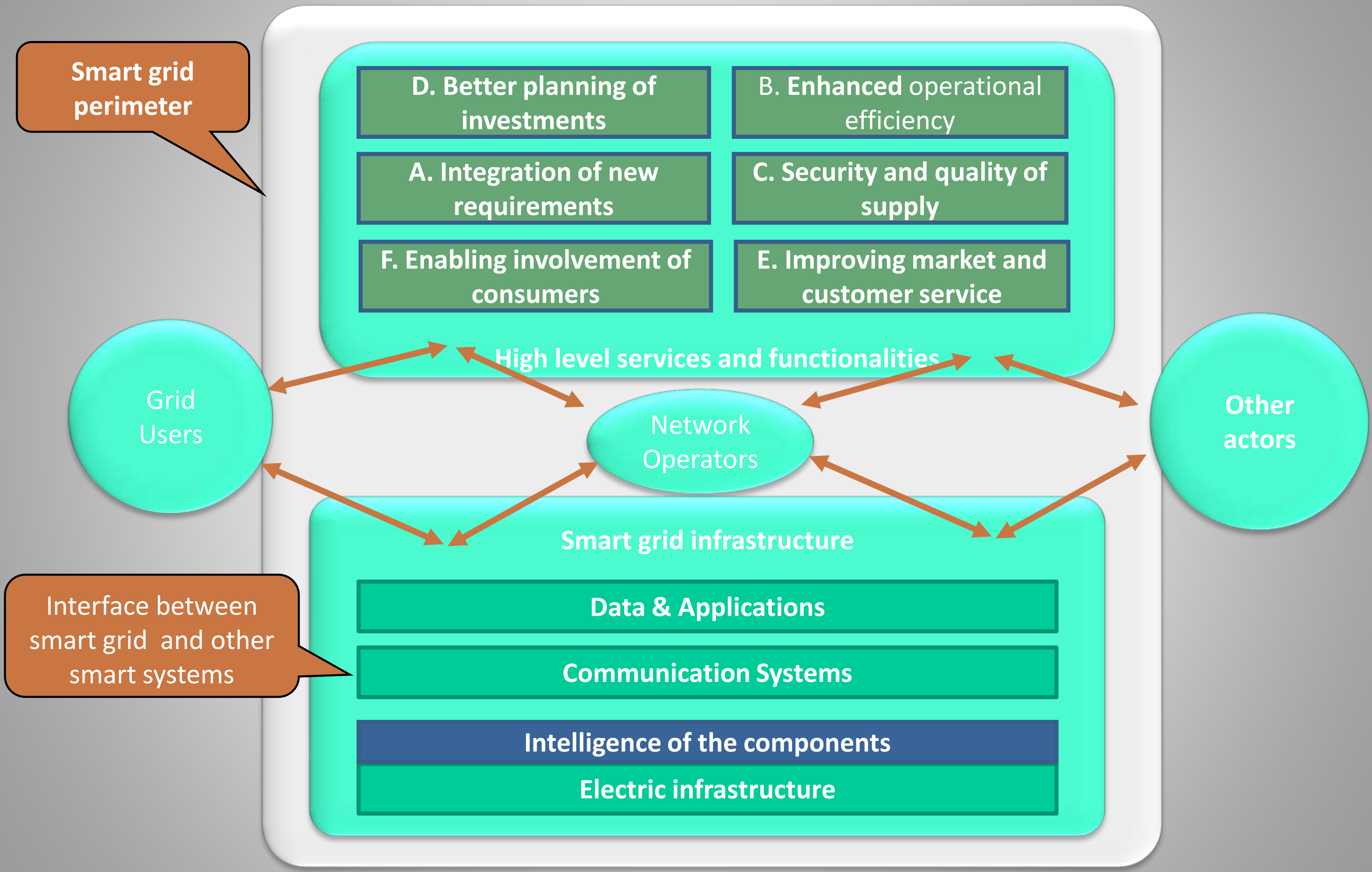
- EoSDH module
- MPLS switch
- SDH mux

Legacy services, eg
- Teleprotection
- Legacy SCADA
- TDM Voice
- etc

A proven and mature network architecture to enable Smart Grid communications

All Rights Reserved © Alcatel-Lucent 2007, xxxxxx
Alcatel-Lucent

European Union vision on smart grids services



TECHNICAL ASPECTS

Smart grids imply the deployment of an infrastructure

- Sensors / switches on the network to collect real-time data
  - Among the sensors, the 'smart meters' are an essential though not crucial brick
  - These meters can be prepayment meters
- Telecommunication supports to transmit these data between the network and the different processing centres
  - The supports must be pooled for several applications to ensure that the system is sufficiently cost-effective
- The data collected are processed centrally
  - in existing systems with enhanced functionalities
  - in new systems required to process the new types of data collected (e.g. remote meter readings or transfer of energy payment for prepayment systems)

What sensors/switches?

- Smart meters installed at delivery points
  - Metrology data for commercial use, possible prepayment system
  - Pi, Pmax, outage, voltage levels, power direction
- Sensors in MV/LV stations
  - on transformers, LV fuses: load, voltage, temperature
  - on MV equipment: remote control and surveillance
- Fault sensors distributed over the networks
  - indicate when fault current is transmitted
- Sensors on underground links are usually integrated into temporary measurement systems
  - partial discharge in the cables
  - Delta tangent

What sensors/switches?

- ❑ Observability of decentralised generation
  - o Proper insertion of decentralised generation into the network assumes measurement of the power fed in and control of this generation (followed or not by direct action on the equipment)
- ❑ Sensors in primary and secondary substations
  - o command of outage instruments
  - o measurement of load and voltage
  - o monitoring of equipment (circuit-breaker, bus, etc.)

What telecommunication supports?

- The data collected by a sensor is useful only if it is accessible remotely and almost in real-time
- The communication infrastructure must therefore link the sensors to data processing centres
- The cost of the communication network infrastructure, investment and operation and the conditions for its installation are key elements in construction of the business model
- Analysis of communication needs (response times, bandwidth) is used to determine the appropriate technical solutions.

What telecommunication supports?

- The local loop
  - Advantage of PLC (Power Line Communications) with concentration at the MV/LV station (or further upstream of the network structure) and data transfer to an upstream network
  - Short-distance radio (provided that technical validation is given according to local constraints)
- The upstream network
  - A must: fibre optic cable when deployed
  - The GPRS: best cost/performance compromise
  - Satellite
- Dedicated links for installations on the premises of major customers, in transformer stations, in production facilities, linking the sensors directly to the processing centres

Data processing

- Large increase in the volume of data
  - Analysis, control, storage, use
- Certain existing systems are enhanced:
  - SCADA
  - System for managing exchanges between network operators and suppliers
- A number of systems are created:
  - Meter control centre
  - Management of remote meter reading or energy prepaid

➔Complex information systems

➔Data and process security to be guaranteed

BUSINESS MODEL

Components of a business model

- Investments
  - Installation of sensors, including meters
  - Development of the communication system
  - Development of the data processing system
  - → Integration of smart grids investments in a global program of network renewal optimizes the total cost
- Operating costs
  - Management of the communication system
  - Data management (marked increase in quantity of data)
  - Equipment maintenance
  - Stranded costs (essentially meters)

Components in a business analysis

- Gains
  - Remote meter readings (or prepayment infrastructure)
  - Remote commissioning and decommissioning
  - Reduction of non-technical losses
  - Reduction of outage duration and simplification of power restore operations
  - Potential gain in energy and power managed by demand management actions

SERVICES
THAT CAN BE OFFERED

Smart grids provide opportunities to enhance the quality and efficiency of service

- improve power restore and fault clearance procedures in the event of a fault
- have a more accurate idea of the actual load on the networks and therefore optimise their running
- improve reinforcement analyses
- anticipate the renewal of obsolete networks further upstream
- combat non-technical losses and fraud
- optimise the supply / demand balance

Improving fault clearance

- Like concentrators in MV/LV stations, smart meters inform the operator of the absence of voltage on the network and provide data to help detect the fault location
- The notion of ‘self healing’ is often highlighted
  - the network is automatically reconfigured in the event of a fault – self-healing
- Information given to the customer can be improved
  - Lead-time to power restore
  - Cause of outage

Optimise network operation

- The availability of real-time data on energy flow on the network helps:
  - operate to maximum capacity
  - avoid the emergence of any uncontrolled constraints
- The communication system between the control centre and the network nodes improves the financial assessment of remote control systems, enabling their numbers to be increased

Analysing reinforcements

- Accurate knowledge of load curves at each point of delivery contributes to
  - either performing network calculations without modelling based on the recorded energy flow,
  - or to fine-tune the calculation on the consumption model, by multiplying the possible measurement points or by making the models more precise.
- Smart meters usually help identify the connection phase
- Precise knowledge of voltage levels per point of delivery means that anomalies can be detected:
  - Neutral wrongly sized
  - Voltage drop outside the public network (e.g. internal installation)
- Data on voltage levels in MV can also be made available

Optimising renewal operations

- One of the touchy issues in asset management is determining the remaining lifetime of the oldest links
- Cable monitoring provides further knowledge on assets
  - off-line monitoring
  - on-line monitoring

  and therefore improves probabilistic evaluations of the failure risk.

Reducing non-technical losses

- Having a real-time overview of all points of delivery coupled with metering at MV/LV stations helps draw up consumption balance sheets and detect fraud hotspots
- Installing smart meters enables each service line to be re-examined and any illegal configurations removed
- Regular index readings help rapidly identify any abrupt breaks in consumption.
- However, we do not know how long the positive impact of installing smart meters on the level of fraud will last.

Optimising the supply / demand balance

- In an almost-balanced system with infrequent load shedding, smart grids offer the possibility of replacing rolling interruptions by fine management of the extreme peak
  - Sending signals to interruptible customers
    - in particular, industrial or commercial customers
  - Routine selective load-shedding per customer segment based on specific contracts.
    - can be used only for customers with a high consumption rate, including a mobile percentage.

Smart grids provide services for a fluid competitive market

- ❑ Customer switching is easier
  - o Possibility of remote meter reading at any moment
  - o Remote connection and disconnection
- ❑ Real time price becomes a reality
  - o With smart meters, price signals can be sent and multi register meters allow to use them
- ❑ Better load profiling for a more precise energy balancing

RISKS AND OPPORTUNITIES

The risks inherent to this type of project

- Cost-effectiveness is usually determined by a triple gain
  - gains on clientele management
  - gains on service sales and the benefits in terms of power and energy profiles
  - gains on network management

  Loss of one of these gain factors can jeopardise the business model.
- The following criteria must be considered:
  - the risk on acceptability and customer involvement
  - the capacity in an unbundled system to pass on the costs supported by the distributers and transporters for the benefit of producers and suppliers
  - the uncertainty as to the reliability of equipment and the short life of new equipment installed
  - the complexity of the information systems, the volume of data to be processed and the consequent security issues involved

Acceptability by customer

- The gains anticipated from demand management can be attained only if
  - the customers are motivated
  - consumption is high enough for arbitration decisions to be made
- Yield management of demand only makes sense if the generation/consumption balanced is generally achieved without frequent load shedding
- The process raises the question of personal privacy

Distribution of financial costs

- The smart grids infrastructure is deployed mainly by network operators
- The beneficiaries and service providers are the network operators, the producers and the suppliers
- In an open market, how can the financial costs of the infrastructure be passed through to the service providers? How can actors be remunerated to encourage greater quality and optimise energy use?
  - New types of regulation to be devised

Equipment reliability and useful life

- A substantial share of the gains stems from the automation of certain processes
  - this assumes reliable equipment, not requiring excessive maintenance, in the automation process. This point must be checked after time and with some experience
  - any generic fault (on meters in particular) would have serious consequences
- One of the technical challenges is the cohabitation of electro-technical systems with a working life of 30 to 40 years alongside electronic and I.T. equipment with a working life of 5 to 10 years. The shorter working life of the latter must be considered in profitability analyses.

Complexity and security of ITSystem

- The ITSystem connected to the smart grids is not the essential cost factor but can be a risk factor
  - complexity
  - size
  - quantity of data
  - cybersecurity (connection between technical and commercial data)
- Data processing is useful only if the results are exploited
  - Cost of exploiting the data

Real opportunities

- The technologies are mature
- The entrepreneurs are motivated
- Experiments are underway in many countries
- The political decision-makers are keeping a close-eye on smart grids as they contribute to achieving the objectives of energy policies
- Major investment is required on a number of electricity networks, which makes it a good time to rethink their design

Conclusion

- Smart grids are the core element in the process to improve the quality and efficiency of service
- A project that federates in a world where business disciplines are compartmented
- Economic, industrial and societal risks to be managed
- A powerfully mobilising factor for decision-makers in recent years, as this project contributes to achieving the objectives set out in energy policies.