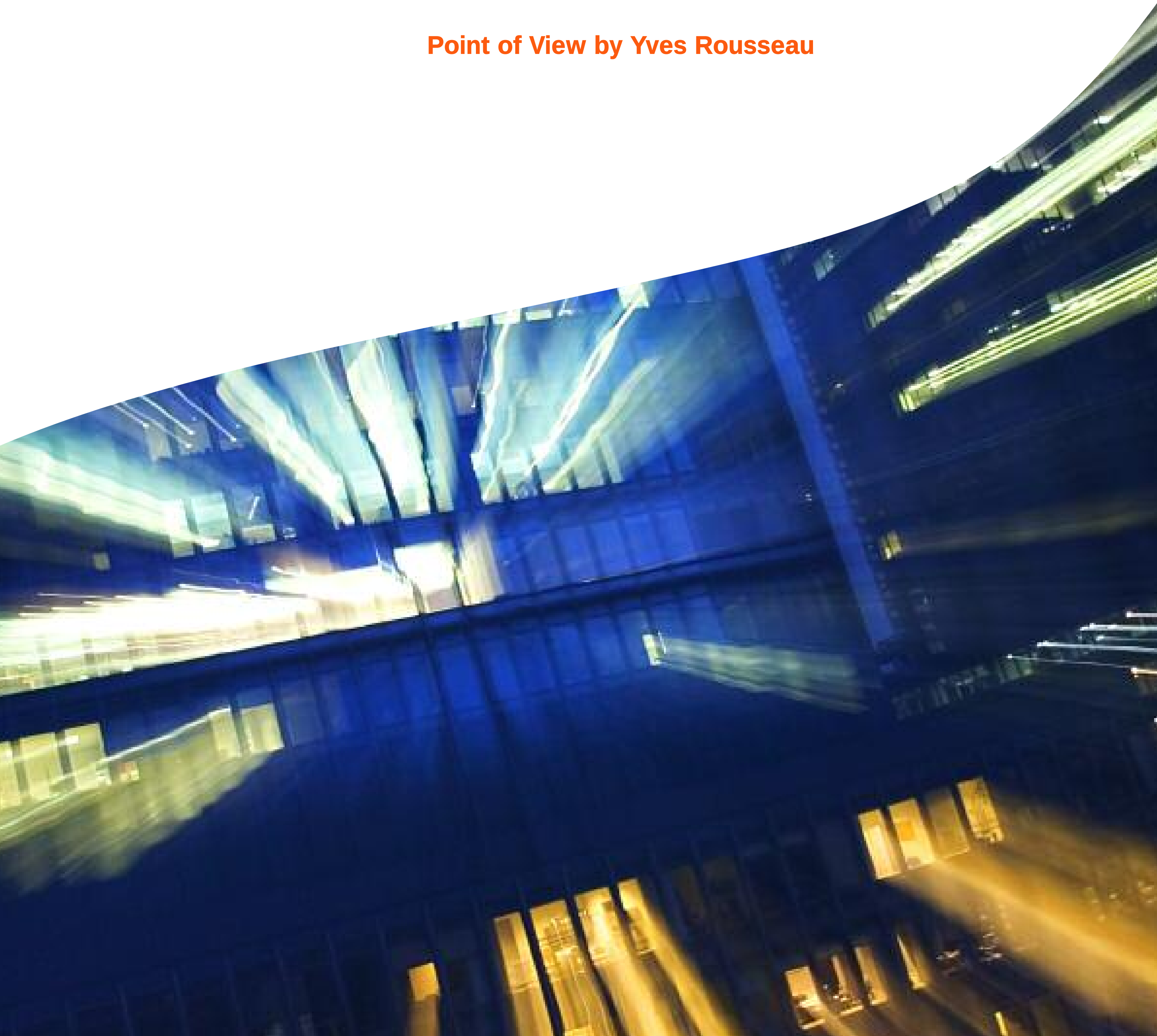
Assessment for the launch of a smart metering project: Illustration with the French business case

Point of View by Yves Rousseau



Contents

Introduction and Definitions

Many countries have started shifting from the existing population of low-voltage power meters to a generalized remote reading or remote management system. These initiatives are aimed at deploying meters with extended functions, in particular: remote transmission of the index, remote transmission of the interval data, remote disconnect and changes of authorized maximum power.

In addition, the latest EU texts invite the member states to adopt more flexible tools that will make it possible to:

- Evolve to real-time demand side management[1],
- Provide users with information about the precise time at which energy is consumed,
- Provide users with bills based on actual consumption[2].

This Point of View is based on a project which was achieved in collaboration with the French energy regulatory authority (CRE). It provides information on key elements of comparison for seven smart metering experiments carried out worldwide. Furthermore, it gives insight into the various technologies that should be considered and suggests approaches for the development of a business case for the global deployment of a telemetering solution.

For a clear understanding of the different smart metering solutions, a few definitions should be set out. Two levels of smart metering devices can be distinguished:

- Automated Meter Reading (AMR) is automated telemetering. The device allows the uploading of information from the meter to the operator of the metering solution.
- Automated Meter Management (AMM) is AMR plus complementary services. It involves automation of manual technical services in connection with metering (activation, change of authorized power, etc.). The device allows two-way communication between the meter and the operator of the metering solution.

Advanced Metering Infrastructure (AMI) is not comparable to AMR and AMM. It designates the set of advanced metering components and technical architecture that allow AMM operation.

1 European directive 2005/89/CE of 18 January 2006   2 European directive 2006/32/CE of 5 April 2006

Main lessons to be drawn from international experiments

First of all, the scope of the regulatory context of the smart metering experiments in progress varies widely in the different countries, as is shown in Figure 1.

While the business cases are structured differently according to the regulatory models, there is however a recurrence of the types of benefits expected from the standpoint of the performance of the electrical system, in particular for the distributor in the case of an AMM-type device:

- Lower billing costs,
- Lower customer management costs,
- Less meter fraud,
- Fewer calls to customer service,
- Lower meter checking costs,
- Lower network troubleshooting costs.

The expected end customers' benefits come first of all from billing on the true index, better information about consumption and the elimination of manual operations requiring the customer's presence. Other expected benefits include the development of time-of-use pricing and of home automation services as well as the impact on consumption, but they are likely to come into effect later on.

Figure 1 : Legal framework and main orientations of smart metering experiments in selected countries.

	Legal framework	Institutions involved	Main orientations
California	Energy Action Plan I Energy Action Plan II	CPUC (Regulator)	• All operators required to submit Business cases • Financial aid for deployment • Goal is completion of a 20 million meter deployment prior to the end of 2012
Ontario	Directive imposing conversion of meters	Government	• Schedule for conversion of LV meters (residential and business) to smart meters (2007-2010)
	Massive deployment plan	OEB (Regulator)	• Deployment of 5 million meters prior to the end of 2011
	Energy Conservation Responsibility Act	Parliament	• Creation of a Smart Meter Entity to drive the integration of the smart metering and data collection system
Sweden	None	Parliament	• June 03: monthly billing on basis of actual data from July 09 • Bill in preparation to require operators to inform end customers of power outages and to indemnify them • Deployment to every customer needs to be complete prior to July 2009
The Netherlands	Draft bill of February 2006	Ministry of the Economy	• Definition of procedures for conversion of low-voltage meters: all LV customers will have smart meters with capabilities of communication and of connection to advanced software executable on commercial option
			• Smart metering mandatory for all new electricity contracts / costs regulated
Italy	Deliberation 292/06	AEEG (Regulator)	• Directives for the installation of smart meters on the low-voltage electricity network
Germany	None	VDN (Association of Electrical Operators)	• Smart metering working groups that created the eHZ program
United Kingdom	None	OFGEM	• Business case demonstrating the absence of economically viable solutions

In the following, selected countries are analyzed regarding the scope of their smart metering experiments, the impacts of the experiment on regulation, governance and their business case.

California / USA

Scope of the Smart Metering Experiments:

- Clear energy control objectives

In California, the smart metering experiments are clearly focused on energy control objectives. They are based on two Energy Action Plans which were published and proposed by the California Public Utilities Commission (CPUC). The Energy Action Plan I of 2003 recommended recourse to advanced meters in order to stimulate the development of time-of-use pricing formulas (varied by season and time of day), and invited the operators to think about plans to deploy smart meters. In July 2004, the intention of the CPUC was confirmed by a decision setting functional requirements for the deployment plans of the main private operators (Pacific Gas & Electric (PG&E), Sempra and Southern California Edison (SCE)).

While PG&E rapidly accepted the CPUC's approach, the criticisms voiced by SCE concerning the non-viability of the business case led the CPUC to step up the pressure with the publication of the Energy Action Plan II in 2005. It then required the operators to submit a feasibility study and a business case for the deployment of smart meters "within a reasonable time". It set up financial aid to the operators for the deployment.

Impacts on Regulation and Governance:
Very strong incentives from the "overseeing authorities" and autonomy of response of integrated operators.

Business Case
The process is based on the development of positive business cases by the operators and of deployment support measures. Southern California Edison announces for example that it has identified additional economic levers (beyond the mere savings linked to the reduction of the payroll of meter readers) by including in its business case the benefits expected in terms of adapting the demand for electricity to the available supply. This is possible thanks to remote adjustments of heating/air-conditioning as a function of the peak and thanks to better consumption information made available to customers. The main promise to the end consumer is better control of consumption. The equipment and deployment costs will be paid off only when customers accept the new pricing.

In California, large benefits are expected in terms of control of the demand for electricity, thanks to remote adjustment of heating/air-conditioning as a function of the peak.The Americans are the only ones to assign a value to the introduction of functions allowing better matching of demand to the existing supply. All three of the major Californian Utilities employ "demand response" as one of the key variables making positive business cases possible.

Ontario / Canada

Scope of the Smart Metering Experiments:
- Clear energy control objectives

In Ontario, the authorities' main objective is greater control of consumption peaks and of the network load. The implementation of time-of-use pricing and of erasure services from the smart meters for all residential customers was aimed at changing behavior by giving a better idea of the true cost and availability of electricity. This objective is massively supported by the government, the parliament, and the state regulatory authority, which coordinated their various levers of action to come up with the most successful plans to convert the existing population of low-voltage meters in any of the seven countries of the comparison.

Impacts on Regulation and Governance:
- Highly prescriptive regulatory scheme aimed at improving the functioning of the retail market by reinforcing a centralized organization

Ontario has the most complete regulatory framework, since political will led to convergent action by the Ministry of Energy, the regulatory authority and the Parliament. The Directive issued by the Ministry of Energy on 16 July 2004 imposes a timetable for the conversion of the population of existing low-voltage meters (residential and business) to advanced meters; by 31/12/2007, objective of installing 800,000 meters (replacement coinciding with the end of life of the old meters); by 31/12/2010, objective of generalized installation (5.1 million meters). This Directive is completed by a plan for massive deployment of advanced meters, submitted to the Ministry of Energy by the regulatory authority, the OEB. Finally, the Energy Conservation Responsibility Act (Bill 21) voted by the Parliament on 27 February 2006 empowers the government to decide the financing of the advanced meters and of the undepreciated assets that will be replaced. It announces the creation of a structure, the Smart Meter Entity (SME), that will be the driving force in the integration of the smart metering system and will have the right to collect metering data from any party (consumers, Distribution Network Managers (DNM), etc.). Finally, the Energy Conservation Responsibility Act paves the way to new measures that will deal concretely with the deployment of the new meters: specification of prerequisites for the meters, the associated equipment, the systems, the technology, conditions of the deployment of the meters and of the tendering procedures, definition of the scope of intervention of the DNMs in metering activities, delegation of authority to the Independent Electricity System Operator (IESO) to choose the model of operation, the type of systems and services necessary for the collection, management, and processing of and access to the metering data, smart metering procedures in specific housing units.

Business Case

In Ontario the total cost of the industrial projects is estimated at CA$1 billion, which represents a monthly charge of CA$3-4 per customer per month once for an average bill of CA$80, or approximately 6-8% per customer.

Sweden

Scope of the Smart Metering Experiments:
- Objective of improving contractual supplier-customer relations

Sweden is an exception as the development of advanced meters is not mandated by law, but the introduction of the obligation to bill monthly on the basis of actual consumption data from 1st July 2009 has created a strong incentive for the Swedish operators to convert the existing low-voltage meters. This orientation is confirmed by the legislature, which is working on a draft bill that would require the operators to inform consumers of power outages and to indemnify them for very long outages.

Impacts on Regulation and Governance:
- Very strong incentives from the "overseeing authorities" and autonomy of response of integrated operators

In Sweden, the absence of legislation specific to advanced metering and the merely legal unbundling of distribution activities leave the operators quite free to determine what smart metering schemes they implement. The comparison also finds very distinct projects, without the question of interoperability of the systems being dealt with. While all the operators plan to deploy AMM projects, only Vattenfall has made significant progress in the deployment of its project. Vattenfall has signed contracts with three consortiums (Actaris / Senea, Iskraemeco / VM-data and Telvent / Echelon) to test different solutions on the deployment of several hundred thousand smart meters. These deployments were an opportunity to test several communication technologies (PLC, GPRS, RF).

Business Case

In Sweden, the Government does not rule out the possibility that part of the investment should be financed by a higher price for network use (or routing rate, a rate that is regulated), commensurate with the benefits perceived by end users.

Netherlands

Scope of the Smart Metering Experiments:
- Objective of improving contractual supplier-customer relations

The smart metering project is part of a larger Ministry of Economic Affairs set of rulings for an optimal working of the energy retail market. The liberalization of metering activities led to a rise in the rental charge for meters "out of proportion to the services provided", according to the Dutch regulatory authority. Furthermore, the Ministry of Economy introduced a draft bill aimed at specifying the terms of conversion of low-voltage meters. All users will have advanced meters (capable of communicating and of running optional software), within approximately six years. For any new commissioning, new housing, or replacement of meters, the installation of an advanced meter is made mandatory. The cost of the physical meter is regulated. Energy suppliers must outsource, to specialized companies, the metering data management activities for which they are responsible as the customers' sole contact.

Business Case

In the Netherlands, the costs of advanced metering will be included in the distribution rates. The cost for deploying smart meters will be carried by the grid operators and the meter tariffs will be regulated, but shall not increase compared to the present cost level (annually around €20 per meter). Grid operators will be responsible for raw data collection and new commercial meter data companies will be responsible for data processing, VEE, incidental meter reads (e.g. switching, move in/move out) as well as meter data related innovations.

Germany

Scope of the Smart Metering Experiments:
- No specific legislation for smart metering, and the only advanced metering projects launched are pilots of limited scope

In Germany, advanced metering for private customers is in its infancy, and the introduction of telemetering systems seems not to be topical. The 13 July 2005 energy law EnWG opens the metering market to competition, for the procurement and the physical maintenance of the meters. The German regulatory authority expects the players in the market to make an active contribution to defining standards in the power metering market. Thinking is in progress within the VDN on ways to implement an advanced metering system. But the meter ownership regime, which makes the end customer responsible for the meter, seems to be an obstacle to the conversion of the existing population of meters.

Italy

Scope of the Smart Metering Experiments:

- Integrated operator strategy on a monopoly

In Italy, ENEL has deployed the largest European advanced metering project, an AMM system aimed at more than 30 million customers, for a total investment of €2.1 billion. But the very extensive functions initially planned in the project have not yet been implemented. Note that the smart meter used in the context of ENEL's Telegestore project allows a change of pricing formulas (against payment of a service charge close to 100 euros). The consumption data reading frequency is still two months. ENEL itself designed its AMR meters, developed them with its partners, and had them manufactured in China by industrialists. The standard meter/ concentrator communication protocols (marketed in particular by Iskraemeco in Italy) and concentrator/AMM system communication protocols (DLMS, for example) were shut out of the market by Enel's choice to develop proprietary technologies.

ENEL is posting record returns on its investment because of the contribution of advanced metering to reducing fraud (abnormally high in Italy). The lack of interoperability of the architecture of the Telegestore project may also suggest that ENEL was trying to close its retail market even more.

Impacts on Regulation and Governance:
Attempt by the Italian regulatory authority to "recapture" infrastructure in order to adapt it to changing market rules.

Business Case
In Italy, since the dominant operator developed its migration project in the absence of any legal framework, ENEL's business case is essentially based on the collateral benefits of automated metering (reduction of fraud) and serves a strategy (de facto) of closing of the domestic market / strategy of conquest of domestic markets served by other regional-scale operators (AEM Roma). This model leaves the regulatory authority AEEG with little room to manoeuvre to establish its regulatory apparatus. In the absence of initial coordination in the industry, the pioneering deployment of Telegestore did not lead to the common adoption of standards by the national market. But at this stage, the question of the impact on ENEL's project remains open: will this deliberation lead to the design of a centralized data exchange system (somewhat like Ontario's) to escape the interoperability constraints imposed by the architecture implemented by ENEL, or will the regional operators finally be forced to gradually accept the standards defined by the dominant operator?

In Italy, ENEL's investment is the largest: €2.1 billion over five years. Amortization is calculated on expected annual savings of the order of €500 million. ENEL states that its investment has already paid for itself thanks to the large improvement of its sales through fraud reduction.

United Kingdom

Scope of the Smart Metering Experiments:

- No specific legislation for smart metering, and the only advanced metering projects launched are pilots of limited scope

In the particular case of the United Kingdom, it should be recalled that it is the country where the process of deregulating metering activities is the most advanced.

The opening of the metering market has proceeded gradually since 2003 and will be completed in 2007: initially, the distribution network managers held the assets linked to metering and re-invoiced the costs to the suppliers (network access cost).

In the transition stage of unbundling of distribution and marketing (2003 - 2007), electricity suppliers were responsible for metering activities, which they could insource or outsource to service providers and with respect to whom the DNMs still had an obligation of last-resort service. In this last case, the DNMs could still re-invoice metering-related costs (for equivalent service) to the suppliers and the costs of the various metering services were still regulated.

Since April 2007, metering activities are totally deregulated. The DNMs are no longer subject to the obligation of last-resort service. The market of metering service providers is assumed to be robust enough and more competitive than the DNMs. The prices of metering services are no longer regulated. However, the historic meter ownership regime in the United Kingdom means that the DNMs currently hold ~90% of the English meter population. The transfer of the Meter Asset Provision activity to service providers could take a long time and so be an obstacle to the development of advanced metering.

Business Case
The United Kingdom is planning to deregulate metering activities totally, leaving few levers for public financing.

Conclusion

The business cases, when known and positive, show the predominance of an integrated approach with as incentive a large profit centered on demand management. Today, most of the projects concerning the conversion of low-voltage meters are being implemented by vertically integrated operators or by regional or local distribution network operators. At a time when few business cases seem to have stabilized, the financing of the conversion remains in most cases an open question.

Similarities of the selected technologies

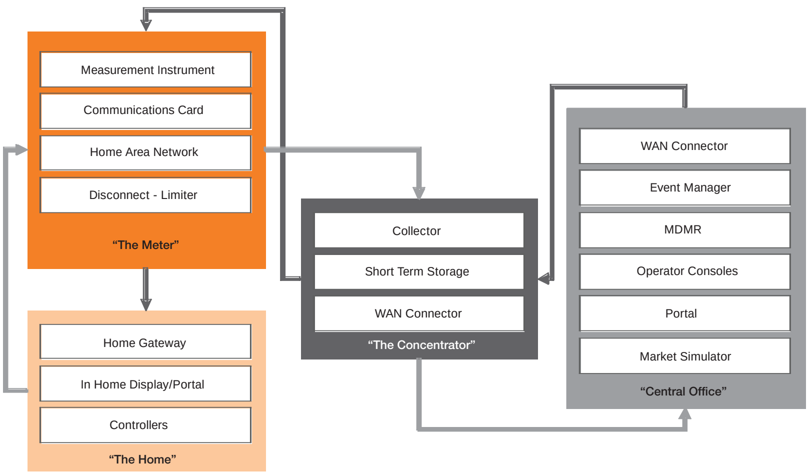
The major components that emerge

An advanced metering infrastructure is a system allowing two-way communication between the distributor, energy suppliers and energy consumers on the one hand, and the energy meter on the other. An AMM/AMI infrastructure comprises three main elements:

- An advanced meter,
- Communication networks capable of carrying two-way calls. At this level, it is possible to distinguish two types of need:
  - A data collection need, with unit volumes that are generally very low (of the order of a few tens of bytes) and a frequency of collection that may be high,
  - A data transmission need, for volumes of a few tens of megabyte (MB) and a relatively low transmission frequency (daily, even weekly).
- A computerized telemetering and remote management system or AMM system that does not necessarily perform many specialized functions.

These functions vary from one system to another but fall into five categories: Data collection, data correction, data estimation, data calculation and data publication. The final choice will be the result of the current status of the actor information system and architecture strategy.

Figure 2 : The components of an AMM infrastructure



The main technological choices

Intelligence at the end of the network

At the lowest level of the architecture, the smart meter must incorporate enough intelligence to provide the following functions:

- Power limiting,
- Remote cut-off/restart authorization,
- Management of interval data to facilitate "suppliers'" pricings,
- Management of distributor pricing on the basis of the existing index,
- Possibility of switching to pre-payment mode,
- Incorporation of physical fraud detection functions.

As an extension, possibly in the form of a specific meter, it is possible to implement:

- Reactive energy metering,
- Injection and forced draining metering.

Medium Power Line Communication is catching on in "dense" countries

The network technologies that can be considered for the collection network are the following:

- Low-speed (under 60 bits per second), medium speed (less then 100 kilobits per second) and high-speed (more then 100 kilobits per second) PowerLine Communication (PLC) technologies,
- The switched telephone network,
- Optical fibers,
- Ethernet cable via ADSL,
- The cable TV network,
- Mobile network technologies - GSM/GPRS, HSUPDA, HSPDA, EDGE, UMTS,
- Radio network technologies - Wimax, WiFi and Mesh.

Given the architecture of the power network, the maturity of these different technologies and of their billing modes, the costs of installation and of operation, and the breakdown of responsibilities among the various players, it turns out that for the collection network in Europe:

- The use of a medium-speed PLC technology is perfectly suited to dense areas allowing the connection of at least 50 meters to a PLC concentrator installed in a medium or low volt (MV/LV) substation,
- In low-density areas covered by the GPRS network, where the installation of a PLC concentrator would be rather unprofitable or where the distances between the meters and the concentrator would require the installation of too long a chain of repeaters, it is preferable to rely on the available GPRS,
- In low-density areas not covered by the GPRS network, where the installation of a PLC concentrator would require the installation of too long a chain of repeaters, a PSTN connection should be used, but only as last resort.

The positioning of the concentrator in terms of relays

The implementation of a medium-speed PLC type technology requires the installation of PLC concentrators in MV/LV substations.

The main function of the concentrator is to perform the concentration of the metering points and to provide a gateway between the collection network and the transmission network. Therefore it is recommended for this equipment to use a hardware and software architecture that is as open as possible. The CPU of this equipment should be powerful enough to allow the implementation of new protocols and standard supervision agents. This openness will make it relatively easy to adapt (simply by replacing the communication board) to the technological evolutions that will inevitably take place in the transmission network in the future. This openness should also make it possible to minimize the impact of the technological choice on the transmission network for the duration of the project.

Functionally, the concentrator must allow at least:

- Daily remote reading of the meters,
- The automatic detection of the network typology in order to allow an asynchronous deployment of the population of meters and concentrators,
- The transmission of orders, on demand, from the AMM system to the meters,
- Interfacing between the data collection network and the transmission network,
- Remote updating of the operating system and applications,
- Compression of the data to limit the pass band used, in particular if use is made of a network operated on the basis of volume billing,
- Encryption of the data, by an open SSL type technology, to ensure the security of exchanges with the central system,
- The storage of the remotely read information in the meters for a period long enough to provide some immunity to possible malfunctions of the transmission network,
- Ability to download firmware and updates to devices attached to the network.

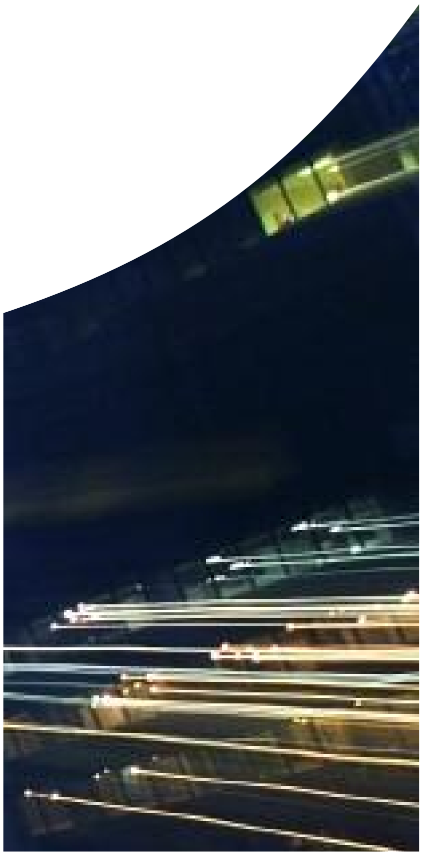
The choices for transmission of the information to the centralized ISs

Three alternatives can be considered, as a function of the installation, timetable, performance, and cost constraints:

- The installation of specific WAN infrastructure,
- Use of the switched telephone network or of the ADSL network,
- Use of the GPRS mobile network.

The installation of specific WAN infrastructure (on the basis, for example, of an extension of the optical fibre network existing on part of the HV network) is an attractive solution in terms of complete control of the infrastructure by the operator. However, the deployment of an optical fibre network generalized to all MV/LV substations would not only entail a very high investment cost but also make the project more complex. This is caused by the necessity to synchronize the deployment of the population of concentrators and the deployment of the fibre in a relatively short period. This alternative can be considered further only if the fibre is in the future shared with other applications or leased for other uses.

Since MV/LV substations do not generally have telephone jacks, the switched network or the ADSL network should be used only for MV/LV substations that are not covered by the GPRS network. Note that the problem of GPRS coverage should be of less importance on the population of concentrators than on the population of meters.



The French case

What were the objectives and constraints of the smart metering model in France?

The objectives of the smart metering model in France were three fold:

1. Improve the functioning of the electricity market, in particular in the interest of consumers

The benefits sought include informing consumers about their consumption, the frequency and quality of billing (actual data), access to metering data by the players (DNM, supplier, user or representatives), the introduction of new supply and service offers, the fluidity, speed and reliability of market processes (actual registers for change of supplier, remote operation of the meter for commissioning or cancellation), correction of random variations of the flow reconstitution mechanism (reading made more reliable and systematic, evaluation of losses by calculation, increased reading frequency, larger number of interval data).

2. Minimize network management costs while maintaining the quality of supply and the level of service

The benefits sought include reading costs (planning of rounds, wasted travel, sharing of gas meter reading costs), the costs of particular operations (cut-off, reconnection, recommissioning, cancellation, change of authorized maximum power, reprogramming of the meter), the cost of the change of supplier to the network manager, the cost of fraud, the costs of processing billing complaints (questioning of estimate), the tracking of quality of supply, the fact that the customer's presence is not necessary for simple operations.

3. Demand Side Management and easier insertion of micro-generation

Through better consumer information and new peak/off peak offers, the demand of energy can be better managed, and may help to reach ambitious objectives of energy savings.

With smart metering systems, micro-generation (such as solar, wind, micro-hydro, etc.) can be better included in the global power system and therefore encouraged.

Three contrasting scenarios

In order to assess the costs and benefits drivers for the French case, three contrasting scenarios were evaluated against a scenario of “business as usual”. These scenarios covered progressive functional scopes.

The Business As Usual (BAU) scenario assumed that the installation of current electronic meters read manually continues, plus specific gains of productivity that would not apply to scenarios A, B, C (e.g. continuing development of remote reading by wire).

All of the three scenarios A, B, and C allow telemetering (automated or on demand), remote opening, cut-off and power limitation: they minimize network operating costs while improving the level of service. In addition, the three scenarios eliminate the need for the pricing signal. The metering system can manage any type of pricing and timetable, according to the needs of the supplier selected by the customer. The offers and the functioning and fluidity of the market are improved in the interest of the consumer.

Taking this into account, the three scenarios have been constructed so as to contrast the functions that might be required:

Scenario A implies monthly readings of the index.

Scenario B manages 60 minute interval data, read monthly. It also manages pre-payment in a simplified way and therefore allows additional pricing creativity. Furthermore, it paves the way to the creation of services (control of energy demand and others), because of the interval data measurement. The interval energy data is made available to the suppliers or to any other third parties mandated by the customers. An interface makes it possible to have a remote display (not provided) in the household. The supplier can propose this display unit as part of its offer, or the customer can purchase it elsewhere. A display in the household is described in all studies as a key factor in control of energy purchases by the customer.

Scenario C includes finer curves, read weekly, or even daily on demand. It triggers a plethora of offers centered on the use of electricity, on the initiative of the suppliers and of other players (manufacturers of equipment, software, etc.). The fine measurement step, the outputs to additional meters, the possibility of daily readings, and the next-day availability of the information to the customer or to authorized third parties allow the mass marketing of services that today require ADSL communication bases and expensive measuring modules. Pre-payment is possible from a keypad or card terminal, proposed by the supplier and used to differentiate its offers. There are more incoming and outgoing interfaces (data, devices). Finally, scenario C makes it possible to add gas or water metering on the same metering platform.

Deployment durations

The range of deployments can be differentiated by customer and/or equipment segments. In the French example, economies of scale did not seem possible; it also transpired that the regulatory authority deemed it necessary to deny some customer segments access to special offers because of their meter capabilities.

The economic analysis therefore evaluated two deployment scenarios, in five years and 10 years, covering the whole country but in patchwork fashion, so as to allow the progressive capture of the gains at local, regional and national levels.

The costs and benefits of a smart metering project

When assessing the costs and benefits of such a project, the whole value chain needs to be investigated: Generation, Distribution, Suppliers and Customers. Figure 3 gives a summary of these different fields.

In the customers' scope the impacts that deemed to be quantifiable and/or important have been evaluated:

- It has been assumed that diminution of energy consumption due to the

Figure 3 : Overview of the benefits and costs of the different fields of smart metering projects ("+" means a benefit and "–" means a cost)

		Generation	Distribution	Suppliers	Customers
Costs	**Investments**	- Maintenance IS - Operations IS	- Meters, Equipment, - Meters, Installation - Meters, Customer Service		
			- Concentrator, Equipment - Concentrators, Installation		
			- Metering Information Systems		
	Costs incurred		- Costs incurred		
	Operating costs		- Meters, Maintenance - Meters, Communication		
			- Concentrators, Maintenance - Concentrators, Communication		
			- Maintenance IS - Operations IS		
Benefits	**Investments avoided**	+ Generation	+ Network Optimisation + Pre-payment meters		
	Operating benefits	+ CO2	+ Twice-yearly reading + Particular operations + Malfunctions and recommissioning + SME, SMI, Power Limitations	+ Customer Service, Reading + Customer Service, Part. Op. + Service Customer, Malfunctions	+ Change of supplier easier
			+ Reduction of Non Technical Losses + Reduction of Technical Losses	+ Reduction of NT losses	+ Customer presence not necessary
				+ Peak smoothing, Sourcing + Pre-payment: unpaid bills	+ Control of consumption
	Gains of the BAU Sc. deducted		- Gains of the BAU sc. (remote reading, etc.) deducted from Scenarios A, B, C		

Figure 4 : Total and per-meter costs of the French scenario (five year deployment, net present value)

A	B	C
€ 5.3 billion € 160/Meter	€ 5.7 billion € 170/Meter	€ 6.2 billion € 180/Meter

Figure 5 : Global costs of the project for each operator

Operator	Global cost of project	# meters	Global cost / meter
Enel	€ 2.1 billion	30 m	70 €
France (global project)	€ 6.2 billion	33.4 m	184 €
England (global project)	£ 5-8 billion	27+21 m	158-253 €
Southern California Edison	$ 1.3 billion	4.7 m	213 €
E.On Sweden	€ 220 million	1 m	220 €
Pacific Gas&Electric	$1.74 billion	5.1 m	262 €
San Diego Gas Electric	$ 650 m	1.4 m	357 €
Ontario (global project)	CA$ 3 billion	4.3 m	453 €

Figure 6 : Net present values of the metering projects (discounted at 5.25%, in Million Euros)

	Scenario A		Scenario B		Scenario C	
Years	5	10	5	10	5	10
Total costs	-5 444	-4 675	-5 810	-5 003	-6 283	-5 427
Total benefits	4 420	3 760	5 188	4 443	5 188	4 443
Net result	-1 023	-915	-622	-560	-1 095	-984
ROI	0,6%	0,9%	2,6%	2,8%	0,8%	1,2%

availability of consumption information would turn directly into gains for the customers,

- Part of the customers' gains in value may be captured by the supplier through the introduction of new pricing or services offers (linked to energy, to Demand Side Management offers, etc.).

In the Generation, Distribution, Suppliers scope:

- The economic analysis evaluates the impacts, both positive and negative (benefits and costs) on the user side,
- The study does not prejudge the evolution in terms of sources (change of pricing, marketing of new offers),
- For this scope, we evaluate the capability of an advanced metering system to be financed entirely through cost reductions within the whole electricity system.

Results: costs within a range of +/- 7%

There is no big difference between the index scenario (A) and the first interval meter scenario (B) (7%), and no big difference either between the two interval meter scenarios (B and C) (7%). Deploying the project over 10 years makes it possible to reduce the cost by approximately 15%, due to discounting effects, but also due to the reduction of the costs incurred.

The total and per-meter costs of the French scenarios, in net present value (investment + operating costs), assuming deployment of the meters in five years, are summarized in Figure 4.

This cost per meter yields an estimate in the low end of the range with respect to the benchmark, which is shown in Figure 5.

Globally, the mean cost of these projects is €200, with a surprising outlier for Enel at €70 per meter.

The gross results are negative in the context of the strict scope of the distributor

Discounted at 5.25%, the metering projects in all cases have negative net present values (see figure 6).

From the distributor's standpoint, the metering project produces in all cases a negative value. The internal rate of return on investment is between 0.6% and 2.8%. The optimum project is scenario B over 10 years. The gains are essentially on the reading, particular operations and non-technical losses.

The introduction of advanced metering for electricity increases the cost of gas distribution, because the readings and particular operations are no longer combined. Over 15 years (the life of the meters) this amounts in net present value € -450 million for a project implemented over five years and € -365 million for a project implemented over 10 years.

In an extended context, the value of smart metering for France is confirmed

The gains of productivity of the distributor alone may be under-estimated

In the model, several factors may improve the distributor's balance:

- The assumptions are conservative,
- Early installation of a metering information system could capture gains at the end of one or two years rather than two to four years (€100 to €150 million),

- The call centre benefits have all been counted in the supplier's scope: a share may fall to the distributor (a share of €200 to €500 million),
- Energy consumption decrease lead to investment avoidance in Generation resources, but nothing has been counted for the distribution networks (they are large enough in the medium term). But in the long term, the International Energy Agency counts €1 of investment in Generation for €1 of investment in Transmission-Distribution (€300 to €700 million).

It is therefore possible that the distributor may come close to break-even if the project is correctly managed.

Positive net present values on the global value chain (from generation to sales)
Opposite conclusions are reached when the analysis concerns the costs of the whole electricity value chain for an integrated actor, managing generation, distribution and sales functions.

To optimise costs on the global electricity value chain, the optimum scenario is Scenario C with a fine-grained interval data and advanced services, implemented as rapidly as possible (five years). The internal rate of return then reaches 12% to 14%.

The cost savings on the chain come from:

- The profits the supplier derives directly from the functions included in the meters (fewer telephone calls, non-technical losses on supplier's side, easier development of pre-payment and limitation of unpaid bills).
- The profits of Electricity Demand Control that impact the means of Generation (investments avoided and CO2) and the supplier's sourcing conditions (smoothing of peaks).

Financing in question
The extra costs occur from eight (for a project over five years) to 12 years (for a project over 10 years). Whatever the scenario and the duration of deployment, the extra cost peaks at about 20% for two to four years (€4 to €5 per year per meter), then falls rapidly to below 10% (€2 to €0). It thereafter becomes less than the cost paid by users without the metering project.

This is the end of deployment of the metering information system, which triggers the benefits and immediate reduction of the OPEX extra costs (activation of automatic reading on all meters installed). The extra cost perceived by the customers therefore seems acceptable in the case of scenarios B and C, with which the benefits of the new meter are visible and tangible, with Demand Side Management benefits that will make up for the €2 to €5 a year in question. In the case of a deployment in 10 years, the initial extra costs are of the same order, but the delays are substantially longer.

The impact on demand side management (and on CO2 control) is clear
The three scenarios have a different impact on the customers' capabilities to control their consumption. This depends on interval data, availability for new services, possibility of acquiring and connecting a display in the life space, much easier pre-payment and further work on pricing differentiation.

Compared to a situation in which customers do not know what they are consuming, the advanced metering infrastructure of scenarios B or C makes a big difference.

Figure 7 : Overview of the costs and benefits for the global electricity value chain (in Million Euros)

	Project in 5 years				Project in 10 years			
Scenario A	Generation	Distribution	Supplier	Global actor	Generation	Distribution	Supplier	Global actor
Total costs		-5444		-5444		-4676		-4676
Total benefits	100	4421	743	5264	81	3761	590	4432
Net result	100	-1023	743	-180	81	-915	590	-244
ROI		0,6%		5,9%		0,9%		5,7%
Scenario B	Generation	Distribution	Supplier	Global actor	Generation	Distribution	Supplier	Global actor
Total costs		-5811		-5811		-5003		-5003
Total benefits	883	5188	932	7003	752	4443	747	5942
Net result	883	-623	932	1192	752	-560	747	939
ROI		2,6%		12,2%		2,8%		11,5%
Scenario C	Generation	Distribution	Supplier	Global actor	Generation	Distribution	Supplier	Global actor
Total costs		-3972		-3972		-3566		-3566
Total benefits	1765	5188	1043	7996	1504	4443	837	6784
Net result	1765	1216	1043	4024	1504	877	837	3218
ROI		0,8%		14,6%		1,2%		11,5%

Figure 8 : Customers' benefits of smart metering according to three scenarios

Scenario	Benefit
A: Remote reading of index	€ 3,9 million
B: Interval data	€ 8,3 million
C: Fine-grained interval data & more services	€13,7 million

The benefits have been evaluated by both top-down and bottom-up approaches, and compared to the available benchmark data. Allowance has also been made for an economic, political and environmental context with respect to energy and a sensitivity to energy consumption in 2015-2025 that are different from what prevailed in 1990-2000.

Advanced metering with the functions planned in scenarios B and C is undeniably an important tool for optimizing the use of electricity. It must however be pointed out that, in most cases, the gains (control of demand and investments avoided) are obtained thanks to a deformation of the pricing signals in order to achieve the desired elasticity of the price of electricity (dynamic or critical peak pricing, time-of-use pricing, etc.).

The improvement of competition is still difficult to determine

It must of course be kept in mind that competitive intensity mainly depends on the number of suppliers that are active in a specific market.

Even so, thanks to AMM available to all residential customers, competition may be developed by the combined effect of:

- Development of customized pricing offers (independence of the pricing signal, agendas ad libitum),
- Knowledge of the customer's particularities (interval data),
- Ease of changing suppliers (use of a real index, impact on the delay, coupling of the change of supplier with a change of power or of routing pricing option),
- The customer's consumption view and therefore the strengthening of the customer's position with respect to their supplier.

Although these factors are real, they are quite difficult to quantify. The ease of changing suppliers and the pricing benefits lead to a downward tendency of 1% of the prices after 10 years.

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Note: The complete report of the study can be downloaded from the site of the French regulatory authority http://www.cre.fr www.capgemini.com/energy