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Energy, Utilities and Chemicals | the way we see it

The Capgemini Smart Meter Valuation Model

How to measure the value of implementing smart meters for Distributed Network Operators

There is an increasing pressure on the Energy & Utility sector throughout Europe in regards to embracing, contributing towards and meeting political goals and visions.

In March 2007, the European Union Ministers asked Member States to commit to the recently developed 3x20 objectives by 2020 (reduce energy consumption and Greenhouse Gas (GHG) emissions, and increase use of renewable energy sources). The underlying assumption is, of course, an improved security of energy (and electricity) supplies as well as a growing European economy with sustained tertiary and industrial employment.

Developments within the utility industry and especially in electricity infrastructures are considered as imperative in the contribution towards meeting the 3x20 EU objectives:

- Energy savings: Slow down electricity growth (+2% CAGR for 2002-2005)
- GHG emissions: Electricity generation produces 56% of CO2 emissions (ETS – 2006)
- Renewable energy sources: By 2020, 2/3rd of new generation power will rely on non-schedulable sources (resulting in challenges regarding existing network infrastructure).

In line with this, national regulators generally want to:

- Improve the functioning of the electricity market, in particular, in the interest of consumers
- Minimize network management costs while maintaining the quality and security of supply and service
- Promote Demand Response—demand side management and easier insertion of micro-generation.

Furthermore, the EU Directive on Energy End-Use Efficiency and Energy Services requires new solutions for providing customers with accurate data (e.g. bills based on real consumption, information on consumption profiles, historical data, etc.).

Historically, the compliance-based industry in which utilities operate, have not offered enough incentive for consumers, regulators or, for that matter, to utilities themselves to take the difficult steps necessary for making electrical energy markets operate efficiently. So, it is no doubt that all these ambitious political objectives and regulations are "shaking up the industry" and require radical changes in utility infrastructures and consumption (on both industrial and residential levels).

Smart meters have the potential to contribute towards the political goals

Since the recent inception of electricity deregulation and market driven pricing around the world, government

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

Countries	Legal framework	Institution involved	Main orientation
Sweden	None (not mandated by law)	Parliament	June 03: monthly billing on basis of actual data from July '09 DNOs to inform cust. of power outage & to indemnify them Deployment to all cust. needs to complete prior to July '09
The Netherlands	Draft bill of February 2006	Ministry of Economy	All LV customers will have smart meters incl. communication and connection to AMM on commercial option Smart meters mandatory for all new electricity contracts
Italy	Deliberation 292/06	AEEG (Regulator)	Directives for the installation of smart meters on the LV electricity network
Germany	No specific legislation	VDN (Association of Electrical operators)	Smart metering working groups that created the eHZ program
United Kingdom	No specific legislation	OFGEM	Business case demonstrating the absence of economically viable solutions
California	Energy Action Plan I & II	CPUC (Regulator)	All DNOs required to submit business cases Financial aid for deployment Goal is completion of a 20 mill. deployment prior to end 2012
Ontario	Directive (conversion of meters) Deployment plan Energy conservation responsibility plan	Government OEB (Regulator) Parliament	Schedule for conversion of LV meters (2007-2010) Deployment of 5 mill. meters prior to 2011 Creation of a smart meter entity to drive integration of the smart meters and data collection systems

Figure 2: An example of how cost and benefits are varying between stakeholders depending on where in the value chain they belong.

	Generation	DNOs	Energy suppliers	Customers
Investments		- Meters, Equipment - Meters, Installation - Meters, Customer Service - Concentrator, Equipment - Concentrators, Installation - Metering Information Systems	- IS frontend	
Costs incurred		- Costs incurred		
Operating costs		- Meters, Maintenance - Meters, Communication - Concentrators, Maintenance - Concentrators, Communication - Maintenance IS - Operations IS	- Operations IS - Operations, Services	
Investments avoided	+ Generation	+ Network Optimisation		
Operating benefits	+ CO2	+ Particular operations + Malfunctions and recommissioning + Reduction of NT Losses + Reduction of Technical Losses	+ Customer Service, Reading + Customer Service, Part. Op. + Service Customer, Malfunctions + Reduction of NT losses + Peak smoothing, Sourcing + Pre-payment: unpaid bills	+ Change of supplier easier + Customer presence not necessary + Control of consumption

regulators have been looking for ways to match consumption with generation.

Traditional electrical meters only measure total consumption, and as such provide no information of when the energy was consumed.

Smart meters, on the other hand, will change this and provide new opportunities which will improve the way electricity is distributed and consumed. A smart meter system allows two-way communication between the distributor, energy suppliers, energy consumers, and the energy meter.

When looking beyond the meter-to-cash process, smart meters have the potential to generate value for all participants in the electrical energy market (including generators, system operators, DNOs, retailers, consumers and governmental institutions).

This potential will be fully realized by applying a wider strategic mindset to smart meter programs, and considering the investment as the foundation of smart grid or intelligent network initiatives.

All in all, the implementation of smart meters has the potential to contribute massively towards the EU 3x20 political objectives. However, even though regulatory bodies often agree on general objectives for smart metering, there are no two similar answers to incentives and legal frameworks.

The question of who should pay for smart meter investments is a central theme in the debates between governmental bodies, market players, energy associations and media

When governments realize that these types of investments are elementary for meeting political objectives and for the functioning and security of the future energy infrastructure, critical decisions are sometimes made on a legislative level which result in massive impact on key stakeholders.

However, the discussion is not straightforward, and the business case is by no means trivial:

- The owners of the meters are typically DNOs who are also its natural investors, though other beneficiaries of the smart meters include generators, system operators, consumers, retail companies and the government
- The complexity is multiplied because the potential value of the smart meters is not necessarily being paid back to the investor, but unequally distributed between other beneficiaries
- It is complex to measure the ROI, include possible new meter functionalities/potential benefits, manage various data transmission systems, integrate with existing systems as well as maintain smart meters
- In the traditional ownership model, all the utility functions had a single owner, and benefits that crossed multiple business segments (e.g. distribution, transmission, and generation for electricity) could be paid for by the single owner of the utility
- As the utility companies get partly and fully unbundled retail and distribution businesses, it becomes unclear how the DNOs can justify their investments in smart meters
- How much of the cost has to come from internal savings? How much of the cost is considered new capital or new Operations and Maintenance (O&M)? In the end, of course, the customer will ultimately pay the cost as they always do.

Unfortunately, the discussions about who should pay often seem to boil down to only one or two parties and the potential costs and benefits they face in the case of a smart meter roll out.

While it might be a necessary discussion to have, it has its pitfalls when limited to only few parties.

The first pitfall is that if one party is going to pay the whole cost, they may choose a cheaper variant with fewer benefits for the whole value chain than if everyone either shared the costs together or the costs were allocated such that the installing party got paid directly by the customer for the added value that they hopefully will ultimately benefit from.

The second pitfall is that if too much cost savings are pushed on to the installing party, they may choose to stall the installation as long as possible or may end up with an incomplete system that does not really offer all the benefits—i.e. the meters are installed but the systems and staffing required to support the operations may get short changed.

On this type of stakeholder discussion "shortlist," DNOs are likely to be found due to their natural or logical network equipment ownership position. These DNOs are often facing challenges in defending themselves against external pressures dictating that the DNO alone should pay for the entire smart meter investment.

A clear and transparent business case is fundamental for decision making and maximizing value on the investment

In a situation like this, where there are disputes regarding the distribution of costs and benefits and who should pay, consensus-driven development of a detailed business case becomes an essential tool for clarification, negotiation and decision-making.

In instances where a decision to roll out smart meters has already been made (e.g. through legislation), the development of a detailed business case can still add significant value, as it will help the relevant stakeholders in showing them how, where and when to capitalize on the investment, both in the short term and long term, and thereby maximize its value.

Capgemini's smart meter business case approach

To match the challenges DNOs are facing today, Capgemini has devised a unique smart meter business case approach. This approach leverages the vast knowledge base that Capgemini has developed from experience in serving the business consulting, information technology and outsourcing needs of more than 75% of the top 20 private and public utilities in the world.

As the No. 1 consulting services provider in the worldwide utilities sector, and the No. 1 in the Western European utilities market for IT services, Capgemini paves the way with its innovative approach that covers:

1. Understanding of vision and strategic context
2. Understanding of technical smart meter setup
3. Business case setup
4. Quantification of costs and benefits
5. Business case calculation
6. Presentation to the decision makers.

This approach is built on the Capgemini business case framework, the Smart Meter Valuation Model, as well as Capgemini's benchmark catalog base that consists of experience gathered from more than 30 international utilities running smart meter installations.

Understand and translate the strategic context into a set of measurable goals

The Smart Meter Valuation Model will provide the DNOs with answers to the following questions:

- Why should we implement a smart meter system?
- Can the investment be justified?
- What are the real benefits?
- How should the benefits be prioritized?
- What are the costs to get the benefits?
- How strong is the business case?
- What are the risk scenarios?

Success is based on a clear smart meter vision that drives purpose, performance, energy and commitment. Having a powerful vision is key to inspire action.

Without it, any business case will dissolve into a list of confusing and conflicting statements, leading in a wrong direction or nowhere at all.

Executives must translate the DNO's vision into tangible goals. Building a business case, and aligning individual and team targets will create commitment and ensure focus on the achievement of smart meter objectives, and ultimately the DNO's vision.

Business cases need to be tailored to the DNO's situation—one size does not fit all. The DNO's current performance dictates what the numbers should be, and its appetite for change dictates the scope of the project.

One needs to understand the DNO's business plans and strategy—i.e. what are the strategic reasons for implementing a smart meter system, as opposed to the strategic implications of doing nothing?

The DNO has to define and agree on the business rationale for implementing a smart meter system. In doing so DNOs have to scope hypotheses (assumptions on change drivers, business issues and solution directions) as a starting point. Furthermore the DNOs must formulate "Why the smart meter program must be undertaken" in a qualitative statement, and try to find out about deeper and less visible reasons for the program.

Capgemini has worked with a number of DNOs around the world who have installed smart meters and has analyzed the value that has been actually harvested in the real world. Smart meters can have an impact on more than 80 business areas, including customer service handling, billing, construction and capital expenses, outage management, forecasting and settlement, and vegetation management.

The technological scope is closely liked with the Return of Investment

The benefit opportunities are fully aligned with the technological ambition and mindset.

The potential of a smart meter system will be fully realized when applying a

wider strategic mindset to smart meter programs, by considering the investment as the foundation of a smart grid or intelligent network initiative.

It is important to analyze the technological roadmap to understand that technology and Return on Investment are closely aligned.

New possible meter functionalities have related potential benefits in the same way as various data transmission systems and integration with existing systems.

Following is an example that indicates how the benefit areas are linked to the technological setup, more specifically the frequency of metering data.

Setting the functionality requirement for smart meter systems is basically about mapping the larger smart meter vendors' standard functionality to the strategic intent of the DNO.

Figure 3: The value of meter data

ODS/ MDMS	Month (s)	Maintenance Planning Design Standards Rate Cases Tariff Design Long-Term Forecasting IEEE Indices
	Week (s)	Billing Meter Reading Simulation GIS - Connectivity/Locations Collections Asset Loading
	Day (s)	Wholesale Settlement TOU Billing Vegetation Management Load Scheduling Curtailment Planning
	Hours	Automatic Shutoff Dispatch Theft Real-Time Pricing
	10s of Minutes	Closing Verification RTO Forecasting
Event Manager	Minutes	Service Verification Power Quality Asset Monitoring Site/Line Status Remote Disconnect On Demand/Call Center
	Seconds	System Security Outage Restoration System Protection

Following is a set of typical smart meter functionality elements that the DNO has to define when choosing the technological requirements:

- Meter reading (frequency of load curve)
- Data sampling (frequency of data sampling)
- Advanced meter management
- Communication with external devices
- Acquisition and storage
- Meter resolution
- Dual and multi-utility meters
- Displays
- Communication architecture
- Back-end integration
- Web access
- Need-to-have and future functionalities
- Market messaging.

In the business case setup, the DNO has to set the key basic assumptions and delimitations

A business case is a financial justification. Therefore, the financial key player in the decision team should agree with the setup and approach of the business case. This person is the financial owner (typically the CFO, Financial Director or Controller).

The financial owner of the business case has to agree on the financial framework and parameters of the business case, which includes:

- The business case approach (cash flow based, before or after tax)
- The investment measure like payback period, NPV and IRR
- Acceptable values or minimal requirements for the selected investment measures
- The evaluation period to take into account.
- The cost of capital for discounting (it is best to get the DNO's point of view on the cost of money, as calculating the WACC is not straightforward)
- What to capitalize and how to calculate stranded costs.
- The discounting interval (e.g. yearly, quarterly, etc.) and what to use as "period zero"
- The preferred presentation format for the business case
- Agree on how to present benefits, especially for sensitive benefits such as labor cost reduction.

Furthermore, it is important to plan how to manage the expectation that non-financial benefits will also be part of the business case. In addition, it is critical to consider any policy issues such as In-house versus outsourcing and lease versus ownership.

Based on the business case setup—including the technological requirements—it should be possible to set the basic key assumptions and delimitations:

Examples of basic assumptions:

- The business case is made only from the DNO's perspective
- General infrastructure costs are associated with DNOs' activities as well as shared services (including billing services)
- The business case is calculated for a scenario of 500,000 metering points
- It is based on a 3-level solution architecture (including concentrators)
- High population density (90% of meters are placed in urban areas)
- Costs include installation, maintenance and running costs
- Benefits include only running benefits
- Costs and benefits period is 20 years
- Deployment period is 3 years
- The main investment is made during the first 3 years
- Full costs and benefits are realized after smart meters are installed.

Capgemini's Smart Meter Valuation Model includes a list of assumptions that can be used as a framework for identification and validation of a DNO's most typical cost and benefit assumptions.

The Smart Meter Valuation Model is based on recent smart meter business case projects carried out by Capgemini in US, France, Germany and Denmark.

The benefit logic is creating the link between the costs, benefits and components of the solution

Identifying and quantifying the cost and benefits is the heart of developing the business case. In this activity, the benefits logic is developed and the cost and benefit areas are identified and quantified. The quantification is in fact performed by the DNO's own staff. Capgemini's task is to bring these people in a position where they are able to come up with numbers.

In order to develop a business case with commitment to act from the DNO, leadership involvement and ownership is essential. This collaboration is the real challenge of smart meter business case development.

Creating a benefit logic diagram establishes the logical links between cost, benefit areas and components of the solution.

By analyzing the benefits logic, a number of cost and benefit areas are identified (typically between 10 and 15).

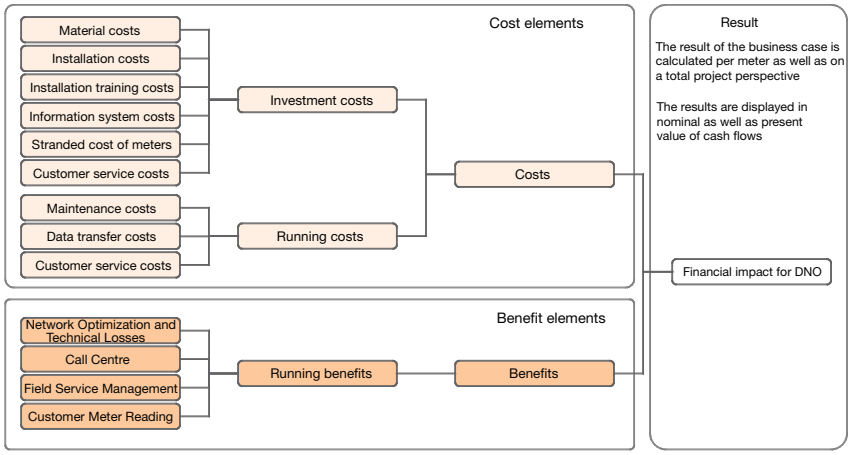
The key design principle is to look for relative independency between the benefit areas. "Independence" implies that a benefit area can be implemented without much interference from other benefit areas. Benefit areas are represented in the benefit logic as a group of drivers.

These areas will be the point of focus when developing the business case because of their substantial financial impact.

The DNO should agree on the benefit and cost areas to make sure that the focus is correct.

For each of the cost and benefit areas, the DNO has to agree and provide data for the underlying assumptions.

Figure 4: Capgemini's Smart Meter Valuation Model is built on a benefit logic composed of cost and benefit elements that are typical for a European DNO



As illustrated by the benefit logic, the final quantification of the financial impact is calculated by summarizing all the cost and benefit areas.

Many different consulting techniques are used to assist the DNO in gaining confidence in the numbers. These techniques include workshops, benchmarks, best practices, analysis, desk research, simulation, reference visits and interviews.

The financial model is calculated in the Capgemini Smart Meter Valuation Model

The Capgemini Smart Meter Valuation Model contains the assumptions, benefit and cost calculations and analysis sheets. In this way, it contains all assumptions, their effect on the cash flows and their ultimate effect on NPV, IRR and Payback Period.

Furthermore, the Capgemini Smart Meter Valuation Model includes sensitivity scenarios that can be developed for three purposes:

1. To evaluate different solutions: A scenario analysis can provide a better insight into the economic difference of the different solution alternatives (Will the extra benefits of a more powerful solution outweigh the extra costs?). The scenario analysis will help the designers in taking design decisions and crafting the smart meter solution.
2. To evaluate different ways to implement a smart meter solution: A given smart meter solution can be implemented in many different ways; for instance, quick, with a lot of disturbance and risks but with early benefits, or slower, less risky, but with the benefits accrued later. A scenario analysis can bring in the economic argument in this consideration.
3. To perform risk analysis: Potential risks are typically identified by the DNO's own staff in a workshop. Scenario analysis can then be applied to understand the economic impact of the different risks; for e.g. investment cost, running cost and benefit risks.
4. Smart meter lifetime sensitivity: A shorter lifetime period of smart meters are reflected in a shorter investment horizon and a correspondingly shorter annuity payment period. The impact of different meter lifetime periods is modeled in the business case.

The outcome of the analysis is fed back to the design team, to ensure that the solution is adjusted to mitigate the risks.

The target group for the smart meter business case is typically the DNO's management

The main purpose of a smart meter business case is to support a decision about whether or not to invest in a smart meter solution, as well as how, when and where to capitalize on the investment.

This decision is typically taken by the DNO's management team, who will also be the key audience for the final presentation.

The smart meter business case can also be used as more than just a financial justification for the DNO

This discussion has focused on the business case from a DNO perspective only. It has been used to describe how a DNO can develop a smart meter business case and thus identify the costs and benefits related to the investment. This gives the DNO a good understanding of how to maximize the value of the investment, which is vital for the DNO both before and after a decision to invest in smart meters has been made.

The business case represents more than just a financial justification; it is an essential negotiation, decision-making and communication tool which will increase and enable strategic understanding of a smart meter investment.

In order to bring the smart meter business case to a higher value level, and increase the strategic dimension of it even further, more stakeholders in the utility value chain should be included in the process.

This will mean that the actual distribution of benefits throughout the value chain will become more transparent, and the costs might therefore be easier to allocate fairly between the stakeholders. In addition, it might become easier to understand, and more motivating to try to realize the true strategic benefit potential of an intelligent utility infrastructure.

There are examples of theoretical smart grid business cases where attempts are made to estimate the full potential of intelligent infrastructures (including, for example, long term social benefits). These types of cases currently exist on a theoretical level; however, the more stakeholders one can actively include and cooperate with in developing a smart meter/smart grid business case, the better are the chances of realizing the full potential of these technologies.

Figure 5: Examples of smart meter sensitivity analysis

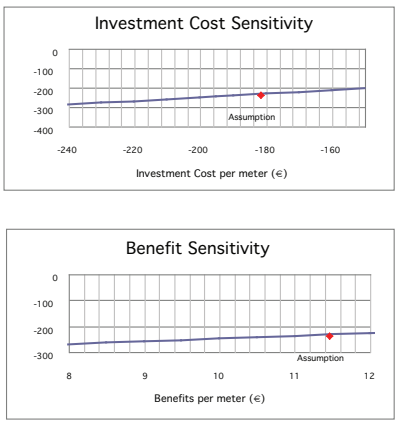
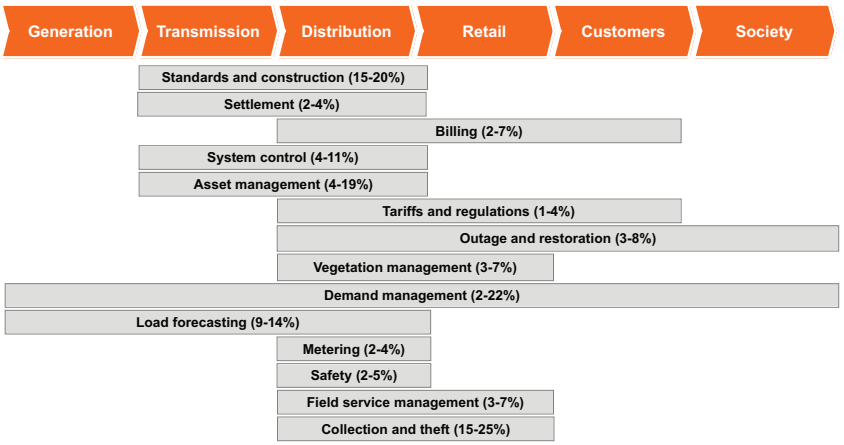


Figure 6: Percentages based on real savings by implementing fully integrated smart meter system



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