



# Annual Report on the Progress in Smart Metering

## 2009

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## **About the European Smart Metering Alliance (ESMA)**

This Report is produced by the Project Team of the European Smart Metering Alliance (ESMA). ESMA is an alliance of companies and organisations for the advancement of smart metering in Europe. ESMA is working to develop best practice in smart metering so as to deliver the best energy saving benefits. It has been formed by a number of interested organisations from across Europe - from academics to utilities and energy agencies - with partial funding from the European Union's Intelligent Energy for Europe programme.

ESMA consists of a Project Team and an Alliance. The ESMA Project Team is responsible for producing a number of European-wide reports on smart metering, including this Report. The Alliance works together closely with the ESMA Project Team and some members have provided material for this Report.

More information about the European Smart Metering Alliance is on the website:  
<http://www.esma-home.eu>

## 1. Executive summary

This is the second Annual Report published by ESMA. The intention of the Annual Report has been to provide a running commentary on progress in the implementation of smart metering across Europe and how it can and has supported energy savings and other social benefits.

The report examines four key items:

- **Progress in implementing smart metering across Europe**

The report provides a number of statements on the progress in countries across Europe. These cover most of the circumstances found in European Member States, ranging from near implementation to little or no progress. The report also contains in-depth studies of The Netherlands, Sweden, The United Kingdom and the Czech Republic. These were chosen as they illustrated important recent developments. A number of European countries and large DSOs have made announcements regarding full implementation of smart metering, committing themselves to roll outs by a certain year. These include Spain, EdF in France, UK, NL, Portugal and Ireland.

- **A listing of the smart metering roll outs across Europe (and globally)**

This shows that there are a large number of individual projects underway or announced. In Italy, Sweden and Finland, smart metering has been or is being fully implemented. Most other projects being announced are trials or pilot projects, in many cases being carried out before making a decision on a full roll out. In some countries individual energy companies are making their own decisions to roll out smart metering to their customers, for example Denmark.. Most of the new projects, stimulated by the Energy Services Directive and 3<sup>rd</sup> Energy Package, have a greater focus on energy savings. One key observation from this review is that the largest numbers of smart metering installations continue to be happening in the US.

- **Advances in Smart Metering Technology**

The last year has seen continued progress in smart metering technology. The report focuses on developments related to customer feedback and energy control. In this area key developments have been continued development of devices linking smart meters to home controls and appliances to support demand response and energy services. This has been a feature of 2009 as smart metering is absorbed into smart grids programmes. Also we have seen both Google and Microsoft launch home energy related software products

A related topic is the development of standards intended to make smart metering interoperable. These are being developed by the European Standards Organisation (CEN/CENELEC/ETSI) in response to the European Commission Mandate M/441.

- **Updating the evidence on the energy savings benefits of smart metering**

ESMA produced a report<sup>1</sup> that reviewed the current evidence for energy savings and other environmental benefits arising from smart metering and this report provides an update on the evidence base and conclusion that can be drawn from it.

- **A review of barriers affecting smart metering**

- There remains much uncertainty about the quantification of benefits as practical experience and historical data are still lacking.
- There are many parties involved, and the benefits of smart metering may accrue to other parties than the ones that bear the costs. Most utilities cannot justify the costs on the basis of their own benefits.
- At the large scale the roll out of smart metering is a very long and costly process, requiring considerable capital expenditures from the responsible market actors while in many EU countries, there is a big opposition from regulators to increase the tariffs to final users to pay for it.
- Lack of interoperability between different smart meter systems has been a barrier to the adoption of smart metering: no open registered standards exists which properly scopes all of the different functions (metering, communications, presentation, and network). This has been recognised and the Commission, through Mandate M/441 and the FP7 Open Meter Project, with the support of industry, has launched a major programme to put the required standards in place.
- There is also a lack of modularity and lack of flexibility of present mass smart metering so special needs regarding distributed generation, demand response, power quality, customer information, energy efficiency automation and services can only be met with high extra costs.

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<sup>1</sup> 1 Report on Effective Customer Feedback Mechanisms, Henk van Elburg, SenterNovem, December, 2007

## 2. Introduction

The European Smart Metering Alliance (ESMA) is a European project that was initiated under the Intelligent Energy Europe (IEE) program. In the ESMA project the metering industry and research organisations have been cooperating to exchange best practices in the field of Smart Metering in Europe. The general objective of ESMA is to increase the energy saving benefits of Smart Metering and to identify and spread best practices in smart metering across European member states. In this context ESMA supports Article 13 of the Energy End-Use Efficiency and ESCO Directive<sup>2</sup>. The ESMA project has produced a series of reports on key aspects of smart metering and especially the European Smart Metering Guide, the third edition of which is published in 2009<sup>3</sup>.

The present Annual Report on the Progress in Smart Metering – edition 2009 is an important complement to the Guide, presenting a review of the situation across EU Member States and Norway, also against the background of chosen regions and countries through the World.

This report constitutes Deliverable 18 of the European Smart Metering Alliance (ESMA) project (<http://www.esma-home.eu>). The report reviews the progress in the field of development and implementation of smart metering that has been achieved by European Union Member States and for comparison by other chosen regions and countries through the World in the year 2009.

## 3. Scope and methodology of the report

The Annual Report reviews the development of smart metering and seeks to identify progress in smart metering implementation in Europe, particularly in a number of countries selected to highlight different approaches to questions related to regulations, law and technical solutions.

“Deep stories” show in detail the current situation with regard to smart metering implementation in the United Kingdom, Sweden and the Czech Republic. The report provides information covering the current status of the roll out process. It also covers many other aspects influencing this process, starting from historical and social aspects, going through problems related to cost/benefit analyses, legislation, promotion and cooperation between market actors. This information is presented in order to help and support decision makers and stakeholders from countries starting such implementation processes.

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<sup>2</sup> DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, of 5 April 2006, on energy end-use efficiency and energy services

<sup>3</sup> Smart Metering Guide, Energy Saving and the Customer, Edition 2010, ESMA

Changes identified for the benefits attributed to smart metering systems, either those under development or fully operating, are also presented. This part of the report is primarily aimed at updating the evidence for or against energy savings arising from smart metering but it also addresses other important benefits, such as improvement in customer service quality, quality of grid operation and demand side management.

Chapter 7 presents information on recent developments in smart metering technology in order to inform all necessary parties of the key features and new possibilities connected with smart meter techniques. This is also important to allow the identification of changes in technology that changes basic assumptions regarding smart metering implementation.

Chapter 8 is dedicated to identification and analysis of the main barriers preventing the spread of smart metering in EU and outside Europe. Special attention is dedicated to legal, economic and technical barriers. Barriers related to awareness raising and customer reaction are also considered.

#### 4. Basic definitions and terms

This report focuses on the promotion of Energy Saving of Energy Customers in relation to Smart Metering. In the utility world several definitions of Smart Metering are used, depending on which of the possible services are included or not. Within the context of this report the following definition of 'smart metering' is used. Smart metering has the following features:

- Automatic processing, transfer, management and utilisation of metering data
- Automatic management of meters
- Two-way data communication with meters
- Provides meaningful and timely consumption information to the relevant parties and their systems, including the energy consumer
- Supports services that improve the energy efficiency of the energy consumption and the energy system (generation, transmission, distribution and especially end-use)

The report is also primarily concerned with developments in Europe. However, depending on the circumstances, the scope has been extended where it was felt that it was necessary to tell the full story. For instance, the extent of the roll out of smart metering in the US is highly relevant to developments in Europe, as it could affect the opportunities to develop business in Europe, and might influence the development of standards.

## 5. Review of smart metering development in Europe

This Chapter includes a review of progress in smart metering development in EU member states made during 2009. The introduction includes comment on some of the common features for all countries and some specific approaches and solutions that have been observed in different countries. This general overview has been updated based on the report by ERGEG of the status of smart metering roll out across Europe<sup>4</sup>. The detailed country information has been provided by ESMA project team members and other national experts.

### 5.1. General review of Smart Metering Schemes in EU member states

The ESD and 3<sup>rd</sup> Energy Package have focused the attention of all Member States on smart metering and all Member States have now examined the subject at the very least. The ERGEG study reports the status for electricity and gas in each country as shown in the Table below.

Country	Electricity	Gas
Austria	30,000 installed, no national obligation but this under review	Roll out under discussion
Belgium	Trials underway – results will determine any national roll out	
Cyprus	There is no smart metering deployed in Cyprus	
Czech Republic	Trials underway – results may determine any national roll out	
Denmark	Several electricity DSO's are deploying smart meters but there is no national plan	
Estonia	A major roll out is under discussion and a roll out may begin in 2011 that would conclude in 2013	
Finland	In March 2009 new legislation that requires nearly full penetration of hourly metering and settlement by 1	

<sup>4</sup> Status Review on Regulatory Aspects of Smart Metering (Electricity and Gas) as of May 2009  
Ref. E09-RMF-17-03, 19 October 2009

Country	Electricity	Gas
	January 2014 came to effect.	
France	EDRF expected to commit to a full roll out in 2010 based on results of trial. Overall target of 96% smart meters installed by 2020	Roll out under discussion
Germany	> 50 trials ranging from 10 to 100.000 electricity meters. A full national roll out is under discussion. Adopting a market based approach, allowing customers to opt in or out.	Similar situation with electricity metering but there is no planed roll out
Great Britain	On 30th of October 2008, the Government decided on a national roll out of dual fuel smart metering for all 27 million households before 2020 1. On 2 <sup>nd</sup> Dec 2009 the Government announced its planned approach to rolling out smart metering.	As for electricity
Greece	A roll out has been decided and will be carried out between 2010 and 2013	
Hungary	A study is currently underway	
Ireland	A pilot study is underway and it is anticipated that this will lead to a full roll out, but the decision has not been made yet	As for electricity
Italy	Currently have 33 million AMM meters and by 2011, all 36 million electricity customers will be equipped with a smart meter	Has made decision to roll out of gas meters with a target of 80% installed by 2016.
Luxembourg	A number of trials are being carried out by DSO's	
Norway	New requirements regarding full scale establishment of smart	

Country	Electricity	Gas
	metering were suggest autumn 2009 - through a discussion document, but the final decision is postponed until the spring 2010. The main reason for this postponement was to find out what happens within the European initiative for standardisation regarding smart metering.	
Portugal	The Regulator has made a preliminary study.	
Poland	There is discussion of a roll out beginning in 2010 and completed by 2017.	As for electricity
Romania	There is no official national plan in <b>Romania</b> on Smart metering;	As for electricity
Slovak Republic	Discussions of a roll out underway	
Slovenia		Roll out under discussion
Spain	A full roll out is underway, beginning in 2008 and planned for completion in 2018.	No economic case for roll out of smart gas meters for customers using < 5,000,000 kWh/y).
Sweden	Will be the first one to achieve a 100% penetration in July 2009 when monthly collection of meter data becomes mandatory.	
The Netherlands	Dutch Senate rejected proposed legislation including a compulsory roll out of smart metering for reasons of privacy and security. Proposed legislation and smart meter standards are now being revised for new discussion in parliament in order to allow a voluntary roll out. New decisions are expected in Autumn	As for electricity.

Country	Electricity	Gas
	2010. In the meantime, Dutch fourth largest energy supplier Oxxio has installed over 100.000 smart meters in the residential sector already.	

One noticeable trend has been a series of announcements of smart cities in Europe and globally. These provide test beds for new technologies in preparation for larger roll outs but also provide a focused community basis to test out the wider customer issues related to smart technologies, including smart metering. Amsterdam is leading the way with its programme with schemes announced or in preparation in ;Trondheim, Norway; Malta; Vienna, Australia; Boulder, Colorado; Dubuque, Iowa; Miami, Florida and the City of Stratford, Ontario.

Appendix 2 presents initiatives, pilot projects and trial initiatives related to development and implementation of smart metering technology through European countries as well as Canada and USA and Australia. This list relates to those projects that are currently active, it excludes those that are complete and those that are proposed but not in the implementation phase.

The data presented shows that, based on current activity, the large majority of smart meters being installed are in the USA and Canada although planned roll outs in Europe could reverse this situation.

Given the increasing number of these trials this list cannot claim to be complete but does give an indication of relevant activity.

## 5.2. Country information

In this section an update on countries around Europe is provided. The information on each country consists of one paragraph on current status of smart metering implementation development and a summary table. The current status and recent achievements in each country are presented against a background of other related developments and specific supporting activities.

### 5.2.1 Denmark

Official country implementation plan	<p>End users with a yearly demand above 100.000 kWh have interval meters with hourly reading.</p> <p>No plan exists for users with smaller demand.</p> <p>However many utilities have invested in new meters that can be remotely read. Around 50% of all users with have such a meter within 2011.</p>
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Law regulations related smart metering implementation – obligations, deadlines/goals	DSO is responsible for metering.
Availability of smart metering technology	
Economic profitability	The utilities that have decided to implement new meters have found this profitable.  Several reports from the Danish Energi Agency have concluded the investment is too high. These reports have focused on demand response and have not included “soft” benefit.
Pilot projects and initiatives	Several pilot projects has been realised. Mostly with a technical focus and testing of implementing speed.
Research and development activities	The TSO (Energinet.dk) has supported several research projects about demand response.  The DSO organisation Danish Energy association have supported projects about smart meters and energy saving.
Number of existing smart metering schemes (in operation)	1.4 million (46%) electricity users will have meters with remote reading. Only few of these are used for advanced purposes (e.g. hourly reading).  Some district heating and water companies have remotely reading of meters.
Key features of the schemes	
Number of smart metering systems available	Many
Number of smart metering meters and provisions of progress in increase of smart metering number	The largest electricity utility demand increase of tariff before they shall invest in new meters.

### 5.2.2 Great Britain

Official country implementation plan	In the UK the Government announced that it will mandate smart metering for the residential sector, On the 28th October 2008. This has been followed by a further consultation and announcement on the overall approach to the roll out. 47 million smart gas and electricity meters will be installed. A company will be appointed to provide a national communication channel that all meters must use. Electricity meters will be supplied with a switch so that they can be remotely set as pre-payment or credit meters. No final decision has been made on whether gas meters should be equipped with a valve. The integration of smart meters into smart
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	<p>grids is to be enabled, although only limited additional meter functionality is to be specified. In principle, all meters will be supplied with a real time display.</p> <p>From 1st April 2009, energy suppliers have been required to provide advanced metering for the commercial market (Profile Classes 5-8) whenever a meter is replaced and that all customers should be provided with an advanced meter by 2014. The government has decided that the remaining commercial customers should be included in the national roll out and receive smart enabled meters by 2020. Real time displays will not be required to be supplied to commercial customers.</p>
<p>Law regulations related smart metering implementation – obligations, deadlines/goals</p>	<p>Overall responsibility for Delivery will be taken by the Department for Energy and Climate Change, working with OFGEM, the UK Regulator. The programme will be governed under the Office of Government Commerce Gateway procedures. The project plan is:</p> <p>Now – summer 2010 DECC and OFGEM that will define the scope and key principles of the roll out.</p> <p>Summer 2010 – summer 2012 Detailed design phase</p> <p>Summer 2012 - 2020 Implementation phase</p>
<p>Availability of smart meter technology</p>	<p>Smart meter technology is available from vendors; however, meter vendors are awaiting a final meter specification from the energy companies before producing meters and systems specifically tailored to a UK roll out.</p>
<p>Economic profitability</p>	<p>The UK Government published a consultation on 10th December 2008 reviewing the level of meter functionality to be included in their mandate. This included figures for the cost benefit of various levels of functionality for electricity and gas smart metering.</p>
<p>Pilot projects and initiatives</p>	<p>There are four major trials of smart metering being sponsored by the UK government. The most recent report from this trial can be found on the OFGEM web site<sup>5</sup>. These began in 2007 and are being conducted by EDF Energy Customers plc, E.ON UK plc, SSE Energy Supply Limited and Scottish Power Energy Retail Limited. The trials are due to conclude in 2010. Other companies are known to be carrying out private trials. British Gas is carrying out its own independent trial.</p>

<sup>5</sup> <http://www.ofgem.gov.uk/Pages/MoreInformation.aspx--docid=116&refer=Markets/RetMkts/Metrng/Smart>

Research and development activities	In the UK a key research activity has been the development of meters that can identify specific loads from the total import measure at the supply meter. The Coracle device has been developed by Sentec <sup>6</sup> and Navetas has recently announced its own ISE product.
Number of existing smart metering schemes (in operation)	In the UK all half hourly read electricity meters must be read remotely, according to Elexon Code of Practice 5, approximately 110,000 meters. IN April this obligation was extended to non half hourly meters within profile classes 5,6,7 and 8. All such customers must have a CoP 10 meter by 2014 and new meters and replacements must comply with CoP 10.
Key features of the schemes	Code of Practice 5 meters meet all of the functional requirements currently being considered for the UK residential market mandate. CoP 10 is similar to CoP 5 but there is no requirement to collect half hourly data. They can both be remotely read, managed and will provide power quality data.
Number of smart metering systems available	The CoP 5 sector currently comprises approximately 110,000 meters. There are 152,000 CoP 10 sites but at present few of these have been equipped with CoP 10 meters
Number of smart metering meters and provisions of progress in increase of smart meter number	Until the full domestic roll out begins increased numbers will come mostly from the CoP 10 sector

### 5.2.3 Cyprus

There is no smart metering deployed in Cyprus as yet. The local utility is planning to install some smart meters but this information is not officially confirmed.

### 5.2.4 Czech Republic

In the Czech Republic, two main pilot projects testing the AMM technology have been carried out recently. The former one was implemented by CEZ, the former monopolist electricity producer and now the leading integrated nation-wide electricity producer, distributor as well as supplier, in East Bohemia (at ca 2 000 supply points) and the latter by E.ON in four selected municipalities in South Moravia (ca 4 000 supply points). In both cases the primarily purpose of their realization was to assess the feasibility and reliability of various AMI/AMM technologies and, so far, have not included the provision of enhanced information on energy use towards end-users. The first results and experience from both pilots (after nearly one year of real operation more less by each) was

<sup>6</sup> [http://www.sentec.co.uk/page/our\\_products/7/](http://www.sentec.co.uk/page/our_products/7/)

presented in autumn 2008 at the conference named “Smart metering” organized by IIR in October in Prague. Representatives from both companies mostly reported on miscellaneous technical problems and bottlenecks which the implementing teams had encountered so far and how these were solved. For each pilot, several technologies for metering of electricity (and for the CEZ pilot, also of gas) consumption and consequent data transfer have been tested. The main subject of the testing was continuous metering of load profile (energy use), remote disconnection of a meter, and use of ripple control (for heating appliances).

Based on the results of both pilots, decision will be made how on how to continue further. As a natural next step (by SEVEN) to complement the existing pilots the effect on the energy consumption behavior of final customers as a result of providing feedback information will be tested.

Official implementation plan	country	In the Czech Republic there is no official implementation plan for smart metering, yet.
Law regulations related smart metering implementation – obligations, deadlines/goals		There are no obligations yet.
Availability of smart metering technology		It has not been decided yet.
Economic profitability		The economic profitability will be analyzed in the upcoming complex pilot scheme to be conducted by SEVEN.
Pilot projects and initiatives		Two pilot technical assessment projects with two utilities have been carried out.
Research and development activities		A new, complex pilot scheme to make us of effective instruments is now under preparation. The pilot scheme will feature a technological solution, information tools as well as financial incentives to be available to end-users.
Number of existing smart metering schemes (in operation)		None yet, but a test scheme currently under preparation (also under discussion with the Energy Regulatory Office)
Key features of the schemes		<p>There are three main components of the scheme:</p> <ol style="list-style-type: none"> <li>1) <b>Technological solution</b> will be either based on the existing pilot project (AMM), or to some extent independent. There are several functions which are to be included whichever solution is finally chosen. The smart metering infrastructure should provide detailed information on energy consumption – total as well as from different loads, energy costs, etc. A system fulfilling the above requirements developed by Czech company KMB systems has been installed at the SEVEN premises and is being tested. The information is then likely to be provided to the end-user through telecommunications network such as GPRS/CDMA/UMTS and other.</li> <li>2) <b>Information tools</b> are a supporting instrument, which should provide the end-user with additional information and advice. It is planned that</li> </ol>

	<p>based on the metered data, the end-user will be able to make his/her own “energy audit” of the household and evaluate potential energy/financial savings. If needed, the information tool will also allow users to carry out control measurements and provide consultancy and advice (suppliers, customer centers, consulting companies, etc.).</p> <p>3) Nevertheless, it is clear that the activity will have to be supported by <b>financial incentives</b> to the end-users. These incentives will have a form of either <b>discount on energy efficient appliances</b> or a <b>creation of special tariff rate, rewarding ‘negawatt hours’</b> generation (as to environmental benefits up to <b>0.04 EUR/kWh</b> compared to referential consumption). Another solution is then to introduce a special premium on end-users electricity consumption (e.g. 0.004 EUR ~ 5 mil. EUR/year), or to use revenues from saved CO2 allowances sale (at cost 5-15 EUR/ton of CO2, ~ 0,005 – 0,02 EUR/kWh of saved electricity)</p>
<p>Number of smart metering systems available</p>	<p>No data available</p>
<p>Number of smart meters and provisions of progress in increase of smart meter number</p>	<p>Presently several thousand AMM type meters installed countrywide in two field trials by two major electricity suppliers, E.ON and CEZ another of similar size (2 thousand. metering points) shall be introduced in 2009/2010 by other electricity supplier – PRE. Under discussion is to extend one of the trials onto 40 thousand households.</p>

### 5.2.5 Finland

<p>Official country implementation plan</p>	<p>Nearly full electricity smart metering penetration by 1 January 2014.</p> <p>There is no official country plan for district heat meters or for water meters.</p>
<p>Law regulations related smart metering implementation – obligations, deadlines/goals</p>	<p>DSOs are responsible for metering. The electricity DSOs have a natural distribution monopoly and must be unbundled from competitive operations such as electricity retail and generation.</p> <p>New legislation (66/2009 Valtioneuvoston asetus sähkötoimitusten selvityksestä ja mittauksesta) came into effect 1 March 2009 and requires the following.</p> <ul style="list-style-type: none"> <li>- 2011 all over 3x63A connection points must have remotely readable hourly metering</li> <li>- 2014 full smart metering penetration with minor exceptions</li> <li>- there are some minimum functional requirements such as: hourly interval measurement data available next day to market actors including the customer, at least one control signal to customer via the metering system and support for TOU-tariffs (thus most DSOs require capability to at least 2 control signals), registering over 3 min outages and two way data communication with data security. (Remotely readable meters already installed are allowed exceptions regarding the</li> </ul>

	<p>minimum functional requirements)</p> <p>- starting 1 January 2012 settlement by hourly metered data is required for all customers that have meters capable to hourly metering.</p>
Availability of smart metering technology	It is a common view that technology is available.
Economic profitability	Economic profitability is inadequately detailed, analysed and discussed publicly.
Pilot projects and initiatives	Full nationwide implementation of smart metering is on the way. There are some pilot projects. These include smart metering for distribution automation and in small scale spot price based control of electrically heated customers.
Research and development activities	There are some ongoing national projects such as INCA and ENETE. The focus of the former is in integrating customers to future smart grids and energy markets. The focus on the latter is on energy efficiency and demand response. In addition there are R&D activities related to using smart metering data in energy analysis.
Number of existing smart metering schemes (in operation)	Many. (More than 10)
Key features of the schemes	Most remotely readable meters are capable to hourly interval metering.
Number of smart metering systems available	<p>All smart metering systems that meet the above mentioned minimum requirements and the own requirements of the DSO.</p> <p>There are about 10 providers of smart metering services for the DSOs.</p>
Number of smart meters and provisions of progress in increase of smart meter number	<p>About 1 million remotely readable electricity meters in operation in 2009. The total number of meters is about 3.1 million. Over 80 % penetration in each DSO is required by national legislation by 1 January 2014.</p> <p>About 50% of district heat meters are in remote reading and many meters are such that can be connected to remote reading. Except for some piloting, the utilities have not yet applied large scale smart metering of water consumption. Multi utility metering is sometimes used but not systematically in all cases where it would be technically beneficial.</p>

### 5.2.6 Latvia

In Latvia the implementation of AMR systems carried out by the main DSO AS Sadales tīkls is based on 4 stages of development:

- 1st stage – 13 substations with cross border meters and 5 power plants (July, 2004);
- 2nd stage – all other substations (September, 2005);
- 3rd stage – regional borders of distribution network and two apartment houses in Riga (April, 2007);
- 4th stage – middle voltage customers and distributed power plants, etc (in progress).

In particular the current status AS Sadales tīkls AMR system includes the installation of 1437 meters for distribution network. In particular:

- 1 168 meters in 110kV substations;
- 49 meters on distribution network region borders;
- 28 meters in cogeneration power plants;
- 17 meters for industrial large consumers;
- 175 household consumer meters in 2 apartment buildings in Riga

Regulations about installation of smart metering and for example about mandatory hourly metering in Latvia for all final consumers are not yet implemented.

All consumers with a permitted connected load of 100 kW and higher are connected to Automatic Meter Reading (AMR) system. Also independent producers of electricity are connected to the AMR system. On the other hand, residential customers have mainly ordinary electromechanical meters, which are being replaced step by step with electronic meters but which are not typically connected to the AMR system.

For residential consumers meter reading shall be done on the first day of each month by the customer and the payment for the consumed electricity shall be made by the end of the respective month. Residential customers have then several possibilities for the payment: payment in cash at banks and post offices, by bank transfer via Internet bank, Internet payment at utility web page and lately as well as automated average billing where the customers are charged automatically the same amount every month based on an average of their consumption over the past six months.

Official implementation plan	country	In Latvia there is not an official implementation plan for smart metering
Law regulations related to smart metering		There are not obligations

implementation – obligations, deadlines/goals	
Availability of smart metering technology	Imported
Economic profitability	
Pilot projects and initiatives	In the residential sector a pilot project in two buildings
Research and development activities	Research on smart grids in Riga Technical university – Faculty of electrical and power engineering
Number of existing smart metering schemes (in operation)	1 scheme for large consumer with permitted connected load 100 kW and higher
Key features of the schemes	For objects that are connected to AMR and who are simultaneously permitted connected load is 100kW and higher – the meter data are exported to AMR system on a daily basis; after that, the data are exported from AMR system to CSPS (Customer Service and Payment System). DSO (Sadales tīkls) sends a bill for distribution system services to the user once a month; at the same time, DSO forwards the load profile data to the trader, who issues a bill for the electricity consumed.
Number of smart metering systems available	1
Number of smart meters and provisions of progress in increase of smart metering number	1 168 meters in 110kV substations; 49 meters on distribution network region borders; 28 meters in cogeneration power plants; 17 meters for industrial large consumers; 175 household consumer meters in 2 apartment buildings in Riga

## 5.2.7 Romania

Official country implementation plan	<p>There is no official national plan in <b>Romania</b> on Smart metering; Every license area has an investment plan approved annually by regulator ANRE. It is possible that these plans include something on metering.</p> <p>It is not sure if all DSOs in Romania understand the same thing by Smart Meters...</p>
Law regulations related smart metering implementation – obligations, deadlines/goals	Metering Code has some recommendation regarding class C meters. This is not enough to promote Smart meters
Availability of smart meter technology	If we refer to TOU meters that has the possibility to be included in AMR/AMI we have on the market and within the network
Economic profitability	Since there is a high number of really small electricity bills economical drivers for Smart metering are extremely low for the moment
Pilot projects and initiatives	Yearly a number of meters in Electrica (3million out of 8 million customers) is TOU and communication ready
Research and development activities	regarding the number of tariffs, we can look at the Romanian regulator (ANRE) site; if it's about communication channels we tested: plain radio, plc, PLC UNB, phone, GSM, GPRS, radio trunking
Number of existing smart metering schemes (in operation)	-none-
Key features of the schemes	-none
Number of smart metering systems available	There are around 10 pilot projects working at the moment and some in test and running
Number of smart metering meters and provisions of progress in increase of smart meter number	Around one new system for every 10000meters depending on local possibility of absorption

## 5.2.8 Norway

Official country implementation plan	There is not an official implementation plan yet: In a discussion document concerning the regulations for metering and settlement, mandatory implementation of Smart Metering for Final Customers in Norway was expected from 1.1.2014. An additional hearing round has been performed due to a lot of responses in the first one. In a letter from the Regulator in October 2009, they have further postponed the implementation to 1.1.2016, to wait for the results in the standardisation projects arranged within EU. The details in the final regulations concerning smart metering are expected to be ready during the autumn 2010.
Law regulations related smart metering implementation – obligations, deadlines/goals	Metering and billing of Final Customers is regulated by the Norwegian Water and Energy Directorate (NVE). According to NVE's rules DSOs are responsible for metering and from the 1st of January 2005 all metering points with annual consumption higher than 100.000 kWh have to be hourly metered. Based on the discussion document concerning the regulations for metering and settlement, all customers should have hourly metering within 1.1.2016. It should be possible to change the metering frequency to 15. minutes.
Availability of smart metering technology	In general the market is traditionally dominated by Smart Metering equipment and concepts from the Nordic Countries as Senea, Kamstrup, Enermet (Landis&Gyr), Telenor Cinclus, Aidon etc. Several advanced technologies have been tested, but cost/benefits estimations limit implementation of very advanced functions.
Economic profitability	Several cost/benefit studies have been recently conducted. The latest conclusion is that implementation of Smart Metering normally is not profitable for DSOs yet, but it is clearly beneficial for the whole society. <a href="http://www.nve.no/FileArchive/84/ECON_Ny_maalerteknologier.pdf">http://www.nve.no/FileArchive/84/ECON_Ny_maalerteknologier.pdf</a>
Pilot projects and initiatives	Smart Metering is in regular operation at big customers (annual consumption over 100.000 kWh). Smart Metering for households has had big scale tests in the last 5-6 years. Today the companies prepare for full scale implementation. There are several initiatives, related to AMR
Research and development activities	End-user flexibility by efficient use of ICT (2001-2004) and Market Based Demand Response (2005-2008) are the central projects, related to Smart Metering. A new project "Environmental benefits from full-scale establishment of smart metering" (2009-2012) will continue this work. <a href="http://www.energy.sintef.no/prosjekt/mabfot/UK/uk_index.asp">http://www.energy.sintef.no/prosjekt/mabfot/UK/uk_index.asp</a>
Number of existing smart metering schemes (in operation)	All existing DSOs have hourly metering of customers with consumption more than 100.000 kWh, while app. 10-15 DSOs have voluntarily implemented Smart Metering for all customers (Status in 2005).
Key features of the schemes	Remote reading of the consumption is hourly or in some cases weekly (households). Possibility to view the consumption data via Internet. Normally the communication is based on smart metering, PLC or combination of those depending of the landscape and settlement.
Number of smart metering systems available	There are no limits for systems allowed to be used. Any existing Smart Metering solution can be purchased and installed.
Number of smart metering meters and provisions of progress in increase of smart	Based on today's regulations 4-5 % of all existing metering points in Norway have hourly metering. This represents approx. 100.000 customers

metering number	and 60 % of the total electricity consumption in Norway.
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### 5.2.9 Poland

Official country implementation plan	<p>There is no an official implementation plan yet. in Poland.</p> <p>In December 2008 The Energy Regulatory Office (ERO) published the Feasibility Study for Implementation of AMR for electricity in housing sector in Poland. AMR is considered there as an important tool for improvement of energy efficiency in housing sector. In June 2009 there was concluded a declaration letter on cooperation between KAPE, ERO and two consumers' organizations on development of SM and its introduction to households with special attention directed to protecting interests of energy consumers. In October 2009 there was organised parliamentary conference starting discussion on necessity for introduction of any legislation for AMR.</p> <p>More information on ERO website: <a href="http://www.ure.gov.pl">www.ure.gov.pl</a></p>
Law regulations related smart metering implementation – obligations, deadlines/goals	No regulation related smart metering at place at the moment. Establishment of adequate “law environment” for AMR is expected in 2011.
Availability of smart metering technology	In market there are already available products and technologies of many different manufacturers and distributors from EU countries as well as from US. It concerns almost all technologies and systems including very advanced functions and data transmission systems.
Economic profitability	<p>The above mentioned Feasibility Study by ERO presents some basic figures. Total cost of full implementation of smart metering for measuring of electricity in housing sector is estimated on 7,5 bln PLN (appr. 2,0 bln €) with average price for LV meters of 470 PLN (appr. 124 €) per unit and for MV and HV meters of 2 500 PLN (appr. 660 €) per unit..</p> <p>Potential profitability measured as a reduction of energy cost is estimated on appr. 100 PLN/year (appr. 26 €) per household.</p> <p>The initial estimation shows that economic profitability of AMR implementation is still problematic for DSOs and for household consumers, however could appear to be beneficial for the whole society when adequate studies could be performed.</p>
Pilot projects and initiatives	No pilot projects identified. However some manufacturers do small scale pilot projects within its R&D activities.
Research and development activities	Some research and development activities are under development by local manufacturers and are related energy management systems for buildings and industry as well as on data transmission technologies and billing services. Social aspects are also covered.
Number of existing smart metering schemes (in operation)	Smart metering is already used on voluntary basis for industrial customers (with higher electricity and gas consumption) and by DSOs for controlling and exploitation of transmission and distribution infrastructure (including gas systems).
Key features of the schemes	Automatic reading of consumption can be realised in any frequency. In most cases the communication is based on smart metering, PLC or combination of those depending of the landscape and settlement.
Number of smart metering	No limits for systems allowed to be used at the moment.

systems available	
Number of smart metering meters and provisions of progress in increase of smart metering number	In industry sector appr. 40% of metering equipment is a smart metering one. Small number in devices in service sector. No smart metering in housing sector.

### 5.2.10 Spain

Official country implementation plan	<p>The Ministry of Industry establishes the Spanish official implementation plan for electrical residential customers on the law ITC 3860/2007 of 28 December 2007.</p> <p>Metering equipments roll-out has a time schedule of eleven years, from 1st of January of 2008 until 31st of December of 2018.</p> <p>The effective implementation of the AMM system must be ready before first of January 2014.</p>
Law regulations related smart metering implementation – obligations, deadlines/goals	<p>The Ministry of Industry has developed smart meter mandatory requirements for the 24 million residential customers called metering point type 5, which are customers with contracted power up to 15 kW, making public the functional and technical specification for electricity smart metering.</p> <p>The main functional requirements for smart meters are:</p> <ul style="list-style-type: none"> <li>- Active and reactive registration in any direction.</li> <li>- Hourly active and reactive energy load profile, with minimum data storage of three months.</li> <li>- Register outages longer than 3 minutes and the limits of the nominal voltage allowed. Remote power quality events.</li> <li>- Load control, remotely disconnection and reconnection.</li> <li>- Up to 6 programmable register for active, reactive and quarter of an hour maximum demand.</li> <li>- Only the utility must be in charge of programming the secret passwords.</li> <li>- Bi-directional communications. The protocols and communications haven't been specified by the Ministry, they are also utility's responsibility.</li> <li>- Remote reading management.</li> <li>- Remote synchronization with concentrators and central system.</li> <li>- Rates remote programming.</li> <li>- Alarms and events registration and storage.</li> <li>- The meter must store the last 3 billing periods. The billing periods could be done manually or automatically (locally or remotely).</li> </ul> <p>The main functional requirements for smart meters are:</p> <ul style="list-style-type: none"> <li>- The meter must fulfil with the Royal Decree 889/2006 of 21st of July of 2006. It describes the metrological control that the smart meters have to pass for active energy. It is similar to the European Parliament Directive 2004/22/EC of 31st March 2004 of measuring instruments, annex VII.</li> <li>- There isn't any technical requirement about standards, preferably</li> </ul>

	<p>these should be publics.</p> <ul style="list-style-type: none"> <li>- The utility could be able to use any communication protocol and interface protocols, i.e. RTC, Gsmart metering, PLC, etc. The meter should have an optical port for local communication and one display to read the consumption in the field. The local reading could be done through this optical port or through an optional serial port RS-232. Remote interfaces are not specified.</li> <li>- The firmware must be updated remotely or locally, the metrological part of the meter must not suffer any disturbance because of that.</li> </ul>
Availability of smart metering technology	As the Spanish Ministry of Industry hasn't specified the smart meter in depth, Spanish utilities need to develop its own smart meter specifications with much more detail.
Economic profitability	There aren't any incentives from government side to the utilities to help them during the huge investment of the roll-out with the exception of a increase on the monthly rental charge of the meter to the customer from 0,54 €/month to 0,81 €/month.
Pilot projects and initiatives	There are pilot projects held by the three of the major Spanish Utilities: Endesa, Iberdrola and EON-Viesgo.
Research and development activities	As Spanish utilities need to develop its own smart meter specifications they are all carrying research and development activities.
Number of existing smart metering schemes (in operation)	Only one at EON-Viesgo with more than 150.000 meters already in operation.
Key features of the schemes	They comply with the requirements asked by the government.
Number of smart metering systems available	<p>There are no limits for systems allowed to be used if they comply with the basic requirements stated.</p> <p>The more important requirements for Smart Metering System according to the Royal Decree 1110/2007 of 24th of August 2007 are:</p> <ul style="list-style-type: none"> <li>- Remote parameterization including time of use, and contracted power</li> <li>- Capability of activation power control mode: maximum demand meter or cut off element.</li> <li>- Power supply remote control: cut off and re-connection supply.</li> <li>- Capability of register load profiles. Allows to record measurement vectors in a flexible way (active and reactive energy, power demanded, current, etc.) selecting periodicity and relevant events to send to the concentrator to their management.</li> <li>- Meters Clock Synchronization remotely and periodically, through concentrators.</li> <li>- Available load management, to reduce demand response at critical moments. Power contracted or available can be programmed.</li> </ul>
Number of smart metering meters and provisions of progress in increase of smart metering number	<p>The Government defined the terms to execute the change to smart meters:</p> <p>Between the 01/01/2008 and the 31/12/2010: 30% of the domestic meters.</p> <p>Between the 01/01/2011 and the 31/12/2012: 20% of the domestic meters.</p>

	<p>Between the 01/01/2013 and the 31/12/2015: 20% of the domestic meters.</p> <p>Between the 01/01/2016 and the 31/12/2018: 30% of the domestic meters.</p>
Endesa Roll Out	<p>Endesa´s smart metering project was officially announced in July 2009, planning to deliver smart metes to its 13,000,000 domestic customers .</p> <p>The metering technology is based on a joint development by Endesa and Enel, which, incorporates a new generation of Enel´s proven and reliable solution, already installed and operated in over 35,000,000 customers in Italy, and Endesa´s experience in the latest technologies in smart metering, communications and systems.</p> <p>The developed system has an efficient cost structure and is adapted to Endesa´s business requirements and Spanish regulations. A key technical innovation is a new generation of robust and reliable PLC communications, based on a BPSK modulation and the field-proven optimized SITRED protocol, already in use in millions of meters in Italy. This allows the PLC system to cope with low voltage networks with multiple signal pathways.</p> <p>Enel and Endesa have recently announced the opening of the PLC communications protocols and specifications, which means that this protocol could be implemented and applied by any utility company.</p> <p>Endesa´s system is defined as a modular system compatible with functionalities of smart grids and customer Added Value Services. During the last quarter of the year 2009 the homologation of field components and system developments will take place.</p> <p>The roll-out will start in the first quarter of 2010 in a controlled manner and by the last quarter of 2010 Endesa will be ready to launch the mass roll-out. The deployment to all 13 million customer will be complete three years earlier than the regulatory schedule in Spain that requires smart metering for all domestic customers before the end of 2018. Remote metering will be started from day one so that ,by the end of 2015, Endesa´s grid will be fully operated using smart metering.</p>

### 5.2.11 Sweden

Official country implementation plan	Legal requirement for monthly meter reading by July 2009 pushed DSOs to implement remote meter reading
Law regulations related smart metering implementation – obligations, deadlines/goals	<p>DSO is responsible for metering.</p> <p>By 1st July 2009 all electricity meters must be read at least once a month for charging of actual consumption.</p>
Availability of smart metering technology	Smart Meter technology is now fully available, but when implementation started several years ago many DSO's selected simpler technologies.
Economic profitability	Not normally considered because introduced by legal requirements. A few DSO's are now looking into extended and forward looking use of the installed Smart Meters.
Pilot projects and initiatives	Full nationwide implementation of remote meter reading is almost completed. There are some ongoing pilots with real

	time tariffs and new energy services by DSO's with Smart Meters.
Research and development activities	Some large DSO's are running internal R&D projects regarding use of Smart Meter data for enhanced grid operation. Yet no industry common R&D of any measures.
Number of existing smart metering schemes (in operation)	Every DSO reads meters remotely. The majority uses Smart Meters.
Key features of the schemes	The functionality and performance of the smart metering systems varies very much
Number of smart metering systems available	Many (more than 100)
Number of smart metering meters and provisions of progress in increase of smart metering number	Nearly 100% penetration of AMR in 2009, but about 10 - 15 % of these meters are in metering systems not capable of much more than monthly reading (= remotely readable but far from being smart metering). These systems will most likely be replaced during the coming years well before their technical length of life.

### 5.3. Deeper stories

Deeper stories are presented for chosen countries and cover the following aspects:

- historical background related to smart metering development
- current status and progress with implementation
  - Legal initiatives
  - DSOs and RESCs engagement and role
  - Consumers response
- barriers and drivers for smart metering development
- presentation of results of cost/benefit analyses
- policy and social aspects
- other supporting and legislative mechanisms
- promotional activities
- cooperation between industry and customers and other market actors
- role of policy makers
- goals and deadlines for future
- research and standardisation

#### 5.3.1 Sweden

In 2007 the Swedish power market had about 5.2 mill. Final Customers<sup>7</sup>. About 4 millions of these were household customers and holiday houses. At this time there were about 170 Distribution System Operators (DSOs), 100 power suppliers and 35 balance responsible companies in Sweden.

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<sup>7</sup> "Timmätning för alla. Nyttä, regelverk och ekonomi", Elforsk rapport 07:26, A. Badano, P. Fritz, A. Göransson, M. Lindén, December 2007

In Sweden the metering services is a monopoly business carried out by the DSOs<sup>8</sup>. It is also the DSOs that own the electricity meters. The Final Customers pay for the metering either by regulated metering tariffs or as part of the grid tariffs.

### **Requirements regarding metering**

In 2003 Sweden became the first EU country to mandate smart metering (indirectly) by legislating new national metering regulations;

From 1 July 2006 the limit for hourly metering is lowered from 200 A for all metering points with a fuse subscription of 63 A. This was expected to increase the number of hourly metered customers by 50.000 – 70.000<sup>9</sup>.

The government mandated monthly invoicing from 1 July 2009, and this encouraged widespread deployment of smart meters<sup>8</sup>.

From 1 July 2009 all metering points should be read monthly and the Final Customers should be invoiced based on their real consumption<sup>9</sup>. These requirements were initiated by consumers' organisations, demanding a better billing from DSOs. The new legislation has encouraged widespread deployment of smart meters, which in practice means that by summer 2009 all Final Customers in Sweden will have smart meters installed. Even though the legislation requires monthly reading, several DSO have already indicated that they will prefer hourly metering and reading.

Sweden has about 15.000 kWh per capita electricity consumption<sup>8</sup>. This represents almost 6 times world average and twice OECD<sup>10</sup> average. Therefore, smart meters, providing more accurate consumption information and enabling new contractual arrangements, can contribute to energy conservation, thus facilitating national policy objectives related to energy efficiency and greenhouse gas emissions.

### **Pilot projects and demand response**

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<sup>8</sup> "Survey of Regulatory and Technological Developments Concerning Smart Metering in the European Union Electricity Market", Jorge Vasconcelos, RSCAS Policy Papers, RSCAS PP 2008/01, Florence School of Regulation, <http://cadmus.iue.it/dspace/handle/1814/9267>

<sup>9</sup> ECEEE 2005: "Smart electricity metering as an energy efficiency instrument: Comparative analyses of regulation and market conditions in Europe", Andrei Z. Morch (SINTEF Energiforskning AS), John Parsons (BEAMA Limited), Josco C. P. Kester (ECN)

<sup>10</sup> Organisation for Economic Co-operation and Development

During the winter 2003 and 2004 the Market Design Research Programme<sup>11</sup> performed a test for demand response referred to peak hours<sup>4</sup>. The objective of the pilot was to test the price sensitivity of domestic customers. The peak demand of electrically heated family homes is about one third of the total peak demand in Sweden. In this pilot household customers with electrical heating got electricity prices during maximum 40 peak hours in the 300-1000 EUR/MWh interval. For the rest of the year the customers receive a deduction on the regular price. Notification was given to the customers via text message or e-mail on the day before as to the time and level of the high price. All customers were equipped with hourly metering.

Along with customer agreement, advice was given on how to temporarily reduce electricity consumption and which measures are suitable depending on heating systems and alternatives. The technical results, questionnaires and in-depth interviews show an unambiguous and consistent picture, that customers generally have considerable interest, ability and persistence when it comes to reducing electricity consumption during instances of high prices. The load was reduced by an average of no less than 50% at times of high electricity prices.

The experience from the Market Design Programme indicates that hourly metering together with suitable tariffs can increase the price elasticity of demand in the market and by that give a substantial contribution to the security of supply and a well functioning electricity market.

In 1997 Sollentuna Energi was the first DSO to install full scale smart metering to all their 25.000 customers<sup>12</sup>. All the customers have hourly metering of their electricity consumption. Sollentuna Energi introduced a power tariff for all the customers. The power tariff has a fixed part (Swedish krona per year) and a power part based on the average consumption for the three maximum consumption hours per month, for work days 07:00-19:00. The tariff is developed in such a way that customers that do not change their consumption, should have nearly the same costs as previously. Customers that shift loads from peak load periods to off-peak periods will get reduced costs.

The peak load was reduced with 2% due to this new power tariff<sup>13</sup>. The power tariff gives the customers incentives to reduce their peak load. No reduction in the energy consumption related to the full-scale employment of smart metering has been registered.

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<sup>11</sup> [www.marketdesign.se](http://www.marketdesign.se)

<sup>12</sup> "Erfaringer fra fullskala etablering av toveiskommunikasjon (TVK"9, I. Graabak, H. Sæle, December 2008

<sup>13</sup> "Market based Demand Response. Research Project summary," O. S. Grande, H. Sæle, I. Graabak, SINTEF Energy Research, December 2008,  
[http://www.energy.sintef.no/prosjekt/mabfot/UK/uk\\_index.asp](http://www.energy.sintef.no/prosjekt/mabfot/UK/uk_index.asp)

## Technical and functional requirements

There exists no Swedish standard defined by the authorities or the energy business regarding functionality for the smart metering system<sup>14</sup>, but there are technical standards regarding metering accuracy and exchange of metering information between actors. SAMS (Svenska mätsamarbetet<sup>15</sup>) was established to work for a common standard. 30 Swedish Distribution System Operators participated in SAMS, and they negotiated for an open front end system for collecting meter data. An open system is a system with a standardised protocol and communication interface. Interoperability between several front end systems has been a requirement from SAMS.

Due to the lack of a common standard several DSOs have cooperated in specifying requirements for a front end system<sup>16</sup>. The main focus has been on the functionality on such a front end system, but since the DSOs also is responsible for collecting the meter data, the requirements are also to be regarding the characteristics for the front end system.

Even if the authorities have required monthly metering, several metering systems have the possibility for additional functionality, such as hourly metering, two-way communication and remote load control<sup>14</sup>. The additional functionality will be considered to be implemented after the requirements from the authorities are met.

## Available functionality

Available functionality in the different smart metering systems depends highly on when the system has been purchased. Newer systems purchased after 2002 have more functionalities available than older systems.

Technical possibilities for smart metering in Sweden were mapped, and the results are presented in<sup>7</sup>. Based on this report, most of the largest DSOs have smart metering systems prepared for hourly metering of the consumption. This is illustrated in Figure 5-1.

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<sup>14</sup> "Införandet av AMS system i Sverige og Europa", EME Analys AB, Stockholm 2007-12-11, [www.emeanalys.se](http://www.emeanalys.se)

<sup>15</sup> In English: "Swedish metering cooperation". The DSOs participating in SAMS represents about 825 000 customers.

<sup>16</sup> "BMSS (Basic Meter System Specification). Kravspecifikation Elmätning (Teknikspecifikation)", Elforsk rapport 06:23, Februari 2006

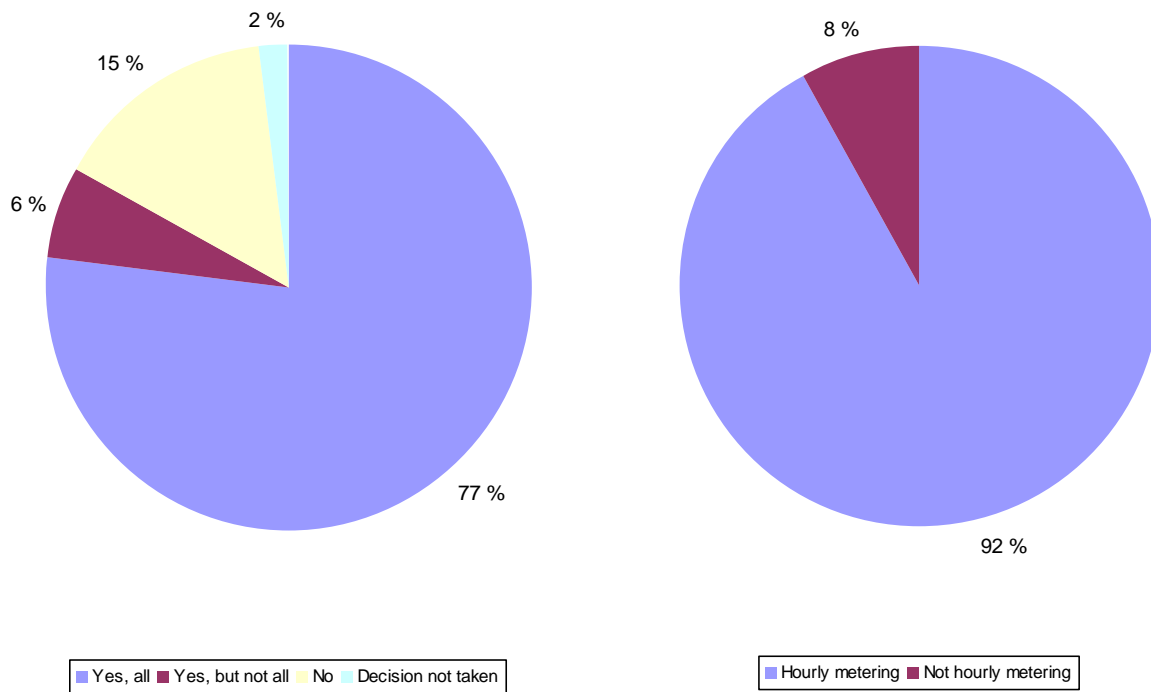


Figure 5-1 Smart metering system prepared for hourly metering<sup>7</sup>

For 77% of the responsive DSOs the meters are prepared for hourly metering, and 8% of the responsive DSOs have some meters that are prepared for hourly metering. Translated into the numbers of metering points about 92% of these points have meters prepared for hourly metering.

### 5.3.2 The Netherlands

#### General

In April 2009 the Upper House of Dutch Parliament rejected a proposal for a compulsory roll out of smart metering in The Netherlands. This after vigorous campaigning by the Dutch Consumers' Association and privacy watchdog groups who claimed a compulsory roll out would constitute a violation of the European Convention of Human Rights. The Dutch government intended to make smart metering compulsory, because it believes that only in this case all benefits in the public interest – such as security of supply and efficient operational management by the grid operator – can only be achieved with a 100% rollout. A voluntary (commercial) roll out would only cover 30 to 35% of all small consumers having a smart meter.

Prior to the decision for a voluntary introduction, in 2008 the Lower House of Parliament already insisted on extra functionalities regarding the smart meter, such as:

- More possibilities for own energy generating;
- A user friendly direct display for in home use;
- An alarm for unexpected peak usage;
- Real time measuring and use versus own generating of energy;
- Possibilities for remote programming of appliances such as laundry machine or dryer;
- Possibilities for communication with other meters.

As a consequence of this, the introduction of smart metering will take place in two phases:

- A two year 'start up' phase for new houses and large scale reconstruction according to the Directive,
- An 'acceleration' phase after discussing the 'Samson Six' and evaluating the other qualities of the present smart meters being used so far.

Other points of agreement between the Minister of Economic Affairs and Parliament are:

- The introduction of a standard bill for consumers;
- Higher volume (5000 kWh instead of 3000 kWh) for own generation of electricity;
- Timely billing by grid operators;
- Specifications for the meter need to be mandated by the Minister of Economic Affairs;
- No extra costs for consumers because of the rollout;
- More privacy protection.

At the time of writing, revised proposal for legislation is being prepared for final approval in Dutch Lower and Upper House. It is expected that the Netherlands will have new legislation for a voluntary introduction of smart metering in place by September 2010.

### **Comprehensive new regulation for the Dutch meter market**

The introduction of smart metering in the Netherlands is part of a larger comprehensive set of regulation proposals to simplify and improve the administrative process involved in collecting and transferring measurement data in a restructured meter market for small consumers. This will involve reallocating responsibilities among the various market parties and making meters subject to regulation. The regulated domain of the grid operator on the one hand will be made exclusively responsible for meter management: the installation and physical maintenance of meters as an integral part of the infrastructure. The supplier on the other hand (market domain) will be made

responsible for the administrative processing of consumption data. On behalf of their own customers, suppliers are required to ensure that measurement data is collected, processed and sent to the parties involved, as described in regulation (*Meetcode*).

The energy supplier will become the primary point of contact for small consumers. The supplier is itself responsible for obtaining and validating measurement data. Instead of being dependent on the grid operator whenever it received validated measurement data, the supplier can now exercise control over this process. To obtain the measurement data, the supplier can enter into an agreement with an authorised metering company. Other parties (for example measurement data companies, suppliers, energy savings consultants) are entitled to independently enter into an agreement with the customer under which measurement data is collected in the context of providing a commercial service. It is up to the customer to decide which party or parties – apart from the grid operator and chosen supplier– are to be given any additional access to the metering device or the (raw) measurement data obtained via the meter.

To ensure that smart meters are also beneficial for consumer and energy efficiency, it is important that all potential advantages are exploited as effectively as possible. For this reason, the statutory framework aims to position meters as an open platform for various services and users that are as accessible as possible. This will create a basis from which more than one party can offer its services to the customer.

Standardisation is also a key requirement in order to ensure that smart meters are suitable for the operation of the entire energy market. The meters that are installed must comply with the statutory requirements. Compatibility and interoperability must be ensured so that the functions of the meter can be effectively used by various parties without any unnecessary technical ramifications. To this end, the *Nederlands Normalisatie Instituut* (Dutch standards institute) in collaboration with the energy sector and the parties involved defined the functionalities of the smart meter in a National Technical Agreement (NTA 8130).

### **Meter charging and meter reading**

It is expected that smart meters in the Netherlands will be assessed and upgraded to the latest technology every two to three years. Modifications can often be performed remotely on the software side, which supports innovation and significantly reduces costs. But even if meter requirements change in the future, making it necessary for the grid operator to make physical modifications to the existing meters, the corresponding costs are covered by the tariffs for measuring gas and electricity (meter leasing). These tariffs are set by the Netherlands Competition Authority. So, it is ultimately the Netherlands Competition Authority that decides when the cost of a major upgrade is permitted that leads to a change in meter leasing tariffs. The grid operator may charge a tariff specified in the regulations for the metering service. This tariff is

set by the Netherlands Competition Authority, charged by the supplier in accordance with the proposed supplier model and paid to the grid operator.

### **Impact on energy and cost savings**

The introduction of smart meters is expected to be an incentive to the market to offer energy saving services. Suppliers may also offer energy saving services either as a separate service or in combination with a supply agreement. This creates a link between the supply market and the market for energy saving services, which is expected to lead to greater product differentiation. Therefore, the requirements set out for mandatory feedback also allow sufficient commercial scope for parties to offer additional feedback services.

In the light of these considerations, national government will introduce legislation making it mandatory for suppliers to provide their customers with information on energy consumption over the period just ended compared with the same period the previous year at least six times a year. Any additional or more frequent information provided by the supplier or a third party would be optional.

A further possible consequence will be the development of a prepaid function or tariff products based on price differentiation per unit of time. This latter means that small consumers may choose from more than one tariff package during the day based on their consumption profile. Such a development would depend on a switch to billing based on interval data, not currently planned in the Netherlands. The specifications of the smart meters allow for the prepaid function to be activated or deactivated depending on the wishes of the connected customer.

### **5.3.3 The United Kingdom**

#### **Historical background related to smart metering development**

Smart metering has a long history in the UK. Electronic meters were developed in the 1980's when the industry was in public ownership; some of these were intended for smart metering applications. However, when the industry was privatised in 1989, it was too fragmented to allow collaborative development of new industry solutions. Also, rather than developing tools for providing better service, the electricity companies were put under competitive pressure to reduce costs. This led to the introduction of electronic meters in the residential sector but purely on the grounds that they were cheaper than electro-mechanical meters. The gas industry went through a similar process, in 1986 it was privatised and the development and roll out of an ultrasonic gas meter was reversed on costs grounds. There were also reports that electricity retailers were moving away from the previous Economy 7 two rate tariff on the grounds that it was simpler and cheaper to offer (and meter) a single rate.

In 2001 the (then) Minister for E-Commerce established the Smart Metering Working Group (SMWG) Its remit was "to consider how "smart" metering technologies can be applied in the

energy arena” Their report recommended that, subject to securing necessary funding from the public and/or private sectors, pilot studies should be set up to establish how far smart metering can best contribute to development of the domestic energy market and to the Government’s social, environmental and security of supply objectives for energy policy and towards its e-agenda.

Although no residential trials came out of this work, in 2003 the Carbon Trust began a project to trial smart metering for SME’s. This work resulted in a Carbon Trust Report<sup>17</sup> that concluded that smart metering was currently cost effective for larger industrial and commercial sites and, with expected reductions in costs, would be cost effective for smaller sites in the near future.

At this time the Energy Services Directive<sup>2</sup> was published and UK government activity has since been focused on responding to that.

With regard to the energy industry, development in the UK has been most obvious in market unbundling. There is separation of Transmission (gas and electricity TSO’s are now merged), Distribution (gas and electricity) and retail. All Suppliers offer dual fuel contracts. Metering has been unbundled and, for electricity, the Supplier is responsible for putting in place contracts for their customers providing meters, meter installation and maintenance and meter reading. Independent companies have been set up to carry out all of these functions but some of the energy companies have also retained each of these functions as internal department, effectively re-bundling the metering function. There are similar but different arrangements for gas metering.

When the electricity market was privatised and generation separated from retail, it was necessary to provide a pricing mechanism for electricity sales from generators to retailers (and hence to their customers) that reflected the time variation in the cost of electricity. For residential customers a profiling arrangement was adopted, allocating a ½ hourly demand pattern. For larger customers (all customers with a supply > 100A per phase) must be metered on a half hourly basis and the meter read remotely every day. This has resulted in a significant sector of around 250,000 daily read meters. As these are randomly spread around the country it has become normal to read these meters using GSM/GPRS or SMS if there is no suitable fixed communications link available. The management of this sector has provided a sound basis for extending similar technology to the residential sector.

### **Current status and progress with implementation**

#### *Legal initiatives*

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<sup>17</sup> “Advanced metering for SMEs, Carbon and cost savings”, Carbon Trust, May 2007.

There has been an extensive series of reports and consultations by the UK Government on the options for a national roll out<sup>18,19, 20, 21,22,23,24,25, 26, 27,28, 29</sup>.

This process concluded in two major announcements. First, in October 2008 the Government announced that it would mandate smart gas and electric metering for the residential sector. This was followed by a further consultation resulting in the next major announcement on the 3<sup>rd</sup> December 2009 setting out the Government's overall approach to the roll out<sup>30</sup>. The key features of this are that 50 million smart gas and electricity meters will be installed by 2020. A company will be appointed to provide a national communication channel that all meters must use. The government has set a minimum level of functionality for both gas and electricity meters.

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<sup>18</sup> Energy billing and metering: changing customer behaviour - An Energy Review consultation, 14th November 2006, BIS

<sup>19</sup> Energy End-Use Efficiency and Energy Services Directive 2006/32/EC, 3rd August 2007, DEFRA

<sup>20</sup> Energy billing and metering: changing customer behaviour - a consultation on policies presented in the Energy White Paper, 3rd August 2007, Department of Energy

<sup>21</sup> A consultation on smart and advanced metering for small and medium sized businesses and sites, and other non-domestic customers, 28th July 2008, BIS

<sup>22</sup> Appraisal of Costs & Benefits of Smart Meter, Roll Out Options, Final Report, 28th September 2008, BIS

<sup>23</sup> Smart Meter Roll Out: Market Model, Definition & Evaluation Project, 8th April 2009, DECC

<sup>24</sup> Smart Meter Roll Out: Risk & Optimism Bias, Annex Two – Optimism Bias Adjustments, 23rd February 2009, DECC

<sup>25</sup> Smart Meter Roll Out: Risk & Optimism Bias, Annex One – Smart Metering Risk Assessment, 23rd February 2009, DECC

<sup>26</sup> Smart Meter Roll Out: Risk & Optimism Bias, 23rd February 2009, DECC

<sup>27</sup> Impact Assessment of smart / advanced meters roll out to small and medium businesses", 11th May 2009, BIS

<sup>28</sup> "Impact assessment of a GB-wide smart meter roll out for the domestic sector", 11th May 2009, BIS

<sup>29</sup> Consultation on Smart Metering for Electricity and Gas, 11th May 2009, DECC

<sup>30</sup> Towards a Smarter Future: Government Response to the Consultation on Electricity and Gas Smart Metering, December 2009, Department of Energy and Climate Change.

Electricity meters will be supplied with a switch so that they can be remotely set as pre-payment or credit meters. The only feature of gas meters not yet decided is whether they should be equipped with a valve to likewise allow remote setting as credit or pre-payment meters.

The full list of gas and electricity meter functionalities is shown in **Table 5-1**.

High level functionality	Electricity	Gas
<b>A</b> Remote provision of accurate reads/information for defined time periods - delivery of information to customers, suppliers and other designated market organisation	✓	✓
<b>B</b> Two way communications to the meter system - communications between the meter and energy supplier or other designated market organisation - upload and download data through a link to the wider area network, transfer data at defined periods, remote configuration and diagnostics, software and firmware changes	✓	✓
<b>C</b> Home area network based on open standards and protocols - provide "real time" information to an in-home display - enable other devices to link to the meter system	✓	✓
<b>D</b> Support for a range of time of use tariffs - multiple registers within the meter for billing purposes	✓	✓
<b>E</b> Load management capability to deliver demand side management - ability to remotely control electricity load for more sophisticated control of devices in the home	✓	
<b>F</b> Remote disablement and enablement of supply - that will support remote switching between credit and pre-pay	✓	✓
<b>G</b> Exported electricity measurement - Measure net export	✓	
<b>H</b> Capacity to communicate with a measurement device within a microgenerator - receive, store, communicate total generation for billing	✓	

**Table 5-1** Government list of high level meter functionalities

### Non-residential customers

Since 1st April 2009, energy suppliers in the UK have been required to provide advanced metering for the commercial market (Profile Classes 5-8) whenever a new meter is installed or a meter replaced and that all customers should be provided with an advanced meter by 2014. The government has decided that the remaining commercial customers should be included in the national roll out and receive smart enabled meters by 2020 except where:

- a) where advanced meters have been installed before April 2014 and the customer wishes to retain the existing meters; or
- b) where advanced meters have been installed after April 2014 under pre-existing contractual arrangements; or
- c) where there are technical constraints on the achievement of smart functionality.

Real time displays will not be required to be supplied to commercial customers.

### DSOs and RESCs engagement and role

#### *Energy retailers*

The UK energy retailers have been very proactive in promoting smart metering. They have cooperated through their trade body, the Energy Retailers Association (ERA). The ERA has produced a series of reports as part of its Supplier Requirements for Smart Metering (SRSM) Project, aimed at defining a smart meter functionality that would meet the need for interoperability. Specifically, the energy retailers require that any smart meter installed by one retailer can be adopted by another company when they take over the customer contract without needing a site visit to change or modify the meter. The latest summary of their work can be found in this report<sup>31</sup>.

### *DSO involvement*

DOS in the UK have become increasingly involved in the smart meter roll out. The DSOs have no responsibility for meters or their operation in the UK and were not much involved in the initial discussions into smart metering. However, the growing interest in smart grids has resulted in the DSO's (via their association the Energy Networks Association (ENA)) taking a growing role in discussions. This resulted in the government carrying out a supplementary consultation and study to examine if they should return responsibility for meters to the DSO's. In the end the government chose not to go down that route but only when assured that the main features of the smart grid could be delivered via the central communications model.

### *Consumers' response*

Consumer response has been the subject of an extensive trial sponsored by the Government and managed by the Regulator, OFGEM. This involves four large energy Retailers and 43,000 customers. The trials include a wide range of measures, going from simple energy savings advice and better billing through to full smart metering and real time feedback. At this time the trials have not reached a final conclusion, the final report is not planned to be released until the end of 2010. Interim reports have not shown any clear conclusion<sup>32</sup>.

In general the UK consumer body has been in support of smart metering. EnergyWatch (which was absorbed into Consumer Focus) recognised the benefits of eliminating estimated bills and better switching. As the roll out approaches Consumer Focus is now addressing consumer interests such as privacy and costs. The government has recognized the importance of consumer engagement in the national roll out plan.

## **Barriers and drivers for smart metering development**

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<sup>31</sup> Smart metering, Operational Framework Summary, August 2007, Energy Retail Association.

<sup>32</sup> "ENERGY DEMAND RESEARCH PROJECT, Review of progress for period September 2008 – March 2009", September 2009, Ref: 115/09, OFGEM

Given explicit support from the Government, Regulator, consumer bodies and energy companies, one might be forgiven for thinking that implementing smart metering in the UK would be relatively straightforward. However, the complex market structure in the UK ensures that this is not the case. The drivers are relatively clear:

- Compliance with the ESD

This has had a relatively small effect in the UK given that the government considered that it could almost comply with Article 13 of the ESD without introducing smart metering. However, the government has chosen to proceed down this route for other reasons.

- Environmental Considerations

The Government has been persuaded that smart metering and information feedback will deliver immediate energy savings benefits and support further energy savings measures. Ambitions are low, though, given the 1%-2% saving assumed in their cost benefit studies. This also links to the pressure from Government on energy suppliers, requiring them to reduce the consumption of their customers, primarily delivered via the CERT (Carbon and Energy Reduction Targets).

- Pre-payment and Fuel Poverty

The Government has long had concerns about the cost of energy for pre-payment customers and looks to smart metering to even out the costs to pre-payment and credit customers. The government also believes that one option for helping customers out of fuel poverty is to provide them with usage information enabling them to reduce their consumption and, hence, energy costs.

- Energy Services

After a long period of head on competition between energy suppliers based on price, they have recognised the opportunity provided by smart metering to offer their customers new energy services.

- Smart Grids, Smart Homes, Telecare, Digital Britain

The Government is increasingly seeing the opportunity offered by smart metering to support smart grids, smart homes, telecare and embedded generation. It also sees a connection between the roll out of broadband to all homes in the UK and the communications needed for smart metering. These considerations were not part of the original government case and the Government is still in the process of developing its understanding of the opportunities and implications for the smart metering roll out. The government has declared that the linkage between smart metering and other initiatives will be considered during the first phase of the roll out programme.

- Improved Business Processes

The UK has seen very high levels of customer switching and this has resulted in high costs for the Suppliers and, when the processes have been unable to cope, high levels of customer dissatisfaction. Smart metering is expected to improve these processes, reducing costs and increasing customer satisfaction. Consumer Focus, the UK consumer body also strongly supports the elimination of estimated billing.

Barriers in the UK are mostly related to the complex market structure.

- Market Fragmentation and Responsibility for Metering

Energy Suppliers are active across all parts of the UK resulting in high levels of geographic intermingling of customers; down any one street there will be customers for a large number of Suppliers. All Suppliers offer both electricity and gas, although customers do not necessarily take both from a single Supplier. This is combined with the responsibility for metering being vested with the Supplier so that responsibility for metering is very mixed in a geographical sense. This makes it hard to organise an area by area roll out of smart metering or provide a shared communications infrastructure. To address this issue the Government has considered moving responsibility for meters back to the DSO or appointing a national body to provide a wide area communications network.

- Interoperability

Given the high level of customer switching the Suppliers have been very concerned about interoperability. Specifically, they require that there should be no need to visit sites to change or modify the meter when there is a customer change. To this end their representative body, the Energy Retailers Association (ERA) has developed a meter specification<sup>33</sup> that will ensure a common meter specification and interoperability. However, even here the market structure has complicated activity; there are competition law issues that limit how much the Retailers can cooperate to develop business models.

- Measuring Instruments Directive (MID)

The UK Government has been very conscious of the requirements of the MID and the limitations this Directive places on what the Government can mandate for the UK market. This has led the government to work at a European level to reconcile the MID and ESD. However, it has also raised concerns that this may introduce undesirable delays into the programme.

- Presentation of results of cost/benefit analyses

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<sup>33</sup> Smart Metering , Operational Framework Summary , August 07 , ERA, [http://www.energy-retail.org.uk/documents/SmartMeteringOperationalFrameworkProposalsandOptionsSummary\\_003.pdf](http://www.energy-retail.org.uk/documents/SmartMeteringOperationalFrameworkProposalsandOptionsSummary_003.pdf)

The UK Government has carried out a series of cost benefit analyses, references..... The earliest analyses were unfavorable and did not support a roll out into the residential sector. Subsequent examination of the cost benefit analyses showed that the consultants had applied optimism biases to the analysis. This was in line with government practice but had the effect of doubling the costs. Partly this was a consequence of classifying the roll out of smart metering as an IT project, a class of projects with which the government has had a poor experience and for which a bias factor of 100% is applied. A subsequent analysis was carried out to examine this bias factor and, on the basis of evidence from roll outs around the world and growing confidence in the meters costs, a positive analysis was obtained.

This was also assisted by the acknowledgement of various benefits by the UK DSO. Previously, given that they have no responsibility for metering in the UK, the DSO's had not involved themselves in the functional definition of smart metering (or accepted any contribution to the costs). The growing interest in smart grids has led the DSO's to declare an interest in the meter functionality and the Energy Networks Association (ENA) has published its own list of required meter functions<sup>34</sup>.

The latest reports from the Government indicate that the net benefit arising from smart metering has now risen to £6b net present value (on the basis of the central communications model)<sup>35</sup>.

- Policy and social aspects

Important aspects for the UK are the issue of fuel poverty and pre-payment, which is often closely related. In most cases UK customers who are classed as fuel poor will be unable to obtain a credit contract with an energy Supplier and will be obliged to use prepayment. Traditionally this has excluded them from the cheapest energy supply contracts and also incurred higher metering costs. As a consequence of this there is considerable interest from UK Government to use smart metering to re-balance the costs for customers. This has been evident in the appearance of a remotely operated switch for electricity meters and valve for gas in UK functional descriptions. These switches and valves are intended to be used to allow meters to be remotely reconfigured between credit and pre-payment mode. If they are universally fitted to meters it is expected that the cost of operating a credit and pre-payment account will be much closer, resulting in a lower penalty for pre-payment customers.

### **Other supporting and legislative mechanisms**

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<sup>34</sup> "Energy Networks Association Response to the Consultation on Smart Metering for Electricity and Gas", May 2009, ENA

<sup>35</sup> "Impact assessment of a GB-wide smart meter roll out for the domestic sector", December 2009, Department of Energy and Climate Change.

UK energy suppliers are subject to the terms of the Carbon and Energy Reduction Target scheme (CERT) where the suppliers are required to spend a small proportion of their revenue on energy savings measures. This funding has been used to support schemes such as low energy lighting and insulation. The scheme excludes any measures that are already mandated and this has been an issue for smart metering as the Suppliers want to claim energy savings benefits for the real time displays. Also, smart metering energy savings are less clear than for the other measures.

- Promotional activities

So far few but there is a growing acceptance that this will be an essential element of any national roll out of smart metering. The government response clearly identified a need to engage in large scale promotional campaigns to explain smart metering to the general public.

- Cooperation between industry and customers and other market actors

There is a cross industry metering forum where UK stakeholders meet to coordinate industry issues (the Industry Metering Advisory Group, sponsored by OFGEM. Whether this body will act as the stakeholder group for the UK roll out or another body formed will be decided in Phase 1 of the roll out.

- Role of policy makers

Overall responsibility for strategic delivery will be taken by the Department for Energy and Climate Change (DECC), working with OFGEM, the UK energy regulator. The programme will be managed under the Office of Government Commerce Gateway procedures. Other key government departments and agencies are the Department of Business and Innovation Skills (BIS), the Department for Environment, Food and Rural Affairs (DEFRA), National Measurement Office (NMO), Elexon. The government has indicated in its response that it believes that community engagement is important and, consequently, has proposed to involve local authorities via the Department of Communities and Local Government (CLG).

- Goals and deadlines for future

The project plan is:

2009 – summer 2010

DECC and OFGEM will define the scope and key principles of the roll out.

Summer 2010 – summer 2012

Detailed design phase

Summer 2012 - 2020

Implementation phase

- Research and standardisation

The UK government has been very active in working with the Commission to ensure that their programme is consistent with the requirements of the Measuring Instruments Directive. As far as possible, meters and other components will be specified by reference to harmonized standards and open specifications and protocols. There is still, however, some concern that achieving a European consensus for meter standardisation may delay the UK roll out.

- Demand response

Although the Government has kept to a minimal set of functional requirements for smart grid use, the meters will be equipped to support demand response and complex tariffs. The provision of a HAN chip and switch in electricity meters will allow remote management of home appliances and thermostats. It will also be possible to impose capacity caps on customer supplies. The latest DSO Price Control Review<sup>36</sup> identifies a need for DSO's to examine opportunities for demand side management:

*DSOs should* "Take a more holistic view of network costs by exposing them to transmission network interface costs. This is important given the potential for non-network solutions with increasing distributed generation and demand side management."

#### 5.3.4 Czech Republic

##### **Pilot trials - focus on technical reliability**

Currently (9/2009), there is no official plan for mass-scale implementation of smart metering in the Czech Republic defined yet.

Instead, only two pilot projects testing rather technical aspects of AMI-based technology has been underway since 2007. The former one is being implemented by CEZ, the former monopolist electricity producer and now the leading vertically integrated nationwide supplier, in East Bohemia (it includes ca **2 thous.** residential customers) and the latter by E.ON a similarly integrated utility in four selected municipalities in South Moravia (ca **4 thous.** residential customers).

In both cases the primarily purpose of their realization was to assess the feasibility and reliability of various AMI/AMM technologies and, so far, it has not included the provision of enhanced information on energy use towards end-users (i.e. absence of feedback).

The first results and experience by both pilots (after nearly one year of real operation more less by each) was presented at the conference named "Smart metering" organized by IIR in Prague in October 2008. Representatives of both companies mostly reported miscellaneous technical problems and bottlenecks which implementing teams arrived at

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<sup>36</sup> Electricity Distribution Price Control Review Final Proposals, 7 December 2009, OFGEM

so far and how were solved out. By each pilot, several technologies for metering of electricity (by pilot of CEZ then also of gas) consumption and consequent data transfer have been tested (PLC, RF, and also GPRS). Subject of testing was continuous metering of load profile (energy use), remote disconnection of a meter, and use of ripple control (automated switching on/off of electric heating appliances, i.e. load management). Management of all the metering points in each pilot is for safety reasons done via specifically created control centers in order not to threaten the stability and functionality of the overall ERP/CRM systems of the companies.

The results of the pilot implemented by CEZ led in 2009 to the decision to undertake another, but more extensive pilot in near future. It shall include about **40 thousand** measuring points which represents about 1 % of all the metering points serviced by the company presently. The increased size of the pilot has as its aim to help to clarify and solve some remaining technical obstacles which could not be solved by the first pilot and lead to the definition of rules and specifications for the future (eventual) mass-scale roll-out.

That “second step” should finally result into a mass-scale roll-out of smart metering technology in one region (about **1 million** inhabitants) by 2015 which was in June 2009 announced by the top management of CEZ corporation as part of the “futuremotion” strategy which envisions the transition to a smart grid, with omnipresent distributed generation and electric vehicles.

The outcome of the second pilot carried by E.ON could be summarized as the general fulfillment of the goals too. The most number of problems were the ones with remote (PLC) communication and problems with big amount of system alarms. What shall be further plans are, however, not known so far.

### **Feedback mechanisms to come**

In neither of the first pilot trials mentioned above, there is provided to final customers information on their energy use other than is present practice (billing on an annual basis).

For that purpose, ESMA national project partner (SEVEN) has been actively trying to stress the importance of provision of feedback mechanisms as an indispensable instrument which customers may utilize to identify and realize energy saving measures.

SEVEN with the support of the Program EFEKT in 2008 designed a possible scheme which shall effectively motivate final energy users to energy savings with the help of information provided by “smart meters”. (In more detail was the proposed scheme presented in the 2008 edition of the annual progress report.)

Its implementation into the advanced pilot trial planned by CEZ is under negotiation and the goal is on the one hand to verify the possible effects of provision of feedback information to final customers (in terms of possible energy as well as financial savings), and thus help to quantify the prospective benefits and the overall economic efficiency of mass-scale smart metering introduction in the future.

### **(Restoration of) Demand Response**

Another new development took place in the field of ripple control which is in the country a well-functioning system established originally in the 1970s offering remote control of electric heating appliances (water heaters, space heating) by a relay switch installed along with a meter. The ripple control leverages load management and those customers, which meet conditions to be eligible to use it (among others the installed output of heating appliances shall be similar to thermal needs) are rewarded with electricity supplies at two different prices at peak loads and at off-peak periods (either 8, 16, or 20 hour-long).

As the evidence, how the function of ripple control is extensively used, can be used following figures: There can be presently automatically regulated as much as 2,500 MWe of various electric heating appliances installed mostly by small-scale customers (direct/accumulation-type space heating, electric heaters), of which simultaneous maximum load amounts to about 1,350 MWe. That represents a total of 10-15 % during maximum/peak load periods in the electricity grid currently recorded during winter days.

Since liberalization and unbundling, the operation of ripple control has been attributed to local electricity distributors which utilize it primarily for optimizing of load in the (local) distribution grid.

But throughout 2009 got underway discussions, how to make use of it for balancing the overall market with electricity, i.e. how to offer demand response as a resource to the system operator in the form of ancillary services.

There must be several obstacles removed to make these things happen. First of all, it must be cancelled the present rule according to which regional distributors are obliged to announce any changes in the schedule of the ripple control application a week in advance. This rule makes the real-time operation impossible and has to be abolished.

The second important obstacle is that the current ripple control is maintained by distribution companies which are not in its nature participants on the market with electricity and not so-called settlement bodies responsible for (im)balances in purchases and supplies of electricity of their and its customers. A solution to this is to allow traders/suppliers to contract the application of ripple control with a local distributor and offer on behalf of him the prospective volume of demand respond to the market operator as an ancillary service.

The implicit problem is, however, that by contracting the volume of demand response in the service area of a given distributor may result in the changes of load of also customers of other suppliers. But such a situation is basically beneficial for all the concerned parties since the change in energy use of other suppliers's customers is opposite to the overall market imbalance. Thus, these problems may be solvable and, hopefully, will lead to the introduction of demand resource as a real resource on the market with electricity.

The ultimate solution to this is the introduction of full-scale smart metering technology if becomes mature enough to address tens or even hundreds of thousand of meters in few seconds like it can be achieved in the old but still well-functioning ripple control technology.

**Expected next development**

Thanks to the approval of the Directive No. 2009/72/ES, the mass-scale introduction of smart metering will be in the years to come subject of an in-depth assessment. It may be expected that the fast development of distributed generation and diminishing power production capacities will increase the benefits of that technology. Thus, as the time passes the benefits of that technology will be more evident and valuable.

## 6. Energy Savings and other Benefits Attributed to Smart Metering Systems

There is general acceptance of the potential benefits attributed to smart metering systems for different stakeholders:

- For final customers to increase energy awareness and decrease energy use and energy cost.
- For metering companies or DSOs to decrease meter operation costs.
- For grid operators who want to prepare their grid for the future.
- For energy suppliers who want to introduce new, customer made services and reduce call centre cost.
- For governments to reach energy saving & efficiency targets and to improve free market processes.

### 6.1. Benefits related to energy savings

Smart Metering is a technology where end-use energy efficiency can be encouraged. Smart Meters can give consumers, at an affordable cost, clear and comprehensive information about their energy consumption and, giving them better information, can help consumers become more energy efficient.

However, installing Smart meter will, by itself, do nothing to save energy since the meter itself is simply an “enabler”. Energy savings will only be achieved if installing the meters results in consumers actually changing their behaviour so as to use less energy in total.

Smart meters systems also provide useful information to distribution network operators. This information can be used to better manage networks thus reducing network losses.

While today the main concern of the utilities is the reliable supply of energy (of different forms), tomorrow will also add responsibility for the provision of energy services to realize energy savings as the ESD prescribes (it instructs member states to oblige energy retailers and distribution operators to offer - directly or indirectly - energy services which will lead to verifiable and monitorable energy savings).

The pre-condition to this is receptive customers’ with a willingness to modify their behaviour in favour of lower energy use (or willingness to be persuaded). This behaviour can be developed through well-targeted information campaigns and the introduction of further stimuli (like reward for the protection of the environment) which will incite customers to take the desired actions. But experience suggests that the motivation towards energy savings must be “refreshed” on a permanent basis otherwise the effect of more cautious energy use may erode over time. It can be expected that, in order for energy savings to be realized, financial incentives (possibly state-

supported or mandated) will also be introduced to make energy saving measures more attractive in economic terms.

The typical demand response is a voluntary reaction by the final customer to a price signal, for example delaying electricity demand by hour (load shifting) or to avoid an extreme price peak (peak clipping).

The introduction of time varying and dynamic pricing can be accompanied by the installation of remote/automatic load control devices/programs. This can maximise the desired load reductions and avoid the need for the customer to take any action.

The typical end uses which may be subject of such remote switching/control are space heating and cooling (or generally “conditioning”) systems or electrical boilers for water heating. More advanced load control programs may also regulate lighting sources and more intensive electric appliances with adjustable time of operation like washing machines and dishwashers.

Apart from areas where there are severe supply constraints, the benefits of demand response are in general not enough to justify large scale smart metering investments alone. However demand response can be an important part of the business model combined with operating benefits, energy efficiency and other elements.

Estimates of likely benefits are needed to justify and design investments in demand response and smart metering. The potential for energy savings can be expected to be different from one final customer segment to another and from one country to another. The current literature throughout Europe gives mixed results about the possible savings.

In 2006, Dr. Sarah Darby, a research fellow at Oxford’s Environmental Change institute, conducted a major review of feedback research in North America and the European Union. The studies she reviewed consistently demonstrated that real time feedback helps residents effectively control electrical consumption. Darby concluded that the norm for savings from immediate direct feedback is to range from 5 – 15%, whereas the savings from indirect feedback have ranged from 0% - 10%.

The studies Darby reviewed consistently demonstrated that real time feedback helps consumers effectively control energy consumption. This finding is supported by one of the most statistically significant (long term and large scale) studies to date on real time feedback, conducted by McMaster University’s Institute for Energy Studies in Ontario. In 2007, professor Dean Mountain reported an aggregate electricity use reduction of 18.1% in Newfoundland and 2.7% in British Columbia, which was persistent and did not decrease over time during the pilot period 2005 and 2006. Mountain concluded in 2007 that real time feedback of energy consumption is indeed effective in promoting energy conservation, hereby confirming his former similar research in the Hydro One pilot which resulted in an aggregate electricity reduction in kWh of 6,5%.

There is a range of technology currently on the market to provide the benefits related to energy savings by making energy use visible in a way that is meaningful to consumers. And while most of the monitors in the past were designed to work with a flat rate, current technology is now being adapted to work with the advanced metering infrastructure for new initiatives such as dynamic pricing initiatives.

In some countries such as the UK and the Netherlands, further investigation is being developed to test innovative combinations of smart meters and feedback mechanisms. Worth mentioning in this respect is the 2009 research from the Energy Saving Trust<sup>73</sup> (EST) to analyze the relative strengths or otherwise of different energy feedback displays currently available in the UK market. This study pointed out that a smart meter roll out will be less effective without stand alone in-house display monitor. Further, the research showed a remarkable convergence in opinions regarding the functionality that consumers identify as being critical to display design. Based on this research EST recommends a set of minimum functionalities such as a default mode in money and power with:

- a clear analogue indicator of current consumption;
- current rate of consumption as a rate of spend in pounds per day;
- cumulative daily spend in pounds.

Other proposed functionalities are spend in last 7 days (day by day) and spend in last complete week, month and quarter, while matching the utility's bills. Finally, the display should be mains-powered, but have an internal battery to enable mobility in the home.

This list should be viewed as a minimum requirement which does not restrict display design to only these features nor limit further innovation.

It should be noted that any developments in the advanced metering infrastructure should be guided by the quality and quantity of feedback provided to households. Direct feedback (displays or internet based) combined with improved billing shows most promise for electricity and carbon reduction, through relatively low cost demand side management. And all these activities together will lay a solid basis for persistent savings through improved consumer education.

### 6.2. Other benefits

Smart metering has a range of other possible benefits not only for final customers, but also to suppliers, metering companies, grid operators and governments.

Smart metering systems may benefit **final customers** in many other ways. The most important are:

- More accurate meter reading and billing and fewer customer complaints because with smart meters bills are based on real rather than estimated consumption.
- Better service quality as the availability of individual service quality measurements allows regulators to design new penalties/incentives to improve the performance of distribution network.
- Easier to change supplier because, as meters can be read at any time on request, it reduces delays for switching to take effect.
- Increased competition among suppliers as suppliers are able to offer customized contracts and added-value services.
- Ability to manage consumption as smart metering systems allows customers to remotely control devices that are able to communicate with the meters.
- The ability to install micro generation measures without new metering arrangements.
- The possibility for prepaid or post paid schemes and easier credit, either by phone or internet for pay as you go meters.

Smart metering systems also offer **suppliers** with several advantages, such as:

- Customized prices: Smart metering allows the supplier a better knowledge of the consumption pattern of individual customers, giving them the opportunity to target them with different prices options.
- Easier change of supplier process through automation of meter reads increases the speed of the process.
- Fewer billing complaints as they are based on real rather than estimated consumption and can be resolved online.
- Fewer bad debts as smart metering allows remote cut-off and reconnection.

Smart metering also reduces operational costs to **metering companies** as different tasks like readings, connection and disconnection, tariff programming, alarms management, clock synchronization and/or firmware update can be done remotely.

The **grid operators/DSO** obtain several advantages from smart metering systems, such as:

- Faster identification of location and restoration time as with smart meters the DSO automatically knows where the power is out and can dispatch crews to restore it without having to wait for customers complaints.
- Better detection of technical and non-technical losses due to better information of the low voltage distribution network and the alarms incorporated on the meters

- Grid voltage and phase monitoring
- Optimization of the distribution network due to better knowledge of it.

To end up, smart metering systems offers additional benefits for **governments** as it helps to reach energy saving & efficiency targets, improve the security of supply and ease free market processes.

## 7. Advances in Smart Metering Technologies and Systems

### 7.1. Developments in Smart Metering Technology

#### 7.1.1 Introduction

2009 has seen considerable developments in smart metering technology. This has resulted from

- Improvements in technology arising from the practical experience of early implementations and general innovation.
- Regulatory and market driven developments such as the Commission mandates on standards for smart metering.
- Growing recognition that smart metering actually is a key implementing measure for other important developments; increasingly smart metering is being absorbed into smart grids initiatives.
- The opportunities for energy savings related to smart metering are increasingly being exploited by companies looking who have developed energy displays and energy saving services based on smart homes technology.

These drivers can be seen acting in each of the following sections where we examine individual technology aspects. Pleasingly, from the viewpoint of ESMA, these drivers match the main thrusts of the various recommendations and reports coming from the ESMA project. This annual report, however, will limit itself to those areas that are directly relevant to energy savings and other social benefits; it does not claim to be a comprehensive review of all developments in smart metering technology.

#### 7.1.2 Overview

What can also be detected is growing confidence in the market opportunity. The 3<sup>rd</sup> Energy Package<sup>37</sup> announced by the European Commission commits member states to roll out smart meters to at least 80% of customers by 2020 who are deemed to have a positive cost benefit result. In the UK, the Government has committed to a roll out of 47 million smart meters, supported by announcements from individual energy companies. British Gas announced that it would be rolling out smart meters to its 15.5 million customers. Their announcement also gave a first indication of the employment implications; they are setting up a new smart meter business unit that will employ 2600 people by 2012<sup>38</sup>.

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<sup>37</sup> [http://ec.europa.eu/energy/electricity/package\\_2007/doc/2007\\_09\\_19\\_explanatory\\_memorandum\\_en.pdf](http://ec.europa.eu/energy/electricity/package_2007/doc/2007_09_19_explanatory_memorandum_en.pdf)

<sup>38</sup> <http://www.centrica.co.uk/index.asp?pageid=39&newsid=1909>

A report by Pike Research<sup>39</sup> forecasts global installation of smart meters of 250 million by 2015. The report goes on to say that Europe is currently the leading region in smart meter deployment but the US will take over by 2015 when 55% of their meters will be 'smart'. There is support for this conclusion in a report from the Federal Energy Regulatory Commission<sup>40</sup> that estimates that there are likely to be 80 million smart meters installed in support of demand response programmes in the US by 2019 with an upper estimate of 141 million meters.

### 7.1.3 Meters

As well as evolution in electricity meter designs, there have been important developments in gas and water smart meters. These meters are designed to integrate with smart meter systems and contain features needed for this application. One example is from Sentec has launched a smart water meter incorporating the Sterling meter core<sup>41</sup>. This meter has very low power consumption allowing long battery life and detects very low flow rates allowing it to detect water leaks. Elster Metering has introduced a similar product under the SmartMeter brand name<sup>42</sup>.

Companies have also been extending smart functionality to existing products; Itron has launched the EnergyPoint.net™ system that utilises the smart metering communication network to allow customers to use the internet to recharge their meter<sup>43</sup>.

It might also be noted that there is evidence of customer unquiet when faced with new metering. In San Francisco, PG&E is facing claims of overcharging after the installation of smart meters and are carrying out a review. Regardless of the facts, a lesson learnt from this is be prepared to carry out such an exercise as such complaints can be expected. Meter operators should ensure that there are well established processes for checking meter accuracy.

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<sup>39</sup> Smart Grid Technologies, Networking and Communications, Energy Management, Grid Automation, and Advanced Metering Infrastructure, <http://www.pikeresearch.com/research/smart-grid-technologies>

<sup>40</sup> ASSESSMENT OF DEMAND RESPONSE AND ADVANCED METERING

Pursuant to Energy Policy Act of 2005 section 1252(e)(3)

[http://www.ferc.gov/legal/staff-reports/sep-09-demand-response.pdf#xml=http://search.atomz.com/search/pdfhelper.tk?sp\\_o=5,10000,0](http://www.ferc.gov/legal/staff-reports/sep-09-demand-response.pdf#xml=http://search.atomz.com/search/pdfhelper.tk?sp_o=5,10000,0)

<sup>41</sup> <http://www.sentec.co.uk/page/sterling/9/>

<sup>42</sup> [http://www.smartmeter.co.uk/page.php?page\\_id=12](http://www.smartmeter.co.uk/page.php?page_id=12)

<sup>43</sup> [http://www.itron.com/pages/news\\_press\\_individual.asp?id=itr\\_017587.xml](http://www.itron.com/pages/news_press_individual.asp?id=itr_017587.xml)

## 7.2. Advances in data transmission technologies

As the number of trials and full implementation grows there is increasing practical experience from these. A key issue has been the performance of the communications networks. Some reports have been published, most notably a report from Energy Australia<sup>44</sup>. This report reviewed the performance a number of competing communications systems. The performance of these systems varied considerably, for PLC systems, the cost per month of meter communications varied from \$1.37 - \$0.32 depending on the system. Some systems had read reliabilities as low as 60% whilst others were operating at >95%. These results are more interesting as a starting point. As companies build experience of operating their systems, they also identify improvements addressing specific weaknesses. An example of this is the PLC communications system developed by Endesa. In their case a low voltage network can be supplied by a number of LV transformers, switched as required. Such a topology makes the mapping between a meter and concentrator uncertain. Endesa's system overcomes this by allowing the concentrator to discover meters on its network and the meters have identifying codes, so that the system can reassign meter pathways dynamically.

Also related to PLC, there is a need to raise data rates and reliability to support more demanding services and to support smart grid communications. Sagem and ERDF have developed an IPv6 based system<sup>45</sup> that uses a new form of PLC and increases the performance and bandwidth available.

Another notable development in communication has been the progress of wireless mesh networks. It had been previously assumed that these networks worked poorly in Europe, compared to the US, where they are widely used. The Gothenburg ZigBee smart metering system<sup>46</sup> used the ZigBee wireless network for communications outside the home. Following this success, a number of companies have been developing other mesh technologies in Europe. A similar ZigBee system has been used in the UK as part of the UK Energy Demand Reduction Trials. Other approaches include Meshnet<sup>47</sup>, who have implemented a number of systems in Finland and Sweden and is an IP based system, operating at 896 MHz. The company Smart Dutch b.v.<sup>48</sup> has also been developing and trialing wireless mesh networks in the Netherlands.

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<sup>44</sup> AMI Pilot Project, Phase 1 Technology Report, EnergyAustralia, October 2008.

<sup>45</sup> <http://www.sagem-communications.com/corporate/index.php?id=1909>

<sup>46</sup> [http://www.aimir.com/success/aimir\\_overseas.html](http://www.aimir.com/success/aimir_overseas.html)

<sup>47</sup> Meshnet by Tritech Technology AB, <http://meshnetbytritech.com>

<sup>48</sup> Smart dutch b.v. <http://www.smartdutch.com/4298/index.html>

In the US, where utilities have different commercial models, there are examples of smart metering and smart grids being based on fiber optic networks.<sup>49</sup> It is unlikely that such integrated schemes could be offered in Europe, owing to the different regulatory domains for utilities and telecoms. However, the UK government has noted the possible link between its home broadband policy<sup>50</sup> and smart metering.

### 7.3. Advance in data processing technologies

#### 7.3.1 Interoperability

Interoperability and standards development has been a major activity in 2009 in response to regulatory and market demands for interoperable smart meter systems.

##### **Commission Mandate 441**

On the 12<sup>th</sup> March 2009 the Commission issued a mandate to the European Standards Organisations (CEN, CENELEC, ETSI) to develop harmonised standards to support smart metering<sup>51</sup>. The mandate required the ESOs to carry out two tasks; dealing with wide area communications and smart meter functionality. To oversee the work programme the ESOs set up a Smart Metering Coordination Group (SM-CG) with a wide ranging membership from stakeholder groups. The work teams have produced an initial report on the two topics<sup>52</sup>. This document presents a thorough review of the current situation regarding standards for smart metering and identifies gaps in coverage that require to be addressed. The report allocates responsibility for progressing the standards development to the appropriate standardisation committees and sets an achievable timetable.

In order to support the development of new standards the SM-CG working groups are developing 'use cases' which define the functions that any system or component being standardised should perform. For instance, one use case would be to allow a approved remote operator to adjust a thermostat or other appropriate device within a customer's home. Although the use case

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<sup>49</sup> Chattanooga EPB, <http://www.epb.net/>

<sup>50</sup> Towards a Smarter Future: Government Response to the Consultation on Electricity and Gas Smart Metering, DECC, Dec 2009

<sup>51</sup> M/441, Standardisation mandate to CEN, CENELEC and ETSI in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability. 12th March 2009.

<sup>52</sup> SMCG Sec0009 DC Smart Meters Co-Ordination Group - Status report on M441 from SMCG, 27<sup>th</sup> Oct 2009.

description is relatively simple it allows a complex set of standards to be developed to fulfil all of the operations necessary to carry out this task. At the same time, it allows standards developers to see what is outside their scope, substantially reducing the development time of a standard. From an 'ESMA' and energy savings perspective, it is important to ensure that the use cases needed for this application are included in the list passed to the standards bodies.

### **Open Meter Project**

In parallel with the work linked to Mandate M/441, there has been considerable activity around the Open Meter Project<sup>53</sup>. This is a collaborative project funded as part of the Commission's FP7 programme. The project covers similar topics as the Mandate, has similar objectives and is closely aligned to the Mandate programme. However, the Open Meter project has a wide stakeholder involvement and is well supported by utilities. This allows it to address a number of key technical issues in greater depth and to increase confidence in the practical performance and interoperability of smart metering systems. This confidence will be a key requirement for any major roll out of smart metering in Europe.

### **Other Developments**

- Teams are hard at work filling the gaps identified in the various studies. Cenelec TC 294 has launched a programme to extend the M-Bus protocol to wireless communications and an industry team is mapping the DLMS data set to the ZigBee protocol.
- A number of protocols that have been developed are being established as 'Open Standards'. An example is the ENEL/Endesa SITRED protocol which is going to be established as an open protocol.
- In the US the National Institute of Standards and Technology (NIST) has set out a roadmap for smart grid interoperability, covering similar ground to the Mandate M/441 for metering but also extending to a wider range of smart grid functions<sup>54</sup>. Given that, for metering, the US and Europe are likely to base their systems on incompatible standards (ANSI and DLMS respectively) it seems that there will be little scope for a common approach. However, as many of the largest vendors are active in both markets, solutions are likely to be similar.
- Moving beyond the standards development phase to practical implementation, three major meter manufacturers; Iskraemeco, Itron and Landis+Gyr, have developed IDIS (Interoperable Device Interface Specifications)<sup>55</sup>. This allows the manufacturers to verify that their products

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<sup>53</sup> <http://www.openmeter.com/>

<sup>54</sup> [http://www.nist.gov/public\\_affairs/releases/smartgrid\\_interoperability.pdf](http://www.nist.gov/public_affairs/releases/smartgrid_interoperability.pdf)

<sup>55</sup> <http://www.prnewswire.co.uk/cgi/news/release?id=266717>

are interchangeable and utilities can purchase from all the vendors confident that the meters will work together. Such certification schemes are likely to grow as vendors seek to provide their customers with confidence in the performance of the meters that they purchase. The Prime Project<sup>56</sup> has announced similar work related to proving the interoperability of power line communications equipment.

### Security

The importance of security to smart metering and has been widely recognised in 2009 and a number of initiatives have been launched. ESMIG has reviewed the issue and In the US the NIST has published a security strategy for the development of a comprehensive approach to securing the security of the smart grid<sup>57</sup>. Also the Advanced Metering Infrastructure Security Task Force has released its first set of AMI system security requirements. New security hardware is being launched as well, such as the SEL-3620 Ethernet Security Gateway, developed with US Government support. The North American Electric Reliability Corporation (NERC) is leading a programme of risk assessments for cyber security related to smart grids. They have also revised their eight cyber security standards<sup>58</sup>.

### 7.3.2 Smart Homes and Smart Grids

2009 has seen a considerable surge of interest and activity in smart grids. Many countries in Europe have announced programmes and a European Smart Grids Forum has been established<sup>59</sup> bringing together stakeholders, including ESMIG<sup>60</sup>, representing smart meter vendors. In the US, there is a very active programme supported by the government and coordinated by NIST<sup>61</sup>. Smart metering and demand management are clearly identified as key topics. This also reflects growing interest in the integration of electric vehicle charging (and possibly storage) into the smart grid.

Smart grids are often closely linked to smart homes developments. One of the key aims of smart grids programmes is to improve the resilience and efficiency of the grid by managing demand.

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<sup>56</sup> [http://www.prime-alliance.org/portals/0/news/2009\\_10\\_12\\_FieldTest\\_Successful.pdf](http://www.prime-alliance.org/portals/0/news/2009_10_12_FieldTest_Successful.pdf)

<sup>57</sup> Smart Grid Cyber Security, Strategy and Requirements, NIST,  
<http://csrc.nist.gov/publications/drafts/nistir-7628/draft-nistir-7628.pdf>

<sup>58</sup> [http://www.nerc.com/news\\_pr.php?npr=336](http://www.nerc.com/news_pr.php?npr=336)

<sup>59</sup> <http://www.smartgrids.eu/?q=node/160>

<sup>60</sup> <http://www.esmig.eu/>

<sup>61</sup> <http://www.nist.gov/smartgrid/>

This is closely linked to smart metering and also to smart homes. Utilities are keen to develop ways to control the energy loads of their customers. To some extent this can be done by relying on customers to respond to price signals but there is more confidence in an automated response. Fortunately, home automation is a well developed technology and utilities are using existing protocols and systems. The key requirement for this is establishing a home area communication network (HAN) and linking to the key energy related appliances.

The proposed European smart meter functionality<sup>62</sup> includes provision for remote control of home appliances. The UK Government's smart meter functionality includes a requirement for such functionality and recent reports suggest that of 100 million smart meters being installed around the world, half will have HAN chips and support home automation<sup>63</sup>. It is clear that this represents an enormous opportunity, both to save energy and to sell products.

There have been many developments during 2009 aimed at making this a practical proposition.

A key issues for utilities is that they do not want to have to deal with the multiplicity of HAN protocols. Their desire is simply to send a common control signal to their customer and be confident that the customer's appliances respond correctly. To enable this a new group has been established, U-SNAP<sup>64</sup> standing for Utility Smart Network Access Port. This group has developed a serial interface port that utilities can fit to their meters and which provided a bridge between the utility and the local HAN system. It allows the utility to send a high level command signal to their customer that will be converted at the meter into the correct format for the local protocol (such as ZigBee, Z-Wave, KNX, LonWorks etc.). U-SNAP is talking to European utilities about transferring the technology to European market; whether this happens or not, it is very likely that some system with similar functionality will be introduced.

Linked to this development a number of companies have announced new smart appliances designed to connect to the HAN and the smart grid. Whirlpool in the US has announced a project to develop such smart dryers<sup>65</sup>. Again in the US, GE, which already has a smart appliance range, has announced an agreement with Tendril to integrate GE appliances into Tendril's smart energy

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<sup>62</sup> Standardisation mandate to CEN, CENELEC and ETSI in the field of measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability, M/441, SMART METERS CO-ORDINATION GROUP, DRAFT REPORT, Version 0.4, 2009-09-18

<sup>63</sup> <http://www.metering.com/node/15504>

<sup>64</sup> <http://www.usnap.org/>

<sup>65</sup> <http://phx.corporate-ir.net/phoenix.zhtml?c=97140&p=irol-newsArticle&ID=1347618&highlight=smart%20grid>

home networks<sup>66</sup>. Subsequently, GE invested in Tendril, indicating their interest in the market sector. Similarly, Echelon and Eaton announced that Eaton will integrate Echelon's Networked Energy Services system into its smart products with a view to introduce products into the European market<sup>67</sup>. Also, KNX, one of the major home automation ecosystems has incorporated the Open Meter System Specification, integrating smart grid and smart homes functionalities. A steady increase in the number of devices designed to connect to the various HAN protocols can also be seen.

One related and notable trend has been the extension of computer systems to embrace the requirement of the smart grid. Amongst others, the companies eMeter<sup>68</sup>, EnergyICT<sup>69</sup>, Netinium<sup>70</sup> and Telvent<sup>71</sup> have all promoted software suites designed to support the smart grid. All of these integrate the smart meter functionality into a broader smart grids functionality.

#### 7.4. Customer feedback and displays - applications development

This has been, and continues to be, a very active area for technology development. It is clear that a number of different options are being explored and these have been set out below. There is some evidence that there is growing agreement on the minimum desirable and essential features of displays. A report from the UK Energy Savings Trust has presented findings on this<sup>72</sup>. This report concludes that customers want very simple displays with a direct, analogue read out of the financial cost of the energy being used. More complex data, such as daily demand profile, is desired but should be accessed via a button press. Such displays are increasingly evident.

It is not intended here to list all the devices that have been developed but rather to pick those that illustrate different approached or novel features. All of the different designs and approaches have been summarised in Table 7-1. First, though, key developments in the various approaches are examined.

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<sup>66</sup> <http://www.tendrilinc.com/>

<sup>67</sup> <http://www.echelon.com/company/press/2009/eaton.htm>

<sup>68</sup> <http://www.emeter.com/solutions/>

<sup>69</sup> <http://www.energyict.com/solutions.php?lang=EN&solcatno=48>

<sup>70</sup> <http://www.netinium.com/index.php?pageview=INDUSTRIES&submenu=UTILITIES>

<sup>71</sup> <http://www.telvent.com/corp/web/en/soluciones/energia/electricidad/soluciones/>

<sup>72</sup> The smart way to display, Full report: exploring consumer preferences for home energy display functionality, CO183b, September 2009.

### 7.4.1 Consumption feedback via internet access

There is a growing number of web sites being provided by energy suppliers to allow consumption feedback of remotely read data. This can at best be day behind data and no better resolution than 15 minutes or such interval. There seems little development in these sites and the presentation beyond that made available by the Danish Electricity Savings Trust my-Home<sup>73</sup>. Perhaps more of significance from the point of view of the internet is the launch by Microsoft and Google of consumption feedback applications. These can in fact present data collected from local, real time meters, but they do require access to a computer to view.

### 7.4.2 Displays linked to meter data

This area is showing the greatest growth as developers recognize the opportunities presented by the major national smart meter roll outs and develop links to meter vendors and energy suppliers. 2009 has seen a steady improvement and refinement of displays with the development of a basic entry level display and, at the same time, the development of higher specification models providing greater levels of functionality. As has been mentioned in Section xxx a number of these displays are now linked to other energy services, such as the thermostat or home appliances.

#### EcoMeter

The EcoMeter is now in widespread use and has been subject to continual development by L&G. It still retains a digital display but the overall design is much simplified compared to the earlier design.



Figure 7-1 EcoMeter

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<sup>73</sup> <http://www.savingtrust.dk/consumer/tools-and-calculators/my-home>

## PowerPlayer, The Netherlands

As with the EcoMeter, the PowerPlayer has been further developed in preparation for the roll out of smart metering in the Netherlands. The development of the design now features a dominant analogue display showing the instantaneous power consumption or cost with other displays accessible via the menu.



Figure 7-2 PowerPlayer

### Control4

The Control4 product, which has been developed in the US, is notable because it has been developed by a company specialising in home automation systems and the smart metering element has been added into the home automation range. The control features extend across home media, smart control and smart metering. This results in a product that combines a wide range of home control features and makes the display especially rich in functionality.

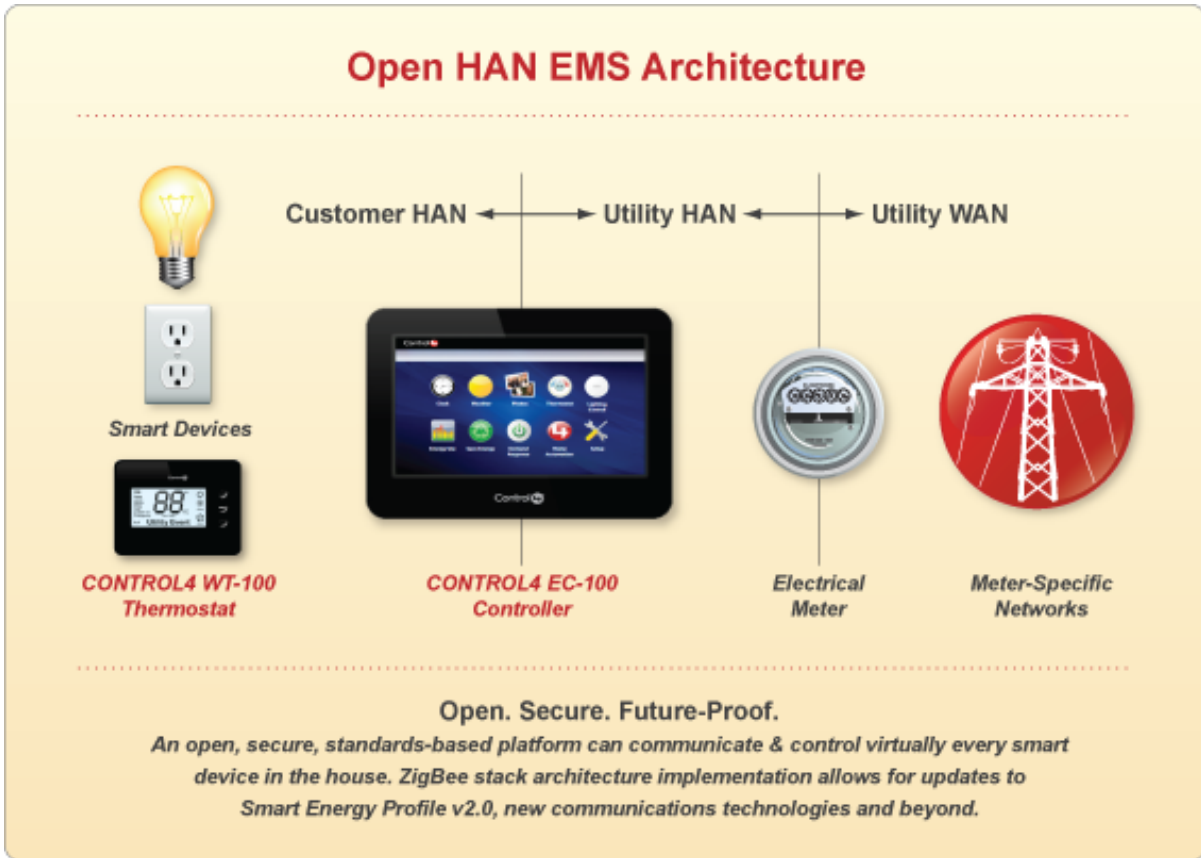


Figure 7-3 Control4

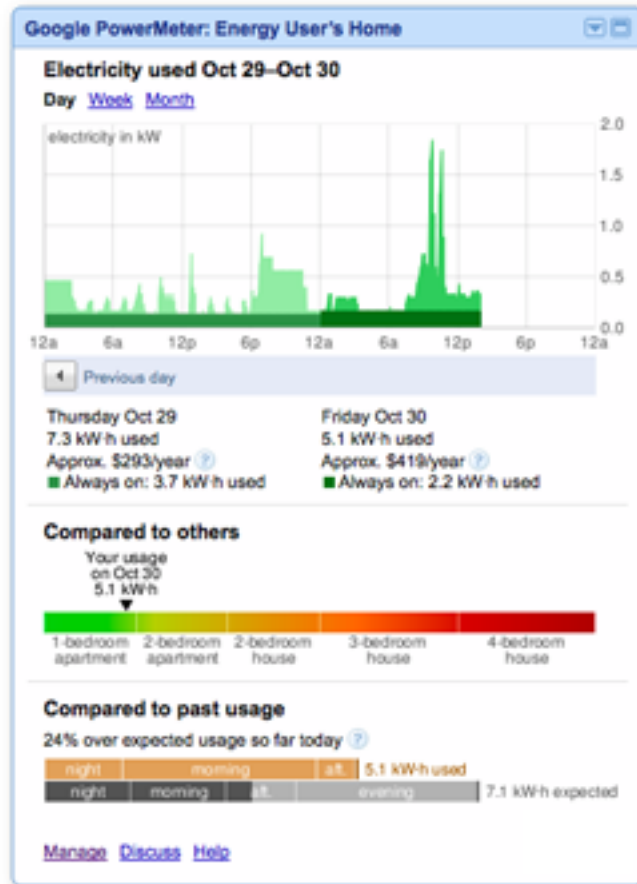
### Tendril Insight

Tendril has added a ZigBee wireless connection to their display and a remotely controlled thermostat.



Figure 7-4 Tendril Insight

## Google Power Meter



Google has launched the PowerMeter as a publicly available application<sup>74</sup>. This can be used as the front end for data provided remotely from an energy supplier's meter data or for a local real time display. The significance of the PowerMeter is mainly related to the reach of Google, making it available to everyone with an internet connection and Google's expertise with computer based data presentation.

In the UK, the Energy supplier First Utility is offering its customers access to their meter data via the Google PowerMeter<sup>75</sup>.

## Microsoft Home

Microsoft has produced the Holm application<sup>76</sup>, a product similar in many ways to the Google PowerMeter but it is currently at the beta testing stage and has not been adopted by any energy suppliers yet. It is free but is currently only available to US based users.

<sup>74</sup> <http://www.google.com/powermeter>

<sup>75</sup> <http://www.first-utility.com/powermeter>



Figure 7-5 Microsoft Hohm

**Ecobee**

Although not an energy display, the Ecobee smart thermostat illustrates the progress being made in smart home control products. The thermostat can be set via a web portal and communicates via IEEE 802.11 b/g or an optional ZigBee interface, allowing it to be integrated into a full smart house system.

**Home Screen** The Home button, found to the right of the touch screen, always brings you to the Home Screen where you can receive instant access to the most important aspects of your home comfort and other ecobee applications.



**Registration** Registering your ecobee Smart Thermostat will allow you to access it from anywhere through a personalized web portal. Receive convenient weather information, participate in the ecobee community and receive important reminders and alerts by email.



**Quick Save** Quick save works just like a light switch. Touch the Quick Save button and your thermostat will automatically set your system to conserve energy and save you money, making it easy to run an energy efficient house.



**Details** The Details button gives you access to all of your heating and cooling settings. You can scroll lists by dragging your finger across the screen to see the full range of options.



**Program** The Program button takes you to the program screen and shows you how your thermostat is currently programmed. There is a wizard function that lets you easily create a basic program for your thermostat and an Editor function that assists you in more advanced programming.



**Settings** The Settings button allows you to customize your thermostat according to your preferences. There is an About function that provides important information about your thermostat and this is also where you connect your thermostat to your wireless network.

Figure 7-6 Ecobee Smart Thermostat

**Navetas**

The Navetas company has developed a number of new products that illustrate interesting developments for smart metering. The smart hub device connects to separate electricity, gas and water meters and provides a local display, supports pre-pay and pay as you go as well as multiple tariffs. It contains a communication link via GPRS. In addition the smart hub:

<sup>76</sup> <http://www.microsoft-hohm.com/default.aspx>

“... incorporates non intrusive appliance monitoring technology, ... as an optional specification. ... and to anticipate future requirements, two upgrade ports are available that allows for simple “plug-in” modules to be easily fitted by consumers for new applications as required.”

[http://www.navetas.com/products/zeo\\_smart\\_hub.aspx](http://www.navetas.com/products/zeo_smart_hub.aspx)



Figure 7-7 Navetas Smart Hub

### **Onzo – Smart Energy Kit**

The Onzo Smart Energy Kit is an interesting development that takes a different approach to other displays. The sensor is connected to the mains cable at the meter and communicates with a wireless display. The display can be connected to the local computer allowing usage data to be uploaded to a web portal. In their current scheme they are working with an energy supplier who can review the data from the web portal and offer advice to the customer.

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# SMART ENERGY KIT

from **ONZO**

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Figure 7-8 Onzo Smart Energy Kit

## Green Energy Options – Home Energy Hub

Green Energy Options has further developed its range introducing a new product at the low end of the market with specifications very much in line with the EST report recommendations. The display features a simple analogue dial showing consumption or cost. GEO have also introduced another display aimed at the top end of the market for commercial customers or more enthusiastic residential customers.



Figure 7-9 Home Energy Hub

### Black and Decker

Black and Decker have launched a display onto the US market during 2009 which is mostly notable for the fact that displays are now being produced by major manufacturers as well specialist display companies. The sensor collects meter data via an optical reader.



Figure 7-10 Black & Decker Energy Monitor

### 7.4.3 Summary

The examples above should have made it clear that there continues to be considerable activity in developing feedback display. It is apparent that there is convergence between some of the designs towards a simple, analogue consumption indicator. However, other trends are apparent; displays are increasing being integrated into smart homes networks and systems. Also, the development of energy services offering from energy suppliers based around displays can be detected.

To provide a benchmark for future reviews of progress a comprehensive summary of the feedbacks devices known to the ESMA project team are presented in the table below.

Table 7-1 Energy Feedback Devices

Display Name	Data Source	Customer Interface	Features	Link
<b>Internet based</b>				
Modstroeam	Utility, ZigBee device, manual entry	Web site	House energy analysis, link to ZigBee devices for home automation and data collection, link to participating utility meter data	<a href="#">DEST</a>
Google PowerMeter	Meter data via utility or direct from meter	PC	Displays consumption profile and data and comparison with historical data and other consumers	<a href="#">PowerMeter</a>
Microsoft Hohm	Appears to require direct input of energy usage data	PC	PC application allows users to analyse their energy consumption and advises on reducing usage	<a href="#">Microsoft Hohm</a>
VEAB EnergiKollen	Utility	Web site	Customers can view their energy usage and compare this with other users	<a href="#">VEAB</a>
DTE Energy MyEnergy Analyzer Based on Aclara EnergyPrism	Utility	Web site	Customers can view their bills, energy usage, get advice on energy reduction. The utility can target specific customer groups	<a href="#">EnergyPrism</a>
Energy Depot	Utility	Web site	Allows customers to calculate their predicted energy costs, compare	<a href="#">Energy Depot</a>

Display Name	Data Source	Customer Interface	Features	Link
			with bills and analyses cost saving measures	
Greenbox – company acquired by Silver Spring Networks	Utility	Web site	Provides real time feedback and allows customers to identify savings opportunities. Links to ZigBee network to provide control function	<a href="#">Greenbox</a>
H-Net	Utility	Web site	Customers can view their bills, energy usage and forecast future usage	<a href="#">H-Net</a>
<b>In-house displays linked to meter data</b>				
ecoMeter	Meter and utility data link, wireless or wired	Display unit	Shows multi utility meter outputs, cumulative demand, coloured lights related to consumption level and communications with utility	<a href="#">ecoMeter</a>
PowerPlayer	Meter via wireless link	Display unit	Shows energy usage, carbon for electricity and gas and forecast costs	<a href="#">Home Automation Europe</a>
EWE Box	Meter via M-Bus	Display unit plus web site	Weekly or daily consumption on display, annual and monthly data on web site.	<a href="#">EWE Box</a>
EMS-2020	Meter via wireless link	Display unit	Daily and monthly display of energy and costs	<a href="#">EMS-2020</a>
PRI Home Energy Control	Meter via wireless link	Display	Multi utility display of instantaneous and cumulative multi utility data. Can control heating system	<a href="#">Home Energy Control</a>
PRI Customer Interface Panel	Meter via wireless link	Display and customer interface	ZigBee enabled display that supports pre-payment, multi-tariffs and usage feedback	<a href="#">Customer Interface Panel</a>
Control4	Meter data via wireless link	Home control panel	Integrated home automation controller using ZigBee wireless communications	<a href="#">Control4</a>
Home Joule	Wireless connection to	Display mounted	Display shows consumption, weather	<a href="#">Ambient</a>

Display Name	Data Source	Customer Interface	Features	Link
	meter and utility AMM network	on plug top	forecast, current electricity tariff and coloured light indicating the relative cost of power	
AzTech In-home	Wireless link to meter	Display and optional link to computer software	Display shows instantaneous or 30 day rolling average consumption and cost. Has light to show level of consumption. Can control thermostat via ZigBee interface	<a href="#">In-home</a>
Tendril Insight	Wireless link to meter	Display	Instantaneous and cumulative energy and cost plus forecast monthly bill. Communications with utility	<a href="#">Insight</a>
HEMS Technology HEMS-DR	Wireless link to meter (L+G Focus meter)	PC	Comprises a wireless mesh linking meter, socket monitors and thermostats, these can be monitored and controlled	<a href="#">HEMS-DR</a>
L.S. Research RATE\$AVER	Meter via wireless link	Display	ZigBee energy profile compliant display, shows current and cumulative consumption and has level alarm  Now U-Snap enabled	<a href="#">RATE\$AVER</a>
Converge Power Portal	Wireless link to meter	Display	ZigBee display providing demand response input – has red/orange/green light to indicate energy price level – has a magnetic backing so it can be fixed to fridge	<a href="#">Power Portal</a>
Black and Decker Power Monitor	Optical detector connected to front panel of meter	Display	captures and displays usage data	<a href="#">Power Monitor</a>
<b>In-house displays linked to separate power transducer</b>				
The Energy Detective	Current transformers and wireless link to display.	Display, this unit also links to software package called Footprints	Has voltage pick up to provide true active energy measure	<a href="#">TED</a>
Eco-eye	Current transformers and	Display	Display shows consumption, cost and	<a href="#">Eco-eye</a>

Display Name	Data Source	Customer Interface	Features	Link
	wireless link to display.		carbon and can store data to give cumulative data	
Wattson/Holmes	Current transformers and wireless link to display.	Display, this unit also links to software package called Holmes	Display shows consumption, cost and carbon, software package stores data to give cumulative data	<a href="#">Wattson</a>
Energy Orb	Wireless link to Internet	Coloured glass globe, colour is linked to energy consumption or energy price	Very simple user interface, can be modified to display energy usage data	<a href="#">Ambient</a>
Onzo Smart Energy Kit	Wireless link from current sensor to display	Display , web page	Display can be connected to home computer and upload data to a web portal	<a href="#">Smart Energy Kit</a>
Sentec Coracle	Power analysis of supply with wireless link to display	Display with options for web access to data	Calculates disaggregated appliance usage from total supply signal	<a href="#">Coracle</a>
Green Energy Options Home Energy Hub	Current transducer at supply point and point of use transducers with wireless links	Display, simple option or dual option with heating, hot water and individual appliance loads	The advanced options allows for control of appliances via smart plugs.	<a href="#">Energy Hub</a>
Ewgeco	Wireless link to display transducer or direct connect to meter	Multi utility display (up to 3 channels)	Display shows instantaneous and peak consumption levels. Links to computer and can have access to web portal with additional analysis tools	<a href="#">Ewgeco</a>
Wattwatcher	Current transducer at point of supply with wireless link to display	Display and link to computer programme for energy analysis	Option for additional appliance sensors. Part of larger programme with community and web site support	<a href="#">Wattwatcher</a>
Cent-a-meter (Australia) Owl (UK)	Current transducer at supply point with wireless link to display	Display, shows instantaneous power, cost and carbon plus temperature and RH	Display has option to accept multiple inputs.	<a href="#">Cent-a-meter</a>
The Meter Reader EM-2500	Current transducer and voltage sensor with wired	Display showing power, peak power, estimated	1% accurate through measurement of voltage and current	<a href="#">EM-2500</a>



Display Name	Data Source	Customer Interface	Features	Link
	link to display	bill, voltage		
Current Cost – new product called Envi	Power transducer with wireless link to display	Display showing instantaneous and cumulative power and cost	Optional link to computer package to review consumption	<u>Current Cost</u>

## 8. Progress in Addressing the Barriers to Smart Metering

Notwithstanding the many benefits of smart metering, its introduction will result in many changes and face many barriers. The ESMA project team reviewed the barriers and these are listed below. The most significant barriers that prevent the general introduction of smart metering within the EU and outside Europe are:

- There remains much uncertainty about the quantification of benefits, especially related to energy savings, because practical experience and historical data are lacking.
- There are many parties involved, and the benefits of smart metering may accrue to other parties than the ones that bear the costs.
- Large scale roll outs of smart metering are very long and costly processes, requiring considerable capital expenditures from the responsible market actors. In many EU countries, there is strong opposition from regulators to increasing the tariffs to final users to pay for it.
- There is still no interoperability between different owner's assets: there are no open registered standards that properly scope all of the different functions (metering, communications, display, and network). The lack of adequate common requirements on functionality and open interfaces (interoperability) fractionalizes the market and increases costs both for smart metering and for the applications and services that use metered data.
- There is also a lack of modularity and flexibility of present mass market smart metering products so that customising systems to meet the local requirements of distributed generation, demand response, power quality, customer information, energy efficiency automation and services, etc. can only be met with high extra costs.

### 8.1. Law and "Lack of Law" barriers

Smart metering initiatives come mostly from governments so the future of smart metering will depend heavily on the policy and decisiveness of the governmental bodies involved. Smart Metering implementation is a very long and costly process, requiring considerable capital expenditures from the responsible market actors. Committing to these investments requires clear policy decisions from government and regulatory certainty regarding key decisions, so as not to deter investment.

The choice of regulatory policies to promote smart metering depends not only on the national legal framework and on the stage of market liberalization but also on the public or industry drivers for smart metering. The type of metering regime (regulated or liberalized) as well as the ownership of the meters can influence the benefits realized from smart metering and their cost effectiveness as an investment.

Roll out mandates are a normal starting point and they are usually combined with specific regulatory tools covering technical, functional and economical aspects. But in some other cases current regulatory imperfections lead to inefficiency and distort a fair cost-benefit analysis of smart metering. For example, in most of the EU countries there is no time of use tariffs so there is no incentive for final customers to reduce demand at peak times. In some countries such tariffs are not allowed.

Another example of “law barrier” is that in some countries the network operator revenues increase with electricity consumption discouraging them to adopt any measure that reduce final customer electricity consumption.

Countering this, the additional requirements of the 3rd Energy Package will put more pressure onto members states to take action while concerted action by ERGEG to align European regulation should minimise distortions.

## 8.2. Economical barriers

There are economic barriers that hamper the introduction of smart metering:

- There is still much uncertainty about the quantification of benefits as practical experience and historical data are lacking on which to base them.
- There are many parties involved and the benefits of smart metering may accrue to other parties than the ones that bear the costs. Several market actors are expected to have direct or indirect benefits from mandatory implementation of Smart Metering but they may not share the costs and benefits equitably. Capital and installation costs are normally solely covered by a local DSO (metering is controlled by Energy Suppliers companies ONLY in UK) which is responsible for the metering but may receive only partial benefit while many benefits go to the energy retailer who cannot influence the design of the system.
- Large scale roll outs of smart metering are very long and costly processes, requiring considerable capital expenditures from the responsible market actors. In many EU countries, there is strong opposition from regulators to increasing the tariffs to final users to pay for it.
- There is no expectation of obtaining grant aid or subsidies from the governments to install smart metering in many of the EU countries.
- High investment costs expose the responsible actors to considerable financial risks during the implementation, commissioning and normal operation period of the system. Such a large investment requires at least to be sanctioned by governments to prevent future regulation undermining the investment.
- Smart metering also entails an organizational challenge. The purchase and commissioning of Smart Metering equipment requires involvement of highly-skilled personnel. This is often a

problem for small- and medium-size market actors, which do not have sufficient technical expertise for the initial procurement process. Additionally there are several cost-driving activities during installation of the equipment, related to logistics and working crews.

- Shorter life time of electronic meters in comparison with electromechanical meters reduces the return of investment of a smart metering implementation.

### 8.3. Technical barriers

There are also technical barriers that stop the implementation of smart metering in a large scale:

Although there are some commercial systems capable of supporting AMI, there is an important lack of interoperability among these systems, which prevents the large scale adoption of the smart multi metering technology. So, the main problem for the large adoption of AMI, is the lack of a set of widely accepted open standards capable of guaranteeing the interoperability of systems and devices produced by different manufacturers. The lack of adequate common requirements on functionality and open interfaces (interoperability) fractionalizes the market and increases costs both for smart metering and for the applications and services that use metered data.

There is also a lack of modularity and lack of flexibility of present mass smart metering so special needs regarding distributed generation, demand response, power quality, customer information, energy efficiency automation and services, etc. will only be met with extra high costs.

A large scale roll out of AMR/AMM without adequate requirements and standardization may prevent the development of services and applications that are based on smart metering infrastructure until it is time for the next roll out after 10 years or so. On the other hand poorly designed standardization can prevent development and innovation.

There is also a weak cooperation between DOSs/RESCs and AMR equipment manufacturers. Joint initiatives, common approaches and consensus, especially on AMR technologies and data transmission, could speed up development of smart metering. Also important in this context is multi utility metering where there is a need for integration of the different systems.

Installation of Smart Metering requires skilled manpower to replace the meters. If the implementation period is short or/and several DSOs are running the process simultaneously, it may create serious problems due to limited access to local manpower.

Furthermore, when a single country implements a mandatory requirement for implementation of Smart Metering within a relatively short time period, it may easily create a shortage of the Smart Metering equipment on the market and cause unnecessary complications for the process.

Several potential risk factors are caused by the present situation in production of Smart Metering equipment. It is a fairly small industry, which is still growing and evolving, with few well-

established and renowned vendors and several middle-sized and small ones. During the last years there have been several bankruptcies, mergers and takeovers in this sector. In some cases it resulted to discontinuation of supplies and support to already installed equipment. Several utilities share a concern that it is difficult to find reliable and competent suppliers of equipment, especially when it comes to small utilities, which do not have as strong bargaining position as big ones. There are several examples of big utilities purchasing a share in Smart Metering vendor companies in order to secure their projects.

Although still valid these barriers are being addressed. The European Commission has issued Mandate M/441 to the European Standardisation Bodies to ensure that there are open standards available covering smart metering sufficient to ensure that interoperability can be ensured. In addition, the FP7 OpenMeter project is being carried out with strong involvement from energy companies and vendors to support M/441 and to carry out more detailed technical work to identify and agree solutions and provide the market with confidence in the solutions.

Awareness and knowledge related barriers (on society level)

Another potential risk to hamper the introduction of smart metering is the negative customer reaction due to different factors:

- Customers may be unaware of smart metering initiative.
- Customers may be concerned about privacy of data and will refuse to participate to show disagreement with the initiative.
- Customers may consider smart metering implementation as a way to increase their bills.
- Customer's will complain if after the implementation the expected benefits do not materialize.
- Customers may not be satisfied with the implementation plan.
- Customers do not understand rate structures and think that smart metering will not help them to reduce their energy bills.
- Customers think that they cannot decrease their energy consumption without compromising their living standard.

To mitigate this potential risks, it is necessary to establish a careful and properly orchestrated communication and education plan to final customers and a well thought out installation process, clearly communicated to customers to minimize their inconvenience during the installation phase.

## 9. Conclusions

This report has reviewed the development of smart metering in Europe. The key finds are that there are many implementations of smart metering underway across Europe. In Italy, Sweden and Finland smart meters are completely or mostly deployed. Most of the other projects are trials

or pilot projects and many are assessing the impact of smart metering on consumer behavior. These trials have yet to provide the evidence needed to allow a conclusive view on the levels of energy savings that smart metering can provide.

Smart metering technology has shown continued and increasing evidence of product evolution. Standardization efforts are addressing interoperability and the definition of, and agreement on, the additional functionalities of smart metering. There has been significant progress in feedback displays, some with their own power transducers and many linked to smart metering. There has also been significant progress with web feedback platforms and major players, such as Google and Microsoft are entering the arena. Also of note has been the growing range of devices that link to open protocol home area networks. As well creating the possibility of very large markets that will bring down prices, this provides a route from the smart metering Wide Area Network through to HAN equipped appliances and controllers.

Driven largely by Article 13 of the Energy Services Directive, the 3<sup>rd</sup> Energy Package and an environmental agenda, a significant number of European Member States have taken major steps towards a full roll out of residential smart metering. This has thrown up into greater relief major barriers around the implementation of smart metering which are being addressed under the Commissions M/441 standardisation mandate.

The key task for the energy saving community now it to ensure that all of these developments pay respect to the needs of energy efficiency.



10. Appendices

**Appendix 1****List of identified Smart Metering projects**

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
<b>Europe</b>								
**	Energie AG	AT	10 000	e	Siemens	2007	2008	Trial – possible roll out to 1 200 000
	Feldkirch	AT	3 000	e	Echelon	--	--	Trial
	Linz Strom	AT	75 000	e	--	--	--	Trial
	Eandis	BE	40 000	G	Itron	2009	2013	Gas smart payment meters
	ELEKTROPRIVREDA HZ HB MOSTAR	BA	200 000	e	Echelon	2008	--	Starting with a trial of 200
	ODS Croatia	HR	20 000	e	Iskraemeco	--	2009	Industrial customers
	Cez	CZ	400	e	Echelon	2008	2008	Trial
	E.ON Czech Republic	CZ	4 000	e	--	2006	--	Trial
	EnBW	DE	1 000	e	--	--	--	Trial - ongoing
	EWE	DE	400	e	--	2008	2009	Trial
	Mainova	DE	1000	e	--	2008	--	Trial
**	Mulheim an der Ruhr	DE	--	e	--	2008	2010	Trial
	RWE Mulhiem	DE	100 000	e	--	2008	--	Trial, cost of €20m
	Stadtwerk Duesseldorf	DE	1 000	e	L+G	2008		Trial
	Stadtwerk Hassfurt	DE	10 000	e	Echelon	2008	2011	Trial
	Stadtwerke Bochum & EVB	DE	500	e	Echelon	2008	--	Trial

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	TWK Kaiserslautern & EVB	DE	1 000	e	Echelon	2007	--	Trial
	Yello Strom	DE	1 000	e	--	--	2008	Trial
	Elro Net	DK	50 000	e	Echelon	2007	2010	
	EnergiMIDT	DK	170 000	e	Echelon	2008	2010	
	NRGI	DK	52 000	e	Echelon	2008	2011	
	Odense Energi	DK	72 000	e	L+G	--	2009	
	SEAS-NVE	DK	390 000	e	Echelon, Gorlitz	2008	2011	Use M-Bus link to legacy gas, water, heat meters
	Syd Energi	DK	250 000	e	L+G	2004	2008	
	TRE-For	DK	200 000	e,h,w	L+G	--	--	
	Empresa Electrica Quito	EC	700 000	e	--	2007	2009	BPL focus
	VKG Elektrivörgud OÜ	EE	35 000	e	ADD	2009	--	
	Fortum Espoo Oy	FI	63 000	e	L+G	--	2007	Fortum has nearly 600 000 distribution customers in Finland and has in 2009 decided to start full AMM implementation soon using Echelon meters.
	Haukiputaa Electricity Cooperative	FI	9 000	e	L+G	2008	2011	
	Helsinki Energy	FI	120 000	e	Aidon Oy	2008	2010	In addition Helsinki Energy has also implemented smart metering projects with other vendors.
	Jyvaskylan Energia	FI	4 000	h	L+G	--	--	
	Kainuun Energia	FI	55 000	e	L+G	--	2008	
	Kemin Energia	FI	15 000	e	--	--	--	
	Satapirkan Sähkö Oy	FI	70 000	e	L+G	2008	2012	

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Tampere City Electric Works	FI	4 700	e,h	L+G	2008	2010	Electricity metering - , April 2008 about 25 000 customers have AMR, all 100 000 customers will have AMR by the end of 2010. Customers have internet access to their own consumption measurement data. Heat metering - may be more meters
	Tornion Energia	FI	11 000	e	L+G	2008	--	replacing old meters at end of their life
	Vattenfall Lämpö	Fi	Full roll out	g,h	L&G	2009	2010	
	ERDF	FR	30 000	e	L+G	2010	--	trial - leadign to 35m meters, L+G have 33% of meter sales
	Lyonnaisse des Eaux	FR	28 000	w	--	--	--	Meters read several times per day
	ESB	IR	21 000	e	Sagem,Elster, Trilliant, Aclara	2008	2010	Trial, expected to do all homes for €4b - 1.8m homes
	Acea Distribuzione	IT	1 500 000	e	L+G	--	2009	
	Enemalta Corporation	MT	250 000	e	IBM	2009	2014	Smart metering installed as part of smart grid roll out
	Oxxio	NL	100,000	e		2006	--	Rolling out to all customers
	Nuon	NL	500	e	--	2009	--	Trial involving IBM and Cisco – part of Amsterdam Smart City initiative
		NL	25 000	e	Kamstrup, EnergyICT	2009	--	Meters have HAN chips
	Kragero Energi	NO	8 600	e	L+G	2007	--	
	Istad Nett	NO	918	e	Kamstrup	2007	2009	Project with focu on energy efficiency

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Istad Nett	NO	527	e	?	?	?	Power tariff
	Midt Nett Buskerud	NO	13000	e	L+G	2008	2011	Midt Nett Buskerud
	GE	NO	16000	e	L+G	2004	2010	GE
	Valdres Energiverk	NO	13000	e	L+G	2003	2009	Valdres Energiverk
	Nord Salten	NO	6500	e	L+G	2004	2009	Nord Salten
	Andøy	NO	4500	e	L+G	2004	2010	Andøy
	Midt Nett Buskerud	NO	13000	e	L+G	2008	2011	Midt Nett Buskerud
	Energa	PL	10 000	e	L&G	2009	2012	For commercial customers
	Energa - Operator	PL	2100	e	L&G	--	2009	All customers
	TAURON/ENION	PL	--	e	--	2007	2009	All big and industrial and bigger service customers
	RWE – STOEN Operator	PL	Appr. 3000	e	--	--	2009	All customers
	EDP Distribucao	PT	100 000	e	--	--	--	Trial
	Quinta De La Portela	PT	2 000	e	ISA	--	2009	Trial
Sweden has completed a full roll out of AMR and there were numerous projects; those shown below have been reported in the press but do not constitute a comprehensive list.								
	E.ON Sverige	SE	390 000	e	Echelon	2007	2009	
	Fortum Espoo Oy	SE	900 000	e	L+G	--	2008	Full AMR implementation in Sweden,
	Goteborg Energi AB, Lerum Energi AB	SE	100 000	e	Kamstrup		2009	well over 100,000 meters for €6.6m
	Gothenburg Energy	SE	270 000	e	Nuri	--	--	

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Halmstad Energi	SE	38 000	e	Echelon	2007	2009	Also SCADA system
	PiteEnergi	SE	20 000	e	L+G	--	2007	
	Staffanstop Energi AB	SE	6 000	e	L+G	--	2008	
	Vaxjo Energi AB (VEAB)	SE	20 000	e	Logica	--	2008	web based portal
	Vattenfall Distribution	SE	900,000	E	Several	--	2008	Also in Finland 360,000 Iskra meters
	Elektrovojvodina D.O.O.	RS	30 000	e	--	2007	2010	
**	Opus Energy	UK	--	--	--	--	--	£5m programme
**	Orsis	UK	--	e,g	--	--	--	
	UK Energy Demand Reduction Project	UK	--	e,g	various	2007	2010	Trial

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
<b>Americas</b>								
	BC Hydro	CA	1 900 000	e	--	--	--	start of procurement process
	Consumers Energy	CA	3 500 000	e,g	--	2008	2014	1.8m e, 1.7g add on comms
	Enersource Hydro Mississauga	CA	185 000	e	Elster	2007	2010	
	Halton Hills Hydro	CA	20,000	e	--	2009	2010	
	Horizon Utilities	CA	231 000	e	Elster	2007	2010	
	Hydro One, Hydro One Brampton, Milton Hydro Distribution	CA	1 400 000	e	Trilliant, L+G	2006	--	6.5% demand reduction in trial 1 000 000 installed
	Hydro Ottawa	CA	230 000	e	--	2006	2008	
	Manitoba Hydro	CA	750 000	e,g	ltron	2008	--	
	Peterborough Distribution	CA	35 000	e	--	--	2010	
	PowerStream	CA	237 000	e	Sensus	2006	--	
	Toronto Hydro-Electric System Limited	CA	680 000	e	--	2007	2009	
	AEP Ohio	US	110 000	e	--	2010	--	
	AEP Texas	US	700 000	e	L&G	--	--	
	Alabama Power Smart Meter of Southern Co	US	1 470 000	e	--	2007	2011	
	Alliant Energy	US	626 000	e,g	Sensus	2008	--	450000e, 176000g
	Ameren Illinois Utilities	US	1 100 000	e	L+G	2006	2008	Aiming for 1.1m - linked to scada system
	American Electric Power	US	5 000 000	e	--	2008	2015	
	Arizona Public Service	US	800 000	e	Elster	--	--	

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Arizona Public Service	US	800 000	e	--	2006	2013	
	Atlantic City Electric	US	500 000	e	--	2008	2013	
	Austin Energy	US	234 000	e	Cellnet	2002	2008	
	Baltimore Gas and Electric Company	US	2 000 000	e	--	2008	--	€2.6b programme budget
	Burbank Water and Power	US	45 000	e	--	--	--	
	Central Vermont Public Service	US	152 000	e	--	2011	2013	
	Centrepont Energy	US	3 000 000	e,g	Itron	2008	2014	5 years upgrading AMR to AMI
	Clarksville Department of Energy	US	54 000	e	muNet	--	--	
	Colorado Springs Utilities	US	530 000	e	GE	2005	2010	
	Columbus Gas of Ohio	US	1 400 000	g	Itron	2010	2015	
	Commonwealth Edison	US	141 000	e	GE, Silver Springs	2009	2013	Trial
	Con Edison	US	58 000	e	--	--	--	Linked to smart grid development
	Cumberland Maryland	US	11 000	w	Sensus	--	--	
	Delmara Power	US	300 000	e,g	--	2009	--	aiming for 500,000 electric and 121,000 gas meters
	Dominion Virginia Power	US	2 500 000	e	--	2009	2012	Part of smart grids scheme
	DTE Energy	US	2 700 000	e,g	Itron	2009	2012	Pilot
	Duke Energy (Kentucky)	US	21 000	e,g	--	--	--	120000 e. 90000 g
	Duke Energy (Indiana)	US	800 000	e	--	2010	--	
	Duke Energy (Ohio)	US	700 000 (e) 450 000 (e)	e,g	--	2010	--	
	EPB	US	500 000	e	--	2008	2012	

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Florida Power & Light	US	4 500 000	e	--	2008	--	
	Georgia Power	US	2 000 000	e	Itron	2007	2012	
	Glendale Power & Water	US	100 000	e,w	--	--	2011	Smart grid scheme, usage data viewed online or via option in house displays
	Iowa Exercises	US	1 400 000	e,g	--	--	--	
	Modesto irrigation District	US	112 000	e	L+G	--	--	
	National Grid	US	42 000	e	--	--	--	Linked to smart grid development
	OG&E	US	42 000	e	--	--	--	
	Pacific Gas and Electric	US	10 300 000	e,g	GE, L+G	2007	2012	Not signed yet, \$1.7b for whole programme, \$450m for meters, 10,000 - 12,000 meter install per day 5.1 million electricity 4.2 million gas meter  2009 - PG&E now has approval to supply meters with Home Area Network interfaces in order to give customers real time energy information
	Peco	US	1 600 000	e				600 000 meters by 21012 1 600 000 meters by 2019
	Pepeco, Delaware	US	1 600 000	e	SilverSpring	2009	2019	600 000 to be installed by 2012
	Portland General Electric Co.	US	850 000	e	Sensus	2008	2010	

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
	Potomac Electric Power Co	US	256 000	e	--	2008	--	Proposal, moving to ami for all 1.8m customers
	Progress Energy	US	2 700 000	e	Itron	--	--	AMR only
	Public Service Electric and Gas Company	US	32 500	e	--	2008	--	trial
	Salt River Project	US	--	e,w--	Elster	--	--	
	San Diego Gas and Electric	US	2 300 000	e,g	Itron	2009	2011	waiting for approval from Californian Public Utilities Commission 1.4m e, 0.9m gas amr modules
	Southern California Edison	US	5 300 000	e	Itron	2009	2012	\$480m for comms plus 80% of meters
	Southern Company	US	4 400 000	e	Sensus	2008	--	1 million now installed (2009), installing at a rate of 4500 per day
	Sulphur Springs Valley Electric	US	30 000	e	Cellnet	--	2010	
	Tallahassee	US	220 000	e,g,w	Elster	2007	2010	110,000e, 25,000g add ons, 85000w
	Xcel Energy	US	100 000	e	--	2008	--	
	Oncor Electric Delivery Company	US	3 400 000	e	L+G	--	2012	Contract signed 200 000 installed, 15 minute data being collected. ZigBee AN chips being included in the meter

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
<b>Rest of World</b>								
	Blacktown Solar City	AU	10 000	e	--	--	--	environmental initiative, total meters split across a number of projects
	Country Energy	AU	10 000	e,g	IBM	--	--	Trial
**	New South Wales	AU	--	e	--	2008	2018	announcement
	Victoria	AU	2 500 000	e	--	2010	2013	PRI and L&G supplying meters to CitiPower and Powercor Australia. Network from Silversprings
	ELEKTROPRIVREDA HZ HB MOSTAR	BA	200	e	Echelon	--	--	Trial, aiming to move to 200000
	Ampla Energia	BR	420 000	e	--	2005	--	ZigBee HAN
	Grinpal Energy Management	IN	500 000	e		--	2010	
	IGMC Project	IR	20 000 000	e	--	--	--	Plans to roll out smart metering to Teheran. Meters to have HAN chips
	Kansai Electric Power	JP	12 000 000	e	--	--	--	Plans to replace meters and provide consumption feedback
	Contact Energy	NZ	500 000	--	Vector, Siemens	2008	2013	
	Genesis Energy	NZ	600 000	e,g	Vector, Siemens	2008	2012	Contract signed with meter provider Vector NGCmetering
	Mercury Energy (Metrix) (Mighty River Power)	NZ	340 000	--	Elster		shortly	successful 5000 home trial
	Meridian Energy	NZ	200 000	e	Arc Innovations	2008	--	1000 house trial in Christchurch, testing new electricity products

Ref	Utility	Country	No of meters	Energy streams	Vendors	Start date	End date	Comments
--		RU	375 000	e	Echelon, ECA	--	2008	\$6800000 for 80,000
	Eskom	SA	120 000	e	--	2008	--	
	Trinidad and Tobago Electricity Commission	TT	400 000	e	Itron	2007	2009	AMR only
	Elektromed	TR	1 500 000	g,e,w	--	--	2009	1 000 000 meters gas, remainder electric and water
	United Arab Emirates	UAE	--	e	--	--	--	Based on energy efficiency



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