

SmartRegions: improving energy efficiency prospects of smart metering through collaboration and innovative services

Henk van Elburg
NL Agency
P.O.Box 8242
3503 RE Utrecht
The Netherlands
31 (0) 6 535 41 319
henk.vanelburg@agentschapnl.nl

Keywords

smart metering, savings, consumers, feedback, direct display, regulation, SmartRegions, landscape report

Abstract

Smart metering is rapidly gaining momentum in Europe, thanks to the Energy Services Directive (ESD) and the 3rd Energy Package. Although, considerations for large-scale rollouts take place in many Member States, it's hypothesized success for energy saving and/or peak load reduction should not be taken for granted. Smart meters can only contribute to energy efficiency, if they come public accepted and in line with truly innovative smart metering services. For that reason, a new Intelligent Energy-Europe dissemination project, named SmartRegions, collects and promotes best implementation practices on smart metering and innovative services. Recently, SmartRegions published its first European Landscape Report, analyzing the development of smart metering regulation and metering services in the Member States. As an example, this paper focuses on the experiences in one of the Member States, the Netherlands, to underline that energy saving prospects of smart metering will be more uncertain without these preconditions.

Until recently the Netherlands appeared to be on track for a high-tech and mandated rollout of smart meters. However, intense opposition from consumers' organizations and privacy watchdog groups slowed down this process of regulation and innovation and stimulated the government to switch from a top-down policy implementation to a more collaborative approach with stakeholders and consumers' organizations. Within a new legal framework based on a voluntary acceptance by consumers, smart meters are considered now more

likely to contribute to increasing energy efficiency, compared to the initial proposed mandated rollout. These learning's can inspire other countries to anticipate and avoid similar setbacks which could eventually endanger the ESD and the EU-target of at least 80 % of consumers equipped with a smart meter by 2020.

Introduction

Backed by rising energy demands and fears over security of supply and climate change, smart metering is attracting a lot of interest across the world. Europe is expected to become a world leading centre of this development, thanks to the European Services Directive (ESD) and the Third Energy Package. The 2006 Energy Services Directive laid the foundation for a Europe-wide legislation for smart metering, by requiring individual energy meters to be installed under specific conditions and standards to result in frequent and understandable energy bills. The 2009 Third Energy Package will accelerate the penetration of smart electricity metering in EU Member States by setting a target of at least 80 % of all households to have a smart meter by 2020, given a positive economic assessment.

Although, considerations for large-scale smart meter rollouts take place in a growing number of Member States, public acceptance and hypothesized energy savings should not be taken for granted. Recent experiences in the Netherlands demonstrate that smart metering can only contribute to increasing consumer involvement and effective household energy savings if smart meters are publicly accepted, future-proofed, standardised and with facilities for direct feedback to the consumer. Without meeting these preconditions in,

rollout and energy efficiency prospects will be much more uncertain.

By elaborating on these experiences and lessons learned in the Netherlands, this paper can be valuable for stakeholders from other Member States who also face (and perhaps fear) growing public rejection of the imposition on them of smart meters. In addition, the solutions adopted in the Netherlands to learn together with relevant stakeholders and subsequently arrive at better policy proposals that also acknowledge end-user needs and ensure more promising prospects for energy savings, can help other Member States to avoid similar (political) setbacks and develop regulatory frameworks that are more likely contribute to consumer satisfaction and increased energy efficiency.

This paper starts with a brief introduction on smart metering and a short overview of current European Member States where large-scale smart meter penetration is already underway or being considered, following the requirements of the ESD and the Third Energy Package. This overview is extracted from the European Smart Metering Landscape Report, a deliverable of the SmartRegions project. This project, funded by Intelligent Energy – Europe (IEE/09/775), focuses on the innovative smart metering services, such as informative billing and feedback, variable tariffs and load control services, that are the most potential to bring energy savings and peak load reduction. SmartRegions aims to inspire and encourage energy utilities, energy service providers as well as law makers across Europe to initiate the development of effective smart metering policies and innovative smart metering services by:

- Monitoring the smart metering landscape in European countries, and giving recommendations for regulatory frameworks.
- Defining the best practices of innovative smart metering services by analysing their economic, environmental and social costs and benefits.
- Promoting the best practices of innovative smart metering services and exemplary smart metering regions as models for other Member States and regions.

The European Smart Metering Landscape Report is a comprehensive report on the developments of smart metering and metering services in Europe and consists of in-depth country profiles of all EU Member States and Norway together with case studies of related services for consumer feedback and peak-load shifting¹. As an illustration from this report, the main section of the paper elaborates on the experiences in the Netherlands, leading to the political climax in 2009 and defines the most important causes.

The paper ends with a brief restating of important preconditions and advice for stakeholders in other Member States for an easier and more effective rollout.

Smart metering characteristics and European overview

Although, traditional static meters allow for accurate and timely information on actual time of use, in practice they provide less than perfect information for both consumers and suppliers. Consumers are generally only aware of consumption on a monthly or even less frequent basis, unless they make time-consuming efforts to monitor the readings on their meters frequently. Also, most suppliers only know how much energy a household consumes after a manual meter read. In addition, difficulties arising from this limited data accuracy cause many disputes over bills, thereby possibly also hindering switching between suppliers and market competition.

Smart meters eliminate these issues for consumers and suppliers by adding two dynamic key features to the functionality of the static traditional meter:

- storage of accurate metering data at specified time intervals and
- automatic two-way communication between the consumers' smart meters and the operating system of the network operator/supplier.

By integrating storage capacity and communication technology, the smart meter allows for a radical change in customer-utility relations. In conjunction with smart technology, utilities can adopt pre-pay or innovative time-of-use pricing plan options that incentives customers to use power more wisely. Smart meters also enable consumers to track their usage in real time and better understand their power habits via in-home display units, web-based interfaces or both.

The benefits from a rollout of smart meters potentially fall to all actors:

- To consumers in terms of more frequent and more accurate bills, (near) real-time information to enable household energy savings, facilitation of micro-generation of energy and new energy services.
- To suppliers in terms of more frequent and accurate information and reduced operational costs to serve.
- To network operators in terms of more efficient network operation and capacity control.
- Finally to society in terms of a better functioning energy market, less environmental pollution and reduced carbon emissions.

The implementation of smart meters is also an important first step towards the introduction of smart grids. Smart grids and smart meters are generally conceived as a set of allied tools to help utilities to balance loads across their electricity networks and consumers to manage their energy demand more effectively. Smart grids integrate the actions of all users connected to an electricity power system, employing communications, innovative products and services, and intelligent monitoring and control technologies to:

- Help utilities to efficiently manage the full array of power generation assets, including traditional generation facilities and renewable sources such as wind turbines, to meet customer needs;

1. The European Smart Metering Landscape Report can be downloaded free of charge from the project's website www.smartregions.net.

- provide consumers with more information about their own usage and peak demand so they can adjust their behaviour;
- reduce the environmental impact of power generation through incentivizing customers to reduce electricity use and/or shift electricity usage from peak to off-peak hours to avoid running costly fossil-fuelled peak generation units.

EUROPEAN OVERVIEW

The adoption of smart metering in Europe is highly dynamic and to a large extent driven by regulations, the European Smart Metering Landscape Report shows (SmartRegions, 2011). Due to EU legislation such as the Energy Services Directive and the 3rd Energy Package, a majority of the countries in Europe have or are about to implement some form of legal framework for the installation of smart meters. Countries such as Denmark, Finland, France, Ireland, Italy, Malta, the Netherlands, Norway, Spain, Sweden and the UK are 'dynamic movers.' They have either decided already about a mandatory rollout, or there are major pilot projects that are paving the way for a subsequent decision. Market drivers such as Germany, Czech Republic or Romania have not established legal requirements for a rollout. Utilities nevertheless go ahead with the installation of electronic meters either because of internal synergetic effects or because of customer demands. In other countries the situation is more ambiguous with ongoing intensive discussions but without a clear decision yet. Finally, there are 'waverers' and 'laggards' where corresponding initiatives have either just started or where smart metering is not yet an issue. However, even in this latter group it is likely that EU legislation will soon result in policy action.

The Netherlands is the first EU Member State to decide for a (partly) voluntary-based rollout of smart meters, after fierce opposition from consumers' organizations and privacy campaigners. Since government-mandated rollouts can be considered as the preferential method to reap the most benefits of smart metering, important questions arise about the significance of this development for future rollout decisions in other Member States. Will the 'Dutch dénouement' lead to a similar reaction in other Member States? And more importantly, will a tendency towards voluntary based rollout schemes jeopardize the initially foreseen economic and environmental advantages of widespread smart metering, as was intended by the ESD?

These questions may be hard to answer at the moment, although similar discussions are starting to take place in other Member States such as Germany and Austria. However, a choice of a voluntary instead of a mandatory rollout does not automatically endanger the energy saving benefits of smart metering as intended by the ESD. On the contrary; the Dutch collaboration with important societal stakeholders for a policy that meet end-user needs better and the pioneering route to a voluntary rollout now offers an alternative with good prospects for a widespread rollout of smart meters and promising energy savings. Overall, it must be realized that a mandated rollout only ensures a full penetration of smart meters, but offers no guarantee for successful consumer involvement and widespread energy savings.

Smart metering regulation in the Netherlands

In order to understand the argument for a voluntary based rollout as an equally effective strategy as a mandated rollout for widespread consumer involvement and effective household energy management, the course of events in the Netherlands will be presented in more detail as a chronological overview of events, an analysis of decisive factors, and finally the switch to a more cooperative approach following a voluntary rollout.

CHRONOLOGICAL OVERVIEW

The Dutch government had already started thinking about introducing smart meters in **2004** in an effort to correct the administrative problems with household energy billing that followed the liberalization of the Dutch energy market. As time went by, other important smart metering drivers surfaced such as facilitating more market competition (easy switch for consumer), operational efficiency for market parties and -last but not least- energy savings for consumers. Limiting peak load demand (e.g. on hot summer days) was, and still is, a less important driver in the Netherlands.

In **2007** the government launched its first comprehensive legal proposal (bill) to change the national Electricity and Gas law in order to improve the functioning of the liberalized national energy market for consumers and small business users and to comply with the ESD-directive. The most fundamental part of this proposal was the restructuring of the national meter market. The key issues of the law proposal were:

- All 7 million households and small business users will be equipped with a smart meter.
- The public grid operators will own the smart meters and pay for the rollout, partly from the current meter tariff.²
- The smart meter tariff will become regulated for consumers and small businesses and this tariff should remain unchanged or even drop.
- The energy retailers/suppliers will be responsible for all customer related processes and the management of the metering data.
- The smart meters must comply with basic functionality and technology, defined in a regulated technical agreement and a smart meter industry standard.

The government opted for a mandated rollout in 2007, because it was believed that in a liberalised energy market without further regulation, a smart metering rollout would probably reach no more than 30 % penetration. In the case of such a partial penetration, the smart meter benefits would probably not be fully realised. Also, the requirements set by Article 13 of the ESD for individual metering and frequent billing (Energy End-use and Energy Services directive, 2006/32/EC) were interpreted as a demand for smart meters.

In **2008** the proposed mandated meter rollout was intensely discussed in public before being debated in the Lower House

2. To date the meter charge has not been regulated and network operators have increased the monthly tariffs by up to 100 % since 2001. The Dutch Competition Authority stated in 2006 that it could not believe there is a convincing relation between the increased tariffs and actual costs.

of the Dutch Parliament. In Particular, the Netherlands' main consumer organisation, Consumentenbond, opposed the new law, mainly because of privacy concerns. Moreover, Consumentenbond questioned the energy saving claims made for the smart meter. Finally, on July 3rd in 2008 and after intense discussion, the Dutch Lower House conditionally accepted the proposed law for the introduction of smart metering in The Netherlands. Important conditions required by the Lower House were related to extra meter requirements in favour of energy saving and own-generation of electricity and a two-year trial period for experience purposes.

In 2009 after three terms of heated political debate and renewed vigorous campaigning by Consumentenbond, privacy watchdog groups and even on national public television, the Dutch Senate declined to approve the mandated roll out of smart meters. Fears that data on energy consumption could be misused curtailed the compulsory introduction of the meters in the Netherlands. Dutch consumer and privacy organisations were concerned that information relayed as frequently as every 15 minutes could allow criminals or utility companies to see when properties were empty or when householders had bought expensive new appliances. In the end, the Dutch Senate considered a mandated rollout of smart meters being a violation of the right to privacy as guaranteed by Article 8 of the European Convention on Human Rights. In weighing the pros and cons of a mandated rollout in relation to these privacy/security concerns and poor energy saving guarantees, the Dutch Senate also considered the mandatory nature of the roll-out disproportional: refusing a smart meter would be considered an 'economic offence', punishable with a fine up to €17,000 or six months in prison. The government was forced to back down and promised a compromise bill based on a voluntary rollout of smart meters.

In 2010 a compromise to the smart metering bill was presented in the Dutch Parliament. This compromise version built on an obligatory providing of smart meters by the grid operators, but a voluntary acceptance by consumers. To regulate the voluntary part of the rollout for privacy reasons, the bill offered four legal options for a consumer in accepting a smart meter:

- The option to refuse the installation of a smart meter and keep the 'traditional' meter.
- The option to have a smart meter fitted (or once it has been installed), but opt out of sending automatic meter readings (smart meter functions as a traditional meter, a meter reader is still required).
- The option to have a smart meter fitted, but with a fixed set of automatic meter reading occasions (bi-monthly consumption and cost reports, annual billing, switching energy supplier, remove to a new house).
- The option to have a smart meter fitted with full automatic smart meter reading, which is (of course) the preferred option for the government and energy market players.

At the beginning of 2011, this compromise was accepted in both Chambers of the Dutch Parliament. Also consumers' organizations and privacy campaigners now expressed their contentment with the bill, providing the hard-won freedom of

choice for consumers. After a two year delay, noisy civil liberty campaigns, public indignation and finally an awkward u-turn by the government, the Netherlands now has a legal rollout scheme in place.

DEFINING THE DECISIVE FACTORS

How could this happen? How could a country that was initially seen as one of the most advanced smart metering markets in Europe (and indeed appeared to be on track for a fast and mandated national rollout of smart meters), end up in such an anti-climax? A review of the developments in the Netherlands clearly points out that the top-down style of policy making triggered part of the resistance. If the consumer and privacy organisations would have been involved from the outset, the upheaval could have been avoided. The two most important immediate causes that determined the anti-climax of the smart meter discussion in the Netherlands were:

- Underestimating the sensitivity surrounding privacy aspects.
- Disregarding the case for accompanying energy savings.

Both factors will be analysed more closely.

Underestimating the sensitivity surrounding privacy

In 2007, when the Dutch Government announced that all 7 million homes in the Netherlands were to be equipped with smart meters, it anticipated little resistance. After all, who would not welcome a device that could save both energy and money? However the Dutch national consumers' organization, Consumentenbond, considered that these intelligent monitoring devices, which transmit power-usage information to the utility as frequently as every 15 minutes, would make consumers vulnerable to thieves, annoying energy marketers and even utility and police investigations. Privacy campaigners joined in and spoke out strongly against this mandated surveillance technology, reviling the smart meters as 'espionage meters'.

A critical moment was the release of a report by the University of Tilburg (Cuijpers 2009), commissioned by the Dutch Consumentenbond, to test the privacy issues of the proposed smart meter bill to the conditions of the European Convention on Human Rights (ECHR). Article 8.2 of this Convention grants a legitimate breach of privacy in accordance with the law, necessary in a democratic society, and in the interest of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others. The main observations of this report were:

- A legal basis for smart metering regulation following the EU Directive 2006/32/EC was in itself in accordance with this Convention, because its objectives of energy efficiency and functioning of the energy market are in the interest of the economic well-being of the country.
- However, in the Dutch case, the mandated rollout was unconvincingly explained as a necessary measure in a democratic society in terms of pressing social needs, the actual providing of these needs and the principles of proportional-

ity and subsidiarity. Questions like 'does smart metering really result in energy savings?' and 'does the goal to improve the functioning of the energy market constitute a 'pressing social need?' were not well addressed.

- Furthermore, the minimum functional requirements of distance read out of consumed energy at very short interval periods (every hour for gas and every 15 minutes for electricity) and remote (dis)connection of capacity do *not* follow from the ESD-Directive and are disproportionate in the view of privacy and security. In the view of privacy, the registration of data regarding energy consumption reveals life patterns and the presence and absence of people in a house. In the view of security, the use of wireless networks is risky and hacking into a network is not inconceivable.

Overall, the report concluded that the mandatory nature of the proposed bill as well as the envisioned minimum functionalities of the smart meter, violate the right to privacy and are inadmissible on the basis of Article 8.2 of the European Convention on Human Rights. Removing the clause on the mandatory nature of the rollout alone does not take away privacy infringements caused by generating and transmitting detailed data on energy consumption. Even though functionalities as (dis)connecting from a distance and functionalities to spot fraud might be valid, without proper motivation, the necessity in a democratic society could not be sustained. Furthermore, in-depth research is necessary into less intrusive alternatives that on the one hand are able to achieve energy efficiency and a good functioning of the energy market, while on the other hand respecting the right to privacy and guarantee security.

Disregarding the case for energy services

Less well known compared to the privacy 'battle' but equally decisive, was the equivocal position of the government towards the energy saving benefits of smart metering. On the one hand the government considered the expectations of substantial energy savings to be the main rationale for a mandated rollout of smart meters. On the other hand the government was reluctant to put regulation in place for accompanying energy saving instruments, stating it is the responsibility of the market to introduce appropriate services.

In response to this seemingly contradictory approach, consumers' organizations as well as politicians stated that a residential smart meter alone does not automatically mean successful consumer involvement either in general or with energy savings in particular. To put it more strongly, the Lower House and Senate criticized the lack of proof that a smart meter will actually lead to substantial energy savings. During the parliamentary debates, experts stressed the importance of additional automation technologies 'beyond the meter' (Boekema, 2008). Without easy accessible and convenient in-home energy feedback services, such as intuitive, aesthetic and affordable in-house displays and customized applications on web pages or cell phone, smart metering will not involve consumers and encourage mass market energy conservation.

ANALYZING THE CAUSES AND REGAINING PUBLIC SUPPORT

The Dutch Government and network operators underestimated the privacy objections for too long a period as 'much ado about nothing'. Their opinion was that there is simply not

much intelligence to be gleaned from 15-minute-interval meter data. There is far more reason to worry about losing control of mobile phone use or whenever a consumer swipes his credit card at the local supermarket than when his smart meter reports the use of another kilowatt-hour. In the meantime, the public image of the smart meter could develop into a 'espionage meter', collecting sensitive information about the consumer's habits (i.e. when someone leaves the house or returns) and insights into a family's living patterns and relationships "which can affect people's freedom to do as they please in the confines of their homes".

In addition to the privacy discussion, the government's ambivalent position on the energy saving potential of the smart meter also weakened the law proposal. To ensure the support for the smart meter bill, the government was forced to announce the introduction of a trial period of at least two years ahead of a large-scale rollout. During this initial rollout period (in which smart meters will only be installed in new construction, renovations and large-scale redevelopment projects), the actual energy saving effects will be extensively monitored. Until the large scale rollout decision, expected in 2013, the energy saving effects of the smart meter will be subject to reconsideration.

Evaluating the causes of the dramatic setback in the Dutch Senate in 2009, Dutch law makers and network operators decided to switch to a more cooperative approach in the build-up to resubmitting a compromise law proposal. While preparing the amended smart metering bill, the 'learning's' described above were now designated as key, and privacy, security, and energy saving were utilised as starting points for revised regulation and system design.

The most important step in the effort of regaining public support and ensuring more promising prospects for energy savings was the establishment of a series of round table meetings. All relevant (societal) stakeholders, including consumers' organisations and privacy experts, developed by mutual agreement the basic conditions for a favourable smart meter rollout and effective energy saving feedback. All stakeholders now work together in defining the essentials for revised system architecture that takes security and privacy and energy saving as design starting points. In the end, this consultation process laid the unanimously supported foundation for:

- a compromise law proposal;
- an updated cost-benefit analysis;
- a revised industry standard for smart meters.

Compromise law proposal

The new Dutch law proposal offers consumers a legal choice in accepting a smart meter, ranging from having no smart meter at all to a smart meter with full functionality that provides a constant stream of data to service providers. Furthermore, the data from the smart meter will only be used for specific regulated purposes and/or only for services for which the customer has given its consent. Additional regulation will set out what measurement data these parties need in order to provide the customer with the information. It is important to distinguish between a minimum level of consumption data for bimonthly cost statements and billing and consumption data at a lower

aggregate level for additional energy services. When accepting a smart meter, the customer will be obliged to authorise the network operator to use the minimum requisite level of consumption data. The customer will also have to explicitly give commercial service providers their consent before the service provider can use any other measurement data beyond the minimum regulated level. The customer therefore determines in advance by contract which measurement data generated by the smart meter is to be used by which party. To be able to access the measurement data, the grid operator will set up authorisation and authentication procedures. These procedures must ensure that individual measurement data is only used for the specific purposes for which the customer has given its consent (Boekema 2010).

Updated cost benefit analysis

In 2005 a societal cost-benefit analysis into the national introduction of the smart meter was performed (Gerwen 2005). The Senate's veto to the original mandated rollout legislation, however, forced the government to commission a revised cost-benefit analysis. This was in order to gain insight into the consequences of the changed circumstances, such as the elimination of the obligation to accept a smart meter, and the increased attention for more robust energy saving prospects. The cost-benefit assessment method has remained largely the same, but important changes have been incorporated. The cost level has also been updated based on the current data (including the costs associated with privacy and security). The energy saving percentage has been substantiated in more detail and the possible contribution of a smart metering infrastructure to a future smart grid has also been considered. More than before, the smart meter is now looked upon as a lever to put important developments in the supply of energy in motion.

The revised study remarkably showed that there is still a positive business case with a net present value of 770 million Euro on a national scale, mainly based on the potential for energy savings in residential sector (Gerwen 2010). Beneficial items, in order of positive contribution, are savings on call centre costs, a lower cost level as a result of increased competition (increased switching) and savings in meter reading costs. The advantages will mainly benefit the consumer, the costs will mainly be at the expense of the grid operator and the national government (lost taxation revenue).

As mentioned above, of the expected benefits, those of energy savings are predicted to be the greatest. A lot of attention has been given in the revised assessment study to this benefit item, particularly in order to substantiate the percentage of energy savings. Although, a certain level of uncertainty in determining the national average savings percentages remains unavoidable, the study assesses direct feedback to result in substantially more energy savings than indirect feedback. Consumers with a smart meter and a display will save on average 6.4 % for electricity and 5.1 % for gas; approximately 50 % more than expected average energy savings from indirect feedback.

Revised industry standard

Following the Dutch Senate's veto of a mandated rollout in 2009, in the series of round table meetings the focus was also on improving the smart meter functionality and technical arrangements in favour of privacy protection, security and energy

efficiency. Stakeholders from DSO's, energy retailers, consumer organizations, technical experts and authorities, discussed the need for additional functionalities and procedures to support privacy and security and energy efficiency. This process led to a revision of the industry standard to be used by all Dutch system operators. Important additions in this respect were:

- the provision of more real-time data on electricity and gas for direct displays to facilitate energy savings for consumers;
- the provision of metering data related to decentralized generation to facilitate small-scale sustainable decentralized generation for customers.

All minimum functionalities for connecting the consumer to the energy distribution infrastructure will now be stipulated in a new 'Dutch Technical Agreement' in this area (NTA 8130). This will be done under the supervision of the Dutch Standardization Institute (NEN). The minimum functionality required for the smart meter also includes among others:

- Remote reading of the energy consumption (both periodic, actual and interval values).
- Remote reading of the electricity supply (both periodic, actual and interval values) – meant for individual (decentralized) generation.
- Monitoring of the quality of the electricity supply (outages, voltage swells and sags).
- Registration of violation and fraud attempts.
- Remote activation and deactivation of the energy supply.
- Temporarily limit the electricity supply by setting a threshold.
- The possibility to connect external services devices.
- Sending short messages to the display of the meter.
- Sending long messages to the meter for on-line interaction – these will be forwarded to the external devices.
- Status information (errors, tariff indicators, breaker and valve positions, thresholds).
- The possibility of firmware updates.
- The provision of access and security.

Conclusions and learnings

The occurrences in the rollout of Dutch smart metering highlight the importance of a well-considered regulatory introduction of smart meters. The intense opposition from consumers' organizations and privacy watchdog groups showed the risk of underestimating the sensitivity for privacy aspects and disregarding the case for accompanying energy savings. The political setback meant that Dutch law makers and network operators had to switch from a top-down approach to collaboration with relevant societal stakeholders for a more acceptable policy, taking into account better the needs of – and potential risks for – end-users. This interactive policy making & learning approach resulted in broad support by stakeholders as well as consumers organizations, while offering more freedom of choice for

consumers and more facilities for direct energy feedback. The most significant outcome of this new approach was the mutual intention to work together in designing the communication to accompany the voluntary roll out of the smart meters. This marks the real change in the troubled relationship between the government and distribution system operators on the one hand and consumers' organizations and privacy campaigners on the other hand.

The Dutch experiences elaborated in this paper are relevant for stakeholders from other Member States who also face growing public reluctance to the imposition of smart meters. An important learning in this respect is that an (enforced) legal choice for a voluntary rollout does not automatically mean a less effective outcome and a missed opportunity for a widespread smart metering penetration and promising energy savings. On the contrary, today the revised smart metering legislation, offering more freedom of choice for consumers and more functionalities for direct energy feedback, will be broadly supported by network operators, energy retailers as well as consumers' organizations. Within such a framework, smart meters could possibly contribute just as much to increasing energy efficiency than in the case of a mandated rollout.

The most important lesson from this, however, is that smart metering can only contribute to increasing energy efficiency, if the smart meters come both public accepted and in line with innovative smart metering services. Without meeting these preconditions, energy efficiency prospects from both mandated or voluntary rollout will be much more uncertain. These lessons the Dutch Government has learned the hard way should inspire other countries to anticipate and avoid similar (political) setbacks, which in the end may endanger the success

of the EU-ESD and the EU-target of at least 80 % of consumers equipped with a smart meter by 2020.

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