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Evaluation of the techno-economic viability of smart metering value network configurations based on a consumer oriented approach

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Abstract

In light of the third energy package and the European 20-20-20 goals, intelligent meter systems have gained a lot of attention in recent research. However, before moving towards a full rollout, the EU allows the member states to conduct an economic assessment. Within these assessments, we have found a lack of focus on the impact of such metering systems on the end consumers, although one of the goals is raising involvement of customers in the future energy market. In this paper, we propose a consumer oriented approach for the smart meter market. We introduce a customer segmentation based on the level of steering intelligence and three distinct value network configurations, covering the spectrum from a vertical integrated solution towards a more competitive market model. These configurations are then assessed upon four facets: technical issues, business challenges, consumer advantages and the impact on competition.

Keywords

Smart metering, value network configurations, consumer oriented, techno-economic viability

1. Introduction

In 2009, the European Parliament and European Commission introduced two different energy related packages, the third electricity package and the climate and energy package. In the latter, the 20-20-20 goals are introduced, namely a 20% reduction of greenhouse gas emission compared with 1990, cutting energy consumption by 20% of the projected 2020 levels and increasing the use of renewable to 20% of the total energy production, which was at that stage around 8.5%. These ambitious targets were set for 2020. It is clear that this package can be seen in the light of the battle against climate change. The third energy package has a different goal (Directive 2009/72/EC). It extends the previous energy packages and sets out the common rules for the internal market for electricity [European Parliament and Council, 2009].

However, an important aspect of this directive covers the impact of a well-functioning electricity market on the efficient energy use. Smart metering is seen as one of the means to achieve this well-functioning electricity market. A smart meter can record consumption and production data, in most cases on a quarterly hour basis, and enables two-way communication between the meter and a central data repository and controlling system. The most important difference with the existing Automatic Meter Reading (AMR) currently applied is that these are not enabled for two way communication and are only used for automatically collecting consumption and status data, together with diagnostics from energy meters. The data is also transferred to a central database for billing and troubleshooting. Smart meters have some important advantages compared with the currently installed electricity meters [Lizak F., 2009]. Delivering frequent consumption and energy production data, provisioning of energy management services, offering innovative price formulas [Faruqui A., 2010], detecting fraud [Megalingam R.K., 2011], etc. are all facilitated with a smart meter. Currently, smart meters have already been rolled out on a large scale in several European countries, like the Netherlands and Italy. However, the directive clearly states that the introduction of such intelligent metering systems should be based on an economic assessment. In the annex of directive 2009/72/EC, more information is given on this assessment. Member states must ensure the implementation of intelligent metering systems that assist the consumer in taking a more active role in the electricity supply market. This implementation may be subject to the economic assessment of all long term costs and benefits of such a system for all actors active in this market. This assessment should be carried out by September 3rd 2012. Following the assessment an implementation plan will be required offering a timetable for the rollout of the smart metering systems. If the rollout is assessed positively, at least 80% of the customers should be equipped with an intelligent meter system by 2020 [European Parliament and Council, 2009].

In Flanders, steps towards this economic assessment have already been taken [KEMA, 2009]. It showed that the full rollout of smart meters in Flanders would result in a negative business case (-€389 million). This is mainly due to the high infrastructure investment and communication costs for the Distribution System Operator (DSO). Reducing costs in these two segments could make the total business case for Flanders positive. When the total cost for the consumers is controlled, we notice a positive business case (€819 million). However, no segmentation of users is taken into account, while the European third energy package directive clearly states the possibility of a segmented rollout. For example, households with only a small electricity consumption could have a negative case, which is compensated by the positive business case for large consumers. In addition, the investments costs of the DSO are not charged to the consumers via the distribution tariffs. In reality, this will most likely be the case, as distribution tariffs are designed to compensate the DSO for its network investments.

In Belgium, one of the DSOs already moved forward in the rollout of smart meters [Eandis, 2010]. They plan to replace all their current electrical meters with smart meters based on Power Line Communication (PLC) technology. As they currently pursue a vertically integrated business model, they will be responsible for most of the roles. They will take care of the rollout of the metering infrastructure, the communication between the meters and the backend and the data management. In such a business model, it may be clear that the DSO will hold a key position within the value network. However, we could question if this business model is the most consumer oriented and if it allows sufficient levels of competition.

Therefore, where previous research has focused on the viability of the smart meter from an industry point of view, we believe that in order to convince the consumer to step into the smart meter story, a more consumer oriented approach is necessary. Little research was found targeting this topic. From user perspective several papers could be found indicating the opportunities for users to participate in smart metering and grids [Hauttekeete, L, 2010], [Honebein P.C, 2009], and competition [Clastres (2009)].

Within this paper, we will introduce a more consumer oriented approach in defining business models for smart meter rollouts. First we describe our value network framework, indicating the different roles we consider in our model. Next we introduce the different business models and compare them based upon several parameters (technical, business, consumer and competition). We end with conclusion and next steps.

2. Smart meter value network

2.1. Business roles

Within our value network analysis we make a distinction of three streams: electricity, telecommunications and data stream (Figure 1). The first stream comprises all the actual flows of electricity from production over the transport and distribution network to the end customer. The second stream focuses on the communication (network infrastructure, home equipment). The last stream includes all the data generation to storage in the network, and required hard- and software. As we only focus in this paper on the consumer side, we make abstraction of the energy production and distribution roles.

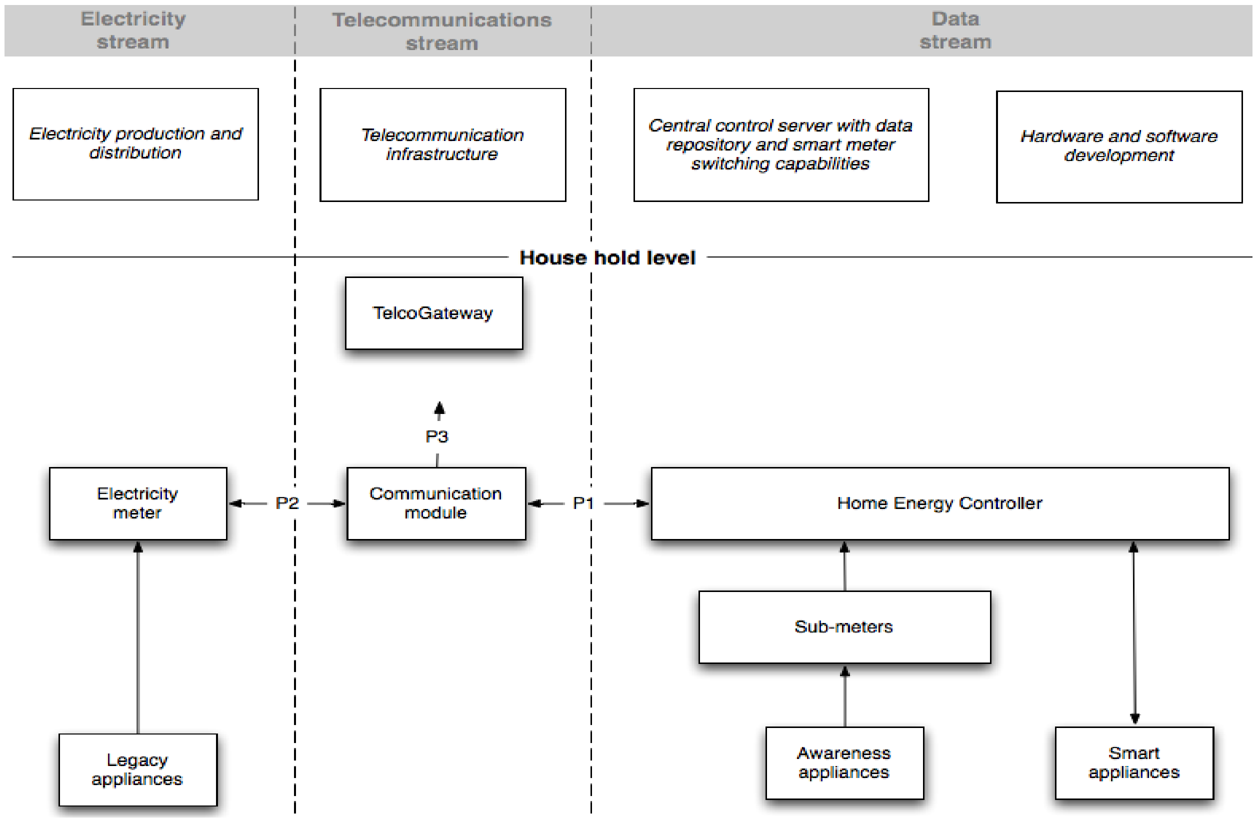

Figure 1: Business roles

2.2. 'as is'-scenario towards the 'to-be' scenario

Currently the electricity meter of the customer only measures the aggregated consumption, based on the consumption of the different circuits, and thus appliances, in each house. The data is reported annually by the customer via phone, Internet or post, or by a technician coming to your premise. This legacy scenario is the 'as-is'-scenario where intelligence and communication ability is not implemented in the meter or in the appliances present in the household. This scenario serves as a benchmark to which all other scenarios can be compared [Depuru, 2011].
To offer smart metering services to the end consumer, the existing electricity service stream needs to be extended with two extra streams, namely a telecommunication stream and a data stream, as can be seen in Figure 1. To move thus from the 'as is'-scenario towards the 'to-be'-scenario, two important changes in the actual technical set-up are necessary. The first extension is the implementation of the mechanical meter with a communication module, allowing a two-way communication between the household and the central repository system. These two modules combined, the metering and communication module form the smart meter. Secondly, to move towards a real smart energy management system, intelligence needs to be included. A home energy controller (HEC) is a gateway with software capable of aggregating information and controlling the different appliances within the household in an intelligent way, based on the different signals the smart meter sends to or receives from the central control system. The functionality of the HEC can be installed on different locations: within the smart meter, the telecom router, a separate device in the household or even a cloud based solution. It only needs to be able to communicate with the sub-meters and appliances within the house. External devices

such as a stand-alone display or via a web-based platform can be used for visualization of the consumption and production patterns in all of these setting.

2.3. Customer segmentation

Together with this generic business model, four different consumer profiles are introduced which we expect to emerge in the future energy market, namely information, awareness, guidance and automation [SmartE, 2011] [Benzi, 2011]. In the existing energy market, only the information scenario is available. On a monthly basis, consumers receive together with their energy bill a sheet with extra information on the composition of the delivered electricity. On a yearly basis, they get information on their consumption and an estimate of the future evolution of their consumption. Consumers can get extra information by searching the Internet and comparing energy supplier tariffs. All consumers are subdivided in this one segment. With the introduction of smart meters, three extra segments will emerge, based on an increasing intelligence of the smart meter.

In the awareness segment, consumers not only search for information, but they are also more aware of their own energy consumption, by keeping track of their daily total consumption or more detailed consumption per circuit or appliance by using sub metering solutions. In theory, no smart meter solution is necessary for this segment, but this would require the consumer to manually check his (sub)meters. The installation of a smart meter could drastically improve the user friendliness, allowing the consumer to check the consumption patterns on an in-home display or a web-based platform. It has been shown in different studies that raising awareness of the end consumer already decreases their energy consumption [OFGEM, 2011][Nye, 2010].

The guidance scenario is more future-oriented. In addition to the smart meter, consumers make use of an intelligent system that tracks their energy consumption and offers advice based on the gathered data. Guidance can consist of benchmarking the total household consumption with similar consumers, giving signals when appliances are still turned on when the consumer leaves the home or advice when best to use appliances based on the current energy tariff.

The automation segment is the most future-oriented one. The homes of the consumers are automated by an intelligent system that tracks energy consumption and behaviour. Combined with the signals received from the central system, the intelligent system can make decisions on switching on or off appliances. This is in contrast with the previous scenarios, where it was still the responsibility of the consumer to act on the signals he received from the central system. Automation can be as simple as automatically switching off lights when there is no person in the room, to intelligent loading schemes of the electrical vehicle based on electricity cost, household solar energy production and distribution network constraints.

This customer segmentation allows for a more realistic future economic analysis of the smart meter introduction in Flanders. It was already indicated that the impact of smart meters on the business case for the end user will not be the same for all users, depending on the type of end customer (consumption pattern, housing type, etc.). Some consumers, mostly with a low energy consumption pattern, will only benefit from an awareness profile. The financial benefit of reduced energy consumption would not compensate for the additional cost of installing extra intelligence in their home. On the other hand, for large energy users or people with decentralized production, a move towards an automated system could result in a more profitable case than the simple awareness scenario.

2.4. Steering of intelligence

As we focus on the consumer side, we leave it open which actor from the current or future value network will take up the role of the central system sending the signals to the HEC (e.g. distribution system operator (DSO), energy suppliers, clearing houses, etc.). These signals can serve the different needs of the actors present in the higher layers of the electricity value network. Suppliers could send Time of Use (ToU) tariffs to their customers, DSOs could send capacity reducing signals when the grid is overloaded and Balance Responsible Parties (BRP) could send price signals to increase or reduce consumption when an imbalance is created due to false forecasts of renewable wind and solar energy. Problems can occur in the end when signals from the different actors will affect the working of the other actor. A priority needs to be defined in order to solve these issues. As all actors play with the same flexibility offered by the customers, this amount will become a scarce good in the future. This would also mean that the DSO is the designated party to take up the role as central system sending the signals. In this case, there would only be one aggregator in a geographic region, allowing for a consequent policy by the DSO in sending the grid related signals. However, since the DSO holds the monopoly in a certain geographic region, a clear disadvantage of this scenario is the lack of competition on the service side of the business. For suppliers and balance responsible parties (BRP), as the DSO can decide on the priority of the different signals send to the households, this could provoke additional balancing costs that would be distributed equally over the different BRPs.
We consider that the intelligence of the smart meter system for the end consumer is installed in the house by means of a HEC (home energy controller). This HEC combines all the received signals and can offer awareness, guidance and automation to the customer.

3. Different business models for to-be scenarios

The previous section introduced the generic value network for a consumer oriented approach when introducing smart meters. Here, we will describe three distinct business models, where different players take up different roles, namely a DSO, Telco and Energy Service Company (ESCO) centric model. These three models can be combined with two different solutions for the intelligence. The different models will be analysed from a technical, business and social point of view.

3.1. DSO centric model

The DSO centric model is a translation of the more vertically integrated approach where one party takes up most of the roles. A fully integrated, and modular meter (with telco choice of DSO concept is elaborated in the following paragraphs.

3.1.1. Fully integrated model

In this model, the DSO takes up all roles concerning the smart meter, metering, communication and HEC functionality (Figure 2). The DSO can take up the role of communication as he can use power line communication (PLC) to send the meter data. We therefore can refer to the Belgian case in the introduction [Eandis, 2010].

Technical: As the meter comprises all functionality, thus the mechanical meter, communication component and HEC software, installation of this system is relatively easy. It is required that the installation of the meter is taking place by a recognized electrician. In terms of operational processes, the existing meter needs to be decoupled and replaced by a smart meter (including communication module), thus the meter data needs to be re-updated in the back office of the DSO, as well as some other administrative issues need to be changed and updated. When problems occur with the meter such as replacement of communication module for a new technology, the recognized electrician will need to come down to each house, shutting down the full smart meter including electricity component, making the replacement and resetting the system. This will require as mentioned above a lot of additional administration in the back office. In terms of communication, the DSO can make use of its own electricity network to connect the smart meters to its own telecommunication infrastructure via PLC. Additional investments are required in the access network installing amplifiers and connections points in order to cope with all the data (two-way) traffic taking into account a low delay and latency. One of the questions will be the openness of the smart meter, thus what are the ways or standards in which other companies and devices can communicate with the smart meter and HEC in the case of automatically switch on/off devices in the house.

Business: As the DSO is taking care of all activities, everything can be arranged in a more organized and efficient way. They also act as SPOC (single point of contact) for the end customer. When faults would occur in the network, either in the electricity, telecom and HEC component, the DSO is the only responsible party. This states that all required competences for all these components are available within the DSO organisation. The main benefits are thus operational savings and network monitoring for the DSO. Also a new monopoly is created with control over the smart meter. No innovation is stimulated for services inside the house e.g. additional displays with consumption information, savings on energy, apps, etc. It all depends on the possible interfaces the smart meter and HEC offer to the external parties e.g. supplier for offering ToU tariffs. As the regulation moves towards the supplier as SPOC for the end customer, this would require that all the information retrieved from the meter is available for the supplier as well in an open way. The major question is if this kind of service provisioning is a role for a party (DSO) who offers a public service. Regulation required a separation of network and services, so this could result (again) in a re-integration of both aspects.

Customer: For the end customer a single solution with one SPOC would be best. Disadvantages are the low possibility of innovation by other parties, the forced placement of the meter and idea of needing to pay (additionally) for a service which is forced by the DSO. Depending on the type of end customer, this investment can be a burden for the end customer as he/she cannot gain enough in energy savings. Different services could be offered depending on the profile of the customer but choice will be limited.

Competition: Level of competition is very low. The DSO is monopolist and controls the ports / interfaces of the smart meter and thus the introduction of innovative services by other actors.

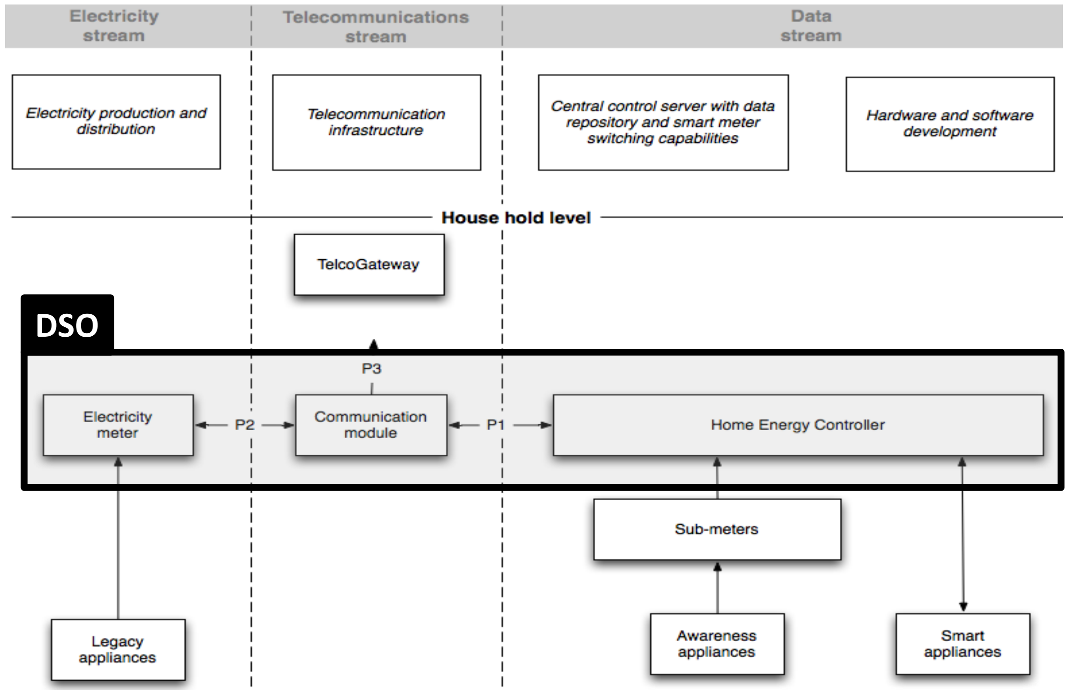

Figure 2: Fully integrated smart meter model

3.1.2. Modular meter model – DSO outsources the communication component

A solution to the communication competences of the DSO would be the outsourcing of the communication module (Figure 3). However, this would require some changes in the meter architecture. The existing integrated meter should be changed towards a modular meter, with the two important modules being metering and communication fully separated. With such a kind of plug-and-play communication system, maintenance and replacement of the communication module will have no effect on the meter component, reducing the need for a recognized electrician to perform these actions. Additionally, as the meter itself will not have changed, the administrative overhead would also be avoided. This alternative model could thus benefit in many ways.

Technical: Splitting up the electricity and telecommunication streams into separate operators benefit mostly in the operational phase. Where the mechanical electricity meter lasts for over 25 years, the telecom component has a life cycle of maximum 7 years, to be explained by two facts: technical and economic lifetime. The technical lifetime is limited by the wear-out of the components, who typically only last for about 5 to 7 years. The economic lifetime is driven by the technological evolution. As technologies change so fast, it is possible that new and improved communication technologies should be implemented within the first 5 to 10 years. As mentioned before, if the electricity component needs to be stopped for changing the telco component, this is very costly and causes a lot of administrative issues. When this could be done separately with a modular meter system, this would benefit the customer and the DSO. This activity can also be done by everyone, not only by an electrician, which would be more convenient and cheaper.

Business: As the cost of the communication module could be paid by the telecom operator, this would lower the total investment of the DSO. A fee for data communication can then be paid to the telecom operator on a monthly basis based on the type of network used. Operationally as mentioned above, this would not lead to additional processes and costs. The total investment cost of the smart meter (split mechanical electricity and communication module) is more expensive than the fully integrated meter, but in operational costs it is more beneficial. When comparing the total cost of operations over 25 years, it shows a better and cheaper solution compared to a fully integrated solution. In a first analysis, we have found that the total initial investment expenditures for a modular meter are about 8% higher compared to the integrated meter for a full rollout in Flanders. However, this initial cost is completely offset by the operational costs over the total meter lifetime. When taking only the reduced wages for the personnel making the repairs and the cheaper hardware costs, since only a communication module is required, the modular meter turns out to be 45% less expensive. In total, this comes down to a gain of 6% in the total cost of the smart meter project. When taking the reduced administrative overhead into account, even more gains could be achieved with the modular meter system.

Customer: The benefits and drawbacks are relatively the same as in the DSO model, as the DSO can choose the telecom operator. One additional advantage would be lesser nuisance as the replacement of the communication component takes less time and would not require the full stop of the electricity circuit. The overall total cost of ownership for the DSO should be lower in the end, hopefully resulting in a lower cost for the end customer.

Competition: Level of competition is still very low. The DSO controls the telecom operator and forces the customers to make use of this service. It also controls the ports / interfaces of the smart meter and thus the introduction of innovative services by other actors.

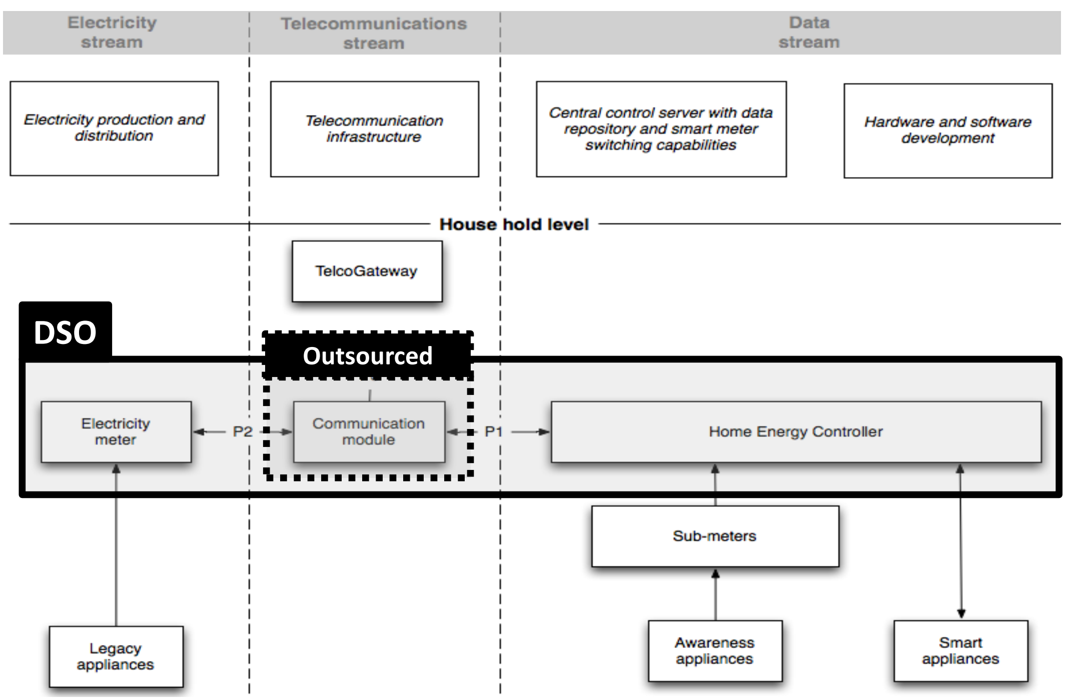

Figure 3: Modular meter model – DSO outsources the communication component

3.2. Telco centric model

In the Telco model, a telecom operator is introduced to take up the communication role. As telecom operator, they are best placed to install and operate the communication module and gateway. In this business model, introducing this actor as taking the lead will require changes in architecture of the smart meter. Historically, the DSO will continue to provide the electricity metering role. However, as communication is not one of their core competences, the communication roles are taken over by the telecom operator.

3.2.1. Modular meter model –Choice of Telco by the end customer

A solution to the lack of communication competences of the DSO would be the outsourcing of the communication module, as mentioned in section 3.1.2. Compared to the model described above, the user can now choose the telco operator instead of a designated operator choice by the DSO.

Technical: The same solution as described above can be used. The only difference is that all the modules by the telecom operators must be compliant (standardized) with the modular approach of the meter and the data sending format. Service Level Agreements (SLA) must be dealt with in order to guarantee the service delivery. Another option could be that the currently available modem of the telecom operator can be reused. For households with an existing Internet connection, which consist of 70% of the households in Flanders [BIPT, 2011], the smart meter signals could travel over this connection towards the central system. When looking at the cost for communication, this could result in lower recurring expenses. For consumers not having an Internet connection, Power Line Carrier (PLC), GPRS or UMTS communication could be introduced as alternative. For customers with an Internet subscription, a WiFi or fixed line connection could be set up with the telco gateway. The HEC functionality still remains in control of the DSO.

Business: The cost of the communication module could thus be paid by the telecom operator, and thus lower the total investment cost of the DSO and its financial risk. A fee for data communication can then be paid to the telecom operator on a monthly basis based on the type of network used. The operational benefits for the DSO still apply. This service could be part of the service offering of telecom operators to its existing customers. The only investment they have to make is a WiFi or fixed line communication component. The risk / SLA lies with the telecom operator, who has the knowledge and competence of offering these services, which is advantageous for the DSO.

Customer: The benefits are relatively the same as the model presented in 3.1.2. Additionally the customer can choose its own preferred operator, which should lower (new subscription) or even leave out (use of existing Internet connection) communication costs. In case of issues, the main problem would be the SPOC: who to contact when problems occur: the DSO or telecom operator?

Competition: Level of competition is better. The customers can choose their preferred telecom operator. As different players will be interested in offering this connection from the smart meter to the data centre, lower prices for the end customer can be obtained. This can be part of the Internet subscription of the telco.

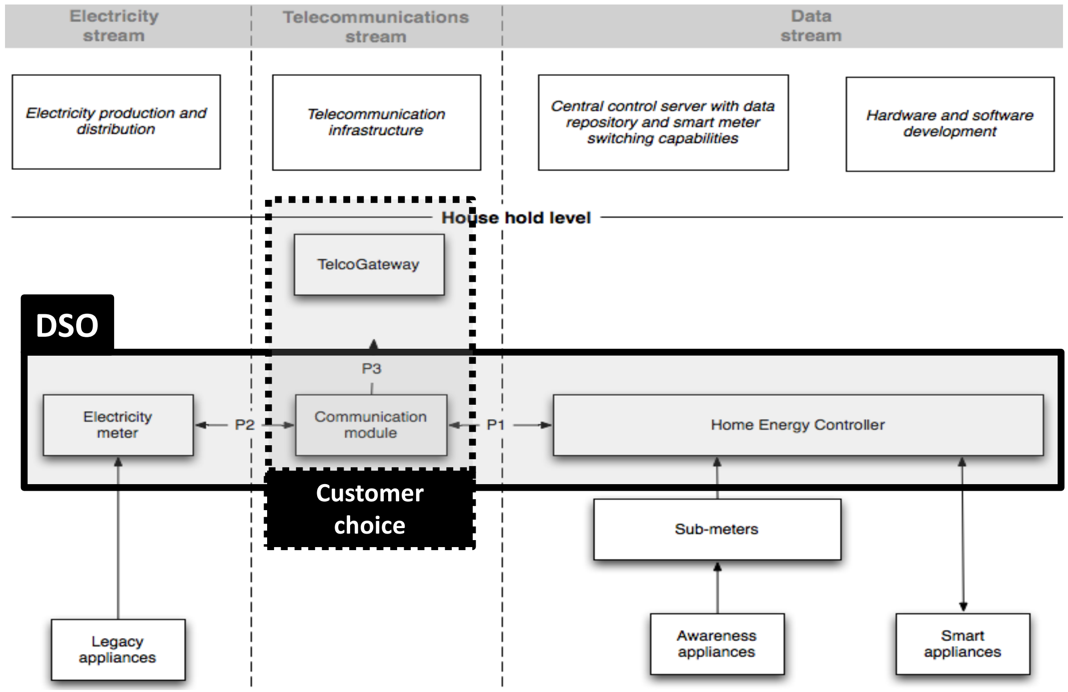

Figure 4: Modular meter model –Choice of Telco by the end customer

3.2.2. Telecom driven service (with HEC functionality)

This scenario takes as point of view that the mechanical electricity meter component and HEC are split up. The HEC functionality role is taken up by the telecom operator. In this case the previously installed modem used for regular Internet and IPTV services can be upgraded to be used as gateway for new services such as HEC, aggregating all data from the different devices within your home.

Technical: This scenario poses some additional requirements for the technical architecture. The modem upon which the HEC software is installed up should be able to interoperate with the smart meter, so a standardized interface is required. Additionally, the HEC functionality needs to be open and independent of the organisation sending the signals to the smart meter. We already mentioned the need for SLA in the previous scenario, where the Telco assures the delivery of signals. Here the communication modem should be always on. Remote management of the system can be executed which is an opportunity of launching services on a large customer base.

Business: The most important issue with this model is that Telco operators currently lack the knowhow of the energy market to offer this type of services. However, offering energy services would result in extra added value next to the existing offer of broadband, TV and mobile and fixed telephony. In addition, telecom operators have good knowledge on marketing and advertising to help boosting the customer uptake of energy services, although it will be uncertain whether the current players on the energy market will allow the telecom operators to enter the market via this model.

Customer: The advantages for the consumer listed in the previous model also apply here. If telecom operators would also offer energy services, this would result in a single bill for the consumer for all his/her services: voice, broadband, television and energy. Also, no additional

point of contact will be necessary. More focus will be paid to awareness and guidance services (supported by advertisements), rather than automation.
Competition: When different providers could offer comparable energy services to the end consumer, competition on the market should increase, resulting in lower prices. However, if telecom operators offer these services, the risk on a digital divide on the smart metering service market emerges, next to the existing digital divide on the broadband market.

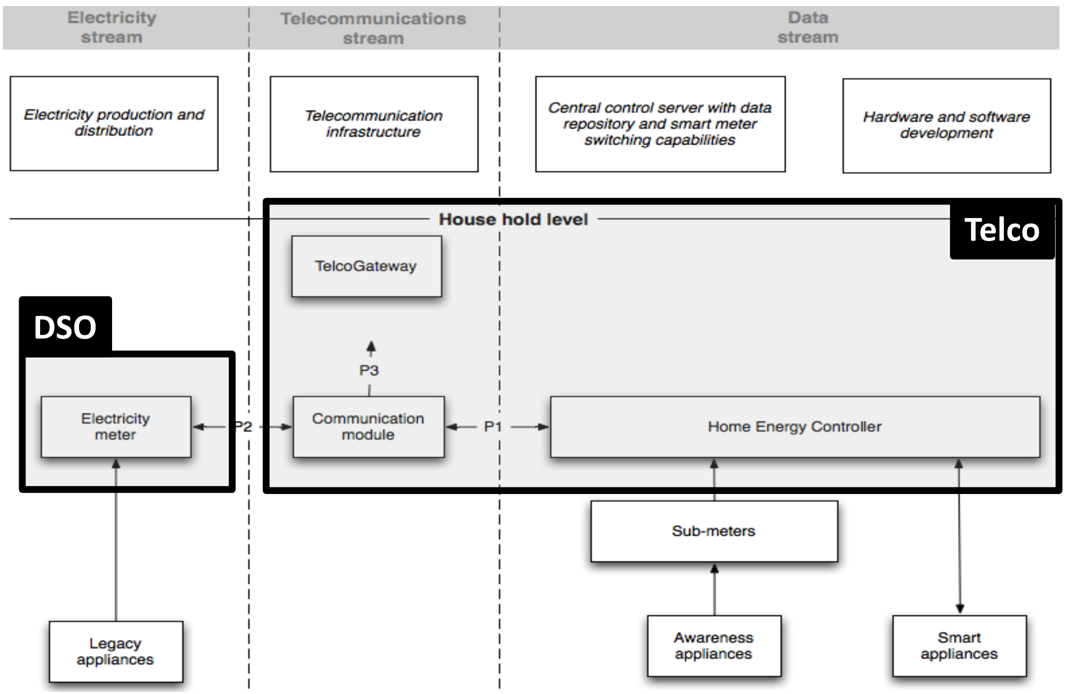

Figure 5: Telecom driven service (with HEC functionality) business model

3.3. Energy Service Company centric model

The last scenario we propose is the third party model. This scenario is in fact a logical extension of the previous Telco scenario, where the HEC hardware/software is provided by another actor, an ESCO who can be independent of the previous two players or even a device developer who currently is not active on the energy market. In our opinion, this scenario will result the most competition on the smart meter market, but will also require most regulation depending on the services offered (awareness, guidance or automation). In addition, each actor focuses on the roles he has the most competences in. Unlike the DSO centric model, the DSO is responsible for the metering and does not move towards the more service oriented roles. This does not mean the DSO has no impact on the signals sent to the households, but they will have to pass via the ESCO framework. The Telco operator only manages the communication roles and does not interfere with the electricity market specific roles. The HEC role is here taken up by an ESCO. This could be an electricity supplier, but could also be a currently non-electricity focusing company who focuses on specific niche markets. For example, a new ESCO could focus on Plug-in (Hybrid) Electric Vehicle owners or solar panel owners. They could provide specific service to these niche markets like internalizing production or charging schemes. In return, the ESCOs could use their consumer portfolios to offer balancing service to BRPs. Notice that services with different levels of customer profiles can easily be offered in this model, depending on the demand of the end customers.

Technical: When the technical issues are considered, they are comparable to the remarks given in the telecom driven service scenario. Standardization of interfaces will be key, to allow any player who wants to offer the HEC service to communicate with the smart meter.

Business: Since any company interested can offer services via this model, they can focus on niche markets most interesting for them. Different companies with diverse background and interests will be able to offer tailored services for a specific segment. Depending on the type of unregulated (awareness, guidance) versus regulated (automation) services, different SLAs will have to be signed between all companies in the different streams (electricity/telecom/data) in the value network.

Customer: With a broad range of companies offering services, customers can choose the ESCO offering the package most benefiting them. However, this can also have a disadvantage if the number of offers is that large that it becomes very difficult for the end user to pick this best package. This results in inefficiencies for all players. Consumers do not get the benefits they could and companies cannot build the customer portfolio most suited for their offers.

Competition: The third party centric model offers the most possibilities for competition. Important when automation services (e.g. active demand) are offered, SLAs and standardization agreements between the different actors must be signed in order not to have a disunited market. However, as for the scenario described above, a digital divide on the smart metering market could emerge. Consumers with only low consumption could be deemed uninteresting by the active companies. They would only bear the costs of the smart metering system, e.g. via higher distribution tariffs and not the benefits such as decreased consumption. Regulation should step in here, e.g. by enforcing an actor to offer basic smart metering services, like awareness to improve energy efficiency. This is much like the current social supplier model.

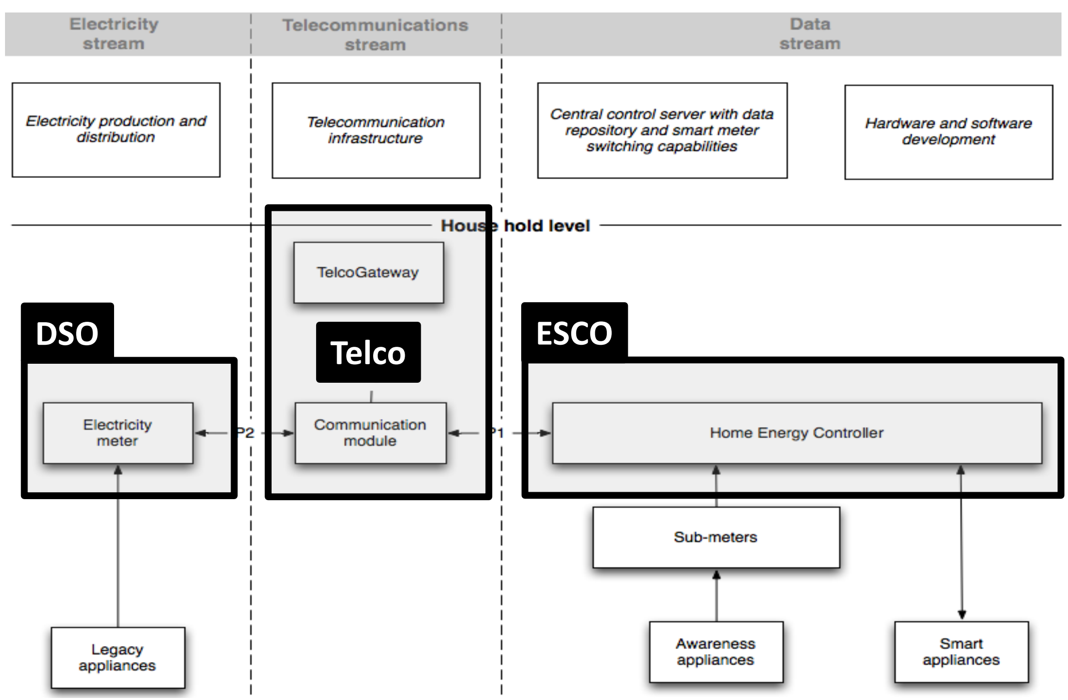

Figure 6: ESCO driven business model

3.4. Business model comparison

In Table 1 an overview of the different models described above can be found, rated on technical, business, customer, competition and service offering level.

Table 1: Overview of the different smart meter business models

Business model	DSO		Telco		ESCO
	Fully integrated concept	**Modular meter concept**	**Modular meter concept**	**With HEC functionality**	
Technical	Fully integrated solution (electricity / telecom)	Modular solution (split electricity / telecom)	Modular meter concept	Intelligence in the telecom gateway, standardization!	Intelligence in independent gateway, standardisation!
Business	Closed model by DSO	Telecom component split from DSO (sharing investment)	Telecom component split from DSO (sharing investment)	Closed model by Telco	Open/cloded model depending on ESCO
Customer	DSO dependent solution, no choice of telco operator	DSO dependent solution, no choice of telco operator	Choice of telco operator – still DSO service offering	Choice of telco operator – choice of telco services	Choice of telco, ESCO and services
Competition	Fully vertically integrated solution	Fully vertically integrated solution	Split between electricity and telecom component	Split between electricity and telecom component – competition in service offering telco operator	Split between electricity, telecom and service component –large competition opportunity
Services / innovation	DSO dependent	DSO dependent	DSO dependent	Competition between telco providers	Competition between ESCO providers
• **Awareness**	+	+	+	++	+++
• **Guidance**	+	+	+	++	+++
• **Automation**	++	++	+	+	+

4. Conclusions and recommendations

In 2009, the EU introduced the third energy packet, laying out the new directives for the regulation of the energy markets. One goal of this package is the improvement of the customer involvement in the energy market. In this light, the introduction of intelligent metering systems is one of the means to achieve this goal. However, the EU allows the Member States to conduct an economic assessment before rolling out the smart meters on their territory. In Flanders, the regulator already conducted a first assessment in 2008, which will be updated before September 2012. A common aspect of most of the existing cost benefit analyses is that the assessment is made for the entire market, and no consumer segmentation is introduced, while this is clearly mentioned in the EU directive. However, since the directive aims at raising the involvement of the end customer, we find that it is important to research the competition opportunities within smart metering value network configurations.

In this paper, we introduce a generic business model for the smart meter market, where we focus on the consumer side of the market. In addition, a customer profile segmentation based on the level of intelligence in-house is presented. Currently, the majority of the households are only offered yearly information on their consumption pattern. Raising this frequency can be achieved without smart meters, but would require a physical monthly meter reading. It is clear that smart meters clearly facilitate this process. With smart meters, three different customer profiles were found, awareness, guidance and automation. These segments differ on the level of intelligence, where awareness only indicates consumption patterns. Guidance and awareness are more future oriented scenarios. Guidance indicates to the customer how he can improve his energy efficiency or reduce his energy consumption; automation requires the highest intelligence, where no more intervention of the customer is necessary. He would only need to set the boundaries wherein the system can optimize.

Based on the generic business model, we proposed three value chains, clearly differing on the level of competition they allow on the smart meter market. The value propositions take up the spectrum between a vertically integrated market and an open model where all players are allowed to offer services to the end users. The integrated business model from the DSO is compared with a telco scenario, where the telecom operator takes up the service oriented role of providing the communication gateway and the HEC functionality. The third proposed scenario is the so-called ESCO model, where a third party takes up the HEC functionality, and as such the real provisioning of the service to the customers. While this last scenario offers most possibilities for competition, it also requires more (enforced) cooperation between the different actors, which could result in high transaction costs. However, an overall assessment of the strengths and weaknesses of the different business models clearly indicates that the open models outperform the more closed ones.

Although competition and regulation levels are important in the assessment of the different business models, a more elaborated techno-economic cost-benefit analysis is necessary to give a complete picture of the different business models and the opportunities for all actors involved and certainly the end customer. When comparing the DSO and Telco scenario, we already indicated that in the latter the hardware architecture can move towards a modular design. The DSO only provides the meter and a telecom operator is responsible for the communication part. In a true modular design, different operators could provide the communication for the smart meter as some sort of plug-and-play system. Depending on the preferences and possibilities for the consumer, different communication providers could be chosen. Future work should extend the current analysis of the different value propositions with a complete cost-benefit analysis, especially for the open models.

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References

BENZI F., ANGLANI N., BASSI E. ET AL. (2011) "Electricity Smart Meters Interfacing the Households", *IEEE Transactions on Industrial Electronics*, 58 (10): 4487-4494

BIPT (2011) *Situatie van de elektronische communicatiesector 2010.* Retrieved September 27, 2011, from http:///www.bipt.be/nl/189/ShowDoc/3592/Jaarverslagen/Economische_situatie_van_de_telecomsector_2010.aspx

CLASTRES, C. (2011) "Smart grids: Another step towards competition, energy security and climate change objectives", *Energy Policy*, 39(9): 5399-5408

EANDIS (2010) *Eandis 'smart metering' uitdaging en uitrol.* Retrieved October 01, 2011, from http://www2.imec.be/content/user/File/Visionair%20seminarie%20Smart%20Grid/Presentatie_Paul%20Coomans.pdf

EUROPEAN PARLIAMENT AND COUNCIL (2009) "Directive concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC", 13 July 2009.

FARUQUI A., HARRIS D., HLEDIK R. (2010) "Unlocking the €53 billion savings from smart meters in the EU: How increasing the adoption of dynamic tariffs could make or break the EU's smart grid investment", *Energy Policy*, 38(10): 6222-6231

HAUTTEKEETE, L., STRAGIER, J., HAERICK, W., DE MAREZ, L. (2010) *Smart, smarter, smartest... the consumer meets the smart electrical grid*. Published in the proceedings of the 9th Conference on Telecommunications Internet and Media Techno-Economics (CTTE), June 7-9, 2010, Gent, Belgium.

HONEBEIN P.C., CAMMARANO R.F., DONNELLY K.A. (2009) "Will Smart Meters Ripen or Rot? Five First Principles for Embracing Customers as Co-Creators of Value", *The Electricity Journal*, 22(5): 39-44

KEMA (2009) *Energiemeters worden mondiger: Resulaten van een kosten-batenanalyse naar de invoering van 'slimme meters' in Vlaanderen.*

LIZAK F. (2009) *General advantages of Smart metering system.* Published in the proceedings of the 5th International Scientific Symposium on Electric Power Engineering ELEKTROENERGETIKA 2009, Sep 23-25, 2009, Stara Lesna, Slovakia.

MEGALINGAM R.K.; KRISHNAN A.; RANJAN B.K.; ET AL. (2011) *Advanced digital smart meter for dynamic billing, tamper detection and consumer awareness*. Published in the proceedings of the 3rd International Conference on Electronics Computer Technology (ICECT 2011), Apr 8-10, 2011, Kanyakumari, India.

NYE M, WHITMARSH L, FOXON T, (2010) "Sociopsychological perspectives on the active roles of domestic actors in transition to a lower carbon electricity economy". *Environment and Planning*, 42(3): 697 – 714

OFGEM (2011) *Energy demand research project: Final Analysis.* Retrieved September 29, 2011, from http://www.ofgem.gov.uk/sustainability/edrp/Documents1/Energy%20Demand%20Research%20Project%20Final%20Analysis.pdf

DEPURU S.S.S.R., WANG L., DEVABHAKTUNI V. (2011) "Smart meters for power grid: Challenges, issues, advantages and status", *Renewable and Sustainable Energy Reviews,* 15(6): 2736-2742

SMARTE (2011) *Deliverable 1.3-4: An in-depth observation of the energy consumption of a selected subset of users.* Internal project deliverable.