The concept of Energy Grid[1] Services

A new perspective

Executive summary:

This paper addresses the need for service orientation in the future energy system. It identifies the DSO/TSO services portfolio. By introducing the concept of energy grid services, it is shown how DSO's can shift focus from managing assets to delivering of energy grid services.
It is shown how, by means of these energy grid services, demand response mechanisms, aiming to engage customers and to influence their behavior, effectively can be synchronized with grid operations, and how this can result in benefits for all participants of the future energy system.
Implementation issues are addressed, identifying what functionality will need to be developed and standardized, thereby also identifying the area's where DSO's and the Telco/ICT sector could effectively cooperate.
Overall, the paper identifies how in EU retail markets dynamic competition can be enhanced, when DSO's are incentivized to deliver the right services and data to these markets and its customers.

1.Introduction: Service Orientation

More and more, we live in a world which is service oriented: we consume services, we produce services. Our physical world is really getting augmented and even controlled by a logical/information world.

Two examples to illustrate that business processes and even commercial offerings are more and more "fully information technology based":

- *flying from Amsterdam to Johannesburg is only possible when your flight booking, online made via the internet, is in the systems of the airline industry.*
- *mobile operators differentiate themselves in commercial offerings, not with the ability of making telephone calls, but by the product proposition (bundles, allowed # minutes and text messages).*

So information technology here is not anymore supporting the business (as a cost center), but has become part of the "core engine" of the business itself.

So more and more we think in terms of services and the question is how this will affect the utilities sector in the next coming years. With implementing smart grids, we will start to change the energy system as a whole to facilitate the energy transition; this by enabling the integration of the prosumers (storage, EV, DER) into the energy system.

1) Also earlier described as energy transport services, but renamed to energy grid services to avoid misunderstanding with TSO's

When flexibility to control electricity at the supply side (production) will decrease, (due to the fact that we cannot control the sun and wind), we will be forced to increase flexibility on the demand side. Only then we will be able to effectively balance the grid (as long as electricity storage is economical not feasible) in order to guarantee security of supply and system integrity.

It is well understood that the role of the customer in the energy system is changing: from a passive user, simply using energy from the energy system ("energy as a cloud service") towards an active participant in the energy system, reacting to pricing signals in the market and also delivering energy services, to the grid and market parties.

Also in international standardization this has been recognized and we see early attempts to define flexibility services, and demand response services; all service based interactions between prosumers, market parties and DSO's.

So it is more than logical and essential that the "rules" of how the energy system of the future will work, will be defined by who will deliver what services to whom. These service interactions can be derived from roles & responsibilities in market models as they are being defined, and should be regarded as the basis for (information exchange) standards on interface points between consumer/ prosumer, market parties and DSO/TSO's (see figure 1).

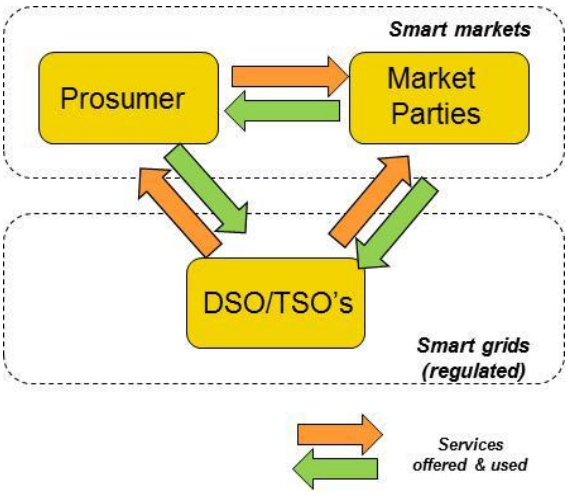

Figure 1
Service interactions

Once having these (information exchange) standards established on European level, they will represent the basic "structure" in the energy system of the future: a structure that will create one addressable European energy market, further

growth of it and a lot of new ICT based products here in, simply because it is based on open standards.

2.Impact for DSO's/TSO's

In this respect it is necessary, that all actors in the energy system, including DSO's, start to think in terms of services, and reflect on what value or services, they bring into the value chain and how they will interact with the other actors.

For DSO's/TSO's the exercise itself, (defining the services a DSO/TSO delivers) is independent of the discussion on future role and responsibilities of a DSO/TSO, and has to be executed in all cases, since an energy system without service interactions with the DSO/TSO will simply not work; the specific outcome ("what DSO/TSO services") however, is off course dependent of the role & responsibility of the DSO/TSO.

Similar as has happened in the transformation of the Telco industry the last 2 decades, the DSO/TSO should define its value add from an "outside-in" perspective (consumer or market party), leading to the conclusion that its value add is clearly not "managing assets" but "transporting energy" (Telco 's also moved in focus away from managing network assets to delivering services).

3.The services portfolio of a DSO/TSO

The DSO/TSO's should start to focus on what services they deliver to market parties and consumers, within the boundaries that exist for DSO/TSO, as they are regulated and not active in commercial market processes, but only facilitate these (although their end-responsibility for security of supply and system integrity might lead in specific situations to interventions in market processes).

Analysis of today's DSO/TSO operations leads to 4 categories of services:

1. Connection & access services: delivering connections and access to the grid infra-structure.
2. Market facilitation services: services offered to market parties, such as providing metering data, facilitating a supplier switch, allocation & reconciliation services. In a future smart grid/ smart market environment this market facilitation services portfolio is expected to grow. For further market growth, It is essential that these services interactions with DSO/TSO's are well defined in order to allow new entrants (or even consumer communities) to enter in the market more easily and to guarantee a level playing field.
3. System operator/ ancillary services, offered today by TSO's and in the future possible also by DSO's; with more integration of intermittent DER sources on distribution level, it will become inevitable also to define these services, related to maintaining system integrity (balancing) on local level.
4. Energy grid services. When defining smart grids services from a customer perspective (which is the EU's intention) then the core business of a DSO is transporting energy, or delivering energy grid services (and of course, as a prerequisite for that, the DSO has to manage its assets). These energy grid services have not explicitly been defined today.

Thinking in terms of a service portfolio in general, and the energy grid services in particular, is relatively new for DSO's/TSO's, and represents a paradigm shift in thinking. However if we really want to develop smart grids and smart market concepts with the customer at its very heart ("outside-in approach"), it is essential that we start to do so.

4.Energy Grid Services

By implementing energy grid services, as defined in the previous paragraph, independently from energy infrastructure, (see figure 2), we are able to decouple managing energy grid services from asset (lifecycle) management. In this way a DSO/TSO will be able to interact satisfactory with the other actors in the system, as the interaction is related to energy grid services (the value add) and not hard coupled to the complex underlying (often legacy) energy infrastructure. This creates significant benefits for the customer/prosumer, the market and the DSO, as will be described in paragraph 7 of this article.

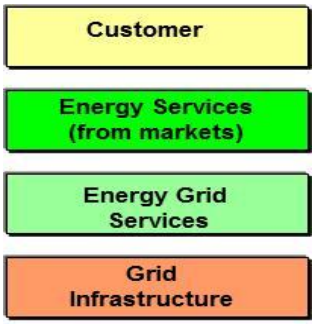

Figure 2:
A layered approach

In the 80ties of 20th century a similar evolution took place in the Telco sector. Initially a telephone call could be made over a copper wire to which also a telephone number was connected: infrastructure & services were integrated.

Then service and infrastructure were decoupled; customers could move and keep their telephone number. Finally, with the emergence of the internet, the service was split into a telecom transport service (DSL-, VPN-service, etc.) and many end user application services (e.g. a VOIP service). New end user services and new business models emerged on top of well-defined telecom transport services.

A 2th example showing the adverse effect of not decoupling telecom transport services from telecom infrastructure; in the past, when, non-standardized, equipment for delivering frame-relay services was not produced by the manufacturer anymore, the telecom operator had not only to retire this equipment, but also to communicate to all its customers that this service would be withdrawn from the market (affecting a lot of customers).

So if we are able to define (a few different) standardized energy grid services, closely related to end customer energy needs and behavior, then we will enable market development and also be able to manage much more effectively and efficiently the future dynamics in the grid.

5.DSO Interaction with market parties and prosumers

In a future energy system, customers behavior can be modelled, as done by the Florence School of Regulation ["Topic 11 report" Shift, Not Drift: Towards Active Demand Response and Beyond 2013]. Market parties will interact with these classes of behavior via demand side management or demand response program's. When infinite grid capacity is available, this will not lead to any interaction with the DSO/TSO's.

However with higher peaks in load, due to massive integration of DG and EV, ánd the strategy of DSO/TSO's to avoid/defer significant grid investments via ICT based mitigations (load shedding, curtailment etc.) infinite grid capacity is not available and, as a consequence, these interactions between prosumer and market parties, do interact with DSO/TSO's. Initial descriptions in which the interaction between the commodity market and distribution capacity market are defined, are already available (traffic light concept).

When this interaction with DSO/TSO's is based on well-defined and separately manageable energy grid services, then prosumer behavior, market party responses and grid load can be aligned and synchronized in a consistent and manageable way: operationally, commercially and regulatory. This is shown in figure 3.

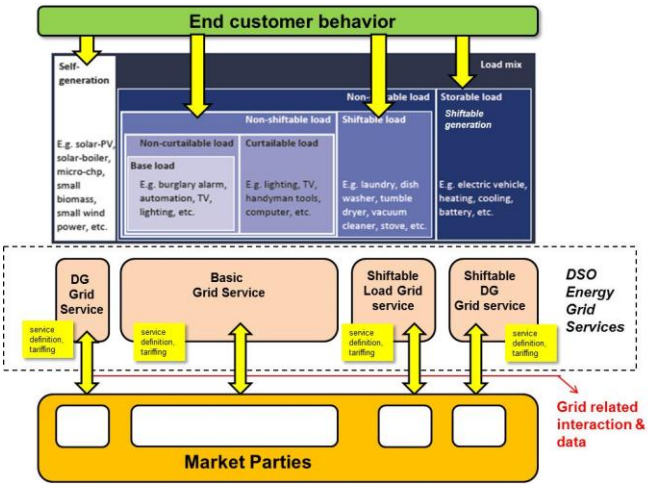

Figure 3
Relation to " customer classes of behavior"

6.Examples of Energy Grid Services

In the current situation we define the existing energy transport to consumers as the "basic energy grid service". Next to this "basic energy grid service" two new energy grid services could be envisaged: one specific related to de-centrally feed-in of electricity, this to accommodate the large scale integration of DG in the grid, and one specific related to charging of EV's, fully focused on the evolution of the electrification of our mobility.

Defining these additional two energy grid services would mean that these energy grid services should be managed independently from the "basic energy grid service", thus without any hindering/ influencing our existing consumer energy household energy usage. Different energy grid services would have different service specifications (tariff structures, guaranteed or best effort, description of DSO intervention in service delivery, etc.) As this makes the energy grid services transparent to market parties and the end customer, this would lead to a higher customer satisfaction, compared to the situation were no different energy grid services are defined, and were the customer would not know what to expect.

As in the telecom industry happened (see box in paragraph 4), the introduction of the concept of energy grid services, will fuel new business models and business propositions. It could also act as an additional instrument for future differentiated

regulation/ legislation, for specific, defined types of energy grid services.

Finally it also will enable the discussion on synergies with the ICT/Telco sector since "service oriented" thinking is already for many years in their mindset, and for achieving results on realizing synergy, it is essential that both sectors at least speak the same language and have the same mindset; a necessary prerequisite for building smart grids and smart markets.

7.Benefits for stakeholders

Defining and implementing different energy grid services will lead to significant benefits for all stakeholders involved. As benefits can be seen:

For Customers/ Prosumers:

- More choice and enhanced products, e.g. multiple suppliers (one per energy grid service, offered by DSO's) on a smart grid connection point.
- Fully supporting self-delivery and community delivery ("cooperatives") options of energy, independently from incumbent energy suppliers.
- Protecting vulnerable customers via the "basic grid service", mostly flat-fee priced, as they will not be burdened by dynamic pricing of energy transport (due to network congestion, caused by other user's classes of behaviour).
- Clear and dedicated energy services specifications ("you know what you get"), meeting customer's expectations; the customer selects energy services from market parties, and market parties select in their offering the right energy grid service from DSO's.
- Contributing to customer privacy protection; for system integrity and security of supply no further information on customer behaviour then the defined behaviour classes, are required;

For Market parties:

- Enabling new business models and product propositions, based on differentiated "energy grid service" data distributed by DSO's; a customer could have on one grid connection point multiple contracts with different Energy Providers/ suppliers/ ESCO's. This would enable market growth and fuel competition.
- Consequently, as energy grid services uniquely match with customer behavior classes, balance responsibility for a customer, when coupled to an energy grid service, could be granted to more than only one supplier, thereby opening the market for aggregators, next to incumbent suppliers and creating a level playing field in flexibility.
- Well defined market facilitation services of the DSO, in which the differentiated portfolio of energy grid services is visible, would contribute in creating a "level playing field" between incumbent players and new entrants (e.g. aggregators, community of prosumers).

For the DSO's:

- Creating the flexibility of applying different pricing schemes to different energy grid services (e.g. flat-fee to basic-, TOU to more dynamic- energy grid services (e.g. DER- , EV charging- energy grid services)
- Thereby supporting an efficient and evolutionary approach towards integrating DER and EV charging into the energy's system and grid (in this way incentives can be created which are only focussed on the behaviour it intends to influence, not having to change to whole energy system).
- DSO itself will benefit from differentiated usage data for more precise and optimal network investment planning, and managing system integrity and security of supply.

For policy makers & regulators:

- The concept of different energy grid services creates an additional instrument for further development of the European liberalized market.
- More flexibility by creating the possibility of applying different legislation/regulation for different energy grid services (e.g. a universal service obligation for the basic energy grid service (protecting vulnerable customers) but not for DER- or EV charging- energy grid services).
- An instrument for implementing the principle of cost causality, well balanced with grid tariffs and investments (via regulated grid tariffs, societal financed).

8.Implementation

Market models should be defined first, leading to well defined on roles & responsibilities. This then will drive the definition of the services portfolio of DSO/TSO's. Use of the ENTSO-E harmonized role model (HRM) should facilitate this, since the "use cases" defined in M490 working group Sustainable Processes (WGSP 2012) use these standardized

roles already and identify the interaction between actors related to these roles.
Implementation of different energy grid services will require additional functionality (information technology) in order to be able to differentiate and manage these energy services independently. This functionality typically would reside at the edge of the smart grid, close to the customer.

Today, discussions on functionality are much "smart meter" centric. Smart meters, today, are already capable to register data on de-centrally feed-in of electricity separate from data related to electricity usage from the grid. Data and functionality related to the EV charging grid services today can also already be separately identified in case the physical charging point represent a dedicated connection point for that purpose. This could act as a starting point.

For the future, discussions on functionality should be much more "ICT platform" centric and future architectures should be modular, defined as an ICT platform, on which apps are running, plus a smart meter (metrology part), with the following capabilities:

- the capability of controlling EV charging from a standard household smart grid connection point, through a dedicated manageable EV charging grid service (e.g. by a charging session set up protocol, related to the physical connector for EV).
- Supporting near real-time direct interactions between market parties and prosumers classes of behavior (DSM, D/R programs)
- Supporting near real-time interaction between DSO and a prosumer class of behavior, in case of a "code red" situation (traffic light system).

This "next gen" configuration should be rolled out gradually, only to customers participating in demand side management or demand response programs, and/or customers connecting PV and/ or EV to the grid.

As a result of expected, massive, integration of PV and EV the next decades, DSO's will have to invest in the future in these type of platforms and functionality to secure grid stability and to guarantee security of supply.

DSO's should be able to respond to the market requests, to open up these platforms for market apps, to support demand side management (DSM) and demand response (D/R) programs of market parties, when market parties would decide not to invest themselves in the underlying infrastructure.

This would lead to near real time market facilitation services, based on standardized platform API's, as shown in figure 4.

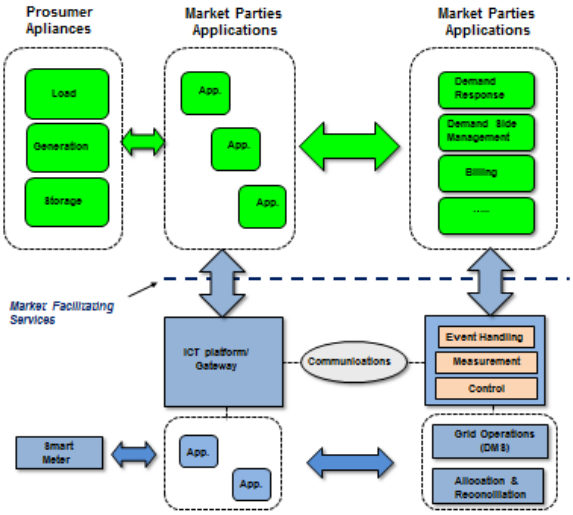

Figure 4
Grid end point architecture

In this way DSO's, in cooperation with Telco/ICT industry, could stimulate and accelerate the implementation of flexibility and demand response in an efficient way, leading to a fast and save transition to the energy system of the future.

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February 2014

About the author:

Peter Hermans has a strong background in telecommunications: he worked for 23 years in the telecom sector in the Netherlands in several senior IT management positions in fixed, mobile and internet network divisions.

Peter started in the Utility sector in 2007 where since then he is driving business and IT strategy, leading to the initiation of corporate and Dutch energy sector roadmaps and business programs, related to energy transition, smart grids and smart meters. He joined Stedin (DSO) in 2010.
Peter is participating in M490 activities of CENCENELEC/ETSI methodology group). Peter is an active member of the EU taskforce smart grids (EG3), and also contributed to EU studies on the future role of DSO.

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[2] *This paper represents the personal view of the author.*