The Impact of Electricity Markets on Customers

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Acknowledgements

Enter any acknowledgements here if required

Glossary

If you use any acronyms – provide a summary here.

Contents

1 Smart Grid Drivers and Definitions

1.1 Description of smart grids

The Minister of Economic Affairs initiated a task force on Smart grids in October 2009. One of the tasks was to propose a widely supported vision and an action program for the realisation of smart grids in the Netherlands. In their discussion document 'Op weg naar intelligente netten in Nederland', the Task force describes smart grids as;
'innovations related to electricity grids, to keep energy supply affordable and reliable and to additionally make it more sustainable. Essential for a smart grid are the two directional electricity flows, between end users, and between end users and suppliers. By adding (information and communication) technology, energy flows can be better controlled and managed. This creates opportunities to:

- Implement demand response programs
- More efficiently integrate distributed generation and storage of energy
- Develop new products, services and markets
- Increase the flexibility of the energy system
- Reduce or postpone infrastructure investments
- Guarantee the reliability of the electricity supply.

1.2 The rational for smart grids

In the future energy will become more scarce and more expensive. The share of PV is increasing, and potentially there will be an increased share of EVs, heat pumps and micro CHP. These developments create new opportunities for (local) energy management. New products and services can be developed to facilitate energy management at dwelling level. Residents may turn from passive users into more 'active' users, or even into prosumers. Acceptance will be key to realize these changing roles. To be prepared to changing demand and supply profiles, investment choices need to be made: either in grid reinforcement and peak generation capacity, or in adding intelligence to the grid to better match demand and supply at European / national and local level.

The vision of the Taskforce is that a large scale introduction of smart grids is not yet urgent, but cannot be avoided. And given the time horizon for grid investments, the first steps need to be made now. First steps would include small scale activities with real users, to learn, in order to be well-prepared and ready for a fundamental transition.

2 Smart Metering

2.1 Smart meter rollout

The Dutch government plans to have the current energy meters of households and small commercial consumers (<3x80A (E), <170.000 m3 (G)) to be replaced by smart meters, aiming at at least 80% of the meters to be replaced by 2020 (as required by the so-called Third Energy Package of the EU). In the Netherlands, these meter replacements will be carried out in two phases. The first phase is a 2-year 'trial period' (2012-2013), in which smart meters will only be applied in specific situations. After an evaluation, smart electricity and gas meters will be introduced in virtually all households in the subsequent period (likely to be a period of six years).

The legislation regarding smart metering has been stipulated in the Dutch Electricity Act and the Gas Act, after amendment of these Acts in 2011. The original idea of a legal obligation for everyone to accept the smart meter has been revoked, after a number of problems arose around the privacy aspects on the use of the smart meter. Consumers who do not want that their meters are read remotely now have the option either to refuse the meter or accept the meter but block the remote reading facility (called 'administrative off'). With these measures a freedom of choice (opt-out) was created for the consumer, that was requested by most of the political parties in the Dutch Parliament.

The roll out of smart meters in the Netherlands started in 2012. The current rollout takes place at a limited scale: only in specific situations smart meters are offered, viz.:

- in case the current meters need to be replaced (regular replacement)
- in new buildings
- in case of large scale renovation
- in case the energy performance of buildings is improved by at least two label steps
- if a residence is renovated up to at least energy class B (of the energy label)
- on request of customers (only in this case 60 euros will be billed to the customer).

Reason to choose for a limited rollout, is to gain experience before initiating the large scale rollout. By the end of 2013 it will be decided, based upon the gained experiences until then, if and how a large scale rollout will be carried out. The aim is to offer smart meters to all households from 2014 onwards.

2.2 Smart metering functionality

Minimum functionality of the smart meters are determined at EU level. In March 2009, the European Commission issued a mandate (M/441) for the standardization of smart metering functionalities and communication for usage in Europe for electricity, gas, heat and water applications that require the standardization process to ensure interoperability of technologies and applications within a harmonised European market.

In the Netherlands the functionality of a ‘standard smart meter’ has been discussed and determined already in 2007. This has been done under the supervision of the Dutch Standardization Institute (NEN). These discussions among different parties in the energy industry have resulted in a so-called ‘Dutch Technical Agreement’ in this area (NTA 8130), which later was expanded with the 'Dutch Smart Meter Requirements' (DSMR) under the control of the Dutch Association of Grid Companies ("Netbeheer Nederland").

In the Dutch Electricity Act and the Gas Act it is determined that the requirements of meter reading installations shall be defined in an implementing regulation (Algemene Maatregel van Bestuur - AMvB). Early 2012 , the requirements for smart meters have been defined in the 'Decision on meters that enable remote reading' ('Besluit op afstand uitleesbare meetinrichtingen’). In summary, smart meters shall be able to register both electricity consumption from the grid and supply to the grid, send values with a 15 minute interval to the grid company (DNO), register the quality of the electricity supply and the metrological quality of the meter, detect fraud, and should enable remote disruption, reduction, and reconnection of the electricity supply.

Meters that are designed according the NTA 8130 and DSMR meet all the requirements of the AMvB.

2.2.1 Access to data, Summary of Smart Metering Functionality and access to, and ownership of, Smart Meter data

Dutch meters designed according the NTA8130 and DSMR will have three data ports, visualised in Figure 1. This figure shows a schematic overview of the smart metering infrastructure as provided for in the current Dutch standards. The law does not stipulate a specific communication infrastructure; although 'open' communication standards will have to be used, the grid operator is free to decide on the infrastructure, provided it complies with the privacy and security regulations.

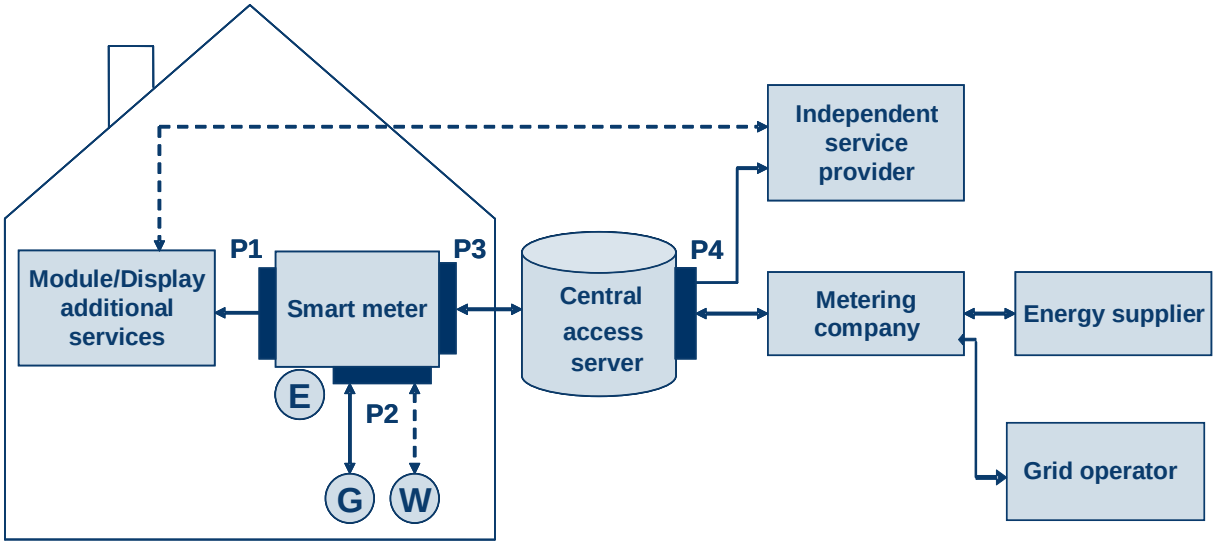

Figure 1 Intelligent metering infrastructure (based on NTA8130)[1].

The smart meter in Figure 1 is an electricity meter with modular information and communication technology. The meter can be controlled remotely by the DNO. From the P3 port data are collected in the central access server. The P3 port can also be used by the ISP and the supplier to send messages to the meter, to remotely change control software of the meter and to disrupt or recover supply of energy remotely.

Other interfaces are the P1 and P2 ports. The P2 port enables connection of other meters (e.g. for heat, gas, water, cooling). Data from these meters will be collected – via the P3 port – in the central access server. P1 is the 'consumer' port or local port, providing access to metering data at 10 seconds intervals (electricity, gas data has hourly intervals). Information from the various meters (not only the electricity meter, but meters connected via the P2 port as well) can be sent to the consumer via the P1 port. By connecting a so called in-home display to the P1-port, metering data can be visualized.

The P4 interface is a system interface, providing independent service providers access to the central access server. Independent service providers need explicit permission from the consumer to get access to the metering data.

As mentioned earlier, initially a law was proposed in the Netherlands that would oblige all consumers to accept a smart meter. Refusing a smart meter during the rollout would mean the risk of imprisonment. This proposal was not approved and in the current, new Electricity Act opting out is an option. Consumers that accept a smart meter, can choose between three modes (see also Table 1):

[1] The figure is based on a figure published in NTA 8130, but adapted according to the latest developments related to data access

- remote data reading is 'switched off',
- metering reading takes place only every second month (and in case of moving houses or switching supplier), or
- detailed meter reading: collection of quarterly hour data on a daily basis.

The second option is the standard option.

Table 1 gives an overview of the various options and the associated functionalities. The option to have the meter turned to 'administrative off' should minimize the number of refusers. In the 'administrative off' setting the consumer port (P1) can still be used, so that the consumer himself does have access to accurate meter data. However, in this setting the consumer cannot be disconnected remotely. The option to select 'administrative off' will undoubtedly lower the threshold for choosing a smart meter.

Table 1: Overview of the functionalities of the smart meter in the various settings.

Functionality	conven-tional meter	smart meter		
		Administrative off	standard reading	detailed reading
remote disconnection or usage limitation	✘	✘	✓	✓
metrological control of the meter	✘	✓	✓	✓
technical control of the grid	✘	✘	✓	✓
bi-monthly reading and at the time of moving house or changing suppliers	✘	✘	✓	✓
frequent reading (e.g. 15-minute values) and tariff management	✘	✘	✘	✓
meter data locally available (P1)	✘	✓	✓	✓
connection to other meters (P2)	✘	✓	✓	✓

Functionalities that are not self-explanatory are explained briefly below:

- remote disconnection and usage limitation: the grid operator has the option to centrally control the meter so that it will allow no electricity or only a limited amount of electricity to get through (gas also has a disconnect, but no limitation)
- metrological control: control and maintenance of the meter (among others reading of the meter status (battery, alarms, error messages), firmware updates, date and time synchronization and recording changes between the various settings 'administrative off', 'standard reading' and 'detailed reading')
- technical control of the grid: reading the metering values and the fault register to monitor the quality of the electricity supply (power quality, short and long-term interruptions of the energy supply)
- tariff management: the possibility to (in theory) charge a variable, time-dependent tariff and to send information to the local port. More about the current tariff structure in the Netherlands can be read in Chapter 4.

2.2.2 Smart Metering and financial settlement of electricity consumption

In case of conventional meters, electricity consumption data (meter reading data) are gathered by the DNO. These data are shared with the electricity suppliers for billing purposes. Data used for billing are either coming from meter reading (often done by the customer him or herself), or from estimations (in case the customer doesn't reply to the request for metering data). Meter reading only takes place once a year. Physical meter reads by the metering company (DNO) only take place once every three years.
Currently (small size) consumers can opt for a separate bill from the DNO and the supplier, but in most cases an integrated bill is sent by the supplier which includes also the grid company's costs. In the near future (as from Spring 2013) an integrated bill will become the only option.
In the case of smart meters, the quality of the data used for billing will improve, as actual consumption data can be used instead of estimations. In case a smart meter is installed, and the consumer opted for ‘standard meter reading’ (see Table 1) bi-monthly consumption overviews will be sent to the customers. However, actual billing will (as currently foreseen) remain on a yearly base.

3 Electricity market structure

3.1 Stakeholders

Market roles refer to the business functional areas in the energy supply chain. Market roles own the business requirements. A description of the energy supply chain is presented in Figure 2 with an explanation of the different market roles described in Table 2. In Figure 2, a distinction between the regulated and the deregulated domains has been indicated. This distinction can be traced back to European legislation[2].

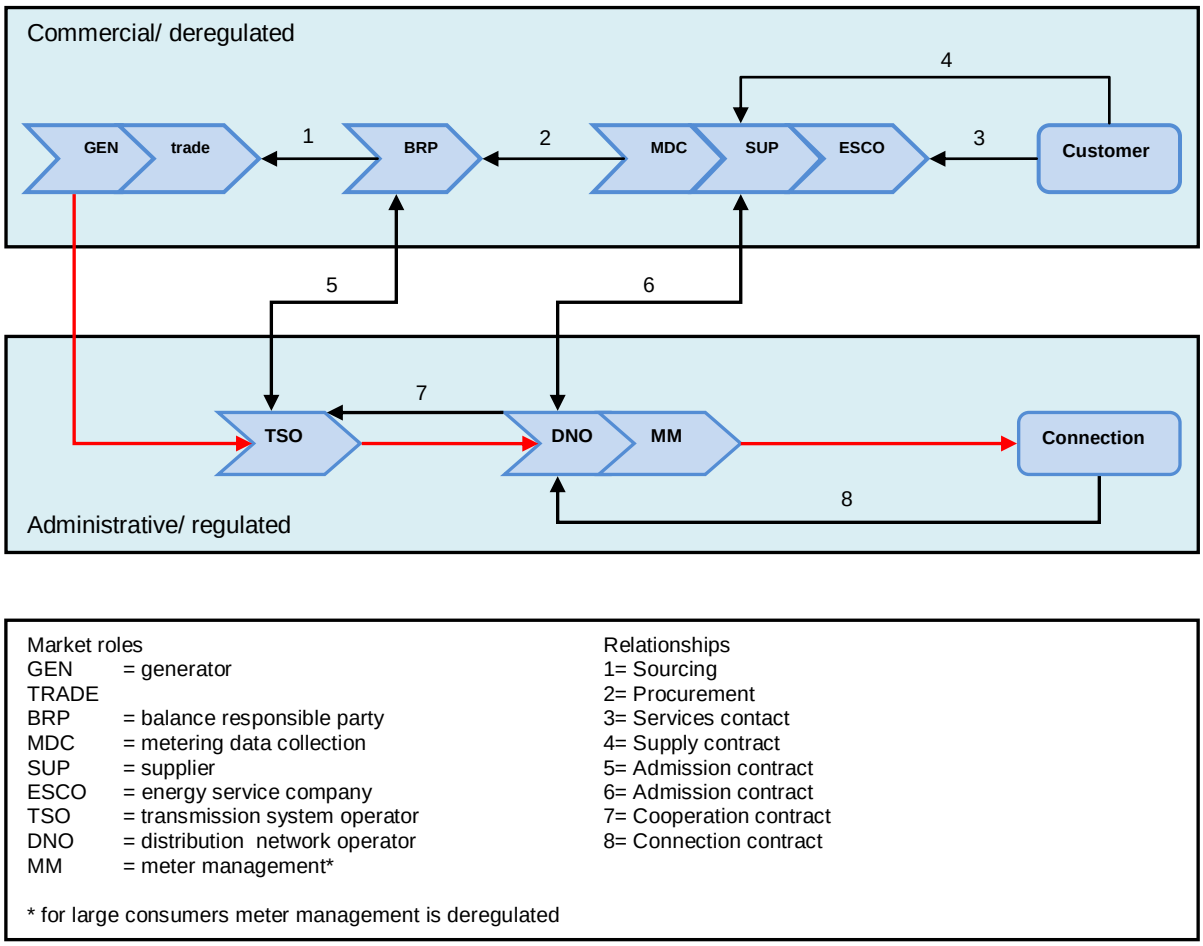

Figure 2 Market roles, source: DNV KEMA 2012

[2] See for example regulation 2003/54/EC "on common rules for the internal electricity market" (which amended regulation 96/92/EC).

Table 1 Stakeholders involved in generation, distribution and supply of electricity

Role	Short Description	Current responsibilities
Generators	Generators produce electricity. Electricity is most often generated at a power station by electromechanical generators, primarily driven by heat engines. However, many other technologies exist that are currently in use to generate electricity such as combined heat-power installations, sustainable energy (from wind, sun, water and bio-mass) and geothermal power.	There are currently 5 large ones and various small ones. Generators report unit characteristics (e.g. availability, cost price, reliability, fuel type) to the Balance Responsible Party.
Energy suppliers	Suppliers are responsible for selling electricity (and often gas) to the end consumer	Suppliers are the commercial and administrative link with the customers. Suppliers make the contractual arrangements for the supply of energy products to the customers, invoices and collect the fees. Most companies supply both gas and electricity. Customers receive just one invoice for energy. The supplier invoices the cost of the use of the network. Suppliers settle accounts with the network management companies and finances in advance. Finally, suppliers may be willing to offer new services to their customers, such as TOU tariffs.
Trade	Traders purchase electricity from suppliers and sell to authorized users.	Traders are the middlemen trading power in a market with fluctuation supply, demand and pricing through time.
Transmission System Operator (TSO)	The TSO is responsible for transmission and system operations of the high voltage grid.	The TSO is responsible for maintaining and restoring the energy balance of the grid, to transport electricity, to guarantee that the transmission of electricity occurs in a safe and efficient manner, to connect large generators (and large consumers) to the grid and ensures connection with foreign networks and auctions available import capacity. It also manages international flows (imports, exports and transits) on its grid.

Distribution Network Operator (DNO)	DNOs are responsible to ensure security of supply for all connections at the lowest cost level as possible.	Regional network operators (DNOs) transport electricity to customers from the grid. Traditionally, the tasks and responsibilities of distribution network operators include the expansion and operation of the distribution network, maintenance of the network and admission of suppliers to the network. There are approx. 7 DNOs in the NLs. With more dispersed and intermittent power in the future, the role of the DNO is likely to change coming years.
Balance Responsible Party (BRP)	BRPs balance supply and demand for electricity for the following day to prevent underload or overload of the transport and distribution grid and contribute to maintaining balance in the electricity supply system. This is a consequence of legal responsibilities towards customers on the grid.	Based on the programs submitted by the BRPs daily, the TSO and DNOs can facilitate transport and distribution on the grid and are able to correct any imbalance and charge for the costs of doing so.
Measurement Responsible Party	Measure, transfer and register measurement data	The tasks and responsibilities of the MDC include: -reading and collection of consumption and production data from customers -processing the data; a.o. (technical) checks on availability -plausibility check of data -aggregation of the data -make the data available to different market parties
Meter management		The tasks and responsibilities within this role include: -installing and connecting energy meters (including communication facilities in case of 'smart meters' being installed3) -maintenance of the energy meters (and communication facilities).
ESCo	An ESCo is a professional business providing a broad range of comprehensive energy related services.	In the European directive on "energy end-use efficiency and energy services" (2006/32/EC), an ESCO has been defined as "a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered can be based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria".

[3] Could also be put under market role 7 (MDC).

Table 2 Stakeholders involved in policy setting and regulation

Stakeholder	Short Description
Regulator (Nma Energiekamer)	Regulators supervise the operation of the energy market.
Ministry of Economic Affairs, Agriculture and Innovation	Electricity and gas law

3.2 Market Maps

3.2.1 Physical power flows

Figure 3 illustrates the potential power flows between actors at various voltage levels. At each of the levels (high voltage, middle voltage and low voltage) energy can be generated and consumed.

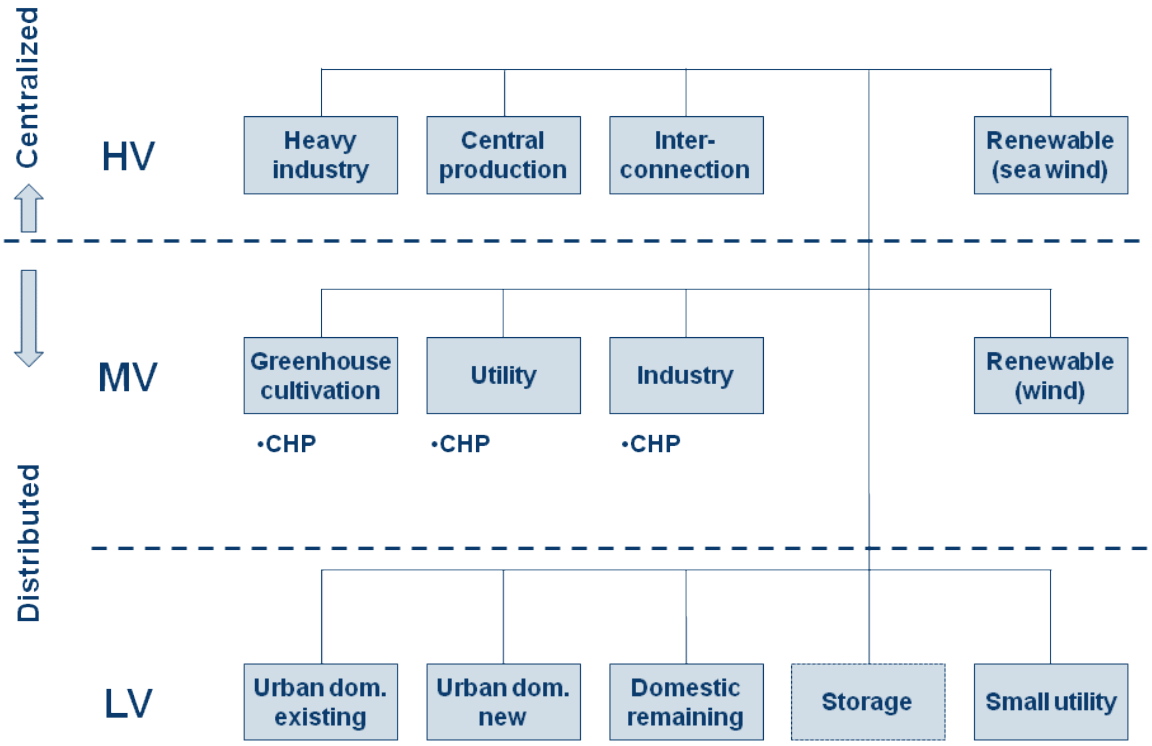

Figure 3 Grid model

3.2.2 Energy purchasing: a description of the market

Retail market

At the retail market, energy supply companies (retailers) sell energy to the small and medium size companies. To be allowed to sell energy to small and medium size customers, suppliers need to have a license.

Wholesale market

Large consumers, large generators and suppliers act at the wholesale market. In order to trade at the wholesale market actors need to be a Balance Responsible Party, or to have transferred their responsibility to a Balance Responsible Party (BRP). BRPs need to be accredited by Tennet, the TSO. An exception is made for Traders, they don't need to be (represented by) a BRP. They have no physical demand or supply to offer and their portfolio is always balanced by default (see also Figure 4).

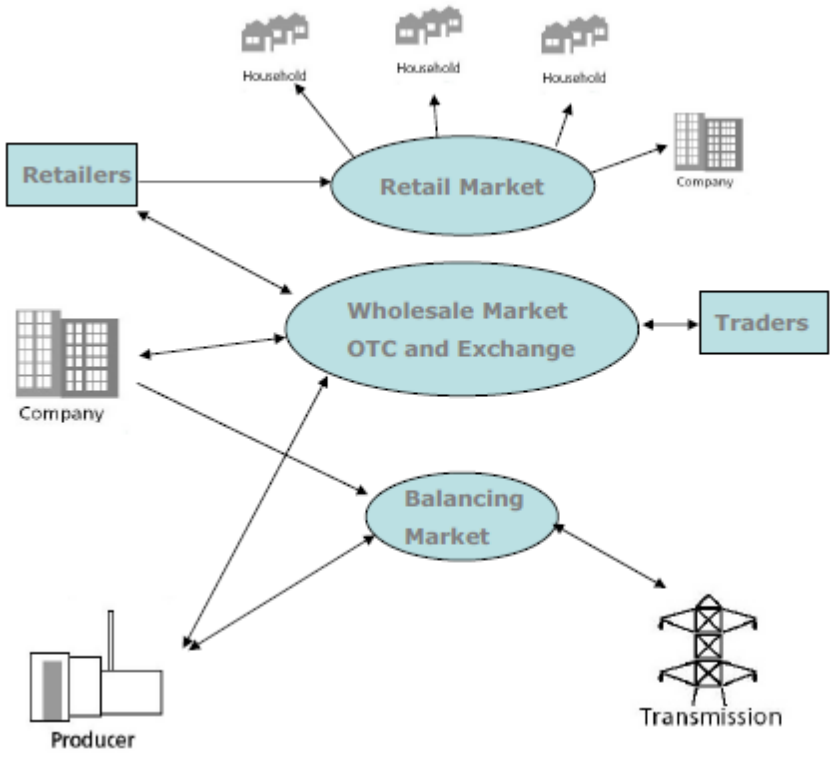

Figure 4 Financial market map(source APX-ENDEX)

BPRs and their responsibilities

BPRs can be large producers, large consumers (or combinations of them). For small consumers, the role of BPR is fulfilled by supply companies. BPRs have the responsibility to forecast the consumption, production and transportation of electricity for the actors they

represent, and to submit programs one day in advance to Tennet (TSO) (see also Figure 5). To the extent that the amount of electricity generated or required, has not be met yet by longer term contracts, it can be covered by trading at the power exchange (day ahead market, APX) or by Spot OTC contracts. At the APX day ahead market (or spot market) electricity is traded for the next day on an hourly basis, with only one price for each hour. Prices can be highly volatile. Shares of the APX spot market are owned by TenneT, while the shares of the forward markets are privately owned.

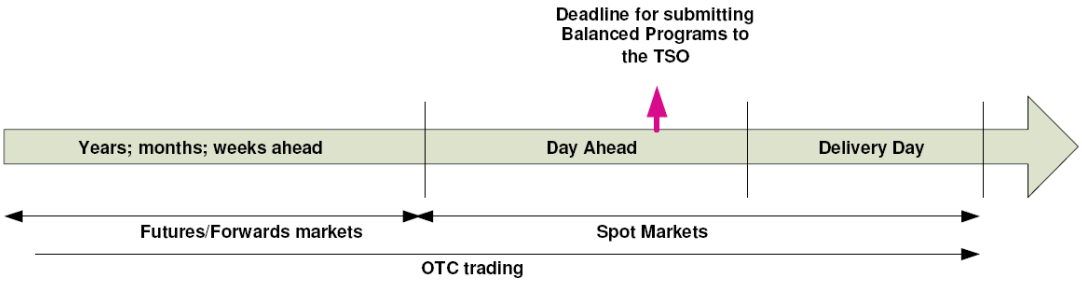

Figure 5 Overview of wholesale market (source APX-ENDEX)

Programs submitted by the BPRs can be corrected intraday, up to one hour in advance at the intraday market (see Figure 6). In case programs (forecast submitted by the BPRs) are not met, Tennet will buy flexibility at the Balancing market to keep the system technically in balance. Flexibility includes both

- additional generation capacity or switching off of large consumption units (in case demand is higher than supply) and
- reduction of generation capacity and/or switching on of consumption units (in case supply is higher than demand)

The costs related to buying these flexible generation and demand units to keep the system technically in balance, will be billed to the BRPs that caused the imbalance due to deviations from their submitted programs. However, recently it has become possible to avoid billing by the TSO due to deviations from the program, by ex-post trading (in a given period between real-time and actual billing by the TSO).

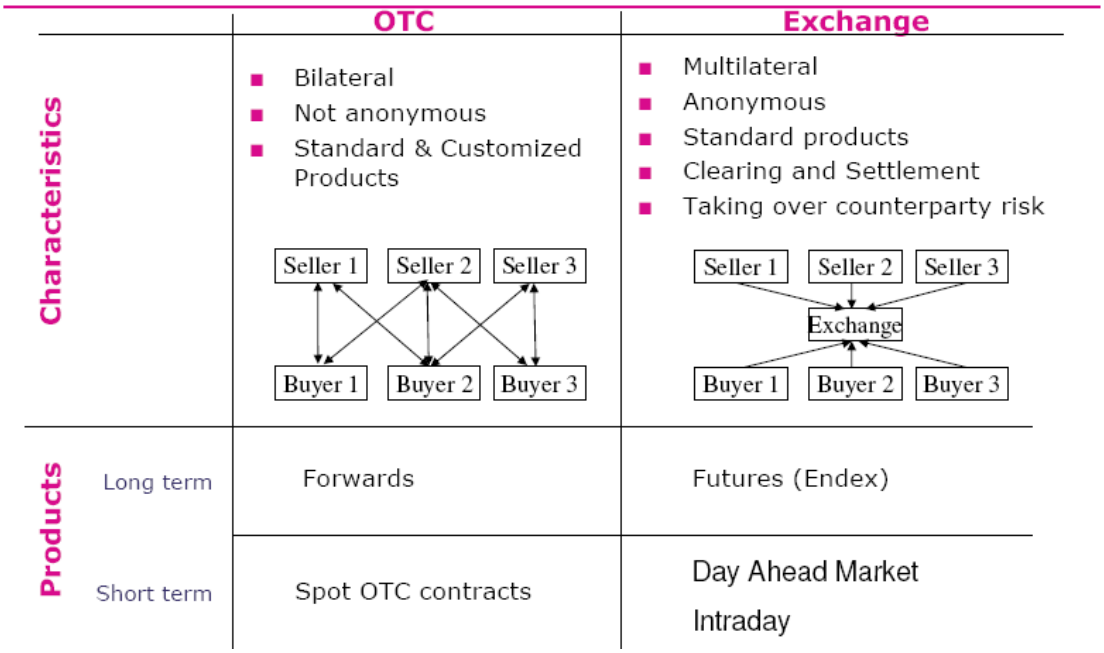

Figure 6 Wholesale market and products(source APX-ENDEX

The largest volume of electricity, about 85% in the Netherlands, is sold in the 'bilateral'market: electricity is directly sold by generating companies to their customers.

3.2.3 Network charges: a description of the market

Costs made by the network operator to transport electricity, to maintain the grid, to disconnect customers, etc are billed to the customer as ‘network charges’. These charges exist out of three components:

- connection services
  - cost for initial connection (billed only once)
  - periodic tariff for maintaining the connection
- transport services
  - transport – dependent tariff
  - transport – independent tariff
- system services
  - system services tariff

Costs related to transport service include costs of depreciation of the grid infrastructure, a ‘fair’ return on the investment of the grid infrastructure, costs for realisation and maintenance of the grid infrastructure, costs related to grid losses and maintaining the required voltage levels, cascaded costs from the grid at higher voltage levels and operational costs.

Costs for transport and system services are billed to customers based on a cascade model. This means that costs made at higher voltage levels are charged to a grid with a lower voltage

level, according to its usage of energy and/or capacity of this last mentioned grid as share of the total energy and/or capacity usage at the higher level. Finally, costs are charged to the customers connected to the grid.

Grid charges for small customers (<3*80A) are based on a capacity tariff. So grid charges for small customers are not related to actual consumption, but to the capacity of their connection. In the capacity tariff no distinction is made between customers that only consume energy, and customers that both consume and produce electricity (prosumers).

4 Tariff structures

The development of total energy costs for residential customers over time and their breakdown is shown in Figure 7. As Figure 7 shows, the larger share of costs on the electricity bill are related to taxes (VAT and energy taxes) and network charges. Costs for the actual electricity supplied form about one third of the total costs charged for electricity. Not included in Figure 7, but charged separately at the electricity bill, are metering costs.

Of the total costs charged to the customer, only the delivery rates are set in a competitive market. Network charges are regulated (see paragraph on network charges). For small customers (customers with a connection capacity of maximum of 3x80 A), metering costs are regulated as well, for larger customers they are not. Energy taxes are based on a fixed amount, VAT is based on a fixed percentage of all other costs.

The electricity price in the Netherlands is dependent on the length and type of the contract. In the first quarter of 2012 the average electricity prices for residential customers, including taxes and network charges, varied between 0.260 and 0.301 Euro per kWh[4] (excluding VAT). An additional cost on the electricity bill of residential customers is '*vastrecht'*. This cost component is fixed part of the electricity supply and is charged by the electricity suppliers. Each supplier can freely set the amount of the cost . The cost varies between 20 and 60 Euro per year. Most suppliers have a *vastrecht* component of about 25 Euro, some have a higher *vastrecht* in combination with lower electricity prices.

Network charges for small connections are independent of the amount of electricity used (but may depend on the capacity of the connection) and consist of four types of charges:

- annual connection costs,
- annual transportation costs
- capacity based transportation costs and
- system service costs.

The network charges are a regulated cost, the NMa checks the method of cost allocation used by the grid companies periodically. System service cost are 0.00111 EUR/kWh. For small consumers they are based on a fixed electricity consumption. Currently the total network charges are around 230 Euro[5] per year, excluding VAT.

[4] Source: cbs.nl
[5] Source: http://www.easyswitch.nl/energie/vergelijk-energie

Metering costs are regulated costs. The NMa decides on the tariff annually. Since 2008, the metering tariff is indexed, based on inflation. There is one tariff for all small consumers. For 2012 the metering costs for residential customers are 26.38 Euro excluding VAT[6].

Energy taxes are base on a fixed amount per kWh and are depending on the amount of electricity used. For residential customers (< 10,000 kWh per year) the tax per kWh is 0.1140 Euro[7]. The Dutch government gives each residential customer a reduction on this energy tax of 379.16 Euro[8] per year. This reduction is for each connection. Finally a fixed VAT rate of 19% (21% from Oct 1 2012) needs to be paid on all components of the electricity bill.

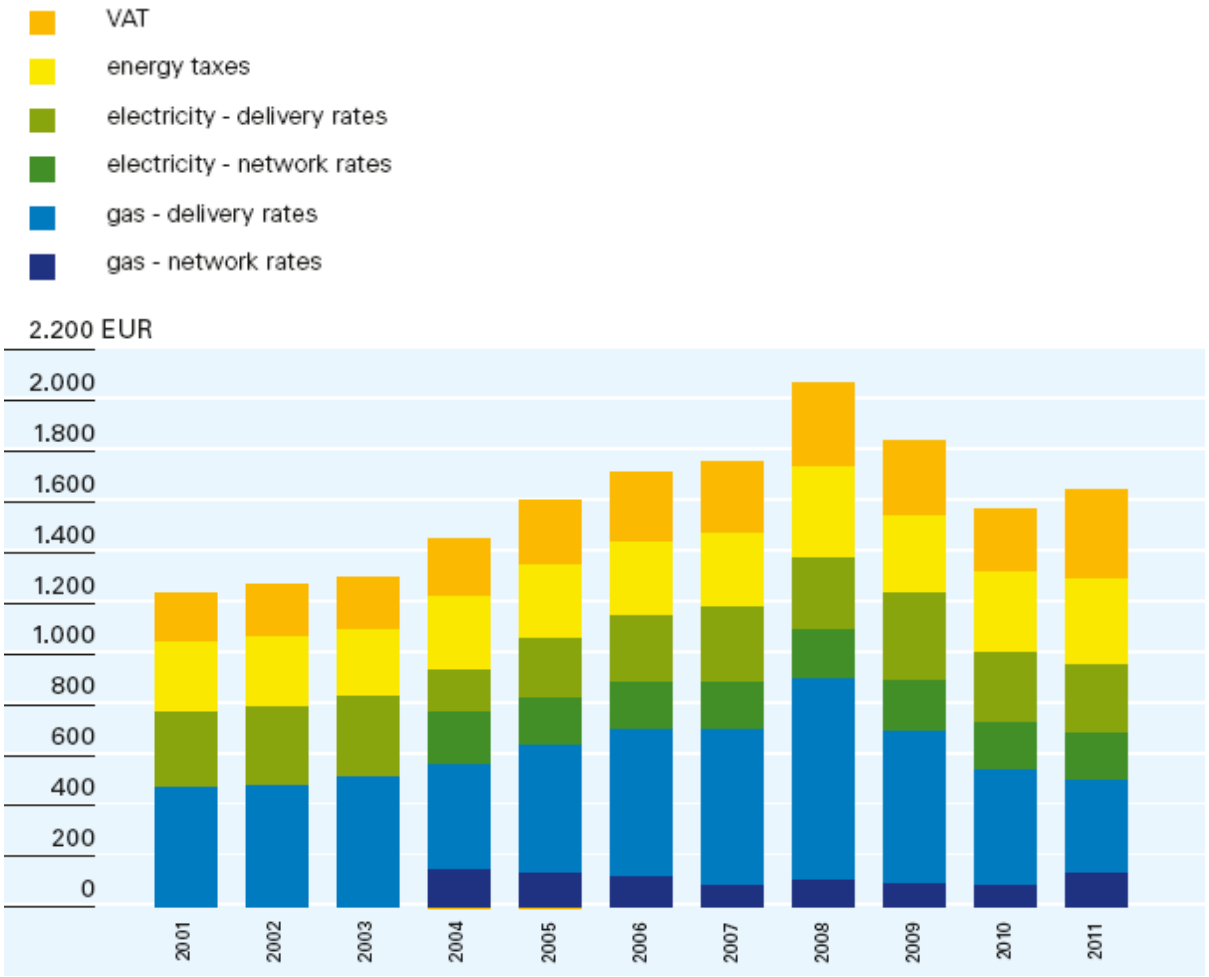

Figure 7, Components of the annual energy bill of an average household (Source:Energie in Nederland 2011)

[6] Source: Besluit tot vaststelling meettarieven elektriciteit 2012, NMa, 8-11-2011
[7] Source: http://www.energieleveranciers.nl/energie/energierekening/energiebelasting
[8] Source: http://www.energieleveranciers.nl/energie/energierekening/heffingskorting-energiebelasting

Currently (small size) consumers can opt for a separate bill from the DNO and the supplier, but in most cases an integrated bill is sent by the supplier which includes also the grid company's costs. In the near future (as from Spring 2013) an integrated bill will become the only option. Bills are sent yearly and are based on meter reading by the customer, or on an estimated consumption. Only every three year actual meter reading by the metering company (DNO) takes place. In the case of smart meters, the quality of the data used for billing will improve, as actual consumption data can be used instead of estimations. In case a smart meter is installed, and the consumer opted for 'standard meter reading' (see Table 1) bi-monthly consumption overviews will be sent to the customers. However, actual billing will remain on a yearly base.
In the energy market, electricity consumption for small customers is settled based on profiles.

The electricity consumption for small customers is settled on the wholesale market through the use of synthetic profiles. For households three profiles exists (1x single tariff, 2x double tariff with different switch times). For SME 2 different profiles exist. The profiles have been determined by measuring a set of representative customers.

Common belief is that these synthetic profiles are not suitable to support dynamic demand response, therefore several market parties are studying the concept of "smart meter allocation", which allows a set of connections with smart meters, to be settled on a quarter-of-an-hour basis on the wholesale market. Changes to the market organization are needed to accomplish this, therefore it may take a few years to realize.