Open data: facilitator of the energy transition

An implementation plan for Distribution System Operators

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Abstract

The energy sector is moving. Changes are necessary to transform the current energy system into a more sustainable system. Changes which all together are being called the ‘energy transition’. The establishment of this transition is complex. Open data is often being mentioned as a facilitating instrument. In an attempt to prove the validity of open data as being potential facilitator of the energy transition, this research came into being.
In this thesis, the developments in the energy sector are analysed, as well as the related challenges. Also the main principles of open data are analysed. This all from the perspective of the Distribution System Operator. Hereafter the found transition challenges are matched with the open data principles to prove the facilitating potential of open data for the energy transition. This results in two developments open data can facilitate, namely more effective and feasible energy policy and the balancing of demand and supply of energy in a flexible way. As open data can facilitate the dissolving of these two challenges of the energy transition, it is concluded in this thesis that open data is a potential facilitator of the energy transition.
Also an open data strategy implementation plan for DSOs is being proposed to bring the described theory in practice. As one of the major DSOs in The Netherlands, Enexis functioned as a case study for this plan. This thesis concludes that, by following the proposed iterative implementation process, DSOs can establish a sound open data strategy. Further research should focus on the feasibility of an open data platform for energy data, which currently does not exist, but which plays an important role in the in this thesis proposed strategy.

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1 Introduction

The energy sector is moving. Driven by the need to reduce carbon dioxide emissions and to be less dependent on the import of fossil fuels, the sector is transforming into a more sustainable system. The magnitude and complexity of the sector demand major changes: in demand, distribution as well as supply. The transition towards such a sustainable system is called the ‘energy transition’. Final goal of the transition is full abolishment of fossil fuels and other non-renewable energy sources.

‘Open data’ is often being mentioned as a high potential facilitator of the energy transition. By unlocking information from its original owner and offering it publicly, re-use should be encouraged enabling new, high-value innovation. Though potential application of (combined) open data sources is promising, opening up and sharing data requires tough changes in existing data management.

Distribution System Operators are aware of the added value of their data when being publicly available for re-use. Nonetheless ideas on open data are often being treated with scepticism, mostly because of feared privacy issues, security issues and uncertainty on the future revenue open data generates. Also the regulated role of DSOs in the energy sector raises questions on the necessity of open data publication.

In an attempt to prove the validity of open data as being potential facilitator of the energy transition, this research came into being. The following research question was defined to guide the research: *is open data a potential facilitator of the energy transition?* To answer this question, firstly the developments within the energy sector were analysed to provide context to the research. The main challenges the sector faces were distilled from this analysis. Then a theoretical baseline was defined, describing the main principles of open data. Hereafter the found transition challenges were matched with the open data principles to prove the facilitating potential of open data for the energy transition. To reduce its complexity, the research only focused on the electricity value chain. Gas and heat were left out of scope.

At last, to bring open data into practice, also an open data strategy implementation plan for DSOs is being proposed. As one of the major DSOs in The Netherlands, Enexis functioned as a case study for this plan. Nonetheless, this plan and the conclusions of this thesis are applicable for other DSOs too.

2 Context: developing energy sector

2.1 Historical background

The Dutch energy market and the corresponding energy policy is a direct derivation of the European energy policy. This policy is focused on a guaranteed, affordable and sustainable international energy supply (PwC, 2012). Guaranteed, regardless the increasing demand for energy. Affordable, regardless the increasing investment value to establish this. And sustainable to prevent further negative effects of non-renewable energy generation on our environment.

One of the priorities of the European energy policy is the formation of one integrated European energy market (European Commission, Progress towards completing the Internal Energy Market, 2014). By forming this integrated market, the European Commission wants to encourage choice flexibility in energy producers by consumers, increase price transparency and stimulate the competition between (new) players in the market. This could only be achieved by breaking down the monopoly positions of national energy producers and distributors, which were mostly owned by national governments (European Commission, 2013).

These ideas were defined in different EU Directives and translated into national law. One of the major laws was the 'Elektriciteitswet'(1998), which launched the phased liberalization of the Dutch electricity market. Between 1998 and 2004 all types of consumers were enabled to choose their electricity producer themselves. This encouraged the competition between electricity suppliers. Another law, The 'Wet Onafhankelijk Netbeheer' forced the separation of the roles of energy supplier and energy distributor, aimed on market encouragement and more efficient operations.

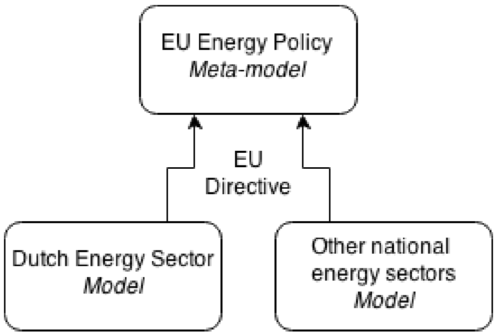

Figure 1. EU energy policy relations.

Apart from liberalization, the EU simultaneously focused on increasing the production of sustainable energy as an alternative for the usage of traditional energy sources, mostly fossil fuel. One important reason for this policy is the intended reduction of carbon dioxide emission and therewith less environmental pollution. Second reason to promote the production of sustainable energy is being less dependent on the import of fossil fuel from outside the EU.

2.2 'Classical' electricity market playing roles

The roles to be played within the 'classical' electricity market can be summarized as follows:

1. Electricity producer, who is responsible for the production of electricity;
2. Auctioneer, who is responsible for balancing the demand and supply between the producers and suppliers;
3. Electricity supplier, who is responsible for the sale of electricity to its customers;
4. Transport System Operator (TSO), who is responsible for the transport of electricity from the power plant, via the high voltage transport system, towards the middle voltage and low voltage distribution system. Furthermore responsible for European exchange of electricity and balancing of grid load;

5. Distribution System Operator (DSO), who is responsible for the distribution of the electricity towards the consumer via the distribution system;
6. Consumer, who consumes the electricity.

The described activities of the parties can be further elaborated regarding the specific roles which need to be played within any electricity market. The European Network of Transmission System Operators for Electricity (ENTSO-E), in association with EFET and ebIX, has developed a role model, identifying all the roles that can be played for given domains within the electricity market (ENTSO-E, 2011). It covers both the electricity wholesale and retail markets. In this thesis no further attention will be paid to this detailed role model, focussed will be primarily on the defined summary.

2.3 Developments

The described market model provides us with a reliable and secure energy supply, at least for now. To maintain the quality level of our energy supply in the future, major changes are necessary. Fossil fuel stocks, on which the largest part of our current energy production relies, shrink. This will result in increasing import costs of fossil fuels . On the other hand our energy consumption increases annually. This while we agreed on lowering our carbon dioxide emissions by saving energy to reduce its negative effects on our environment (SER, 2013).

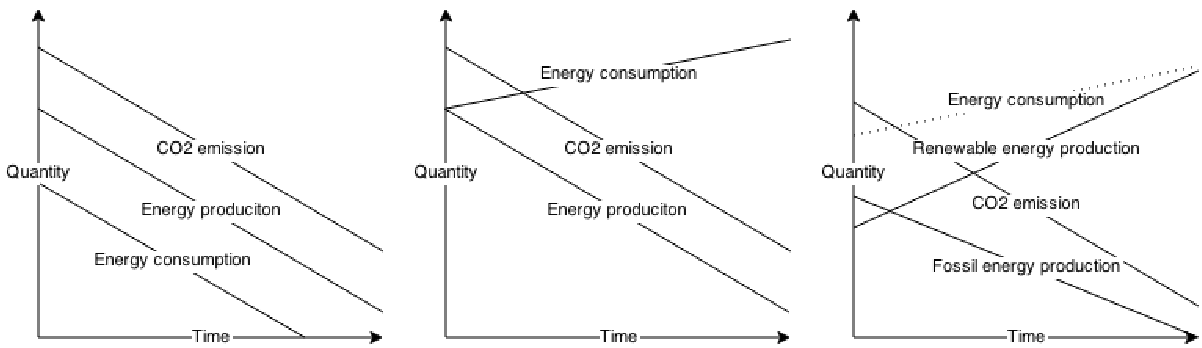

Figure 2. Relation between CO_2 emission, energy production and energy consumption.

Figure 2 summarizes this area of tension. The left graph represents the desired CO_2 emission reduction, implicating a reduction in energy production and energy consumption. The middle graph represents that, despite the desired CO_2 emission reduction and thus reduced energy production, our future energy consumption is expected to increase. The right graph represents a possible solution, namely to decouple the energy consumption and establish the desired CO_2 emission reduction by reducing fossil energy production and developing more renewable energy production capacity.

In short, we face major challenges which need to be tackled with major changes. All these changes together are being called the 'energy transition', the transition we have to make to ensure a sustainable energy supply for the future. The precise actions to facilitate this energy transition differ from country to country, dependent on a large variety of interests of a large amount of parties involved. In The Netherlands intense negotiations between over forty major Dutch stakeholders resulted in September 2013 in the 'Energy Agreement for Sustainable Growth', an ambitious agreement, which gives voice to the willingness of many parties to work on a sustainable society and economy. The overall purpose of the Energy Agreement is "to express the Rutte/Asscher

Government's aim of achieving, within an international context, a wholly sustainable energy supply system by 2050" (SER, 2013).

The Energy Agreement comprises ten basic components, namely:

1. Saving energy;
2. Scaling up renewable energy generation;
3. Decentralized energy generation;
4. Energy transmission network;
5. EU Emissions Trading System (ETS);
6. Energy generation from fossil fuels and coal-fired power stations;
7. Mobility and transport;
8. Employment opportunities;
9. Energy innovation and energy export;
10. Funding programme.

The challenges which will be elaborated in the following paragraph are related to these components.

2.4 Challenges for the current energy sector

2.4.1 Increasing demand for electricity

Technological progression and growing welfare are among others factors, which lead to an increasing demand for electricity in the near future (ECN, Nationale Energieverkenning 2014, tabellenbijlage, 2014). This increase implicates that more electricity has to be produced, but also needs to be transported to its consumers. The challenges within our current production model, which is mainly centrally organized, will automatically become tougher: growing electricity production will lead to growing voltage drop during transport and growing grid capacity necessary. The first challenge has mainly financial consequences, since more electricity needs to be produced to compensate the loss of voltage. The second challenge is more complex, since the scalability of the electricity grid is relatively low. For example the expansion of the middle and low voltage grid capacity on a large scale asks huge financial investments, since large amounts of underground infrastructure need to be excavated, replaced and reinstalled.

One typical technological innovation, which enlarges our electricity consumption, is the emerging electric transport market. Gradually, more and more electric vehicles are being used for transport, mostly hybrid versions, some fully electric. The energy demand from these vehicles has shifted from the gas station to the electricity connections at home, at work etc. This means that the electricity connection, which in most cases is not originally intended to be used for electric vehicle charging, will have to carry a higher burden. Though one electric vehicle will not be problematic in our current energy landscape, an entire neighbourhood which switches to electric vehicles can be problematic, especially when all being charged at the same time.

2.4.2 Increasing decentral energy production

Another major challenge is the development of more efficient and thus profitable decentralised energy production infrastructure, which has boosted the presence of this type of infrastructure in the electricity grid substantially. Take for example photovoltaic systems (PV systems), which are designed to generate electricity by means of photovoltaic. The efficiency of these systems has increased substantially last years, which makes the installation of these systems more affordable and profitable (ECN, 2014). The main advantage of these systems for domestic use is that consumers can produce their own electricity and become less dependent on the electricity grid. While using self-produced electricity, the demand for electricity from the grid will reduce, which can be valuable, for example during peak hours when the grid burden is high. Problem is that decentral energy production depends on mostly factors which are not in control by human beings, like sunshine or wind. Consequently, consistent peak reduction can't be automatically guaranteed. Furthermore, since electricity cannot be stored, voltage surplus can occur when more electricity is being produced than consumed. This can be harmful for the grid.

Optimal usage of large scale decentralised electricity production can only be achieved when supply and demand can be managed. This implies that the amount of decentrally produced electricity and centrally produced electricity must be tuned. Also the demand for electricity must be tuned with the available amount of electricity to prevent voltage surplus or voltage shortage.

Decentral electricity production also has a direct impact on the electricity market role model. Role number 6, the consumer, will change into a so called 'prosumer', who consumes as well as produces energy. Apart from the technical implications like preparing the grid for redelivering decentrally produced electricity, also traditional processes need to be modified. Prosumers can for example be compensated by electricity suppliers for the electricity they deliver to the grid, instead of only being billed for the electricity they consume. All these changes have impact on the 'classic' electricity value chain.

2.4.3 Upscaling renewable energy production

In 2012 only 4.4% of the total energy consumption in The Netherlands comprised renewable energy. Biomass accounts for more than 70% of all renewable energy, less than 20% comprises wind power. The remainder consists of other sources, like hydropower, solar energy, geothermal energy and ambient heat (ECN, 2014).

One of the main goals of the Energy Agreement is "an increase in the proportion of energy generated from renewable sources from 4.4% currently to 14% in 2020, in accordance with EU arrangements; a further increase in that proportion to 16% in 2023." An ambitious goal, requiring a "cost-effective rollout that provides certainty for investors, creates additional employment, triggers innovations that reduce costs, and contributes to boosting the competitiveness of Dutch companies in this sector" (SER, 2013).

Concrete steps defined to achieve this goal are among others: upscaling offshore wind power production, increased investments in onshore wind power and ambitious tackling of renewable energy generation from the various other sources. Related to this is a substantial reduction in the amount of energy produced with fossil fuels.

The 'Nationale Energieverkenning 2014' (NEV) is a report that describes the current situation within the energy sector and its expected developments until 2030 (ECN, 2014). The report has been written by 'Energieonderzoek Centrum Nederland' (ECN) in association with 'Planbureau voor de Leefomgeving' (PBL), 'Centraal bureau voor de Statistiek (CBS) and 'Rijksdienst voor Ondernemend Nederland (RVO) on behalf of the Ministry of Economic Affairs. The conclusions of the report were not as promising as expected in 2012. Especially the goal of achieving 14% renewable energy production in 2020 appears to be infeasible. When the current energy policies are being maintained, a proportion of only 10.6% can be expected. When all plans are being implemented successfully, this proportion can grow to 12.4%, which is still below the absolute minimum as agreed with Brussels.

Different reasons are being mentioned for this, like social resistance for onshore wind power, which automatically delays these projects. Also a cost reduction of 40% for offshore wind power is being classified as 'ambitious' within the set timeframe. This results in uncertainties whether planned projects for upscaling renewable energy production can continue or not.

Also The Dutch Government is being criticized to be not as reliable and consistent as initially being assumed. Recently the Minister of Economic Affairs announced that the agreements about offshore wind power will change to reduce the costs of it (Kamp & Schultz van Haegen, 2014). This resulted in the revocation of nine existing permits for offshore wind farms and therewith uncertainty whether planned projects to build these wind farms could continue or not.

Consensus on the feasibility of the defined energy goals is not reached yet. The same counts for the possible causes of the possible infeasibility of the goals. Is it the related policy which is not effective? Or were the goals in principle not feasible at all? Still many questions exist, which cannot be answered without proper insight in facts on the current situation instead of assumptions.

3 Perspective: Distribution System Operator

To understand the transition challenges DSOs face, the role of DSOs in the energy sector will be elaborated first. Hereafter attention will be paid to the challenges they face in the near future.

3.1 Role of DSOs in the energy sector

Distribution System Operators (DSO) are responsible for a continues distribution of electricity towards their customers. Their playing field is regulated by the Government, their tasks being determined by law, in The Netherlands by the ‘Elektriciteitswet 1998’, chapter 3. This law discusses the following topics:

1. Appointment of grid providers (paragraph 1);
2. Tasks and duties of the DSO (paragraph 2);
3. Construction, recovery and extension or renovation of the grids (paragraph 3);
4. Connections to the grid and transport (paragraph 4);
5. Metering devices and metering data (paragraph 4a);
6. Pricing and related conditions (paragraph 5);
7. Pricing and accounting by the DSO (paragraph 6);
8. Dealing with disputes (paragraph 8).

Within The Netherlands eight electricity DSOs are active, all within a fixed region of the country. This implicates that customers can’t choose for a certain DSO, but are bound to the DSO which provides its services in their living area. In this situation, market competition is difficult to establish. However, to establish some form of market competition, DSOs may charge their customers based on the annual quality of their services. By performing better than other DSOs, higher prices can be charged and more income can be generated.

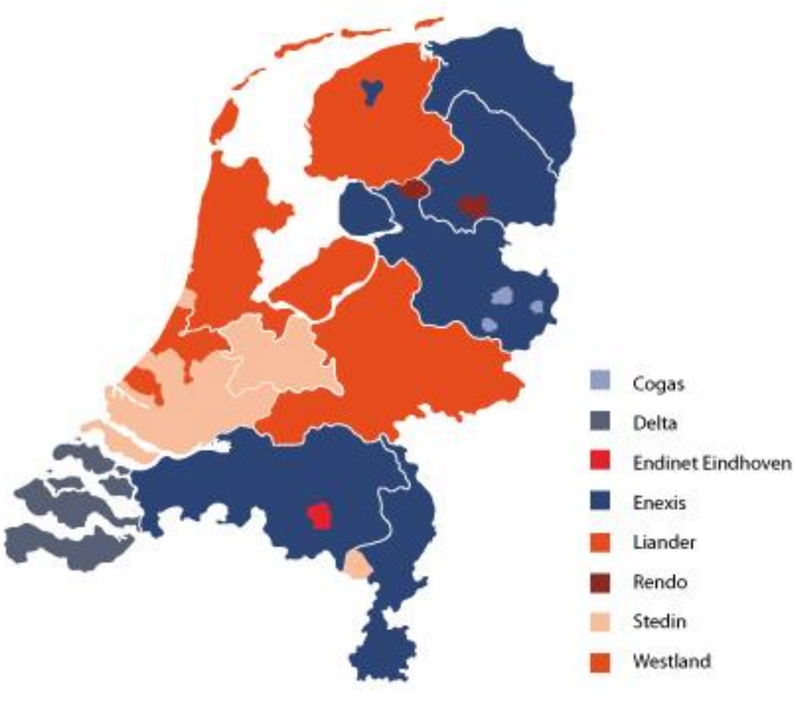

Figure 3. Distribution of DSOs over The Netherlands.

The tasks of DSOs consist mainly of managing and maintaining the electricity grid to safeguard the security and reliability of the grid and the transport of electricity via this grid. Also repairing and extending the grid is part of DSO's responsibilities, including connecting (new) consumers to the grid and installing metering devices.

The 'Autoriteit Consument & Markt' (ACM) supervises the activities of DSOs to safeguard fair pricing for the distribution of electricity and the connection to the grid. The ACM sets maximum prices for electricity transport and stimulates DSOs to maintain the quality of their grids on a high level. The ACM also handles complaints from customers regarding the quality or unlawfulness of services of DSOs.

3.2 Challenges for DSOs

3.2.1 Reliable grids

Outage time is one of the key performance indicators of DSOs, on which service quality and thus service prices are being based. A reliable grid is an important condition for low outage time. Since the middle and low voltage electricity grid are installed mainly underground, the quality of assets cannot be monitored easily and replacement of assets is labour intensive and costly. Therefore new infrastructure needs to be of high quality and continuous development and implementation of smart monitoring functionality is necessary.

The developments in decentral electricity generation furthermore challenge DSOs to facilitate the (often most efficient) local use of decentrally generated electricity and if not possible, distribution of it elsewhere. The grid should be prepared for two-way traffic, to prevent damage due to redelivering of electricity by prosumers (Netbeheer Nederland, 2013).

3.2.2 Smart grids

As explained before, the energy sector faces major challenges in the near future. Smart grids are being seen as the key to solve many of these challenges (Netbeheer Nederland, 2012). As manager of the electricity grid, DSOs will have to play an important role within these changes. It is their responsibility to modernize the electricity grid with among others ICT to better monitor and manage it, but also to provide producers and consumers with information they need about grid capacity, congestion etc. Therewith, the current infrastructure can be used in a smarter way, preventing major investments in grid capacity extension, while safeguarding sustainable electricity distribution for the future.

Additional challenge regarding smart grids is the regulated playing field in which DSOs operate. Though the present investment capacity of DSOs could hypothetically boost smart grid developments, it is not allowed for DSOs to undertake additional activities which disturb the electricity market. Cooperation with market players, like electricity providers, is therefore necessary.

4 Abstraction of the transition problems

4.1 Measuring effectiveness and feasibility of policy

Main goal of the 'Nationale Energie Verkenning' is to sketch the state of affairs within the Dutch energy sector and its expected developments towards 2030, based on defined and planned governmental policy and other measurements and agreements. The outcomes of such a widely set-up analysis should give reliable insights in the effectiveness of the current energy policy.

As described in the NEV, goals about energy efficiency and sustainable energy production, as defined in the Energy Agreement, appear to be not feasible. This raises questions about the existing energy policy, resulting in public pressure from different stakeholders of the Energy Agreement. Main point of discussion are the exact figures and the derivation of these figures. In a debate in the Dutch Parliament on October 7, 2014, on the possible infeasibility of 14% sustainable energy in 2020, the Dutch Minister of Economic affairs defended his policy by stating:

"The report says: one wants to achieve 6,000 MW onshore wind power, but will achieve only 5,000 MW. Furthermore a cost reduction of 40% concerning offshore wind power will not be achieved. Both statements are not correct" (Parlementaire Monitor, 2014).

The Minister refers to agreements which have been made with provinces and industries to achieve the defined goals. These are not correctly been taken into account in the NEV, resulting in wrong figures and wrong conclusions. During the debate more figures were discussed, whereby arguments from the Parliament, based on the figures from the report, were all refuted by the Minister, who based his arguments on his own figures.

Apparently, the figures from the report and the figures from the Minister didn't match. Questions can be raised about the sources on which the figures and arguments of both are being based, on which truth existing policy is being based and whether this truth can be considered as publicly shared truth. One can conclude that there is no widely supported truth since the figures of both are not consistent. According to the Minister, the truth is that our current energy policy is sufficient to achieve the defined goals. According to the Parliament, the truth is that current energy policy is failing in achieving the defined goals.

In public debate, the phrase "knowledge is power" ("Scientia Potentia Est", Francis Bacon, 1597), is still valid. Apparently, the Parliament is not able to refute the arguments of the Minister with well-grounded facts, which can be seen as a weakness of the EVN. But also other stakeholders or public institutions could participated in making proper analyses on the effectiveness and feasibility of the energy policy, aiming on achieving consensus on the truth about the state of affairs of the energy sector.

Necessary for the involvement of these organizations and the encouragement for independent analysis of these complex agreements and policies, is access to high-quality data, which in many cases isn't publicly available. By enabling organizations to perform (better) analyses by providing them with high-quality, open data, consensus on the truth about the state of affairs of the energy sector can be achieved. This truth can function as a baseline for proper public debate. It furthermore reduces the uncertainty about these complex agreements and related policies, which has a positive effect on the investment climate and willingness of stakeholders to actively participate. At last it can give insight in the overall playing field, which is extremely complex due to intensive crosslinking with other European electricity grids and developments within all facets of the electricity value chain.

Figure 4 visualizes the described problem:

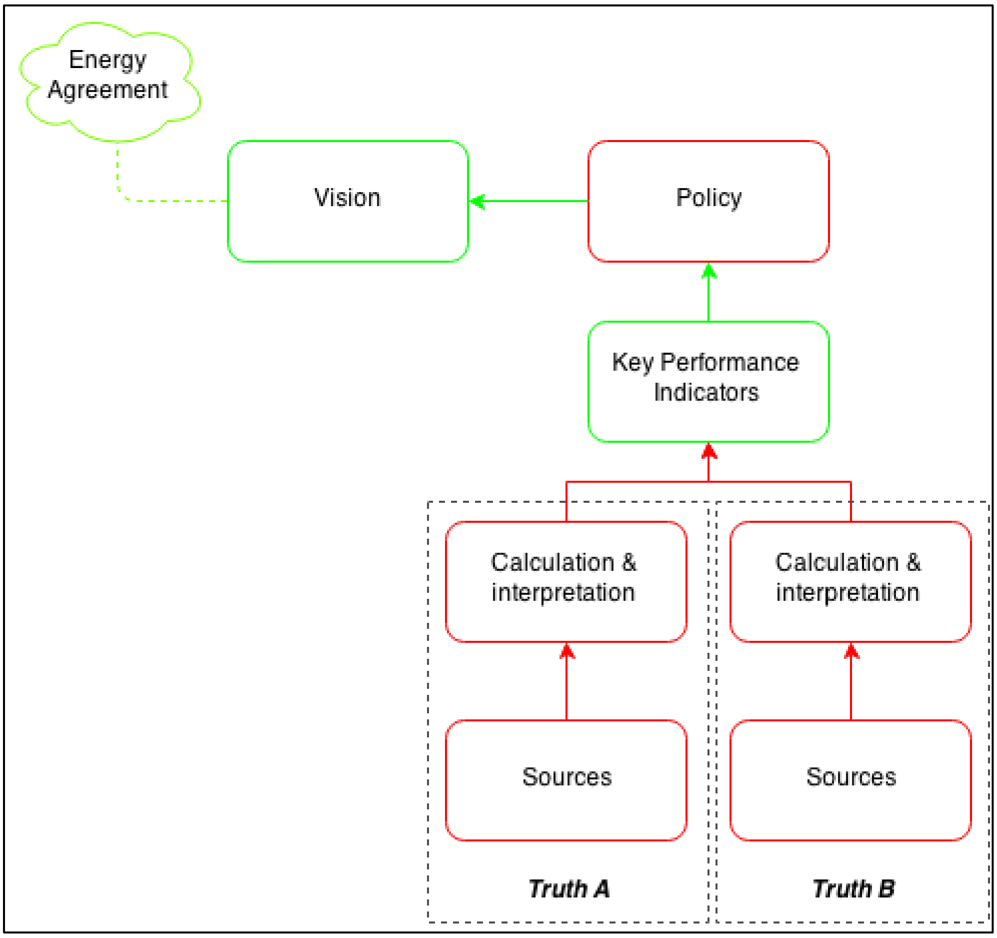

Figure 4. Establishment of energy policy.

The Energy Agreement is leading in the common vision formed on the energy transition, resulting in policy to achieve the defined goals. The effectiveness of the defined policy can be measured using Key Performance Indicators, describing which quality level should be reached and when. Based on these KPIs, the existing policy can be maintained or can be modified to fit the KPI figures.

Consensus has been reached on a shared vision, the initial policy necessary to achieve this vision and on KPIs to monitor the progress and effectiveness of the initial policy. Nowadays, one year after closing the Energy Agreement, different opinions on the KPI values raise, based on different sources, calculations and interpretations. Different truths developed on the implementation of the closed agreements, on the effectiveness of the energy policy and on the feasibility of the defined goals. A similar trend can be recognized in the discussions around climate change and global warming. Reaching consensus on a shared vision was not the hardest part. Reaching consensus on how to achieve that vision still is the hardest part, since different people have different opinions and interest and try to convey their truth to the public.

Calculations and interpretations based on reliable sources result in objective truths. Ideally, all truths contain similar conclusions resulting in a shared opinion on policy. Assuming that calculations and interpretations are correct and unambiguous, different truths can only occur when different sources are being used or the same sources are being used in a different way. Clear example is the discussion whether or not wind power has a positive effect on carbon dioxide emission reduction. When focussing on the Dutch energy sector, this positive correlation is often being recognized, since wind power partly replaces the generation of power by fossil fuels, resulting in less carbon dioxide emission. A broader focus can result in another truth. When including the European Union Emission Trading System, a neutral correlation can be concluded. This due to the fact that emission rights, which are not being used in The Netherlands, can be sold to other countries, which therewith are allowed to emit as much carbon dioxide as we have saved with our wind power.

In conclusion, different scopes and contexts can result in different data selections and therewith different objective truths. Necessary for a valuable discussion on the relevance of each truth is transparency in choices being made on scope, context and used data and transparency from stakeholders in their knowledge and thus their data.

4.2 Balancing demand and supply in a flexible way

As the first problem abstraction describes a more general problem affecting the entire energy sector, the second problem abstraction is more focussed on the Distribution System Operator. As we see the demand for electricity and the decentral production of electricity rising, problems within the current grid will occur, mainly because the production of decentral electricity production is hardly manageable.

Currently, electricity consumption patterns can be predicted quite precisely and electricity generation, distribution and consumption can be matched nearly perfectly to each other. But when demand and supply can’t be matched as precise anymore due to unmanageable decentral electricity production, electricity surplus can occur when more electricity is being produced than we consume and electricity shortage when our demand is higher than we produce.

The unmanageability of decentral electricity production is mainly due to the fact that it is dependent on certain types of weather. When there is a lot of wind, wind power generation will increase, but with a lack of sunshine, less solar power will be produced. Since we are able to forecast the weather quite accurately, the production of decentral electricity can theoretically (dependent on knowledge about installed decentral electricity production hardware) be forecasted too. But forecasting is not equal to managing, which also has to do with anticipating on the predicted situation. In the current situation TSOs can act when electricity shortage or surplus is likely to occur. When large scale decentral electricity generation is in place, this complicates the TSO’s response to prevent shortage or surplus.

To prevent the negative effects of electricity surplus (mainly damage to assets) and shortage, grid capacity could be adjusted to the changing electricity flows. In practice this can result in huge necessary investments in grid extension, to create capacity for additional electricity flows in case of electricity surplus and shortage. Alternative solution is to use the current grid capacity in a smarter way by managing demand and supply in a more flexible way. As increasing grid capacity is expensive due to hard scalability of the grid, instead one could choose to manage the demand of electricity in addition to the current supply management (Boivin, 1995). Promising is the example of smart charging of electric vehicles, which shows substantial differences in the maximum amount of cars which can be charged using the same connection (Vandael, Nelis, Holvoet, & Deconinck, 2010).

Managing demand and supply is a problem which occurs in lots of sectors, including the transport sector. Where the costs for the increase of highway capacity are high, the government tries to encourage motorist to use highway capacity as efficient as possible. This to prevent traffic jams or additional highway capacity which is only being used during peak hours. By encouraging motorists for example to avoid rush hours, expensive highway capacity extension can be reduced. Also by providing information on when and where capacity surplus or shortage occurs, motorists can adjust their ride to improve traffic flow.

Balancing traffic load can be compared with balancing grid load. When encouraging consumers to use electricity when available or to suspend electricity consumption when less electricity is available, grid capacity extension can be reduced. An example of a related incentive is cheaper electricity during the night, based on the fact that during the night less electricity is being used. Problem is that in contrast with the transport sector, within the energy sector (real-time) information on grid load is not freely available. With this information, as well as information about electricity consumption and production, consumers can be encouraged to change their electricity consumption behaviour, which is promising alternative for expensive grid capacity extension.

5 Instrument: open data

5.1 Introduction in open data

Since the promotion of an open government strategy by President Obama of the United States, Prime Minister Cameron of the United Kingdom and several other governments, open data developments gained momentum (McDermott, 2010). 'Openness as a strategy' has been adopted by governments around the world to increase transparency of their organization (Jearger & Bertot, 2010). Apart from transparency, open data is increasingly seen as a strategy to realize economic activity by enabling the re-use of data (Harrison, Pardo, & Cook, 2012). Developments in the semantic web, social media and other information technologies enabled us to easily do so.

Open data can be defined as *datasets which are offered under an open license enabling unrestricted access and re-use* (Folmer, 2014). Large scale sharing of data has the potential to unlock large amounts of economic value by enabling the development of new products, services and markets, merely by reusing data. Data, which already existed but has been kept for private purposes, while now being shared for public re-use. The European Commission estimated the added value of European public information on approximately €70 billion.

The relation between sharing data and unlocking economic value can be illustrated by the DIKW hierarchy (Rowley, 2007). Open data is mainly situated in the lowest part of the hierarchy: the 'data' part. Sharing of data can be compared with sharing bits and bytes, which are created within a certain context but need structural interpretation by humans or computer to become information.

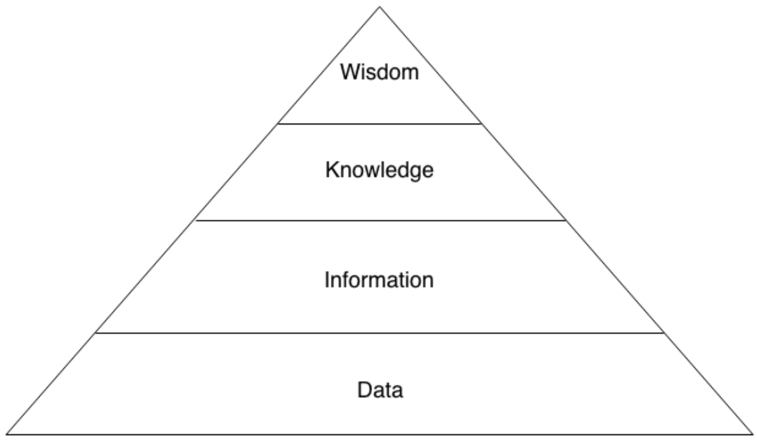

Figure 5. DIKW hierarchy.

Meta data defines the rules for interpretation of the data. So an important aspect of open data is the sharing of meta data, which enables re-users to give meaning to the actual data and translate it into information. When properly interpreted and re-used, information becomes knowledge which carries certain value. This approaches the field of 'business intelligence': which information can be extracted from the data possessed and what can be done with that information to transform it into knowledge which adds value to the business?

Also information on the dataset itself is an important part of the meta data. This can be information on when the data were gathered, for what purpose etc. This provides context to (re-)users on how to interpret the information the dataset contains.

Apart from analysing data to create added value for the own business, data can be shared to enable third parties to transform the data into valuable knowledge, which the original owner of the data could or would not do. This approaches the level of 'Wisdom' in the DIKW hierarchy. Examples are 'Zoom in op Energie', 'Zonatlas' and 'Energy Map Amsterdam'. These applications could not have been developed when the necessary data, which already existed, was not available for re-use.

Important to address is that open data by itself is not a goal, it is a means to reach higher goals as transparency and commercial benefit. It is a new trend following the philosophy of ‘openness’, similar to open innovation, open source, open standards, open web platforms and, predominantly in the public sector, open government.

In this chapter the fundamentals of open data will be described, which function as a theoretical baseline for the implementation of open data within an organization. The term ‘open’ will be elaborated, several open data principles will be discussed, as well as what open data means for governments and the drivers, enablers and barriers for open data in the (semi)public sector.

5.2 What is ‘open’?

As mentioned before, open data is following the philosophy of ‘openness’. In essence, openness refers to a kind of transparency, which is the opposite of secrecy. Most often this transparency is seen in terms of free and unrestricted access to information especially within organizations, institutions or societies.

The Open Knowledge Foundation[1] gives in its Open Definition full details on the requirements for ‘open’ data and content. The definition can be summarized as “Open data can be freely used, modified, and shared by anyone for any purpose”. It automatically addresses the three key features of openness, which are:

1. Availability and access: the data must be available as a whole and at no more than a reasonable reproduction cost, preferably by downloading over the internet. The data must also be available in a convenient and modifiable form.
2. Reuse and redistribution: the data must be provided under terms that permit reuse and redistribution including the intermixing with other datasets. The data must be machine-readable.
3. Universal participation: everyone must be able to use, reuse and redistribute — there should be no discrimination against fields of endeavor or against persons or groups. For example, ‘non-commercial’ restrictions that would prevent ‘commercial’ use, or restrictions of use for certain purposes (e.g. only in education), are not allowed.

The goal of the first feature is to lower the barriers which complicate access to the data as much as possible. When these barriers are too high, access becomes complicated which restrains the re-use of the data. The goal of the second feature is to make clear which forms of data processing are allowed and which not. This to prevent unintended re-us by third parties. The goal of the third feature is to prevent discrimination between different purposes for re-use or between different persons or organizations who want to re-use the data.

Apart from the mentioned advantages of open data (transparency and unlocking economic value), also important risks exist of which the most important are related to legal issues like privacy infringement. The distribution of personal data is in most cases without specific consent of the concerned individual, prohibited by law. This counts for personal data organizations possess, but also for data which is primarily anonymized but which can reveal personal data in combination with other

[1] Open Knowledge is a worldwide non-profit network of people passionate about openness, using advocacy, technology and training to unlock information and enable people to work with it to create and share knowledge.

data sources or when being processed by intelligent analytics tools. Therefore one can choose to restrict the openness of the published data by publishing under a restrictive open license, anonymize or pseudonymize the data or publish the data on a higher aggregation level. Other reasons for restriction could be undesired re-use like commercial re-use or redistribution without mentioning the original data provider. By restricting re-use, the level of 'openness' of the data reduces. There is no metric describing the degree of restriction which classifies data as open or closed, this depends on the chosen definition of openness.

5.3 Open data principles

5.3.1 Licensing

Important aspect of data sharing is licensing. Licensing data is required to protect open data from undesired processing by re-users. It helps creators of creative work to retain copyright, while allowing others to copy, distribute and make some use of the creative work. This differs from the definition mention in chapter 5, as this definition prescribes publication under an open license. As described in the previous paragraph, this type of publication is not always desired so in practice a proper balance between openness and restriction needs to be found. Some define this as 'semi-open data'. Nonetheless, an open license will more easily encourage re-use, as a restrictive license raises additional barriers.

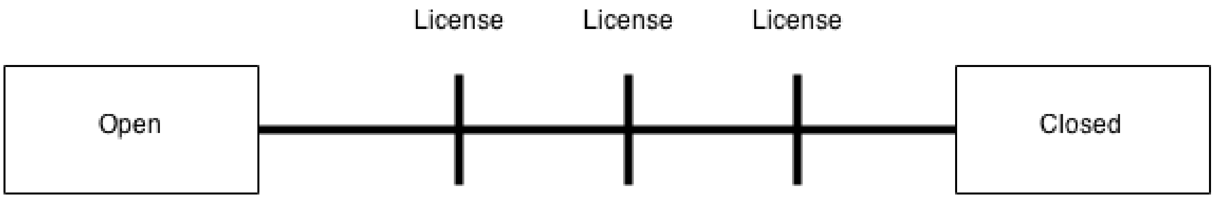

Figure 6. Licenses determine the level of openness.

Common features of licenses are: whether or not it is allowed to commercially use the creative work, whether or not it is allowed to share adaptions of the creative work and whether or not the original publisher of the data should be mentioned when the data is being re-shared. On top of these common features, licensors can choose to grant additional permissions or define additional restrictions when deciding how they want their work to be re-used.

On July 17, 2014, the European Commission published a recommendation on the licensing of public sector information. The Commission recommends all member states of the EU to use standardized open licenses for the publication of public sector information. The Creative Commons[2] license model is being mentioned as proper instrument for this and is being used explicitly by the Commission itself. Since 2010 also the Dutch Government makes use of the Creative Commons license model. In chapter 7 this model will be further elaborated.

5.3.2 Meta data

A license is part of the meta data of a certain data set. This meta data provides a mechanism to interpret the data and gives information on what re-users can expect from the data in a human readable format. This can be technical information, like file size, API details etc. but also information regarding language, period of data gathering, durability of the data, quality, completeness etc. By

[2] Creative Commons is a nonprofit organization that enables the sharing and use of creativity and knowledge through free legal tools.

providing data in combination with meta data, re-users are aware of the context of the data. This helps to prevent unintended or incorrect interpretation of the data and related negative consequences.

5.3.3 Machine readability and accessibility

Apart from minimizing the juridical, economical and technical barriers, creating added value with open data can only be achieved when publishing the data on the web in a machine-readable and open, structured format (e.g. CSV, XML or RDF) (Krzysztof, Hitzler, Adams, Kolas, & Vardeman II, 2014). When offering data following open standards, the accessibility of the data grows substantially. Tim Berners Lee created a Five Star Model, which can be used to rate the accessibility of data sets, based on the following criteria:

- ❖ The information is available on the internet in whatever format.
- ❖ The information is available on the internet in a structured format, suitable for automated re-use.
- ❖ The information is available on the internet in an open file format.
- ❖ The above criteria, supplemented with the use of the open standars 'Resource Description Framework' (RDF) and 'SPARQL' to enable others to easily refer to your data objects.
- ❖ The above criteria, supplemented with references to other's data objects to provide additional context.

The fourth and fifth star represent the implementation of linked open data. The term 'linked data' represents linking data on the internet instead of linking webpages as we currently do. Combining open data and linked data results in 'linked open data': data offered on the web in an open format and mutually connected. Linked open data will not be further elaborated in this thesis.

5.3.4 Quality and guidance

Open data loses value when being incomplete, outdated or being published under a too restrictive license (Dawes, 2010). A proper open data strategy is necessary to prevent these issues. However, organizations often find the process of opening data cumbersome (Janssen, Charalabidis, & Zuiderwijk, 2012).

Lifecycles can help to successfully implement an open data strategy resulting in high value open data sources. They are being used to guide the development of open data (Hyland & Wood, 2011). Lifecycles capture the development of certain phenomena (describing) and predict the next steps in the development (prescribing) (Lane & Richardson, 2011).

The added value of a lifecycle model is that organizations can go through multiple cycles to gradually develop an open data strategy. It is an iterative process, in which the learning effect of going through multiple cycles is an import aspect. Finally a sound open data strategy will be in place, which among others defines the responsibilities of the actors within the lifecycle process and which determines choices, such as which data to open up and which stakeholders to include.

5.4 Open data in the (semi) public sector

5.4.1 Open government data

One of the boosters of open data developments is the commitment of governments, aiming on full transparency towards their citizens under the header of 'Open Government' (Jaeger & Bertot, 2010).

One day after his inauguration, president Obama of the United States announced: “My administration is committed to creating an unprecedented level of openness in Government. We will work together to ensure the public trust and establish a system of transparency, public participation and collaboration” (Obama, 2009). How? By publishing government data in the form of open data. On May 9, 2013, President Obama signed an executive order that made open and machine-readable data the default for government information (Obama, 2013).

The British and Dutch governments launched similar initiatives, among others resulting in open data portals bringing together government data in one, searchable website. In addition, in 2011 the Open Government Partnership was launched, providing an international platform for domestic reformers committed to making their governments more open, accountable and responsive to citizens. Also the PSI Directive (Directive 2003/98/EC on the re-use of public sector information) encouraged the open government developments. The general idea behind this directive is that data gathered with public funding should be freely accessible for the public to maximize its revenue. These developments furthermore encourage semi-public organizations to increase transparency by opening up their data. Also their facilitating role in our society can be seen as a logical driver for this.

The motto of the Dutch Government on open data is: ‘open unless’. This motto summarizes the Open Government vision, adopted in 2013. The vision entails a proactive attitude towards opening up governmental and public sector information.

5.4.2 Drivers, enablers and barriers

While many government organizations aim to open up their data, the process of opening data is usually cumbersome and many challenges persist. In a study by Van Veenstra and Van den Broek drivers, enablers, and barriers of open data were identified by reviewing literature and by conducting a case study on open data in a semi-public organization in the Netherlands (Van Veenstra & Van den Broek, 2013).

One of their conclusions was that while the drivers for opening up data remain the same in every phase of the process, the enablers and barriers shift between the different phases. Being a semi-public organization was seen as the main driver for having an open data strategy, mostly considered from the viewpoint of transparency and accountability. The second most important driver identified was business value open data could generate for the organization. Third driver identified was the importance of enabling re-use by third parties to maximize the revenue of the data, collected with public funding. Other drivers mentioned are that open data can function as an instrument to foster innovation and that it can result in more efficient information exchange.

Interesting to mention is the trade-off between driver one and two, namely between transparency and commercial interest. Why giving away (valuable) data for free for transparency reasons, while that data could also be commercially offered?

The study furthermore exposed the importance of organizational enablers in the early phases of open data developments, such as pilot projects, open data strategy and management commitment. In later phases factors related to the re-use of data were found especially important, such as privacy, standardization and publishing metadata. Also the development of open data communities was considered useful for stimulating re-use of data instead of randomly uploading data. So throughout the process focus shifted from the internal organization to external users of data.

At last the barriers. Most important barriers that were found in the preparation phase were low data quality and security risks. The lack of interest from third parties was unexpectedly considered the least important challenge. After publication, privacy risks replaced the security risks as an important barrier. Also the uncertainty on how open data would generate future revenue was identified as a barrier. So throughout the process the more technically oriented barriers became less important, while later on factors regarding the impact of open data during re-use became more important. One barrier remained important during the entire process, namely the difficulty of mobilizing organizational support for an organization-wide open data strategy.

6 Open data as an instrument to solve the transition problems

6.1 Repetition of the defined transition problems

In chapter 4, two main problems were identified, which are abstractions from the challenges the energy sector faces regarding the energy transition.

The first problem abstraction is situated on the overall energy sector level, namely problematic measuring of effectiveness and feasibility of policy. This problem is based on the political debate whether or not the current energy policy is sufficient to achieve the goals as defined in the Energy Agreement. This debate not only takes place within Parliament but also outside in public media. The truths which are being preached by different parties are all based on correct figures, but the selection and therewith the interpretation of figures often differs, resulting in different conclusions. *The real truth can only be revealed when all necessary information is available for independent analysis and results can be discussed in public debate*. The problem is that the important underlying data are not always freely available to feed the public opinion.

The second problem is on the Distribution System Operator level, namely the problematic balancing of demand and supply in a flexible way. Due to changes in electricity consumption patterns and electricity production patterns, the amount of electricity and the way that electricity flows through the distribution grid, will also change. Within the current setup of the electricity distribution grid, electricity surplus and electricity shortage can - as a result of these changes - occur. A traditional paradigm prescribes that grid capacity should be adapted to the maximum peak demand. When the demand for electricity increases, this can become extremely expensive due to the hard scalability of the grid. A better solution in this sense would be to manage the demand for electricity and therewith re-establish the balance between demand and supply. By doing so, the capacity of the current grid is being used in a smarter way. *Flexibility from consumer and producer is needed for such a solution, based on accurate, (real-time) information*. Among others on electricity consumption, electricity production, grid capacity and grid load. The problem is that the underlying data are not freely available for the implementation of such a balancing system.

6.2 Verification

In the following two sections, the facilitating potential of open data for the defined transition problems will be verified.

6.2.1 Effective and feasible energy policy

As described in previous sections, discussions around effectiveness and feasibility of policy lose value when arguments from different parties are being based on different sources. When different parties are only aware of their own data sources, their own calculations and interpretations and thus their own truth, consensus about a shared truth and related policy is hardly achievable. Continuous debate will be insurmountable.

Feeding the public discussion with objective data, directly from its original source, will enable interested parties to oversee the complete playing field more easily. Resulting analyses, interpretations and conclusions from different parties will be based on merely facts, resulting in objective truths. By providing interested parties in a non-discriminatory way with raw data from its original source, conclusions will be better comparable, increasing the value of the debate around the formed truths. The chance for achieving consensus on a shared truth will therewith increase.

As mentioned in the previous chapter, open data can generate business value for the organization. This is an important driver for open data implementation within the (semi-)public sector. The same counts for the importance of enabling re-use by third parties to maximize the revenue of data, collected with public funding. Measuring policy effectiveness and feasibility by re-using data can be seen as a step in maximizing the revenue of data, which was primarily gathered for other purposes. How? By opening up data, third parties can analyse these data, searching for interesting facts. Furthermore, different data sets can be combined, possibly resulting in new insights on a wider scale, which could not be gained without combining the different data sets. At last, instead of assuming the analyses and conclusions of 'trusted parties' are correct, open data enables parties to check the correctness of other's conclusions, resulting in increased reliability or rejection of conclusions made.

The research on drivers for open data implementation was focused on the (semi-)public sector, while also different private parties like energy suppliers are part of the energy sector. Motivating these parties to open up their data for public re-use is much harder because of their often commercial interests. But, as concluded in the research, business value generation can also function as a driver for open data implementation. This driver fits commercial interest and thus can function as an important driver for private parties too.

Apart from the development of new, innovative products and services, indirect business value can be generated with reliable (governmental) policy. Since organizations are partly dependent on (governmental) policy, the reliability of this policy is an important aspect for the developments of these organizations. Incorrect or unreliable policies have negative effects on the investment climate of organizations, resulting in cautious developments and less income, compared to a reliable relation with the government, which often results in a fruitful investment climate and progressive developments. *Organizations can contribute to reliable policy by offering insight in their sector, resulting in more reliable policy than policy merely based on assumptions and unilateral analyses. Open data can function as an instrument to facilitate the related exchange of information.*

6.2.2 Balancing of demand and supply in a flexible way

Prerequisite for a proper balancing system is transparency: in demand as well as in supply. When information on both is present and communication between demanding parties and supplying parties is possible, one is able to manage the system in such a way that demand and supply fit and shortage and surplus can be avoided more easily.

Demand Side Management (DSM), as the modification of consumer demand is often being called, is the type of management necessary for effective balancing. When consumers can be motivated to lower their demand for electricity during peak hours, instead of ultimately demanding more electricity than the grid can distribute, investments in additional grid capacity can be avoided. Furthermore, lower peak demand results in lower asset wear, which increases the lifespan of assets. Both effects result in lower costs for DSOs and ultimately lower distribution costs for consumers.

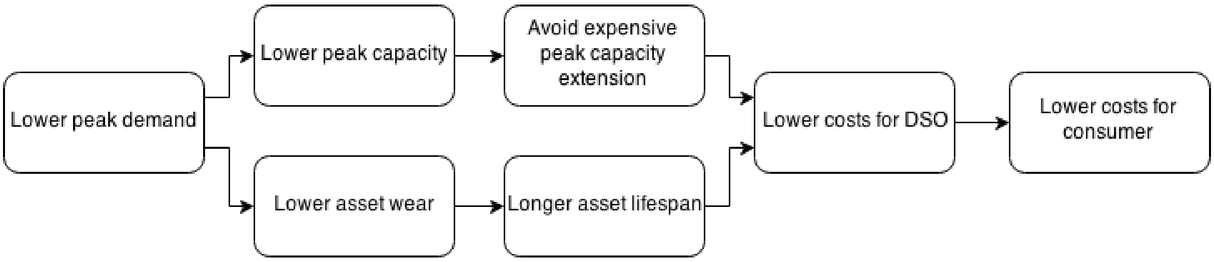

Figure 7. Implications of lowering peak demand.

Also electricity suppliers can achieve substantial gain with demand side management. Namely, when the demand for electricity can be managed in such a way that the difference between the actual demand and expected demand is as low as possible, electricity suppliers will have less additional costs due to unexpected and more expensive, late electricity purchase.

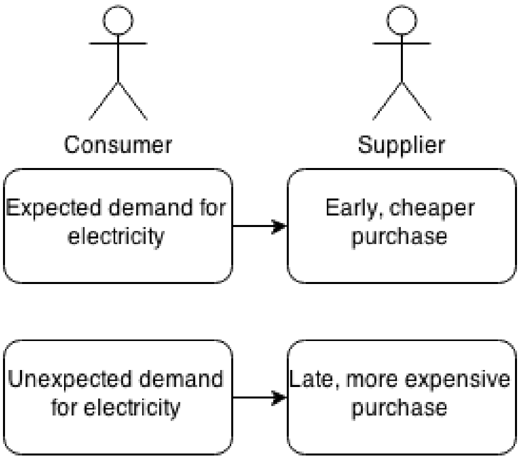

Figure 8. Relation between expected demand and purchase costs.

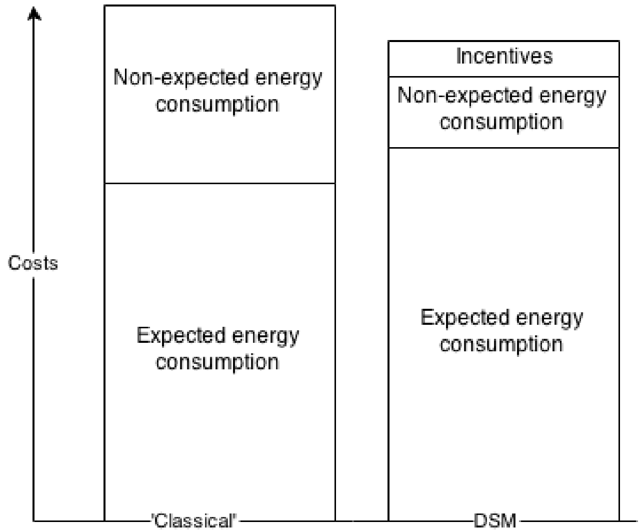

Figure 9. Indication of costs of DSM.

Apart from the question which incentives are appropriate to motivate consumers to change their electricity demand behaviour (financial incentives are often being proposed), question is on which triggers consumers should change their electricity consumption. When sharing real-time information on demand and supply, incentives can be offered to lower electricity demand and ultimately lower grid load. When these incentives lower the amount of non-expected energy consumption and decrease the total amount of costs, the DSM system is cost effective.

The implementation of a platform which enables consumers, suppliers and prosumers to exchange data on demand and supply and the implementation of DSM services using these data is a typical market role, which in essence can't be fulfilled by DSOs due to their regulated playing field. Their role is to provide the necessary data to such a platform. Since the interests of DSOs in these types of services are high, optimal market facilitation is necessary to stimulate the market to play this role.

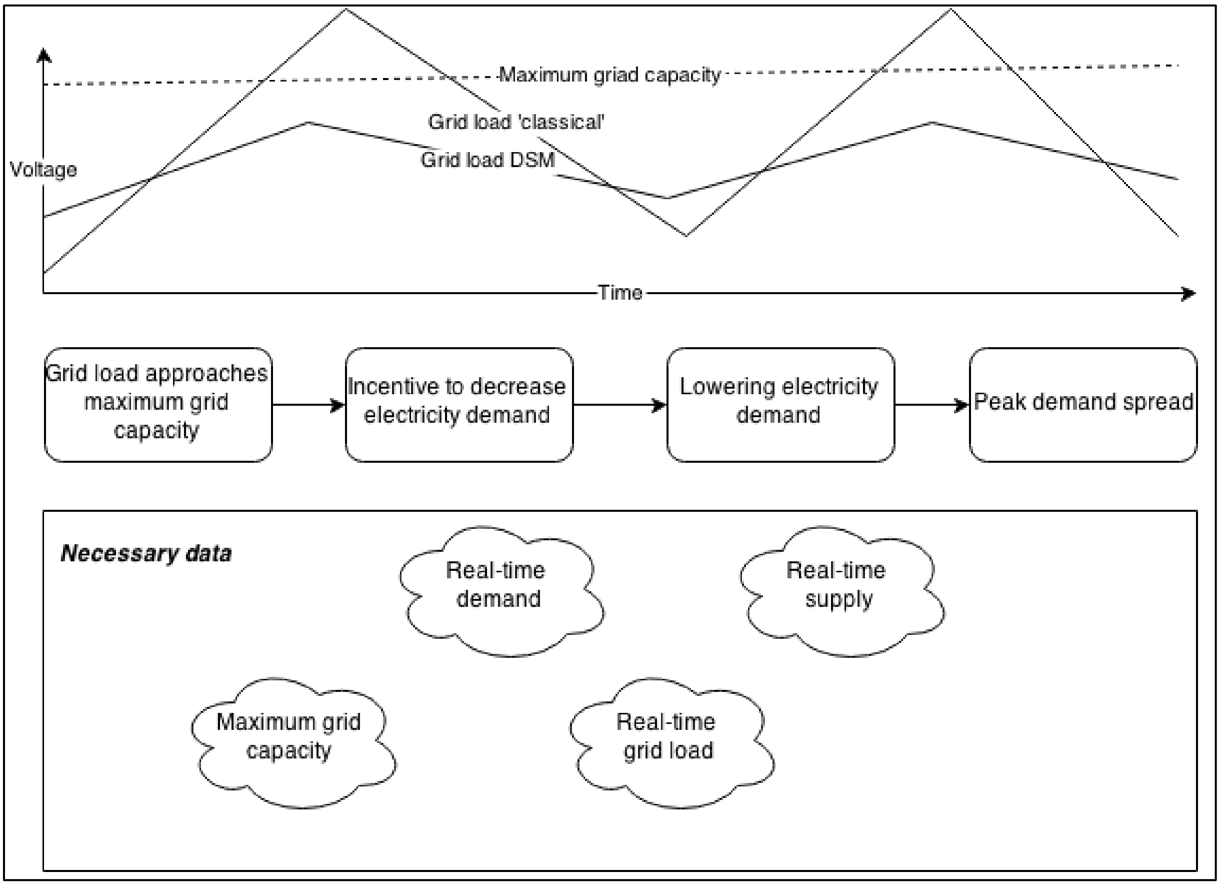

Figure 10. Simplified representation of a DSM system.

Given the value of open data previously described, open data can serve as a means to optimize this market facilitation and therewith boost the implementation of a DSM system within the electricity sector. First reason for this is that market parties currently do not have access to all necessary data on demand and supply for the implementation of such a system. Without access to these data, the needed information on which behavioural change has to be founded, cannot be extracted. So access to data is prerequisite.

This does not automatically require open access to data. However, when the concerned data are not freely accessible, an open market cannot be created. Generally accepted is the fact that an open market model encourages price competition and quality competition, both having a positive effect on a balanced offering of goods. However market competition can only occur when different players are present within a market, which in this context implicates that different players have access to the necessary data. Apart from creating an open market for DSM implementations, another advantage of opening up data is that potential market players can enter the open market with innovative solutions, encouraging quality competition. Last advantage of an open solution is the prevention of data lock-in. When offering data in a structured, open format, different players have access to the data and can use it within their systems. When locking the data in a predefined system, alternative system implementation will become much harder.

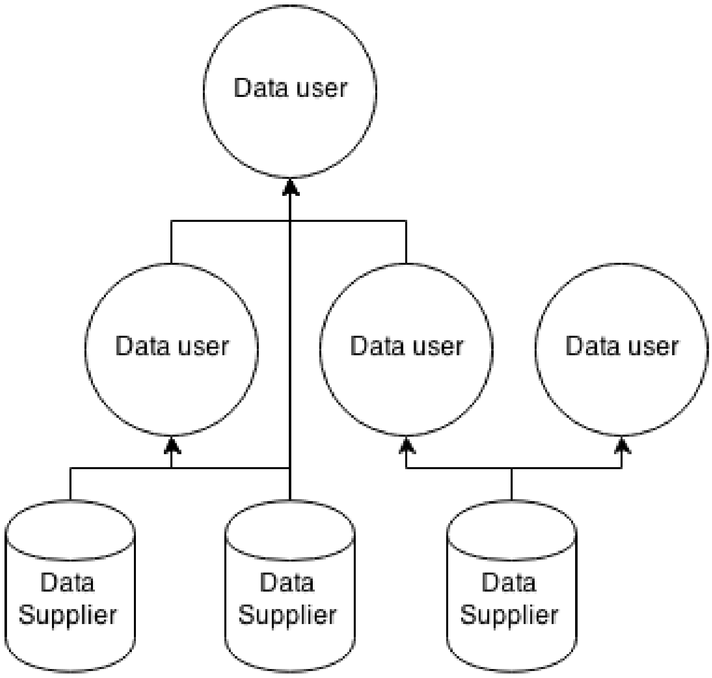

Figure 11. Less optimal market facilitation.

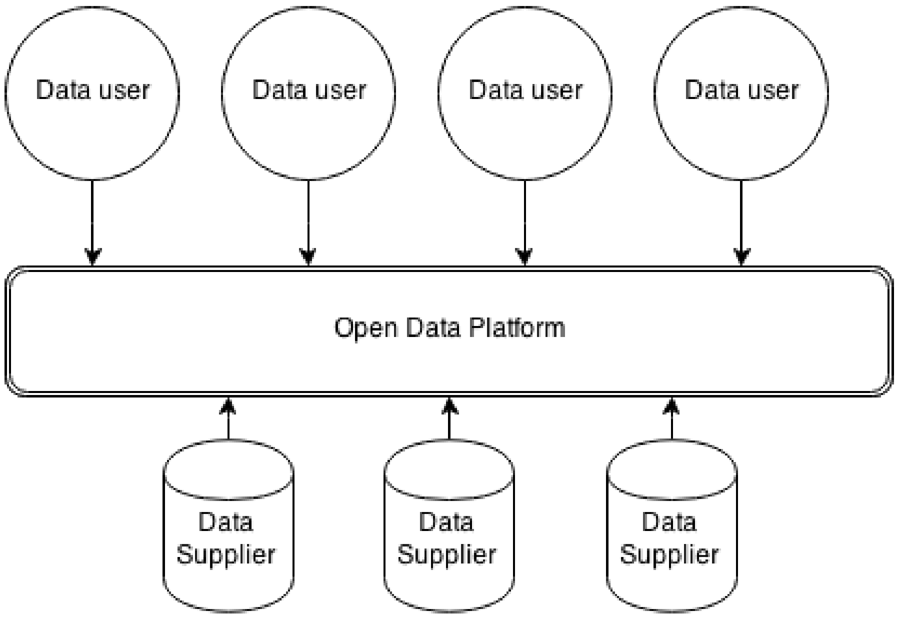

Figure 12. Optimal market facilitation.

7 Open data implementation

7.1 Introduction

The transition from a closed data landscape towards an open data landscape is complex. It demands changes in IT infrastructure as well as in policies and processes within the entire organization. Organizations often experience the transition process as cumbersome (Janssen, Charalabidis, & Zuiderwijk, 2012). To help these organizations, different implementation methods have been proposed (Van Veenstra & Van den Broek, 2014). However, organizations differ and a single solution for all types of organizations is utopic.

In this chapter an open data implementation plan for Enexis, a major DSO in The Netherlands, will be proposed. The plan outlines concrete steps the organization should make, focused on different disciplines which are involved within the process. These disciplines are among others: juridical affairs, IT architecture, corporate strategy, asset management, IT management, data management, enterprise architecture and innovation. Same counts for the different bodies within Enexis charged with open data matters, including the 'Open Data Community', 'Data Management competence centre' and 'CIO Office'.

The proposed implementation plan is set up following the method of Backcasting. The concept of Backcasting is developed by 'The Natural Step'[3]. It is often being used as an approach for the planning of sustainable development and innovation. In contrast with forecasting, Backcasting starts with defining a successful future vision, followed by asking the question: 'what do we need to do today to reach that vision of success?' (Dreborg, 1996) .

Backcasting is often more promising than forecasting, which "tends to produce a more limited range of options, hence stifling creativity" (The Natural Step, 2014). Another difference is that forecasting is often based on assumptions and the status quo of today, while this knowledge is always incomplete and things can change over time. Within the Backcasting framework, unpredictable changes are not a problem as long as consequent steps lead towards the defined vision.

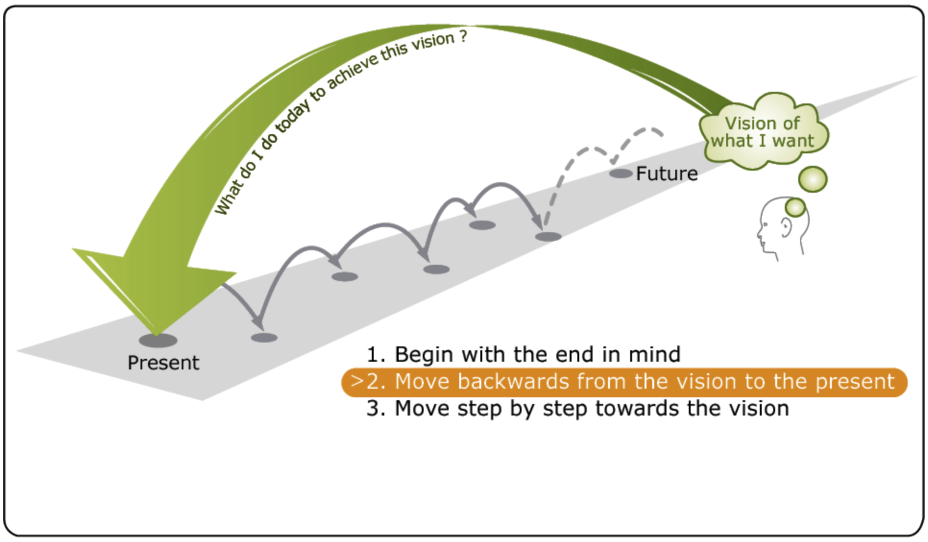

Figure 13. Backcasting.

[3] "The Natural Step is a globally recognized network of offices and individual associates that share the same brand, principles and training in strategic sustainable development" (The Natural Step, 2014).

7.2 Vision

The vision elaborated in this paragraph is based on open interviews, conducted with Enexis employees and other open data professionals (among others from the Ministry of Economic Affairs, TNO and Netbeheer Nederland) between September 2014 and December 2014. During these interviews different ideas on open data were discussed and placed in the context of the interviewee's discipline. The results of these interviews, supplemented with the results from the literature study form the basis of this vision and the further implementation plan.

7.2.1 Open data offering and integrating

Following the in chapter 5 described potential of open data for organizations, Enexis' open data strategy should be aimed on two activities: open data offering and integration. The first, open data offering, contributes to Enexis' strategy to be "transparent in our information supply" (Enexis, 2014). Enexis plays a utility role in society, currently adding value by providing electricity (and gas). *This added value can be extended by providing society with Enexis' data and therewith facilitating the energy transition.* The second aim, open data integration, is about integrating open data (services) within the own organization, which adds value to Enexis' activities.

7.2.2 Open data platform

The role Enexis plays within the first aim, is the role of 'data provider', within the second aim it is the role of 'data consumer'. Two roles requiring two different approaches, but which come together in one type of infrastructure: an open data platform. Such a platform can be seen as an abstract cooperation between data providers offering their data to a shared data integrator, which data consumers can use to collect the data they want. Main advantage of such a platform is that data providers don't have to organize data services for single data consumers and that data consumers can collect their data on one single place. *An open data platform facilitates Enexis in less complex offering of data and less complex integration of external data services within the organization.*

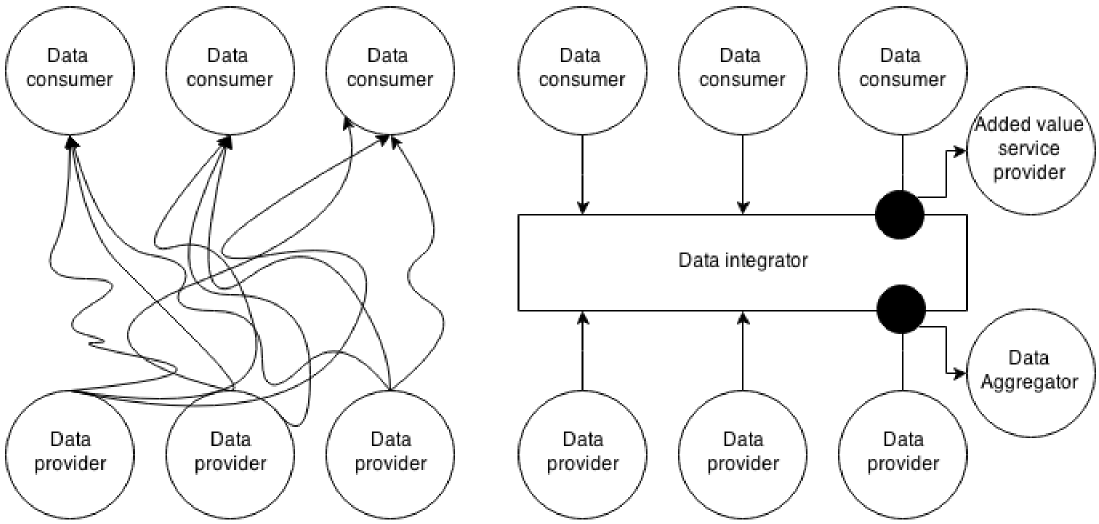

Figure 14. Advantages of an open data platform.

Apart from the data provider, integrator and consumer role, also the role of 'data aggregator' and 'added value service provider' can be played within the platform. The goal of data aggregation is twofold:

1. By aggregating data to a higher level (e.g. from individual address level to postcode 6 level), the derivability of data to individuals becomes harder. This can be a solution for privacy infringement when opening up the original data set.
2. By aggregating different data sets concerning the same entity, new insights can be retrieved from the combined data.

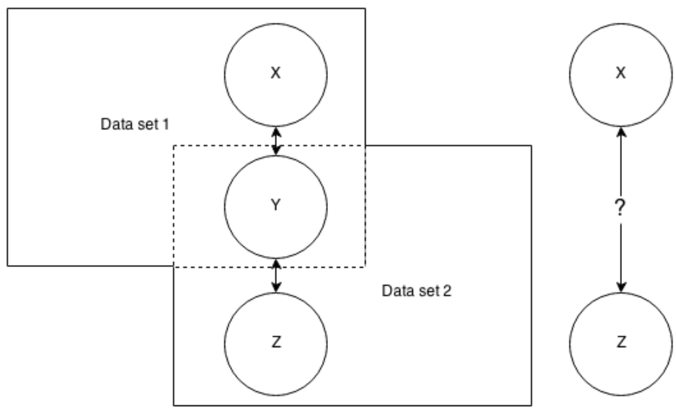

Figure 15. Aggregation of data can result in new insights.

The goal of the added value service provider is to develop added value services, based on the data available within the platform and to offer these services to the data consumers. This simplifies the re-use of open data by third parties, since they can make use of already developed and offered services instead of developing these functionalities themselves.

Important to address is that the described role model is a conceptual model, describing the roles which can be played. Not all roles necessarily need to be played. Furthermore, different roles can be played by the same actor, for example the role of data provider and data consumer. This can be the case when organizations offer their data to the platform and simultaneously make use of the value added services, which combine the organization's data with data from other organizations.

7.2.3 Proactive and reactive data sharing

An open data platform as described in the previous section is a clear example of proactive data sharing. By offering (new) data to the platform, new ideas on how to use that data can rise and new services can be developed, implementing those ideas. Proactive data sharing fits the motto 'open unless' of the Dutch Government as described in paragraph 5.4. This can also work the other way around. When new ideas rise, the need for certain data to implement that idea can rise too. In such a case, data providers can respond on that need by offering the required data in an open format. Instead of a proactive attitude, this indicates a reactive attitude.

When proactively offering open data, potential data consumers can be encouraged to come up with innovative ideas which become possible by re-using the provided data. It also doesn't limit data providers to share their data for certain purposes, which can broaden the applicability of the data. Third advantage is that proactively offered open data prevents requests for these data, saving time and labour to handle those requests.

Nonetheless, DSO's investments should always be publicly responsible investments, because these investments are indirectly sponsored by tax payers' money. Since the Energy Agreement contains commitment of many institutions to open up different types of data, investments in opening up these data by Enexis can be publicly justified. Though, future re-use and application of data sets by the public cannot always be predicted. So opening up all kind of data sets which primarily do not contain public value cannot easily be justified. *That is why proactive open data publishing should be strived for, keeping in mind the applicability and possible added value of the data.*

7.2.4 Legally controlled data sharing

As described in paragraph 5.2, potential risks of data sharing are often related to legal issues like privacy infringement. Different legal instruments are in place to control the sharing of data. This among others to deal with legal issues concerning privacy violation, intellectual property violation or cybercrime. *Open data publication should always be in compliance with all concerned legislation*.

Important instrument to address is the European Convention on Human Rights, which safeguards the right to respect for private and family life. This right, described in Article 8 of the Convention, forms the baseline of European privacy legislation. In addition, 'Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data' was adopted in 1995, regulating the processing of personal data within the EU. The European Commission plans to replace this Directive with a Regulation. On January 25, 2012, a proposal for a 'General Data Protection Regulation' (GDPR) was released, which still awaits to be adopted.

On a national level, this EU legislation is translated into national legislation, among others in the 'Wet Bescherming Persoonsgegevens' (Wbp). As long as the Data Protection Directive is in place, the Wbp applies on Dutch legal privacy issues. The adoption of the GDPR will replace the Data Protection Directive as well as the national translation of it, (partly) covered by the Wbp.

Opening up data by Enexis should be in compliance with this privacy legislation. This among others implicates that the distribution of personal data is not allowed, only on an anonymised or pseudonymised level. Also data which in combination with other data can be related to individuals is not allowed to be published. This automatically results in a grey area, since it cannot be predicted which data in the future might be available, which in combination with your published data can be related to individuals. Appropriate measures should be taken to avoid or limit accountability for such occurrences.

Another aspect to consider is the legally controlled playing field in which Dutch DSOs operate. The 'Energiewet' defines which activities DSOs are obliged and allowed to undertake. So opening up data by Enexis should be in compliance with this legislation too. This implicates among others that disturbing the energy market is not allowed. Also here a grey area arises. DSOs are not allowed to undertake activities which market parties undertake too. But when for example no market parties offer certain open data services, questions can be raised whether DSOs are still forbidden to do so. This often results in a situation in which DSOs boost certain innovation and later on withdraw when market parties come in place.

When willing to open up certain data, two more questions should be answered:

1. Who is the right holder of the concerning data?

2. What type of re-use is appropriate according to us?

Infringement of intellectual property rights is forbidden. 'Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004 on the enforcement of intellectual property rights' assures that proper measures, procedures and remedies are available for right holders to defend their intellectual property rights when they are infringed. These could be copyrights or related rights, trademarks, patents, designs etc. To avoid legal issues concerning unlawful publishing of data due to infringement of intellectual property right, one should always on beforehand consult the right holder of the concerning data and never publish the data without the right holder's explicit consent.

To prevent unintended re-use of published data, measures should be taken to put legal conditions in place on the re-use of the data and to inform re-users on these conditions. Unintended re-use could for example be re-use for commercial purposes or re-use without mentioning the original source of the data. *Due to the utility role Enexis plays within society, a non-restrictive approach would be appropriate.*

Last legal issue important to address is accountability. As a large, semi-public organization in The Netherlands, the public expects Enexis' data to be correct when being published. Re-use of open data which afterwards appears to be incorrect can result in damages for which the data supplier can be hold accountable. Appropriate measures should be taken to prevent this negative effect of publishing open data. Obvious measure would be to only publish data of which hundred percent correctness is proven. But since (partly) incorrect data can carry value too, this measure is not always desirable. Alternative is to publish the data and explicitly mention in the meta data what re-users can expect from the data. Though this reduces the risk of accountability for damage, the risk of reputational damage, as being unreliable, is still present. *Therefore one should strive for the publication of open data only when being (nearly completely) correct.*

7.2.5 Open data lifecycles

As described in paragraph 5.3, the process of implementing a full open data strategy is labour intensive and complex. *Therefore a step-by-step approach is more suitable than attempting an instant implementation.* Lifecycle models can give guidance in gradually implementing an open data strategy. Following the guidelines of lifecycles, the process of implementing an open data strategy is iterative. Given the complexity, organizations likely go through multiple cycles to optimize the learning effect of each cycle. Following this step-by-step approach, a sound open data strategy implementation gradually develops.

Part of this step-by-step approach should be the identification of data suitable for open publication, the preparation of the data and the publication itself. After publication, evaluation and monitoring is important to optimize the learning effect. Part of this is evaluation with re-users who might have interesting ideas about the process and published data. Also the durability of the data should be considered and defined to avoid an ever growing amount of eventually outdated data.

Implicit part of the open data life cycle is to determine the desired level of openness. Blindly and fully opening up data entails the risk of unforeseen, negative consequences like leaking business secrets. Though this should not deter organizations to open up data, analysis on which data to publish and which level of openness is appropriate (e.g. restrictions on commercial re-use), is recommended.

7.2.6 Publication

Different techniques are possible for publishing open data. A method, often easy to carry out, is to extract a CSV file from a database and to publish the file on a website. Advantage of this method is that the data can be easily manipulated, without being constraint by the capabilities of particular software. It is also a less complex solution compared to API implementation. But also more advanced techniques exist like publication using URIs to denote things so that one can point at your data. Also techniques exist to get fine-granular control over the data items and optimize access to the data.

As described in paragraph 5.3, Tim Berners Lee defined different levels of open data publication. As the investments necessary to achieve a higher star rating increase each level, the value of the offered data increases in most cases too. *For maximal revenue a five star rating should be strived for. Though, from case to case the added value of each additional star can differ and thus a cost-benefit analysis can be used to adjust the target rating.*

7.2.7 Accessibility

Prerequisite for re-use of published data is the accessibility of the data. When barriers which potential re-users face in accessing the data, are being removed, re-use will be much easier. These barriers occur when data is hard to find, hard to attain or hard to use. Especially for data from DSOs counts that, when data is being distributed by DSOs themselves, consumers need to retrieve data from multiple sources for national coverage of the data. When brining these data together, physically stored in one place or by means of an open data platform, accessibility will improve.

The accessibility model of Backx describes three layers of accessibility that one has to go through to be able to re-use data as intended to be used (Backx, 2003). The first layer is about knowledge, knowledge that the platform exists, what it offers and where one can find it. The second layer is about attainability, standing for the availability of data and easy access to the offered data. The third layer is about usability, standing for easy usage of the offered data, but also its clarity and reliability.

The success of an open data platform depends on each of the three layers. When all being implemented correctly, data consumers can easily find, attain and use the offered data.

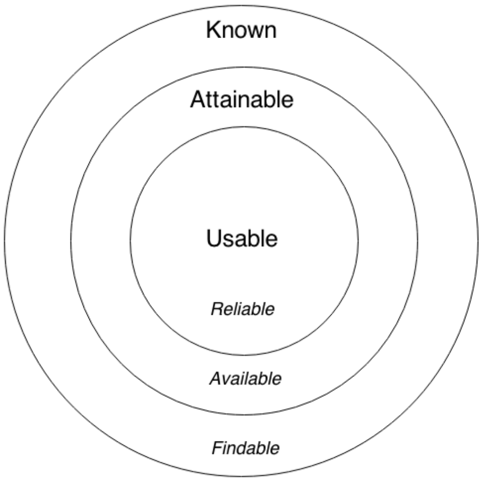

Figure 16. Accessibility model of Backx.

7.2.8 Organizational aspects

DSOs should recognize that besides their grid infrastructure, data becomes a more and more important asset, which needs to be managed. Apart from the DSOs role as ‘Trusted Asset Manager’ within the energy sector, a second role of ‘Trusted Data Manager’ can be (partly) played. *Their facilitating character within the sector should encourage DSOs to not only facilitate the public with the distribution of electricity, but also with the distribution of available energy data.*

Important condition for the distribution of data by DSOs is that the distribution is non-discriminatory. This means that distribution to a selected group of organizations, while other organizations are being excluded, is not allowed. Non-discriminatory distribution is a direct result of the regulated playing field of DSOs; market interference or disturbing is prohibited by law.

7.3 Current situation

Though progress has been made last three years, within Enexis open data implementation is in its infancy. The first steps Enexis made were triggered by smart grid innovation projects, which resulted in a Roadmap Smart Grids. Open data is an important ambition of this roadmap.

The first steps in the direction of open data implementation were mainly governance and policy steps. Basic ideas on the reason for choosing for open data, possible risks of open data and open data use cases were formed. Recently an Open Data Agenda 2015-2018 was published, stating the planned activities on open data implementation for the next three years.

An important result is the formation of an Open Data Community (ODC) within the organization. This community consists of employees with different types of expertise. It functions as the central body for open data affairs within the organization; for publishing Enexis open data as well as integrating external open data services within the organization. Their mission is to prepare necessary policy and establish governance around open data activities. Part of this is for example an evaluation procedure for open data requests from external parties.

Another important result is the start-up of TKI Switch 2 Smart Grids Project: 'Toegankelijke Energie Informatie' (TEI), ('accessible energy information'). This project is funded by the Dutch Government, which aims on facilitating the energy transition and in particular stimulating smart grid innovation. Enexis is leading party within the project, supported by TNO[4] and KPN[5]. The goal of the project is to implement a proof of concept open data platform, in which multiple parties cooperate in offering and re-using energy data. The project chose a use case approach. This means that by elaborating promising use cases which the platform can facilitate, the architecture of the platform will be shaped. By doing so, in an early stage external parties were being involved, enlarging the support base of the project.

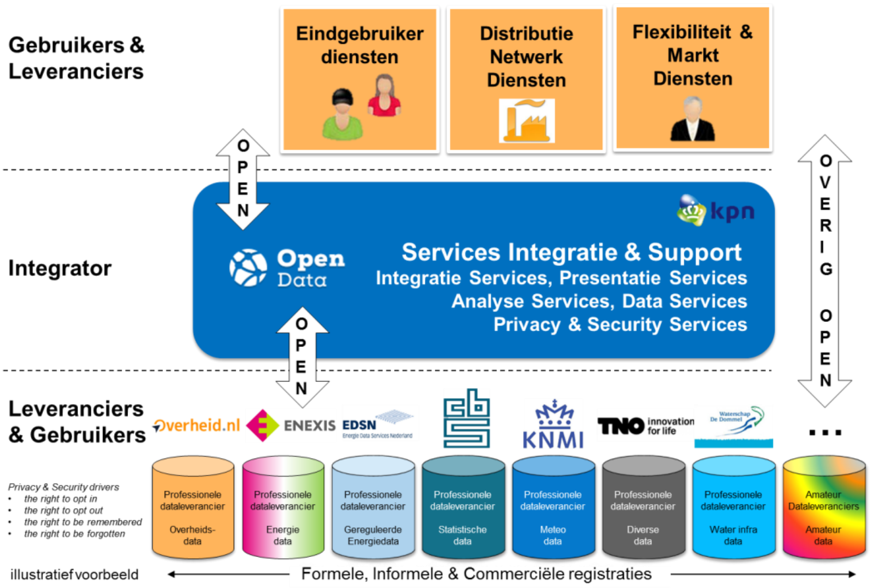

Figure 17. Illustration of TEI project.

[4] TNO is an independent, Dutch organization, founded by law in 1932 to enable business and government to apply knowledge.
[5] KPN is a major supplier of telecommunication and IT services within the Netherlands.

The project is currently running for one year. Several use cases have been selected for different defined domains: 'end-user services', 'DSO services' and 'flexibility and market services'. In 2016, a working open data platform will be delivered, offering the selected use cases as implemented services.

Last important result is the established cooperation with external partners. Important partner is the 'Platform Open Data', which is part of Netbeheer Nederland[6]. All Dutch electricity DSOs are represented within this body, that discusses open data affairs on a national level. Added value of such a national body is that organizations who request open data on a national scale, have one point of contact instead of having contact with all DSOs separately. Furthermore, DSOs can easier align their open data policies and support each other in implementing their open data strategy.

7.4 Stepping stones: towards professional implementation

After three years of pioneering activities the time has come to upscale the started activities to professional, organization wide implementation. Several steps need to be taken to achieve the in the previous paragraph defined vision. These steps will be described in this paragraph.

7.4.1 Lifecycle implementation

As described in chapter 5, open data lifecycles give organizations guidance in implementing an open data strategy. Since most lifecycle models are not based on empirical findings, Van Veenstra and Van den Broek developed a lifecycle model based on literature and practice (Van Veenstra & Van den Broek, 2014). The model defines five main phases: identification, preparation, publication, re-use and evaluation. Also the related activities and roles which need to be played within the different phases are being defined and elaborated in their study.

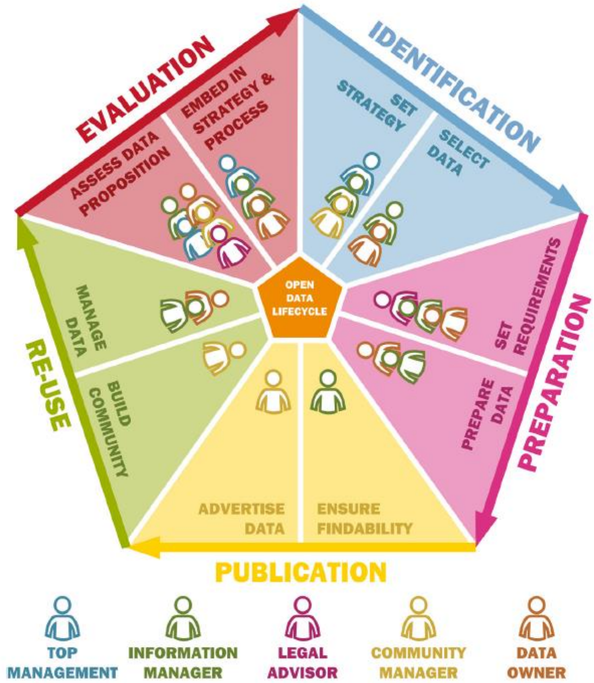

Figure 18. Open data lifecycle.

Notable conclusion of the study is that open data implementation is an organization wide change process, in which management, operations and the community surrounding an organization play important roles. This while mobilizing organizational support for an organization-wide open data strategy is being experienced as a barrier during the entire process. By following a predefined lifecycle, all actors can be defined upfront. The lifecycle subsequently gives guidance during the entire process.

This process starts with identifying data sets eligible for open publication. Within Enexis, not much effort has been made so far in the analysis necessary to do so. When starting with this analysis, it becomes more concrete what the organization can expect from 'open data implementation' which

[6] Netbeheer Nederland is the Association of Energy Network Operators in the Netherlands.

can benefit the acceptance of it. Furthermore it becomes concrete which data is not eligible for publication, avoiding unnecessary concerns of stakeholders.

Second phase is the preparation phase, in which the data is being prepared for publication. Data sets are rarely immediately prepared to be published. Steps to be taken in this phase could among others be: anonymizing data, converting data into a machine readable, open format and adding meta data. Important aspect for DSOs is the storage location of the data. EDSN[7] plays an important role in this as for instance manager of the 'Centraal Aansluitingsregister' and 'Productie Installatieregister', two important datasets related to DSOs.

Third phase is the publication phase. First step in this phase is to ensure findability of published data. Best solution to achieve findability is to make use of an open data platform. As Enexis is a semi-public organization, it can join the Dutch governmental open data platform. By joining existing platforms, proliferation of open data platforms can be avoided, which benefits the findability of the data. Second step is to advertise the published data. This is a clear task for Enexis' community manager. Different forms of communication may be suitable, such as press releases, blogs, app contests, hackathons, information sessions etc.

Fourth phase is the re-use phase. This phase focusses on community building and data management. When actively collaborating with stakeholders, a network will rise around the data. This network can be used as an instrument to foster the re-use of the published data, but also as a source for feedback. This feedback can be used to manage the data, for example to revise incorrect parts of the data set. Other aspects of data management are for example updating the data, updating the metadata and keeping track of the durability of the data.

Fifth and last phase is the evaluation phase. Part of this phase is assessing the value proposition. In this step the results of publication should be evaluated. This can be financial results, but also social results like transparency. Last step is to embed open data in the organizational strategy and processes. All stakeholders should be involved to evaluate the process, strategy and results to learn from mistakes made and give input for a revised strategy.

When all steps being gone through, the organization likely needs to go back to the beginning and start a new cycle. Whereas the first cycle could function as a pilot project in which just one or a few data sets are being published, a second and third cycle can be used to upscale the amount of published data sets and improve the quality of the implementation process.

As the life cycle model gives guidance from the first steps of open data implementation, the Community Managers of the 'Open Data Community' of Enexis and 'Platform Open Data' of Netbeheer Nederland should start a first cycle, bringing together the necessary human resources and together gaining first experiences.

7.4.2 Role within open data value chain

As described in the previous paragraph, different roles can be played within an open data value chain: data provider, aggregator, integrator, consumer and added value service provider. Question is which role Enexis wants to play within this chain and which role Enexis is allowed to play. *As long as the data publication is in compliance with the law, Enexis can play the role of data provider. Also the*

[7] Energie Data Services Nederland (EDSN) supports the data traffic between parties in the energy market.

role of data consumer is obvious as Enexis can make use of existing, external open data which benefits the own operations.

The role of data aggregator is more complex since questions can be raised in which degree Enexis should invest in open data processing for external purposes. This for example to avoid privacy infringement, but also to create added value. *Guideline in this should be the facilitating role Enexis has in society, as long as the result of the aggregation is generally applicable.* In this way the result of the aggregation remains open data, carrying business value for the public, instead of creating added value for certain organizations. When doing so upon request of external organizations, these organizations may be charged for the costs made. Making profit is in this light not desired.
Data aggregation for the own benefit is allowed and even recommended, as long as the benefits outweigh the investment.

7.4.3 Licensing

To prevent legal issues about unintended or unwanted re-use of data, open data should always be subject to a license, describing which type of re-used is allowed an which not. Internationally recognized and recommended are the Creative Commons[8] licences. These licenses incorporate a three-layer design:

1. The first layer consisting of legal code in the kind of language and text formats suitable for lawyers;
2. The second layer summarizing the most important features of the license in a user-friendly way and understandable for the public;
3. The third layer summarizing the license features in a format understandable by software and other technology.

Figure 20. Creative Commons, three layers of licenses.

Different types of licenses exist, comprising different levels of openness and allowing different types of re-use. Depending on the intended re-use, the data supplier should choose the desired license, setting the right conditions for re-use. By adding the licenses to the meta data, data consumers are aware of the conditions on which the data is being distributed and available for re-use, providing the data supplier with an instrument to protect his data from unwanted re-use.

Apart from choosing and communicating a proper license, analysis on the legality of publication should take place. Part of this should be analysis on the ownership of the data, possible privacy infringement and possible market disturbance. Also the correctness of the data should be assessed to prevent issues concerning damage due to re-use of incorrect data.

[8] "Creative Commons is a nonprofit organization that enables the sharing and use of creativity and knowledge through free legal tools" (Creative Commons, 2014).

8 Side-effects

Apart from the identified facilitating potential of open data for the energy transition, different side-effects can be mentioned of open data implementation by DSOs. Four side-effects will be elaborated, namely ‘increased transparency towards stakeholders’, ‘increased revenue of data, gathered with public funding’, ‘public facilitation’ and ‘increased data management quality’. This thesis does not go into further detail on potential applications of open data.

8.1 Increased transparency towards stakeholders

Apart from openness aiming on the creation of added (business) value, openness can also be aimed on transparency towards stakeholders. The in paragraph 5.4 described Open Government policy is a clear example of openness aimed on transparency and accountability. Especially in the (semi-)public sector, where activities are indirectly sponsored by tax payers, transparency in expenditure is important to guarantee responsible investments and avoid corrupt practices. Open data can contribute to transparency by providing insight to the public in organizational activities, resulting in full accountability to all stakeholders.

8.2 Increased revenue of data, gathered with public funding

As activities of DSO’s are indirectly sponsored by the government and thus by tax payers, enabling re-use of related data by the public is a logical consequence. ‘Directive 2003/98/EC on the re-use of public sector information’ encourages the publication of open government data. The Directive intents to “facilitate the creation of community-wide information products and services based on public sector documents, to enhance an effective cross-border use of public sector documents by private companies for added-value information products and services and to limit distortions of competition on the Community market.” Also DSOs fall within the scope of this Directive.

Interesting paragraph is the one defining the term ‘re-use’:

“*‘re-use’ means the use by persons or legal entities of documents held by public sector bodies, for commercial or non-commercial purposes other than the initial purpose within the public task for which the documents were produced. Exchange of documents between public sector bodies purely in pursuit of their public tasks does not constitute re-use;”* (European Parliament and Council, 2003)

Noteworthy is the explicit mention that commercial re-use is allowed, other than the initial purpose. When not allowing commercial re-use, the development of new innovations by market parties, using public sector information, would become much harder. Where appropriate, data suppliers may impose conditions for re-use through licences, as long as the conditions unnecessarily restrict possibilities for re-use or restrict competition. The latter refers to Article 10, which states that “any applicable conditions for the re-use of documents shall be non-discriminatory for comparable categories of re-use.” So opening up data should always be done in a non-discriminatory way, as also stated in paragraph 7.2, section 8.

8.3 Public facilitation

The semi-public nature and non-commercial character give DSOs a facilitating role in our society. Every activity of these utilities should be aimed on serving the public good. Where formerly the public only expected electricity distribution from DSOs, nowadays the value of data DSOs possess, triggers the public to demand for data distribution too. Data, created with public funding, shared for the public good. When DSOs act following their utility role in society, data sharing is inevitable. It is what the public expects and what the public will esteem.

8.4 Improved data management quality

When pro-actively opening up data for external parties, these data automatically become available for internal re-use. This can simplify data exchange between different systems within an organization, which is often hard due to data lock-in in specific systems. Also new processes which need input of data can be set up more rapidly, as the needed data is already accessible.

9 Conclusions

The energy sector is moving. Decreasing fossil fuel stocks, the desire for less dependency on the import of fossil fuels and the need to reduce carbon dioxide emissions ask for major changes: in the generation, distribution and consumption of energy. Changes which all together are being called the energy transition.

As described in chapter 4, two major problems of the energy sector are 'problematic measuring of effectiveness and feasibility of policy' and 'problematic balancing of demand and supply in a flexible way'. Based on the analyses in chapter 4 and 5 and the verification in chapter 6, it can be concluded that open data can function as an instrument to solve both problems. As an instrument which can be used to provide better insight in the energy sector, resulting in a more effective and feasible energy policy than policy merely based on assumptions and unilateral analyses. And as a means to boost the implementation of a Demand Side Management system, facilitating flexibility in demand and supply of electricity.

The research question of this thesis is: is open data a potential facilitator of the energy transition? As open data can facilitate the dissolving of two major problems of the energy transition, it can be concluded that open data is a potential facilitator of the energy transition. Based on this research, no more conclusions can be drawn on additional potential of open data within the energy sector. Also, since the energy transition comprises many more challenges, open data remains a potential facilitator of the transition. However it cannot be excluded that open data cannot also facilitate these challenges. Nonetheless, when the interests for energy data continue to rise, open data can gain momentum, enabling new developments which cannot be foreseen yet.

As described in paragraph 7.2, for DSOs counts that open data contains a lot of potential value for future challenges, by providing as well as integrating open data. Also from the market an increasing amount of requests for energy data arises. As a result, the Energy Agreement prescribes that the rollout of smart meters should become public as well as energy consumption data. The latter mainly to provide insight in consumption patterns for energy saving purposes.

When discussing DSO's activities, the regulated role of DSOs in society and their assigned primary tasks should always be kept in mind. As the environment in which DSO act, changes, DSOs should respond and anticipate on future challenges. This to safeguard a continuous distribution of electricity in the future. Their utility role should encourage DSOs to open up valuable energy data for public benefit. Perhaps even more important is to seize the opportunity to integrate externally available open data within the own organization. This to increase the efficiency and effectiveness of internal processes.

10 Discussion and suggestions for further research

As described in chapter 5, the exact re-use of published open data and its potential future application cannot be determined upfront. Therefore it is often hard to make estimations on the added value of publishing open data and thus to make a positive business case. This will be easier when inventorying concrete needs for data. Also maintaining contact with re-users of previously published open data can result in indications for data in which other parties are interested.

Also within Enexis questions on the necessity to publish data on the internet rise. Not only the possible added value for the public is being criticized, but one also wonders whether DSOs are responsible for the publication of this type of data. This touches a fundamental question in the discussion on open energy data, namely: who is responsible for the gathering and publication of reliable energy data?

Currently, no central platform exists for the publication of open energy information, which is an important element of open data publication (chapter 5). Within several other sectors such platforms already exist. For example the ‘Informatiehuis Water’ (IHW), which was established in 2010 in partnership with the Dutch Government, the ‘Interprovinciaal Overleg’ (IPO) and the Water Boards. The IHW is a platform, enabling the gathering and publishing of uniform, accessible and usable information on water. It among others plays an important role in the national and international reportage obligation for the Water Boards.

A similar initiative for energy information would help all organizations, which are active within the energy sector, in publishing and retrieving reliable energy information. Question is who should initiate such initiative. Because of the governmental interests in energy production and consumption data (for example for energy saving purposes), the government would be a logical partner. But as also market parties are interested in energy data, one could argue to let market parties invest too in such an initiative. And what should be the role of the DSO in this? Further research should focus on the feasibility of such a platform, the added value of it and the organizations which should be responsible for implementation.

Another point of discussion is how to involve energy consumers in the publication of their consumption data. As energy consumption data are privacy sensitive, publication by DSOs of consumption data on an individual level without explicit consent of the consumer is not allowed (paragraph 5.2). As explained in chapter 7, aggregation to a level which makes the data non-reducible to individual consumers could be a solution. This assuming that consumers do not want to publicly share their consumption data. But what if consumers are willing to share their consumption data with third parties, in return for a favour? Currently no mechanism exists to put the consumer in charge of sharing his (energy) data. Further research should focus on the exact requirements of such a mechanism and who should be responsible for implementation.

Apart from the publication of open data, the integration of existing open data within the organization can benefit internal processes(chapter 5). For example the ‘Basisregistratie Adressen en Gebouwen’ can function as principal source of address data, replacing systems which can contain different or outdated data. DSOs are aware of the value of integrating external datasets, however a concrete need has never been examined. Further research should focus on the vulnerabilities in the current data landscape, external datasets which could replace these vulnerabilities and the availability of these datasets as open data.

11 About Enexis

As one of the major DSOs in The Netherlands, Enexis provides about 2.6 million customers with electricity and gas, mainly in the northern, eastern and southern parts of the country. In 2009 Enexis officially split from Essent NV, which effectuated the intended goal of splitting the roles of electricity provider and distributor.

Figure 21. Enexis' service area. Green: electricity, purple: gas.

Enexis formulated its mission as follows:
"Enexis does its utmost to ensure a sustainable, reliable and affordable energy distribution to its customers."

The strategic pillars underlying this mission are:

- Reliability of both the infrastructure and the organisation;
- Affordability as a duty to customers who have no choice regarding their grid operator;
- Sustainability as an instrument for realising the energy transition and a logical task for a modern, socially relevant company;
- Customer-orientation, whereby the company strives to deliver the highest quality of service to its customers.

Enexis is an active player within the energy sector, regarding the publishing of open energy data. To gain more experience with open data, Enexis formulated the assignment to analyse the potential of open data for the organization and offered its services to this research. The results of the research will be used to support a professional open data implementation within the organization.

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Perspective: Distribution System Operator

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Discussion and suggestions for further research

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Appendix: about Enexis

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