Institutional and technological change in the modernization of the electricity network

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1 Introduction

Infrastructures such as telecommunication, electricity, and railway have been liberalized in the recent decades. This resulted in various performance outcomes among countries and sectors. Nowadays, there is a growing concern that these liberalization efforts might have resulted in electricity networks with insufficient incentives for modernization. For example in the Netherlands, a substantial number of components of electricity networks date from the 1960s. Assuming a life time of approximately 40 to 50 years, there is a need for either replacements or upgrades.[1] In addition, the load of the networks is growing annually with approximately 2%. The problem is not just Dutch or European. A recent global survey of the utilities sector identified the most attributable cause of security of energy supply issues: the lack of infrastructure investment and the lack of capacity (PWC, 2005).[2]

The modernization of the electricity network is interpreted as the process of bringing the technical network up to date, to giving it a modern character and adapting it to modern needs and habits.[3] This means that any effort to change the overall ageing process of the electricity network by implementing or renew technological artefacts is considered a path of modernization. Concrete examples are the replacement, expansion and renovation of existing networks by implementation of new components and entirely new systems. The part of modernization that we focus on is technical change of the

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[1] See e.g. interview with Johan Smit in (NRC, 2003) who emphasises the urgency for modernization.

[2] Others referring to the problem and possible lack of long term investments: Graves and Baker, 2005; von Hirschhausen *et al.*, 2004.

3 Modernisation of networks should be understood as an engineering concept and should not be confused by similar nomenclature within different fields. For example, modernism is a cultural movement that generally includes the progressive art and architecture, music, literature and design which emerged in the decades before 1914. It was a movement of artists and designers who rebelled against late 19th century academic and historicist traditions, and embraced the new economic, social and political aspects of the emerging modern world. In addition, the concept of modernization should not be confused with modernization theories from sociology that have been developed and popularised in 1950s and 1960s

network. What are the barriers and drivers of innovation and adoption of new technology? A glimpse of the answer may be obtained through a comparison before and after the start of the sector reforms in 1989. In order to assess these hindering and stimulating factors for modernization, we follow an institutional and innovation theory approach which focuses on the institutional and technological change. We first present the framework to analyze the modernization process of networks. Second, we explain the logic of the different parts of the framework. Furthermore, we will illustrate the framework with the Dutch electricity network. In conclusion, we reflect on the results and the framework itself and give suggestions for further research.

2 An analytical framework of network modernization

The following section will explain the concepts in the analytical framework (see fig. 1).

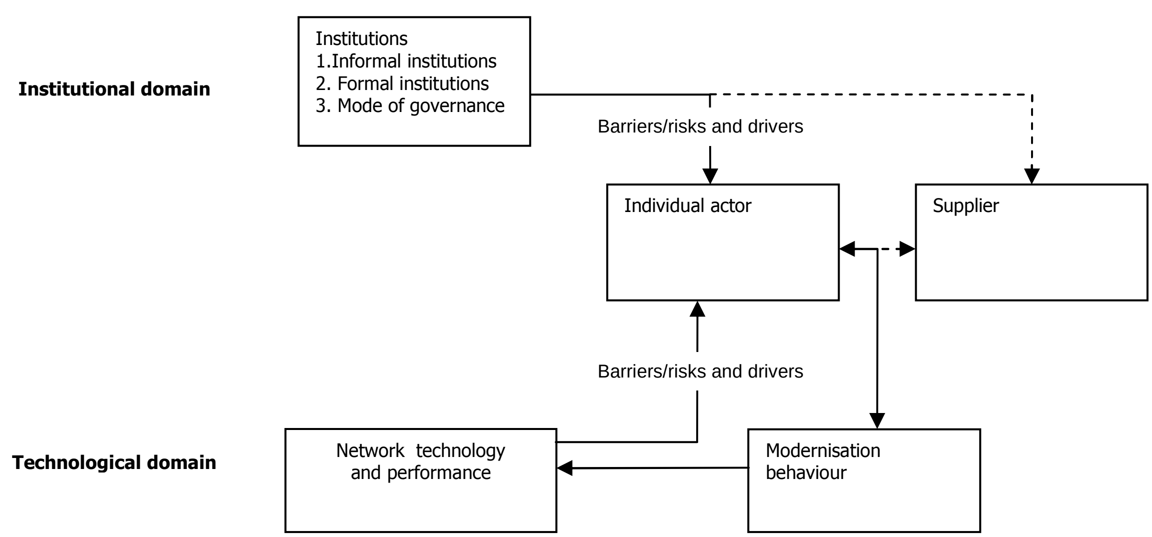

Figure 1. Analytical framework

2.1 Institutions

A useful framework for understanding the economics of institutions is provided by Williamson (1996 and 1998) and Groenewegen (2005). They make the distinction between informal institutions, formal institutions, institutional arrangements and individual actors. The informal institutions are related to the embeddedness of behaviour of actors, like values, norms, traditions, and customs. These institutions are socially and culturally inherited through many generations. Change in this level is usually very slow. The formal institutions are the formal rules of the game. This level of analysis is comprised of formal legal arrangements such as the legal rules, like property rights and the public organisations like bureaucracies. The institutional arrangements deal with the governance and the play of the game. Analysing from the firm's perspective, organisational and contractual arrangements need to serve the individual objectives of the actors. The purpose of this new institutional economics is to explain the institutional arrangements given the formal institutions and the preferences of individuals. Our current research aims at explaining the process that results in a certain modernization actions given certain institutional and technological selection environments and certain preferences of individuals with regard to the implementation and selection of a variety of technologies. In the proposed framework the "institutional selection environment functions as a set of 'signposts in innovative behaviour, 'selecting' […] the type and direction of innovative paths in society." (Steen, 1999: 93). This is closely linked with the approach of the national systems of innovation (NSI) which looks at technical change and innovation processes from an institutional perspective. It considers the institutional set-up of an economic system as the constraints and incentives, or the barriers and drivers, for innovative behaviour.

2.2 Network technology and service characteristics

The technology also serves as a selection environment for modernization. We distinguish between technical and service characteristics of technology similar to Saviotti's (1996) twin characteristics framework. We assess the technological network characteristics at different levels: artefacts, structure of the network and technological regime. The first level is at the level of artefacts and refers to the approach of complex products and systems. The unit of analysis is the complex system of the electricity network, which can be understood as a technical hierarchy, consisting of materials, components, devices and subsystems. This view has a strong focus on the artefacts itself. Another approach is the network approach.[4] Some concepts include central versus distributed (coordination), density, planar versus non-planar, number of cycles, isthmus connections, types of network and directions of flows. The technological regime refers to the distinction between embodied and disembodied technology. The technological trajectories are the pathways of incremental technological innovation resulting in physical hardware. Nelson and Winter (1982) explain the occurrence of these trajectories by technological regimes, described as the cognitive routines that are shared by engineers and designers in different companies. The technical network characteristics influence the network service characteristics, which refer to the functionality and performance of the network.

The network service characteristics are divided in technical performance and economic performance. Technical performance refers to quality of electricity supply, a

[4] For a good assessment of the structure of these networks and their development, I refer to the network typologies as proposed by scholars like Barabási (2003) and Newman (2003).

concept that is divided in dimensions of reliability,[5] power quality and commercial quality (CIGRE, 1987, 1992).[6] Economic performance refers to the productive or price efficiency. Productive efficiency can be defined as using the least amount of resources to produce a given good or service or output is being produced at the lowest possible unit cost. The allocation efficiency refers to serving all customers that are willing to pay at least the market price.

2.3 Actor

The main actor in the process of modernization, the netcompany, is the executor of modernization behaviour, deciding on particular investments with regard to modernization. Another important actor is the supplier of technical equipment. The behaviour of the first actor is viewed in two phases of the modernization process: the innovation phase, in which technical change is created, and the adoption phase, in which an innovative technology is implemented by the net operator.[7] The supplier will only in certain situations play a relevant role in the modernization process.

Our approach taken is methodological interactionism, assuming upward and downward causation of institutions and the actor. However, as we view the modernization actions of the actor towards the physical network, we will focus on the influence of the institutions on the main actor rather than on the influence of the actor on

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[5] Adequacy is a measure of the ability of the power system to supply the aggregate electric power and energy requirements of the customers within component ratings and voltage limits, taking into account planned and unplanned outages of system components. Security is a measure of power system ability to withstand sudden disturbances such as electric short circuits or unanticipated losses of system components or load conditions together with operating constraints. Another aspect of security is system integrity, which is the ability to maintain interconnected operations. (

[6] Some infrastructure scholars make a distinction between basic service and value added services. The first two dimensions refer to the basic service, the third to the value added services.

[7] See e.g. Voss (1988).

the institutions. Next to the institutions, the actor is influenced by the technical network characteristics in the decisions regarding modernization.

2.4 Modernisation

Modernisation activities are related to making the network fulfill modern needs based on the contextual view of network technology as a system in context. This view, developed within the evolutionary economic literature, helps to understand why certain technological options are chosen by companies, the reasons of which have to do with the technologies in place, the adoption capabilities and the mental models of industrialists and nature of the regulations and market conditions (Kemp *et al.*, 2003). In evolutionary economics, concepts from the biological evolutionary field are applied in the analysis of the process of technical change (Metcalfe, 1989).[8] Variation and diversity of technology exist because of deliberate or unintended innovation. The variety of technology enables the selection mechanism. Through the selection of certain innovations, the direction of technical change is determined. The variety of innovation is bound by the *technological paradigm* (Dosi, 1984). The direction of technical change follows a certain so-called *technological trajectory*, or, "a cluster of possible technological directions whose outer boundaries are defined by the nature of the paradigm itself" (Dosi, 1984: 154). This introduces the main dichotomy of technical change is between incremental change and radical or disruptive change often characterised by its impact on existing markets or businesses. Incremental innovation refers to an evolutionary innovation, a step forward along a technology trajectory with a high chance of success and low uncertainty about outcomes. Radical innovation, on the other hand, involves larger steps in the

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[8] See e.g. Basalla (1998) for an empirical application of the evolutionary perspective using novelty, diversity and selection as the main explanatory concepts.

advancement of a technology or process. Using relevant concepts from the evolutionary economics, we distinguish these modernization actions between the phases related to the previously used concepts of variation and selection: innovation and adoption. As we are interested in the innovative elements introduced in the network we will focus on these two concepts and the barriers and drivers that accompany these activities. Three situations of the first phase, innovation, will be elaborated (see fig. 2).

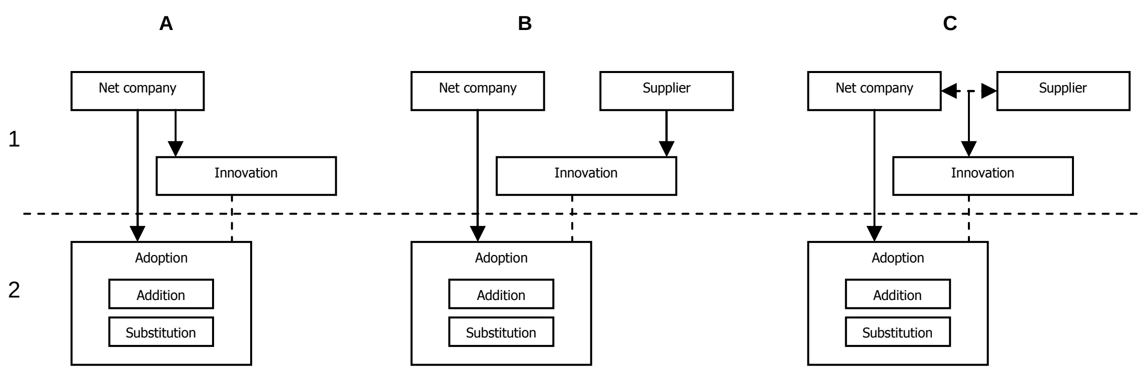

Figure 2. Modernisation actions

According to fig. 2, (A) is the situation in which the net operator performs the role as innovator, which can be regarded as a technology pull. In situation (B), the supplier performs the role as innovator, often referred to as a technology push. In that case it might also ne a driver to modernization. Situation (C) is a combination of both. In this case the innovation is delivered as cooperation between the net operator and the supplier.

The second phase is when the net operator adopts an innovation by implementing it into the network. A distinction can be made between the addition and the substitution of a component, as is common among network operators. Substitution of a component is described here as the dissolution of one component of the electricity network and the simultaneous deposition of another in its place. This view is strongly related to substitution approaches which understand technological transitions as a replacement process in which new technology substitutes existing ones (e.g. Nakićenović, 1986; Grübler 1991, 1998 and Farell, 1993). This is typically referred to as competition. "Substitution of a component," according to Geels (2005: 33) "may have wider cascade dynamics in the entire artefact [the network]. Changes may thus cascade from lower to higher levels in the technical hierarchy." However, according to Pistorius and Utterback (1997: 68), "there are many cases where technologies interact in a relationship that is not confrontational and where the interaction between technologies is therefore not one of competition in the strict sense of the word." This is often referred to as symbiosis or the addition of components. This is the case where two technologies have positive reciprocal effects on one another's growth rate. The addition of components relates to the emergence of technology rather than shifts from one technology to another. Addition of components and systems might be done to make the system more redundant or to raise its overall capacity.

2.5 Barriers

Barriers are related to every step in the modernization process as depicted in the framework. An institutional barrier might be regulation that has perverse incentives with regard to modernization. A barrier related to radical technological change can, for example, be found in the need for extra investment in learning to install and maintain the new technology. Risks form a distinctive barrier to the modernization of networks. Different ways of modernization are accompanied by different risks. Moreover, new developments such as liberalisation of the sector might induce new risks. Morgan et al. (2000) believe that it is infeasible to compare and rank large numbers of risks systematically. Hence, we will only assess the most prominent risks that accompany modernization.

2.6 Drivers

Drivers can be appointed to several phases in the analytical framework. For example, in the institutional part, the political urgency for a sound electricity supply can be the driver for certain modernization changes related to investments related to security of supply. Also technological progress can be a driver to innovate. There are drivers that demand a network change, such as the substantial penetration of distributed generation. Note that a driver for a certain direction of change can be a barrier for another direction.[9]

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4 The electricity sector in the Netherlands

The Dutch electricity sector provides a sound illustration of the barriers and drivers in the different phases of the modernization process. The adoption of the 1989 Electricity Law was a major breakthrough in the liberalisation process. A comparison between the situation before and after this law would reveal the major changes in the modernization of this sector.

The empirical data is obtained by semi-structured interviews with Dutch electricity network experts: five experts from the transmission network company, six experts of two distribution companies, four experts of three equipment suppliers and one experts from the major research consultancy institute on electricity network equipment. All experts have a long working experience in the sector, sometimes at several network (related) companies.

[9] See Künneke (2003) for an overview of recent drivers for innovation.

4.1 Pre-reforms developments

In the Netherlands, before adoption of the 1989 law, the energy sector used to be very regional, taking care of their integrated regional production and network facilities. These companies were divided into provincial energy companies and municipal energy companies. The provincial companies were richer and larger than the municipal companies. Due to the financial situation of the provincial energy companies there was a lot of room for innovators. This institutional arrangement could (partly) explain their informal attribute of innovativeness of net companies that merged out of provincial companies. The many different regional utilities companies were united in the Samenwerkende Elektriciteits Produktiebedrijven, a central coordination organisation for production and transport of electricity. Moreover, it was responsible for the construction and maintenance of transmission lines.

During the 1960s and 1970s there has been a huge expansion of the electricity grid. Reliability was the main cultural attribute of the sector. Therefore investments were done to make the network more meshed. Moreover, there was quite some overinvestment in the sense that, there was anticipation on future demands in the construction of the grid. The reliability paradigm made the sector somewhat reluctant to risky innovations. All the interviewees agree on this. However, the history has shown many innovative activities at the component level, e.g. from oil pressured cables to plastic cables, from mechanical relays to electromagnetic ones to digital relays, from pneumatic switches to electromagnetic switches, etc.

4.1.1 Innovation

Energy company innovation

Reliability was the informal institution to which companies adhered. The innovations were partly driven by this. Moreover, small scale innovations were easy to initiate and to implement due to the easy discount of the costs of the innovation risks in the network tariffs. The energy companies mainly comprised of engineers. The personal interest of engineers in technology was a big driver for innovation. In general it was found that most innovations started from personal initiatives of employees. These uncoordinated activities led to many non standardised innovations. The question is whether this was beneficial economically overall. Next to these informal innovation activities, the electricity companies used to have laboratories in which they could do their innovative research.

Supplier innovation

The situation right after the Second World War was that of a sector in which knowledge on innovation was low. There were only few Dutch suppliers and most of the equipment was purchased from France. Gradually numerous national technology companies emerged, such as suppliers of cables and switches, suppliers of transformers, suppliers of converters, and a new testing and a certification company. A more mature national electricity sector came into being. Moreover, the energy companies and the suppliers increased their cooperative efforts of innovation.

Joint innovation

The energy companies got accustomed to cooperation and collective long-term planning. The innovations were institutionalised in the long term research assignment of the main national research institute on electricity and the energy companies. The energy companies did not compete in this institutional setting so technological information was freely distributed among actors. Looking at the main actors and the innovation process, we see that innovation was often jointly performed by the numerous small national suppliers in cables, switches. Due to the relatively small size of these suppliers, it was easy to make these companies participate in innovation projects. Moreover, the small sizes of the energy companies made it very easy to test innovative products as approval procedures were quick and informal. Another factor was that innovations were easy to initiate and to implement due to unlimited discount of risks in the network tariffs. This resulted in innovations, out of hobby instead of economic viability.

A barrier could be found in the contractual procedures of a joint effort. We see that the tendering from the energy companies to the equipment suppliers were mostly on technical specifications. This leaves no room for joint innovations, but could be regarded as merely a tender procedure of prescribed conventional technology.

4.1.2 Adoption

A general barrier to adoption of new technology is the risk averseness and the conservatism as part of the informal institutions. Conventional technology is ‘proven technology’, while new technology has a risk of failure. Experience with a new technology can be an important factor for adoption. As the companies were relatively small it was easy to test the new technology. Permission was more easily granted by the engineer in charge due to the informal links between employees in a small company. A sound financial situation of the energy company, i.e. provincial companies, gave extra financial room for innovators to implement their innovations in the network. From the

1960s on adoption of a certain technology was hindered by provincial and municipal regulation on electricity lines. This was a driver for innovation in direction of cables technology.

4.2 Since the adoption of the 1989 Law

The 1989 Electricity Law initiated a major change in the sector. This Law replaced the internal planning mechanism with the market mechanism, signalling a major change in governance structures. It compelled a separation of electricity production and distribution. Moreover, it created the energy distribution company (Verbong and Geels, forthcoming). The Law also introduced market mechanisms on the supply side, as electricity production by other actors became free.

In 1998 the Dutch adopted a new Electricity Law which extended the market mechanism to the consumer side. This Law created new actors such as Tennet, the national system operator responsible for maintaining the energy balance and for operating the transmission grid. Tennet is regulated by the Dutch regulator. This regulator also regulates the regional distribution company, of which about thirty exist. The role of the regional distribution company is to transport the energy from the transmission grid to the consumers. It is connected to a single system operator and it does not have the responsibility nor the authority of managing the energy balance. This technical system nowadays consists in total of approximately one hundred thousand of substations and hundreds of thousand kilometres of cable in network configuration. The rules and regulation for the net companies with regard to investments in the network is laid down in the Netcode. In the first regulation period (2000-2003) an x-factor was introduced, an efficiency factor for as an incentive to cost efficiency that limited the discounting of network costs into the tariff. The imposed x-factor of the regulator resulted in a substantial downfall of investments. It has, however, next to IT been a driver for innovations with regard to asset management technologies. Using these technologies is much cheaper than replacement of assets. Due to the x-factor regulation so-called services for retrofits emerged: replacement of only the critical components that are at the end of the life time and keeping the framework intact. This has been a trend of last eight years. The second regulation period (2004-2006) the q-factor was introduced that took into account the quality of the network. This is accompanied by a focus on innovations related to quality and reliability.

4.2.1 Innovation

Net operator innovation

After the x-regulation, the focus shifted more towards regulation on quality by adding the q-factor in the regulation. This gave a drive to innovation of quality measuring and improving technology. The lack of cheap and simple products for monitoring power quality etc. led to new innovations by smaller companies for cheaper equipment. Installations have all been incrementally innovated towards more functionality and more advanced, lately by big international suppliers. However, this made the costs of investments also increase. This barrier to adoption has been a driver for innovation of a cheaper alternative.

An important barrier for innovation can be found in organisation of the main actor: the net company. First, may engineers have been replaced by people with an economic background. Second, the budget for innovation has become a trade off with the annual bonus of the chief executive officer. Third, the shareholders of the company are nowadays more interested in safe investments with a short payback period than innovative and risky investments. Although there is a tendency to have an innovative company profile, one interviewee responded that media does not pay sufficient attention to this innovative profile in order to be a factor of importance.

A factor for the difference in innovation activities of network companies is also explained by the time that employees are in the same job position. In one company employees were already eight years in the same position and they got so much acquainted with a technology that they were able to innovate on that. In case of continuous mergers and job relocation, it is hard to fully understand the technology which is needed for creative thought on it. Also a driver for innovation is the proximity to a research centre as was seen as an explanatory variable of the innovativeness of a certain net company.

Supplier innovation

The regulation on tendering procedures might have changed the innovation budget of suppliers. As cost efficiency due to the x-factor has been the prime criterion for granting projects by the net companies, the suppliers have been very much focussed on keeping costs low and innovating more on the production process of conventional technology than on the invention of new products. For small national companies the lack of investments and criterion of net companies on costs was very hard. Many small companies have either gone or have merged with international companies. Next to the mergers at the side of the suppliers there is a trend of mergers and acquisitions at the side of energy companies. If we want these power blocks to compete as postulated in European Union law, more interconnections have to be built. Suppliers anticipate on this, by innovations in that direction. Another driver to innovation is the standardisation of equipment by international the suppliers, e.g. the plug and play electronics to every device.

A barrier to consistent supplier innovation is the fluctuating regulation and subsidy schemes for new distributed generation facilities. It is a barrier to innovations of network components required to connect for instance the wind parks onto the network.

Joint innovation

Since the liberalisation there are national subsidy schemes especially for network modernization and innovation. However, in general it was said that the formal budget for innovation decreased since liberalisation. This might be off set by the present innovations that emerge from commercial projects. This is facilitated by the tendency to to base the specifications in a tender document on functionality instead of technology. This leaves room for joint innovations.

Much innovation used to be initiated by small national suppliers in cables, switches. It was relatively easy for energy companies to involve small suppliers in an innovation project. It is much harder with big internationals due to the small scale of the potential subsequent sales, especially when it concerns non standard technology. The few small national suppliers that are still left are sometimes involved in innovation projects to counterbalance the big dependency on the supply and service of the few international suppliers. According to one interviewee, the extra costs of this strategic cooperation are offset by its strategic value.

4.3 Adoption of technology

As already mentioned, the sector generally is conservative and historically driven by the reliability paradigm. There are many examples of net companies preferring to adopt conventional technology instead of innovative technology. The innovative technology might be better or cheaper, but is not ‘proven’ technology. In other words, “the incentives are to invest in established dominant design technology over perceived risky alternatives.” (Unruh, 2000: 825). Also emotion and routines still play a huge role as barrier to adoption of new technology. An example is for instance the present reluctance to adopt of DC cables instead of the familiar AC cables for high voltages.[10]

An additional barrier could be the number of components to add or replace which can make it a costly effort. First, there is a general reluctance to replace old equipment as it is still more or less working properly. Although the new technology would for instance safe energy, the old technology serves its purpose. Second, the great number of replaceable components can make it a costly effort. Moreover, there is the uncertainty of using a new material, e.g. plastic for the usual life cycle of forty years. Third, a barrier can be the extra effort of attaining the technological capabilities to produce and operate the new technology. For example, new machines have to be developed for the production of the innovative equipment. It takes time and learning to make the innovative equipment a cost efficient alternative. The high cost of adoption is even worse when there are only expensive products for sale. In recent decades, installations from suppliers have all been incrementally innovated towards more unnecessary functionality and advancement. However, this made the costs per product very high. This barrier to adoption has been a driver for innovation of cheaper alternatives as innovated in cooperation with small national suppliers. It also was a driver for adoption of an old but robust switching technology, the Magnefix. However, this switch might be a barrier for newer technologies as it is not very flexible in use or expansion of functionalities.

[10] DC: direct current; AC: alternating current.

The focus on cost efficiency by the imposed x-factor also has been a driver for adopting technology with regard to asset management. Due to asset management techniques, from liberalisation on the investments were very low. The low voltage network was very much meshed and radial operated. Before the reforms investments were done based on experience and gut feeling. Due to use of statistical methods and the drive to be more cost efficient it was shown that in order to the minimise costs and failure minutes, the high voltage and low voltage can be equipped lighter and the middle voltage level should be equipped heavier, i.e. more meshed.

In the subsequent period the focus on quality is a driver for adoption of quality measuring and improving technology. For adoption of certain innovative technologies net operators preceded the actual institutional embodiment. Examples are innovations with regard to magnetic fields, such as innovative cables or innovative electricity poles. A big driver is to get a good public profile.

Hobbyism used to be a driver to innovation and subsequent adoption. Nowadays, for adoption a business case has to be made while in the earlier days it was more on gut feeling. Although this can be a barrier to innovation, it also makes sure that present adoptions are economically viable. When there is a good business case for adoption of an innovation, it will not be rejected on base of gut feeling.

However, for radical change technical aspects of the present network might prove to be a barrier. For example, a new technology is the current limiter. This device enables us to use lighter and cheaper electricity cables as they do not require the cables to transport a very high current in case of short circuit. Although there are suppliers developing this, adoption might be difficult. First of all, it will not work with current safety devices. Moreover, it requires the operations to be changed radically.

Taking a look at the development of the actor itself we can state that the big merged net company can serve as barrier to adoption. Mostly adoption is preceded tests. For testing it used to be easy to get approval from your direct colleague. In a big company serving a big network you have to get approval on a higher level and more people have to be informed.

A driver for adoption of new technology can be found in the mergers of the private energy companies. As these companies form increasingly big power zones and if we want to adhere to the competition paradigm as postulated in EU law, more interconnections have to be built. This is a driver for innovation and adoption in that direction.

5 Conclusion

In the Dutch electricity networks, innovation and adoption used to be more driven by informal institutions and cooperative efforts. Although interviewees described the sector as very conservative, we have seen many innovative efforts also before the start of the reforms. We have seen that the informal institutions towards innovation are historically driven and dependent on the critical mass of innovating engineers within the net company. The direction of innovation has mostly been a result of personal interests of innovators or as a big joint effort of companies. Nowadays innovation and adoption is more out of economic interest. This means that current innovations might be more economically effective compared to previous innovations. The present innovations clearly follow the direction of the regulation. First it was on cost efficiency, and then it was on reliability. Many examples of both innovation trajectories were found. Moreover, regulation on underground cables and magnetic fields and the emergence of environmental groups are also triggers for innovation in a certain direction. These barriers for investments proved to be drivers for asset management innovations, new sensors, new cables and new electricity poles.

Due to the reliability paradigm and the intrinsic scepticism to new technology innovations are mostly adopted after thorough testing procedures. However, tests in the actual networks seem harder to arrange in the new bigger companies than in the smaller companies. It was seen that many of the current innovations take place during actual projects. We might see a shift of innovation from research and development projects to innovations “on the project”, integrating the innovation and adoption phase. A driver to this could be the shift from technical specifications to functional specifications in tendering documents, leaving room for innovation. We also have seen that the EU tendering regulation have been shifting the activities of suppliers towards cost efficiency instead of product innovation. It needs further research to assess which of these tendencies prevails.

Our analytical framework proved very helpful in identifying the barriers and drivers of the modernization process. It served its purpose in the factors relevant for the innovation and adoption processes. The paper clearly follows a qualitative approach. The number of interviews made it possible to check data and have certain perspectives confirmed. Therefore, we are convinced that the presented data is a good overview of the barriers and drivers to modernization. However, the barriers and drivers are not exhaustive. Moreover, we do not yet have a good idea of the prevailing barriers and drivers. In line with this, due to the limited number of interviews, no ranking of importance of barriers and drivers could be distilled from the interview data. A quantitative approach would be advisable to obtain more arguments for the prioritisation of these barriers and drivers allowing policy makers to focus on the most important ones in order to stimulate modernization.

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