COLLABORATION IN A WORKING SMART GRID – A CASE STUDY FROM HUNGARY

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Received: May 25, 2021
Received revised: August 4, 2021
Accepted for publishing: August 23, 2021

Abstract

In a traditional electrical supply chain, both the flow of electricity and the flow of information are essentially unidirectional, starting from the power plant and moving to the end consumer. In smart grids, it's all a two-way process; in addition, communication takes place parallel and through a complex network of relationships due to the increased role of the participants. Today, smart grids usually operate in the form of separate pilot projects and are closely related to the technical, legal, market and economic conditions of the national and regional electricity networks. In our study we present the increased and expanded roles of smart grid players. The relationships of actors in an operating smart grid were investigated empirically using the case study method and ANT theory. The good practice presented demonstrates the various benefits of each side and the effectiveness of the learning process related to the non-professional users of smart grid.

Key words: smart grid; managing networks; electrical supply chain

1. INTRODUCTION

If we think of electricity in general, we imagine that the electricity starts from the power plants and reaches the consumer's home or the user's organization. However, the activity of the electricity supply network is not simply electricity, but the availability of electricity where and as much as consumers need it. The electricity supply chain operating today is unique in its kind, not only because of its fixed distribution routes, but also because of its strictly pull-system strategy. While the number of energy consumers and the amount of energy consumed is constantly increasing (the average growth rate of global energy demand will be 1.6% by 2035 (International Energy Outlook, 2016)), electricity supply chains face with a lack of storage and balancing facilities within the system. So, on the one hand, consumers are more dependent on electricity grids today, and on the other hand, they have growing expectations of electricity providers. Maybe smart grids can meet these diverse, high-demand expectations.

Smart grids are automated, widely distributed power supply networks characterized by two-way electricity flow and information that can track and respond to everything from power plants to customer preferences to individual devices (IEEE, (International Energy Agency), 2011). Smart grids can therefore also be seen as an important part of the circular economy.

The technological and IT side of smart grids is a popular topic in journals, while from an economic point of view, mainly smart meters and the tools and mechanism of demand-side management (DSM) are discussed. In our opinion, in addition to the theoretical testing of operating models and scenarios, it would be necessary to get to know more about the behaviour of the participants of smart grids, and examine the inherent uncertainties and risks and thus support the future stable operation of smart grids.

The new tasks, roles and responsibilities of the various actors in this special supply chain raise a number of issues, some of which we will examine in our case study. So we sought answers to the following questions:

- How do non-business actors cope with the increased number and quality of technology in a smart grid in everyday life?
- Are they aware of their increased role in the smart grid?
- If so, how and in what form? If not, does this cause any disadvantage in the operation of the smart grid?
- How do business and non-business actors work together in a smart grid?

2. RELEVANT LITERATURE REVIEW

In this section, we first introduce the key differences between smart grids and the traditional power supply chain, and then explain the increased roles and responsibilities of the involved actors. The topic of relationships and integration of actors in supply chain is a basic classical issue in supply chain management literature in which a new focus is on the empowered customer (e.g. Coyle et al. 2017; Lu 2011). For example the lack of supply chain cooperation – among other conditions – result the bullwhip effect. However poor cooperation among supply chain actors generally may increase manufacturing cost, inventory cost, replenishment lead times, labour cost for shipping and receiving and may decrease the level of product availability etc.

Today national and worldwide energy networks carry all the features of a traditional supply chain and different transmission phases form integrated networks between different producers until the product reaches the final consumer (Hofbauer and Wenninger, 2011). In order to reach the right customer, at the right time, with the right amount and of the right quality of energy, system operators perform supply chain management tasks such as network planning, production planning, order management, sales and operations planning, collaboration with suppliers and customers and a number of other processes through which this global supply chain is successfully designed, operated and managed.

The traditional electricity supply chains tend to operate with strong state influence, are often vulnerable to changes in national policy, and, although interconnected internationally, operate mostly in national markets. In addition, the electricity supply chain is a natural monopoly, in part or in whole, where huge power generators, transmission or distribution companies dominate the markets.

As electricity demand increased by the end of the twentieth century, system operators and power generators are looking for ways to handle peak loads. The costs of building and maintaining peak capacity are shifting in the direction of system operators to study demand periods, prepare appropriate pricing, and encourage customers to shift their consumption from peak to off-peak. The goal is to match consumption to production, which requires a mode of consumption that can only be measured as the daily time of consumption, on the one hand, and cumulative consumption, on the other. The introduction of automatic - smart - metering devices in the 1970s has contributed to the feasibility of smart grids.

In the traditional chain, the role of participants is clear and limited, but this is expected to change in smart grids. “A smart grid is an electricity network combined with an ICT network, adapted to renewable energy sources. Its ‘smartness’ allows balancing the supply and demand of energy on the grid, thus making the electricity grid more sustainable, efficient and robust” (Planko et al. 2017:38). As can be seen from the definition, the diversity of the origin of electricity is already a fundamental feature of smart grids due to the use of renewable energy sources. At the same time, the task of monitoring will also change and self-monitoring will appear. In the case of a problem, the self-healing ability of the system is taken into account, but - in our opinion - this may not always happen due to the behavioural uncertainty of the participants (especially non-professionals). (Faruqui et al, 2010; IEA, 2011)

Our literature review on the behaviour of smart grid actors primarily summarizes the experiences of a relatively small number of empirical studies, most often pilot projects. In most regions, in addition to universities and research institutes, multinational companies take an active part in smart grid pilot projects. But it can be seen at this early stage as well that some important social features will be recognizable in future smart grids, such as the State Grid in China Corporation of China is a primarily central player in today’s relevant network developments (Liu et al. 2020).

Table 1. Comparison of roles of actors in electric power supply chains

	Tasks in traditional electric power supply chain	Tasks in smart grid
power plants	generating power, delivery	generating power, delivery
alternative power plants (e.g. wind)	generating power (not relevant proportion)	generating power (in increasing scale)
commercial and industrial users	whole sale, retail, end-use	whole sale, retail, end-use, services (IT, maintenance)
residential buyers	end-use	producers (e.g. due to renewable energy sources), end-use, retail
individuals who own electric vehicles	-	end-use, recharging electricity (by V2G), retail
energy cooperatives	-	delivery to its customers or members

Source: Own editing

As it is illustrated in Table 1 in the traditional electricity supply chain, electricity is generated by large power plants. The supply chain operates in a pull system, which here means that power plants produce and load as much electricity into the grid as it is needed at the time. In the case of smart grids, not only conventional power plants will be involved in electricity generation, but also renewable power plants (e.g. wind and bio power plants). In addition, during free market operations, electric vehicle owners (business and private) will be involved in production through the V2G (vehicle-to-grid) process. But the question is to what extent the V2G and G2V (grid-to-vehicle) processes will have an impact on the power grid. Actually there are still only pilot projects on this subject (mainly in the US, Japan, Denmark and the United Kingdom) (Wandell, 2020; toyota-tsusho.com; parker-project.com) with the active participation of leading companies such as Nissan or Toyota. And today only some electric cars are capable of V2G (e.g. Nissan Leaf). It is also a major technological problem that the more often a battery is used, the sooner it needs to be replaced. And electric car owners are likely to want to use car batteries primarily while driving, rather than storing electricity and then recharging it into the grid. It seems that the imagination of researchers was soon seized by the V2G and G2V processes, but its practical, technical implementation is a much slower process.

Several studies have addressed the predictable and unexpected behaviour of prosumers as well as a number of factors influencing their behaviour (e.g., Miller et al. 1999; Ko et al. 2009). However, Rathnayaka et al. (2011) go further, as they gather all the economic, cultural, social factors influencing prosumer's behaviour, group them into categories, and plan to create an appropriate algorithm and model in the future. In our opinion, this is forward-looking, because it introduces the expected behavioural variables of prosumers, as one of the key players in smart grids, and enables grid operators to prepare properly. It is also very useful to use the elements and advantages of fuzzy logic or machine learning to model the behaviour of prosumers (e.g. Obert et al. 2018), but if we do not know their presuppositions and beliefs, then we cannot consider alternatives and prepare for them with appropriate solutions.

It often seems that when modelling the behaviour of smart grid actors, the authors assume actors' fully predictable, rational behaviour, although accepted theories claim the opposite. According to Herbert Simon's theory of limited rationality, decision-making ability and capacity are constrained. Simon noted that for complex goals, sub-goals might not be clearly defined. The formulation and designation of these strongly depends on the subjective parameters of the decision maker. These cases are discussed in psychology in the topic of problem visualization. For example, it may be important to manage a complex mass of information so that the formulation of the problem can help solve it. Examining the effects of identification with sub-goals, Simon was always at odds with the classical decision theory paradigm, which only told how to choose between alternatives in such situations, but his predictions clashed with real experience.

Additionally Daniel Kahneman (together with Tversky) developed the prospect theory. The essence of this theory is that people do not usually follow the rules of rational calculation of expected utility or the statistical regularities of forecast when formulating their forecasts and statements (Kahneman – Tversky, 1973). Instead, some basic heuristic procedures are used for judgment. These heuristics can be broadly described as mental operations or "shortcuts" to decisions. In complex and risky decision-making situations, according to Nobel Prize-winning theory, actors often simplify the problem - and instead of rationally analysing the situation – they rely on their subjective feelings, prejudices and thumb rules. (Tversky–Kahneman, 1974; Kahneman–Tversky, 1996)

The prospect theory is also considered suitable by Saad et al. (2016) to study the behaviour of smart grid actors. The authors refer to Kahneman that people do not behave optimally when buying or selling shares and think that end consumers will not behave optimally when buying and selling electricity. On the one hand people can make subjective decisions due to the weighting effect of prospect theory and on the other hand the decisions of other consumers influence their behaviour, so their decisions may change over time. In addition, weather changes have to be taken into account due to the nature of the renewable energy source. Therefore, Saad et al. (2016) propose a probability model that can handle decision-making uncertainties and draw attention to the lack of real data on end-user behaviour.

However some authors see an advantage in expanding the role and responsibilities of consumers on the demand side (e.g. Kirschen, 2004; Su et al, 2009; Goldman et al, 2005). As consumers shift their electricity demand from expensive peak times to lower price periods, their energy costs will decrease. This will also reduce the power generation costs of the system in general. The overall cost reduction will also affect end-users who do not tailor their needs in the way mentioned above. Stoft (2002) and Su (2007) add that this more flexible demand is likely to reduce power plant profits, but in turn will increase social welfare as well as the efficiency of the electricity market. It is therefore questionable to what extent power plants will accept a decline in their profits.

The smart grid was also studied by Almaghrebi et al. (2020) for the behaviour of individual consumers, more specifically electric car owners, using data from electric charging stations in the state of Nebraska. Yanine and co-authors (2020) in Santiago, Chile, study a micro grid that serves 60 homes basically with renewable energy, and found that both energy sharing and an energy reward system for efficient and low consumption significantly reduced the annual cost of electricity consumption. Consumers who did not want to participate in energy sharing were free to do so as the system could handle it as well.

The behaviour of actors in the modern electric supply chain may influence security, flexibility and therefore efficiency issues. We are aware that many theoretical modelling and experiments are taking place on this topic. We think smart grids will create a whole new situation in a number of ways:

- the active role of renewable energy sources (importance / management of weather factors),
- the growing role of technology, including IT,
- new operating mechanisms,
- two-sided (or rather diversified) information flow,
- the emergence of new players in the network (increase in the number and importance of electric vehicle owners, electricity associations), and

- a large-scale expansion of the roles and responsibilities of existing actors (especially end-users).

3. MATERIALS AND METHODS

3.1. Applied case study

In this research, we focus on empirical results and our aim is to draw practical conclusions. We present the experiences of a smart grid operating next to Budapest (Hungary), for which the case study and the ANT theory methodology were used. Babbie (2004) classifies the case study as a subset of the field research from the aspect of data collection. During the application of the case study, one examines and studies a phenomenon that has already happened. What distinguishes the case study from other observation techniques is that it is not merely data collection but also a theoretical activity. The case study is a special blend of facts and experiences.In our research, the smart grid chosen as an observation was not selected at random, but after relevant information collection, so it is an information oriented selection, more concretely "Paradigmatic case to develop a metaphor or establish a school for the domain that the case concerns" (Flyvbjerg 2006:230). The selected smart grid case has almost all the features of the smart grid and uses several renewable energy sources, using the most modern technologies.

Among the widely accepted Yin (2003) case study types (descriptive, exploratory, and explanatory), we used the explanatory type, whereas the type of explanatory case study is a causal story based on a causal relationship that examines which action or decision resulted in the circumstances. The aim of our case study-based research is to present a specific case and to get to know the behaviour of the actors involved, as well as the benefits and difficulties they experience and perceive during the operation and cooperation.

The following data collection methods were used in our case study: extensive documentation on the history and key performance indicators of the smart grid park, site visits, monitoring, and in-depth interviews with the professional operators and non-professional end users.

While in our research we were primarily interested in the perceived and real behaviour of smart grid actors, we also used the ANT theory. Actor–network theory (ANT) was based on studies in social science and technology. The ANT theory is a theoretical and methodological approach to social theory that looks at everything in the social and natural worlds through ever-changing networks of relationships (Latour, 2005). It assumes that nothing exists other than these relationships. Today, ANT theory is used as a research method in other fields of science as well. Indeed, ANT focuses on the relationships that are established and transformed between the human and non-human entities that are part of the issue at hand.

The outline of the in-depth interviews used in the case study was based on the research of Ma and co-authors (2018) that also relied on ANT theory to learn about the working smart grid.

3.2. Introduction and background of case study

In order to examine the Park on which the case study is based, we need to know its social and technological embeddedness. In this way we can better understand the behaviour of the Park (smart grid) employees and their cooperation with ELMŰ (electricity supplier). We also consider a brief summary of the past to be justified, as the events and experiences of the past serve as a basis for the results of today's situation. Our case study examines the management of the Living Future Park (Park) (https://www.livable-future-park.org/home.html), a working smart grid a few km north of Budapest. The Park is located in the Equine Therapy Centre of the International Child Rescue Service (Equine Therapy Centre), more concretely it has been serving the needs of the Equine Therapy Centre since 2012.

The area of the Park before 2012 was garbage, neglected and there was very often a power outage at the Equestrian Therapy Centre because power came on very old wires and the computers also often went down. ELMŰ-ÉMÁSZ, one of the largest electricity suppliers in the country, supplies electricity in this region and has been supporting the International Child Rescue Service for more years. Now it helped the Equestrian Therapy Centre by building a new transformer house, and the Equestrian Therapy Centre became a separate contracting partner for ELMŰ-ÉMÁSZ, thus eliminating the perpetual power outages. Since then, investments and developments have been made in this area year after year.

Today, the Living Future Park includes the following facilities and solutions. The list below is presented because we want to prove that it is a truly world-class smart grid, many of which are not found in Europe either; moreover, the Park does not operate on a test basis for a limited period of time, but in a real, systematic manner, making it excellent for empirical research.

- Small-scale solar power plants (small-scale solar power plant with a total capacity of 15.6 kilowatts consisting of 65 panels), solar-powered, automatic horse feeders and solar hot water production systems.
- Wind farm: a wind farm producing a 20 kW low-voltage grid. One of the advantages of this type of wind turbine is the low starting speed: the blades can move even at a wind speed of 3 m / s.
- Dwarf Hydroelectric Power Plant (Rated Power 200 W): The implemented dwarf hydroelectric power plant generates electricity from the water of the local stream, which is fed into the low-voltage network of the Centre.
- Air-to-water heat pumps (Nominal heat output 14 kW, Nominal electric output 5.21 kW): connected to the heating and cooling system of the Park Visitor Centre. The unit is able to heat in winter and cool in summer by means of an underfloor piping system.
- Energy storage regenerative system (Rated power 20 kVA, rated capacity 84 kWh, number of batteries 372, rated voltage 372 V, operating temperature -20°C to +50 °C): The system is continuously connected to the mains and able to store locally generated electricity in batteries for a certain period of time on the basis of a schedule and then return it to the electricity network if required.
- Smart street lighting and solar park lighting: It can also be used to connect low-power consumers (camera, 3G / 4G - Wi-Fi router, etc.) to the existing public

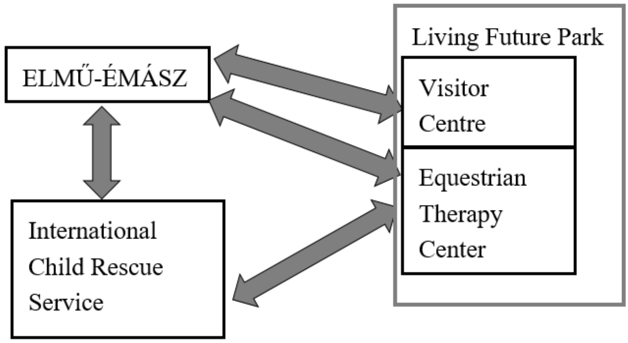
lighting network that requires 24-hour supply. This energy is provided by the device's built-in batteries when the street lights are off.
• Intelligent energy monitoring system: These systems are based on the so-called SCADA system (supervisory control and data acquisition) and become truly "intelligent" through special target software (add-on modules).
•Electric car charging equipment: With a free-standing electric car charging column and a wall charger it is possible to charge the batteries of up to four e-cars at the same time.
• Low-consumption, LED, smart street lighting: Solar LED lamps do not require mains supply, in case of intense sunshine the batteries are charged in 3-4 hours, the diffused light is enough to charge the batteries.

According to a relevant practitioner this level of complexity of the Park is unique not only in the country but also in Europe.

3.3. Managing the Park (smart grid)

As can be seen in Figure 1, the examined smart grid, the Living Future Park operates in the area of the Equestrian Therapy Centre, its primary task is to meet the needs of the Equestrian Therapy Centre (the area is otherwise state-owned). One of the stages in the development of the Living Future Park was the establishment of the Visitor Centre. This modern building performs two basic functions; on the one hand, the Central Intelligent Energy Monitoring System of the Park is located here, and on the other hand, external visitors, interested young children and research students come here.

Figure 1. The involved actors of the investigated smart grid



Source: Own editing

The Equine Therapy Centre is part of the International Child Rescue Service and began operations in 2003. The owner, International Child Rescue Service, has been in contact with ELMŰ-ÉMÁSZ for many years. ELMŰ-ÉMÁSZ, as the electricity supplier of the area, is continuously developing the Park based primarily on the needs of the Equestrian Therapy Centre which is a very useful CSR activity at the same time.

The experiences of the previous year, as well as the needs and challenges of the coming years, are discussed annually in a research meeting with the participation of representatives of ELMŰ-ÉMÁSZ, the Equestrian Therapy Centre and the contracted universities. But this is just one form of the interactive and continuous communication.

The end user of the smart grid is the Equine Therapy Centre, where special education teachers and staff caring for horses work. They are not electricity professionals, yet they were not afraid of many techniques in the beginning, because they knew that ELMŰ-ÉMÁSZ, as a professional background, would operate them properly. There seems to be complete trust in ELMŰ-ÉMÁSZ, which is also fuelled by the fact that on both sides (ELMŰ-ÉMÁSZ and Equestrian Therapy Centre) the same contacts know each other well and meet regularly in the Park as well. The experts of ELMŰ-ÉMÁSZ pay great attention to the fact that their communication (e.g. during the scientific discussion or when teaching a new tool) can be understood by non-specialists as well.

The staff of the Equestrian Therapy Centre can see and understand the values of smart meters and other displays. Modern technology is not a problem for them to solve, as they do not have to operate the devices (they just have to turn them on) because they all go with automatic operation. A general learning process has also taken place, for example, they already know what weather they consume the least electricity. If there is a problem, it is indicated (only one phone call is needed), the evaluation and troubleshooting will be done quickly by ELMŰ-ÉMÁSZ.

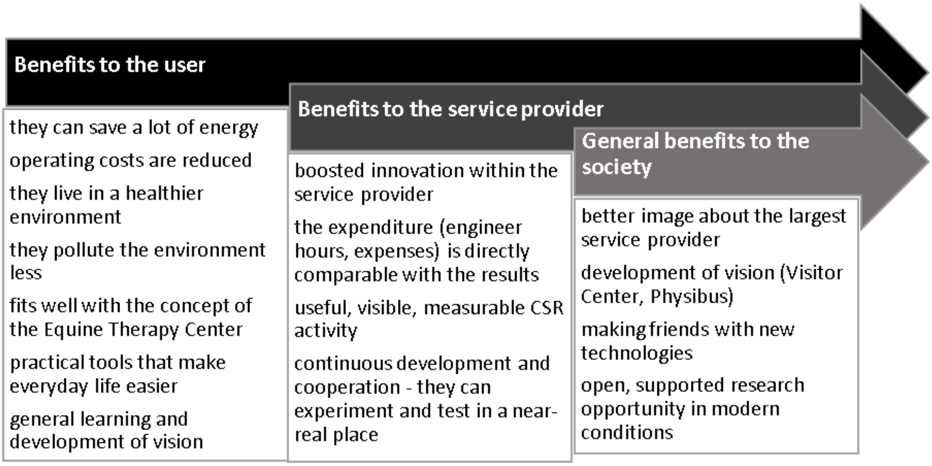
ELMŰ-ÉMÁSZ therefore operates and develops the Park within the framework of CSR activities. Most of the equipment and solutions were purchased, installed and developed by them, but the Equine Therapy Centre also bought some equipment with tender money. The Park has boosted innovation within ELMŰ-ÉMÁSZ, many things are being tried out in the Park for the first time. For example, ELMŰ-ÉMÁSZ had no previous direct experience with solar, battery-powered LED street lighting lamps. Therefore, three solar LED lamps from three manufacturers were installed in the Living Future Park to illuminate the playground. In the Park, they are watching how the temperature and warming of the ground affects the cables, the temperature of the cables, as there are roughly life-like conditions there.

The staff at the Equestrian Therapy Centre usually does not notice much about testing or software developments. According to ELMŰ-ÉMÁSZ, if they do not notice, they love it, and listening to the other side, that is probably the case. The service provider said that in the beginning, there were problems that one system did not turn on or the light was on for too long or too short, but the end consumers do not remember that. They seem to have not only made friends with new, modern technologies, but also loved them. The fast, precise work of the service provider and the user-friendly communication obviously contributed to this situation.

4. RESULTS AND DISCUSSION

As it can be seen the Park operates well, which is a good example of a win-win situation. Although separate organizations, representatives of different professions are involved, they can work well together and successfully in the smart grid. Each party finds its own benefits and is aware that this is also beneficial to the other party. These many different positives (see Figure 2) take the Park forward and contribute to its development.

Figure 2. The various benefits of the of the involved actors of the investigated smart grid and the wider society



Source: Own editing

ELMŰ-ÉMÁSZ carries out useful CSR activities while getting a giant sandpit close to reality, where they can test and try things. Their own network company can utilize the results and experiences and during the visits everyone can benefit. According to the engineers of ELMŰ-ÉMÁSZ, the latest techniques are often not really tested (e.g. motion sensor lighting) and then, together with the manufacturer, they learn the normal operation of the given system or device in the Park.

Several factors contributed to this successful collaboration. For years, the two most important involved partners, ELMŰ-ÉMÁSZ and the Equestrian Therapy Centre, have had a good relationship. The latter knows the 1-2 colleagues from ELMŰ-ÉMÁSZ they can turn to in case of trouble, who can usually help with remote control, or if they do not, they go out to the Park. A style of communication on the part of ELMŰ-ÉMÁSZ is understandable to outsiders (e.g. when a new tool is made). There is complete trust in ELMŰ-ÉMÁSZ, also in the field of smart meters. Nevertheless, it is also important for ELMŰ-ÉMÁSZ to have a good cooperation, as a lot of money has been put into the Park, and the continuous innovation that takes place there is extremely important for this type of company.

In scientific, empirical research, researchers rarely encounter a situation or collaboration where everything works well. In our case the organization under study and its affiliated relationships work well, that’s why good-practice and traceability come to the fore. In short, the open attitude of the parties, as well as the learning process that followed and the trust that was established, are the main results of the empirical research. We also suggest that participants in smart grids move in this direction, although we know that the Park analysed is special in several respects.

With general, understandable, user-friendly communication and education, society should be prepared for the expected benefits of smart grids, along with the expected tasks and limitations (e.g., they cannot consume an unlimited amount of electricity at all times). If people see why they are sacrificing, what benefits it will bring them, they are more likely to behave responsibly and predictably.

5. CONCLUSION

According to Håkansson and Snehota (1995), a business relationship is a mutually oriented interaction between two mutually committed parties, whose technological and social embeddedness is well illustrated by the ARA model (Activity links - Resource ties - Actor bonds). The players of smart grids are large and small companies, retailers, various service providers, individuals, so this network will bear the B2B, B2C, but if we add the public players, the characteristics of G2B and G2C connections as well. In this complicated situation, it is also worth observing the role and changes of social capital (trust, social norms and networks). In our case study, we saw that trust and a cooperative attitude supported heavily the success of the Park. A long-term, well-functioning network of relationships supported all this. Moon (2001) also highlights the social antecedents of enterprises, which include, for example, social and legal acceptance or rejection of the structure of a given enterprise.

On the side of the end-user, Equestrian Therapy Centre, a learning process took place unnoticed; they got to know the new technologies, solutions, methods, then they got used to it all, and today they fell in love and became part of their everyday lives. Perhaps the wider sections of society could be made aware of the benefits and risks of the smart grid through similar degrees.

There was no awareness of their increased role in prosumers in our examined smart grid, but this is due to the special circumstances. In the Park, a number of tasks are taken over from the end user (Equestrian Therapy Centre) by the service provider, ELMŰ-ÉMÁSZ, such as the management of renewable energy in prosumers' area or V2G processes. In addition, a service provider is unable to provide common consumers with the same number of new and latest technologies year after year. User-friendly communication, training, as well as fast professional problem solving and error handling, on the other hand, are factors that would be good to generalize in all service-end-user relationships.

It was scientifically important for us to see empirically how a smart grid works in practice, whether the behavioural uncertainty of actors, especially non-professionals, poses a security risk and operational uncertainty or even operational risk. The presented case study was able to provide a limited answer to our latter questions due to the special situation of the Park. In the course of the research, however, we were able to study a working smart grid and make recommendations based on good practices.

The mechanism of operation of smart grids depends not only on the direct (organizational and private) actors, but also on the legal, technological, as well as historical and cultural background. National cultural background affects the general level of trust in organizations, authorities, or individuals.

Researching the electrical supply chains of the future from a management perspective, i.e. examining the possible behaviours and decisions of actors, can provide valuable and useful information in designing smart grids as well as ensuring their safe operation. We hope that by asking our questions and presenting our case study we support smart grid designers and decision makers.

Not only do we consider the application of mathematical models or cases of game theory, or the demonstration of the benefits of certain key tools (e.g. smart meters or a dynamic pricing system) to be expedient, but we urge a more general approach to managing smart grids. Together with several authors (e.g. Saad et al, 2016; Gercek et al, 2019; Binder et al, 2019), we recommend more empirical knowledge and assessment of the behaviour of actors, especially non-business ones, and in the light of the results and the operation expected from smart grids (e.g. technology and IT) we consider appropriate education and dissemination important to a wide range of society.

Acknowledgments: I would like to thank the representatives of the Equine Therapy Centre of the International Child Rescue Service and ELMŰ-ÉMÁSZ for making this research possible.

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