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Published in:
RELP: A JOURNAL OF RENEWABLE ENERGY LAW AND POLICY

Published: 01/12/2016

Document Version
Peer reviewed version

Please cite the original version:
Legal and Regulatory Challenges in the Development of ‘Smart Electricity System’ in Finland

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Climate change mitigation targets push forward drastic changes in electricity systems and cause new challenges for electricity market actors. Smart grids are commonly seen to support the solving of these future challenges. This article focuses on the question, how smart grid and smart electricity system development have been integrated as targets to the Finnish electricity market legislation. Electricity distribution system operators (DSOs) are expected to carry the main burden in the smart grid development, so the focus will be in the regulation and legislation applied to them. However, smart grids only are not enough to create smart electricity system, but also smart markets are needed. As the encouraging elements in regulation for both smart grids and smart markets seem to be currently inadequate, a certificate system for smart grids will be suggested.

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I. Introduction

In December 2015, the global climate target was set as holding the average temperature increase ‘well below 2°C’ compared to the pre-industrial levels.¹ To meet this target, the energy system needs to be radically renovated. In the energy production side, this means a transition to low-emission and emission-free sources. As regards to the electricity system, the increasing share of renewable energy in electricity production requires that the flexibility of the system is improved. In the traditional electricity system the production has mainly followed the consumption, but in the case of using intermittent renewable energy sources, the flexibility coming also from demand side is crucial². At the same time, to guarantee the adequacy of the energy sources, energy efficiency improvements are necessary. On the other hand, the reliable functioning of electricity system is crucial as societies are more and more dependent on the electricity along with the electrification.

To address the flexibility and efficiency challenges, electricity infrastructures need to be updated.³ ‘Smart grids’ are commonly seen to be one solution to improve flexibility and efficiency of the system by enabling demand side response measures, interconnection of small-scale production and energy storages and thus optimizing the use of electricity and capacity of the grid.⁴ Furthermore,

¹ Paris Agreement art 1, para. a. In the European Union, the key energy and climate targets are the well-known ‘20-20-20’ by 2020, and by 2030 the reduction of greenhouse gases by 40 % compared to the level of 1990, the energy efficiency target of 27 % improvement and the renewable energy target of 27 % share. In the long term, i.e. by 2050 the target is the transition to a low carbon economy by reducing emissions 80-95 % compared to the 1990-level, see Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Energy Roadmap 2050, COM (2011) 885 final.
² Peter D. Lund, Juuso Lindgren, Jani Mikkola, Jyri Salpakari, ‘Review of energy system flexibility measures to enable high levels of variable renewable electricity’, (2015) 45 Renewable and Sustainable Energy Reviews, 785, http://dx.doi.org/10.1016/j.rser.2015.01.057 accessed 16 October 2016. ‘Demand side flexibility’ can be seen to include both demand-side management (DSM) that takes into account different demand-side flexibility and efficiency measures (peak shaving, load growth, load shifting), and demand response (DR) that refers just to the timely load shifting. However, these definitions have not become completely established and they are often mixed.

The main changes are forecasted to be seen at the level of distribution networks where the technical development and automatization has not yet been comprehensive.\footnote{Pertti Järventausta, Sami Repo, Antti Rautiainen, Jarmo Partanen, ‘Smart grid power system control in distributed generation environment’, (2010) 34 Annual Reviews in Control, 277, <http://dx.doi.org/10.1016/j.arcontrol.2010.08.005> accessed 15 October 2016, noting that utilizing the potential flexibility reserve from small electricity users and distributed generation units requires more advanced grid design especially at the distribution level. As noted, for example, in Xi Fang, Satyajayant Misra, Guoliang Xue, Dejun Yang, ‘Smart Grid – The New and Improved Power Grid: A Survey’, 2012 14(4) IEEE Communications Surveys & Tutorials, 944, 945 <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6099519> accessed 10 October 2016, the traditional distribution networks were not planned for two-way electricity and information flows, but smart grids are. The research does not take into account the high-voltage distribution systems. The reasoning behind this limitation is that smart applications relate often to the end-consumers which are generally not connected to the high-voltage grids.} Electricity distribution system operators (DSOs) are the ones responsible for constructing and operating the distribution networks and accordingly the legislation regulating them is a natural starting point when considering the near-future development of smart grids from the legal point of view.\footnote{For example in Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Delivering a New Deal for Energy Consumers, COM(2015) 339, 8.} DSOs have been seen as the main drivers of smart grid development\footnote{For example, ECORYS, The Role of DSOs in a Smart Grid Environment, Final Report, Amsterdam/ Rotterdam 23 April 2014; ACER, Energy Regulation: ‘A Bridge to 2025, Conclusions Paper, Recommendation of the Agency on the regulatory response to the future challenges emerging from developments in the internal energy market’, 19 September 2014; Council of European Energy Regulators, ‘The Future Role of DSOs, A CEER Conclusion Paper’, (C15-DSO-16-03) 13 June 2015; Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Launching the public consultation process on a new energy market design, COM(2015) 340 final, 11.}, and therefore the economic regulation models of DSOs directing operation and their investments, as well as the future role DSOs in electricity systems and smart grid environment, has been under discussion in the EU.\footnote{The purpose of the article is to contribute to this discussion and analyse how the current Finnish legislation takes into account}
and enables the required changes in electricity networks and, on the other hand, how the current role of the DSOs affects the development towards smart grids.

The term *smart grids* has often been used to describe a smarter *electricity system*. However, here *smart electricity system* is used when meaning a system relying on smart grids, energy storages, integration of different energy systems, like vehicle-to-grid, power-to-gas, as well as smart markets utilising potential of demand side management (DSM) and energy efficiency services.\(^{11}\) Muench et al. (2014) have used a distinction between smart grids and smart markets which is considered as a useful terminological division in this context, too.\(^{12}\) Smart electricity system includes both aspects. As the construction of the smart grids is not enough to develop the smart electricity system and the important next step being the development of smart markets, the aspects of market side will be discussed in the end of the article, too.

Finland has been seen as one of the forerunners in smart grid development. However, after the roll-out of smart meters in Finland by 2014, there is no national plan on the implementation of smart electricity system.\(^{13}\) Though, smart grids are mentioned in policy papers, like in the current Government Strategic Program, and probably will be in the new Energy and Climate Strategy that is currently under preparation.\(^{14}\) A working group set by the Ministry of Economic Affairs and Employment has recently started to study the possibilities of smart grids.\(^{15}\) In addition, Finnish pilot and research projects have already taken place.\(^{16}\) Despite this incipient development, a smart

\[\text{\footnotesize\textsuperscript{11} This definition is based on the article Peter D. Lund, Juuso Lindgren, Jani Mikkola, Jyri Salpakari, ‘Review of energy system flexibility measures to enable high levels of variable renewable electricity’, (2015) 45 Renewable and Sustainable Energy Reviews, 785, http://dx.doi.org/10.1016/j.rser.2015.01.057 accessed 16 October 2016, where authors have analysed the potential ‘flexibility measures’. Partly the same elements can be found in Commission Staff Working Document, ‘A Technology Roadmap for the Communication on Investing in the Development of Low Carbon Technologies (SET-Plan)’, SEC(2009) 1295, 78, even though the term smart electricity system is not used in this context.}\]

\[\text{\footnotesize\textsuperscript{12} Stefan Muench, Sebastian Thuss, Edeltraud Guenther, ‘What hampers energy system transformations? The case of smart grids’, (2013) 73, Energy Policy, 80, 86.}\]

\[\text{\footnotesize\textsuperscript{13} The future electricity market and technology scenarios have been analysed in Energiamarkkinavirasto, ‘Loppuraportti, Tiekartta 2020-hanke’, (2009) Dnro 96/040/2009, 15 November 2011, but there is no real action plan for further smart grid implementation.}\]

\[\text{\footnotesize\textsuperscript{14} Action plan for the implementation of the key project and reforms defined in the ‘Strategic Government Programme’, 16, in http://valtioneuvosto.fi/documents/10616/1986338/Action+plan+for+the+implementation+of+Strategic+Government+Programme+EN.pdf/12f723ba-6f6b-4e6c-a636-4ad4175d7e4e, accessed 16 October 2016.}\]


\[\text{\footnotesize\textsuperscript{16} For example, in Vaasa, see ABB, ‘Älykkään sähköverkon pilottialue Vaasaan’, 22 September 2014, (in Finnish)}\]
electricity system does not appear to be a key target in the Finnish electricity market legislation nor the economic regulation applied to the DSOs in Finland.\textsuperscript{17}

II. Structure and Methodology
The energy law research has traditionally focused on the questions relating to competition law. However, the problem setting of this article is originating from climate law. Smart grids or smart electricity system are seen to improve security of supply, competition and above all sustainability of the electricity system\textsuperscript{18} so they can be considered as instruments to reach the climate targets. The background of the article being in the climate change mitigation and the related legal and policy targets, the approach is comparable to the climate law research in which the methodology of environmental law has been commonly used\textsuperscript{19}.

As smartening of the electricity networks, or systems, is not yet an out-stated and clear target in the electricity market legislation, neither at the EU nor the national level, legal dogmatism as a method or regulatory theory approach studying the effectiveness of the legislation compared to its targets, is not enough to cover the whole research question. More like, a ‘systemic integration’ approach will be utilised.\textsuperscript{20} The key question is how this climate targets and in particular smart electricity system development as a climate change mitigation measure is currently integrated and

\textsuperscript{17} The Finnish legislation does not mention nor define the terms smart grid and smart electricity system. Though, a pointed out below, the TEN-E Regulation defining ‘smart grids’ is directly applicable in the Member States but the scope of it is limited.

\textsuperscript{18} Cédric Clastres, ‘Smart grids: Another step towards competition, energy security and climate change objectives’ (2011) 39, Energy Policy, 5399 <http://www.sciencedirect.com/science/article/pii/S030142151100396XIt>, accessed 17 October 2016, can be noted that the smart electricity system and smart grids, used as synonyms in many policy papers, are often described to solve all the problems of electricity and even energy system. This seem to be quite unrealistic, as the questions to be solved are numerous.

\textsuperscript{19} Climate law is often classified to be a part of the environmental law, or at least originating from the environmental law, see, for example, Jacqueline Peel, ‘Climate Change Law: The Emergence of a New Legal Discipline’(2008) 32(3) Melbourne University Law Review, 922, <http://law.unimelb.edu.au/_data/assets/pdf_file/0008/1705652/32_3_5.pdf> accessed 15 October 2016. Climate law has direct impact on energy law sector, these impacts being even radical.

\textsuperscript{20} Inspired by Harro van Asselt, Francesco Sindigo, Michael A. Mehling, ‘Global Climate Change and the Fragmentation of International Law’ (2008), Law and Policy, <http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9930.2008.00286.x/full> accessed 13 October 2016, where the authors suggest a systemic integration to address the fragmentation of international law regimes.
could be better integrated to the legislation. The target is to provide not only the insight of the challenges in the current legislation but also some recommendations *de lege ferenda*.

As noted above, smart grids are not enough to form smart electricity system, because smart markets are also needed. Therefore, the scope of the article will not be limited to the DSO regulation but the target is to provide solutions also from a more ‘systemic perspective’, i.e. taking into account also the other actors in the electricity markets. The DSO regulation is, however, the starting point as until now the legal discussion has focused on this part of the legislation.  

After presenting the legal state-of-play relating to smart grids, the relevant sections from the Finnish legislation will be studied. To open the current Finnish legal framework and DSOs’ investment and operation field for the reader, the focus will be first in the definition of network operation which together with unbundling regime defines the operative field of DSOs. Secondly, the economic regulation, i.e. the Finnish rate of return model, will be examined. The research question relates overwhelmingly to the investments and economic choices of DSOs, thus the central legal instrument directing them will be observed. Thirdly, the energy efficiency regime representing the substantial requirements applied to DSOs will be surveyed with the purpose to analyse what kind of measures the legislation in force provides to encourage the operators to develop their grids.

In the Discussion, a summary on the current legal situation and discovered challenges will be given. The solutions proposed in the literature will be briefly described. In addition, ‘smart certificate system’ will be introduced as a possible solution to the some of the discovered challenges. As mentioned, an important next step relating also to the development of smart markets, the grid perspective will be widened also here to the other market players. The certificate system is to take the systemic perspective into account, too. Figure 1 illustrates the legal and regulatory framework studied in the article.

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21 In addition to the fact that DSOs are expected to drive the smart grid development, this probably originates also from their characteristic as natural monopolies and the regulation applied to them in the EU.

22 Energy efficiency requirements together with emission trading scheme, emission reduction targets out-side the trading scheme and renewable energy targets form the core of the European Union climate legislation.
III. Legal Background

The legal scholarship has not comprehensively discussed the case of smart grids and smart electricity systems. Therefore, to provide an understanding for what is the current state-of-play in the field of law, a brief overlook to the EU and national level instruments is taken. Finnish national legislation is still lacking the key concepts of smart grids and smart electricity system, thus a more comprehensive background can be found from the EU level.

The need for the smart grids has been identified in several policy documents, already in the Commission Communication ‘Smart Grids: from innovation to deployment’ from 2011 and more recently in the so called Trans-European Energy Networks (TEN-E) Regulation No. 347/2013. In the Energy Union Package from February 2015, smart grids are considered as an important enabler in the desired development towards consumer-centric markets. Smart grids are seen to promote the main targets of the EU energy law, competitiveness, security of supply and


24 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, ‘Smart Grids: from Innovation to deployment’, COM(2011) 202 final.


26 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, ‘Delivering a New Deal for Energy Consumers’, COM(2015) 339, 5. The consumer-centrism is one of the essential issues in future energy and electricity systems.

sustainability, but despite the TEN-E Regulation, the substantial legislation has still focused on the smart meters of which comprehensive roll-out is lacking in several EU Member States.

‘Smart metering system’, which according to the Energy Efficiency Directive (2012/27/EC) means ‘an electronic system that can measure energy consumption, providing more information than a conventional meter, and can transmit and receive data using a form of electronic communication’, has commonly been considered as the first step towards smart grids. In the Third Electricity Market Directive (2009/72/EC), an obligation for roll-out of smart meters was set requiring Member States to ensure, in case it is economically feasible, that 80 % of the consumers by 2020 would have smart electricity meter.

Smart grids are defined as ‘an electricity network that can integrate in a cost efficient manner the behaviour and actions of all users connected to it, including generators, consumers and those that both generate and consume, in order to ensure an economically efficient and sustainable power system with low losses and high levels of quality, security of supply and safety’. The definition emphasis’ the efficient integration of different actors’ behaviour, and does not make difference how this integration is technically carried through. In some other contexts, focusing on the technical characteristics of the grid, the smart grids have been described as grids that integrate electricity,

31 Reliable data on consumption are seen as the key factor, Commission Staff Working Paper, Interpretative note on Directive 2009/72/EC concerning common rules for the internal market in electricity and Directive 2009/73/EC concerning common rules for the internal market in natural gas, Retail markets, Brussels, 22.1.2010, 7. On the other hand, some DSOs have emphasised the importance of real time access to this reliable data, and criticised the importance of smart meters as such, see news article Elza Holmstedt Pell, ‘Smart meters ’not needed’ after all for European power grid’, Euractiv (16 June 2016, updated 23 June 2016), <http://www.euractiv.com/section/energy/news/smart-meters-not-needed-after-all-for-european-power-grid> accessed 17 October 2016.
33 TEN-E Regulation, art 2, para. 7. It can be noted here that the definition is directly applicable in the Member States in the scope of the Regulation.
communication and information technologies in the electricity system.\textsuperscript{34} In the EU definition, smart grids seem to be an enabling part of a larger system, which is referred in this article as ‘smart electricity system’, thus the requirements for the functions of the grid are coming from the ‘smart users’ of it.\textsuperscript{35} As can be noted, both of the definitions are rather open-ended and it is not totally clear what is meant by these concepts.\textsuperscript{36} It can be also noted that the level of harmonisation in the EU is currently not high when it comes to smart grid development.\textsuperscript{37}

In Finland, the obligation for DSOs to install remotely-readable, individual electricity meters that can be referred as ‘smart meters’ was set already by the Governmental Decree on Settlement and Metering of Electricity Deliveries (66/2009).\textsuperscript{38} The Decree requires that hourly consumption data is collected, the possibility of controlling customer load is included in the meter, and longer than 3 minutes interruptions are registered by the meter.\textsuperscript{39} Even though the DSOs were given possibility to leave 20\% of the consumption places out of the smart meter roll-out within certain conditions, they have been installed to almost every consumption place.\textsuperscript{40} Smart meters are normally seen as a first step in the smart grid development, thus the Finnish electricity networks are often described as a smart grid 1.0.\textsuperscript{41} Also the automatization and use of information systems in distribution network management exist.\textsuperscript{42} Though, the smart meter roll-out has been successful, the smart

\textsuperscript{35} Compare to Anita Ronne, ‘Smart Grids and Intelligent Energy Systems: A European Perspective’ in Martha M. Roggenkamp, Lila Barrera-Hernández, Donald N. Zillman and Inigo del Guayo (eds), Energy Networks and the Law: Innovative Solutions in Changing Markets (Oxford Scholarship Online, 2012), 143-144, where the author uses the terms smart grid and intelligent energy system as synonyms.
\textsuperscript{36} Of course, this also leaves room for different kinds of innovations.
\textsuperscript{37} The smart meter roll-out is still lacking in many of the countries, see Report from the Commission, ‘Benchmarking smart metering deployment in the EU-27 with a focus on electricity’, COM(2014) 356. The further requirements for smartening of the grids are mainly lacking.
\textsuperscript{38} Chapter 6, Article 4 of Governmental Decree on Settlement and Metering of Electricity Deliveries (66/2009) amended by Governmental Decree (217/2016).
\textsuperscript{39} Chapter 6, Article 5 of Governmental Decree on Settlement and Metering of Electricity Deliveries (66/2009) amended by Governmental Decree (217/2016).
\textsuperscript{40} According to Government Bill for Energy Efficiency Act (182/2014), 8, the coverage of the meters was 97\%.
market development is still on its way. Remote readable hourly measurements of smart meters already now enable new kind of dynamic tariffs that would support improved energy-efficiency and operation of electricity market. In addition, they has been seen as an enabler of competition in electricity market for enhancing flexible change of energy retailer.

The requirement for DSOs to install the smart meters is currently the only direct and strict obligation to make the electricity distribution networks smarter. In the following chapters, it is discussed how the Finnish DSOs legislation otherwise handles smart grids.

IV. Distribution System Operators’ Role and Tasks

Network system operators are commonly referred as natural monopolies. To patch the lacking competition and to improve efficiency of natural monopoly companies, economic regulation of network companies has been adopted in the EU. According to the Third Electricity Market Directive (2009/72/EC), Energy Authorities in the Member States shall approve either the transmission and distribution tariffs or methodologies to calculate them ex ante. In addition to this, unbundling regimes are applied in the electricity sector: the network operations shall be unbundled from the competed operations in the electricity markets. This is to guarantee the efficient competition and to ensure that the network companies invest in their networks sufficiently and do not hinder the market access from other market players.

In Finland, a remarkable share of the DSOs is legally unbundled, meaning that they are legally, organisationally and operationally unbundled from the electricity production and supply functions. If the threshold for the legal unbundling is not exceeded, the unbundling of accounts

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48 In 2013, almost 90 % of electricity was distributed by legally unbundled companies (Government Bill for Electricity Market Act 20/2013, 14) , and in the end of the year 2014, more than half of the DSOs were legally unbundled (National Report 2015 to the Agency for the Cooperation of Energy Regulators and to the European Commission, Finland. Energy Authority, (1842/601/2015), 10 July 2015, 16.
49 According to the sections 60 and 61 of Electricity Market Act (588/2013), vertically integrated DSOs which have distributed at least 200 GWh per year in their 400 V network during the last three years, shall be unbundled legally,
will be applied according to the Chapter 12 of the Electricity Market Act. In practice, the unbundling rules limit the functioning of the DSOs to the network operation which is separately defined in Electricity Market Act (588/2013). Network operation is subject to licence granted by the Energy Authority.51

The core functions of the network operation are clear but the fringes of it have been under the review of the national Energy Authority. Until now, the Energy Authority has interpreted narrowly ‘the other operations relating to electricity transmission and distribution’. What is especially interesting from the point of view of this article, is that the demand side flexibility and energy efficiency services are not part of the network operation, because these services are potentially competed activities.52 According to the Energy Authority’s recent unbundling recommendation, the operation of large scale energy storages cannot be counted as part of the network operation, neither.53 Whether this interpretation covers the small-scale storages is not totally clear, but it would be the most logical outcome when taking account of the potential competition aspect. However, no explicit stand on this has been taken.

In the earlier discussions on future role of DSOs, the ‘local balancing’ by using (indirectly or directly) energy storages, demand-side management and distributed energy resources has been mentioned as a part of the future network operation also at the distribution level.54 In the imbalance

organisationally and operationally from the electricity production and supply functions (legal unbundling). In the case of vertically integrated companies with at least 50 000 customers, the management shall be unbundled, as well.

50 According to the Electricity Market Act (588/2013), section 3 para. 1 p. 6 (author’s translation) network operation means ‘offering of the network for pecuniary interest for those who need transmission or distribution of electricity or other electricity network services, electricity network operation includes network planning, construction, maintenance and use, connection of network users’ appliances, metering of the electricity, customer service and other operations relating to electricity transmission and distribution, that are conducted by the network operator and that are necessary for the electricity transmission, distribution or other network services’. The electricity network means ‘the entity consisting of the connected electricity cables, electricity stations, and electrical devices and equipment, systems and software that serve the production of network services, and that is destined to electricity transmission and distribution’ (Electricity Market Act (588/2013), section 3 para. 1 p. 1).

51 Electricity Market Act (588/2013), section 4.

52 Energiamarkkinavirasto, ‘Uudet palvelukonseptit ja regulaaation rajapinnat’, Lausunto/tiivistelmä Dnro 592/421/2013, 13 June 2013. The statement was given before the new Electricity Market Act (588/2013) came into force, but the unbundling regime of DSOs have not changed in this sense, so the statement is still accurate. In practice these services could be, for example, the consumption time shifts and management for the customers.


settlement, the tasks of DSOs relate today only to the information delivery, and in near future, delivering this information to the data hub that is currently prepared by the subsidiary of the Finnish transmission system operator (TSO). DSOs’ tasks do not include balancing itself; the balance responsibility parties have the balance service agreement with Finnish TSO that is in the last resort responsible for the maintenance of the power balance. There are no ‘local balancing tasks’ for the DSOs in which they could possibly make use of the smart grid technologies, like electricity storages, or by managing customers’ loads or distributed generation units.

As noted above, smart grids should enable smart markets. These markets include also demand side flexibility and energy efficiency services which rely to the technology of smart grids, i.e. smart meters and collected data. The idea of these services is to make electricity system more efficient, by reducing the use of electricity or switching the time of use to optimize the use of the production or the network capacity. When the amount of distributed electricity is decreased, incomes of DSOs based partly to this amount decrease, too. However, the DSOs may increase the tariffs as they are not directly regulated but trough the reasonable rate of return. In practice those consumers who do not offer demand side flexibility or produce themselves electricity but use the network services pay for the more sustainable behaviour of others. So, even though DSOs are not allowed to increase their revenues by providing customers for these services, they do not necessarily suffer from the reduction of distributed electricity. One solution could be power-based network tariff structures which also executes the matching principle in terms of costs.

56 Electricity Market Act, sections 46, 73.
57 The operation of electricity or energy storages is not in the scope of network operation and the DSOs are not able to include storages to their network assets (i.e. they are would not be allowed to get return for them).
59 See, for example, Kimmo Lummi, Antti Rautiainen, PERTT Orventaus, Pirjo Heine, Jouni Lehtinen, Markku Hyvärinen, ‘Electricity Distribution Network Tariffs – Present Practices, Future Challenges and Development
If the DSO’s need to invest in its network was reduced by using these services, it could have motivation to improve the platform for them.\textsuperscript{60} One of the key principles in the EU energy and electricity law is third party access which means that the network operators shall connect customers to their networks and transmit or distribute the fed electricity within some technical conditions.\textsuperscript{61} If there are technical constrains, the obligation to develop the grid so that it meets the reasonable requirements of the users may lead to the situation where the DSO has to start to reinforce the network.\textsuperscript{62} In these situations, more efficient use of the available network infrastructure could provide a solution to avoid reinforcing. However, the reasons relating to the Regulation Methods described below may disturb this encouraging effect as the investments can actually be profitable for the DSO.

At the European level, the role of the DSO has been seen as the one of a neutral market facilitator meaning that DSOs should not disturb the competed markets but provide them for platforms and information enabling new services and business models.\textsuperscript{63} The Finnish Energy Authority’s interpretation seem to be similar. The scope of the network operation still vary between Member States and regarding e.g. the energy storages, the EU wide legislation is currently lacking.\textsuperscript{64} As the European Commission will publish its proposal on electricity market design in the end of this year, some clarification to the role of DSOs can be expected to come.\textsuperscript{65} Until now the guideline has

\textsuperscript{60} As noted in Lappeenrannan yliopisto, ‘Selvitys sähkö- ja kaasuinfrastrukturin energiatehokkuuden parantamismahdollisuuksista, Tutkimusraportti’, Lappeenranta 28 June 2015, 17, the DSOs should invest and operate the infrastructure enabling the DSM while the benefits are mainly turned out to the other market actors, so there is an inherent conflict of interest.

\textsuperscript{61} Electricity Market Act (588/2013), sections 20 and 21.

\textsuperscript{62} Electricity Market Act (588/2013), section 19.


seemed to be that unbundling rules are to be respected, and the more competitive the new emerging business opportunities are, the more certain it is that the network operators’ are not allowed to participate in them. In the prevailing paradigm, also in Finland, DSOs are seen as neutral facilitators investing in their networks and enabling the new markets to emerge. How the Finnish rate of return regulation encourages this will be discussed next.

V. Rate of Return Regulation

The economic regulation directing crucially the investment decisions and economic operation of DSOs is carried through by the methods to calculate the reasonable return given by the national Energy Authority. As described, unbundling regime limits the scope of the Regulation Methods to the ‘network operation’, and the competed actions are not in this scope.

The new Regulation Methods came into force in the beginning of the year 2016, and they should be valid during two following, four-year surveillance periods (2016-2019, 2020-2023). In January 2016, new tariff levels of several distribution companies were substantially higher than before. This was resulting mainly from the strengthened national requirements for DSOs’ security of supply. The Regulation Methods do not set limits for the investments and thus enable that DSOs can make the necessary investments frontloaded. After large media attention and public condemnation, Ministry of Economic Affairs and Employment requested the Energy Authority to study how the economic regulation of the DSOs could be modified so that huge increases in the tariffs would be avoided. In the Draft Government Bill, a tariff increase cap was suggested as a

European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, ‘Launching the public consultation process on a new energy market design’, COM(2015) 340 final, 11.
67 Act on Surveillance of Electricity and Natural Gas Markets (590/2013), section 6, para. 1 p. 1.
68 The Regulation Methods, 15.
69 Act on Surveillance of Electricity and Natural Gas Markets, section 10, para. 4.
70 According to the Electricity Market Act (588/2013), section 51, para. 1, the outages in electricity distribution shall not be over 6 hours in the population centre areas and 36 hours in the other areas. The level of new requirements should be achieved stepwise, the first target being 50 % by the end of 2019, the second 75 % by the end of 2023 and finally 100 % by 2028 (section 119). Also in the Regulation Methods, the economic effects of supply interruptions were strengthened, see quality incentive in the Regulation Methods (68-78)
71 Energiavirasto, Energiaviraston selvitys sähkön siirtohintojen muutoksista ja siirtohinnoittelun kohtuullisuuden valvonnasta, 298/403/2016, 3 February 2016.
However, no changes to the Regulation Methods or Electricity Market Act has been accepted, yet.

According to Electricity Market Act (588/2013), the pricing of the network services has to be reasonable when assessing it as a whole. The surveillance of the reasonableness should be based on the real value in use of the network. Thus, the Regulation Methods define that the reasonable return of the DSO is defined as a product of adjusted equity and interest-bearing debt and the reasonable rate of return. After the surveillance period, the reasonable return is compared to the obtained return of the DSO and if the obtained return is bigger, the DSO has to lower its tariffs for the next surveillance period. If the obtained return is smaller, the DSO is allowed to raise its tariffs. The Finnish model is, however, not a traditional reasonable rate of return (RoR) model as several incentives are taken into account when calculating the obtained adjusted profit. With these incentives, the Regulation Methods are to direct the performance of the DSOs and similarities to the ‘out-put based’ regulation can be seen. Figure 2 depicts the key aspects of the Regulation Methods.

When considering the Finnish RoR-model from the smart grid development perspective, certain issues can be highlighted. The effects of smart grid development to the DSO’s cost structure are not totally clear. According to some studies, use of distributed energy sources in the active distribution system management would decrease DSOs’ operational expenses (OPEX), whereas the capital expenses (CAPEX) could in short term increase but decrease in the long run. Also the

73 Electricity Market Act (588/2013), section 24. According to the Government Bill (20/2013), 82, this would mean that the pricing reflects reasonable costs of the management, operation and construction of the networks and provides reasonable rate of return for the capital invested taking into account.
74 Government Bill 20/2013, 82.
75 The Regulation Methods, 6.
76 Act on Surveillance of Electricity and Natural Gas Markets (590/2013), section 14, para. 1. If the excess is at least 5% of the reasonable return, the DSO to take into account the interest when decreasing its tariffs during the next surveillance period.
77 The incentives are investment, efficiency, quality, innovation and security of supply incentives.
79 Sophia Ruester, Sebastien Schwenen, Carlos Batlle, Ignacio Pérez-Arriaga, ‘From distribution networks to smart distributions systems: Rethinking the regulation of European electricity DSOs’ (2014) 31, Utilities, 229 <http://dx.doi.org/10.1016/j.jup.2014.03.007>, accessed 17 October 2016. According to the authors, the OPEX can be decreased by the use of distributed energy resources in distribution system management instead of voltage control.
automation of the network control could decrease OPEX but in the same time possible increase the CAPEX\textsuperscript{80}. In some contexts, smartening is generally estimated to increase OPEX while CAPEX would decrease.\textsuperscript{81} The use of energy storages in the distribution system operation is estimated to potentially be a cost-efficient alternative for the grid reinforcements\textsuperscript{82} and on the other hand a potential measure to reduce costs of supply interruptions\textsuperscript{83}, though the storages cannot be currently counted to the network assets. The research and development costs are on the other hand included in the Finnish model in OPEX, so at least in the case of these actions, the increase of OPEX would be logical\textsuperscript{84}. Because of these uncertainties, the total expenses (TOTEX) approach has been suggested in the European context.\textsuperscript{85}

In the Finnish model, OPEX is not taken into account when defining the reasonable return of the DSO. Regarding the operational expenses, a separate efficiency incentive is directed basically to the controllable OPEX (COPEX)\textsuperscript{86} and the DSO is compared to its own earlier COPEX level.\textsuperscript{87} If smartening of the grid changes the cost structure of the DSOs, the model may prove to be discouraging in the case that COPEX increases. If COPEX decreases, for example as a result of

and loss compensation. The article focuses on the use of distributed energy resources in distribution system management, so the results cannot be directly reflected to the current Finnish system.

\textsuperscript{80} The staff costs are included in the OPEX whereas the investments in platforms and new technologies are part of the CAPEX.

\textsuperscript{81} EURELECTRIC, ‘Innovation Incentives for DSOs – a must in the new energy market development’, A EURELECTRIC Paper, July 2016, 3.


\textsuperscript{84} A separate innovation incentive is applied to these costs, see below.


\textsuperscript{87} The Regulation Methods, 78–82. The general efficiency target where the company would be compared to other DSO is 0 % so it is not applied in the ongoing surveillance period.
decreased outages and the following compensations for the customers⁸⁸, the model could encourage the smart grid development.⁸⁹

In general, it can be questioned, why DSOs would make ‘smart investments’ which are normally riskier than the traditional ones⁹⁰ when these investments are not specifically incentivised⁹¹ – unless they provide for some direct benefits to the DSO.⁹² This kind of benefit would be the reduction of standard compensations which the DSO has to pay in the case of the long outages.⁹³ The avoidance of long outages could be possible by improving the capability of ‘self-healing’ in the network by different kinds of microgrids.⁹⁴

‘Smartening of the grid’ would in many cases mean investments in new technologies and components, like the ones increasing automation in the network or the updates of meter data systems to improve the information exchange between DSOs and electricity suppliers⁹⁵. The method to define the adjusted network value may cause risks for those DSOs who would like to

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⁸⁹ The company has to pay for its customers ‘standard compensations’ if the electricity distribution is interrupted. These compensations are included to the COPEX. The costs of purchased loss energy is not included to the COPEX. See the Regulation Methods, 61.


⁹¹ For example in Italy, higher rate of return is applied for smart grid investments than ‘normal investments’. See Tuomas Vanhanen, ‘The Evolving requirements for smart secondary substations in three European Regulatory Market Environments’ (Master of Science Thesis, Tampere University of Technology, 2014), 61–63. The author compares three regulation models from Finland, Germany and Italy.


⁹³ Section 100 of Electricity Market Act (588/2013). The so called standard compensations have to be paid if the outage lasts at least 12 hours. The amount of the compensation depends on how long the outage lasts. In addition, the Section 51 of Electricity Market Act sets as a general quality requirement for distribution network operation that there should not be over six hours’ outages in city areas and over 36 hours’ outages in rural areas. Also in the Regulation Methods a quality incentive takes outages into account and sanctions on them, see Regulation Methods, 68–78.


make these investments. Network value is based on the list of components approved by the Energy Authority and DSOs have to refer this list when reporting their network components and the values of them to the Energy Authority.\(^\text{96}\) If the DSO has chosen to use other components, possibly new smarter ones, and want to get these components (in their full value) taken into account, they have to be separately accepted by the Energy Authority. The first player takes at least some kind of a risk on whether the Energy Authority accepts the component in its full value or not.\(^\text{97}\) Though, it is difficult to evaluate how big the risk is in reality.

The innovation incentive applied to the research and development (R&D) of new technologies allows DSOs to pass-through an amount equalling 1% of their turnover used to the R&D targeting to encourage DSOs to these activities.\(^\text{98}\) The innovation incentive was updated for the ongoing surveillance period, and no information is yet available how it is used. However, during the earlier period, when the incentive level was 0.5%, DSOs were not actively using this possibility.\(^\text{99}\)

Network asset based RoR-model has been seen to direct to over-investments, but in the Finnish model, a reasonable straight-line depreciation level smoothens this effect.\(^\text{100}\) The deprecations cannot be made arbitrarily high to reduce the ‘obtained return’. On the other hand, the straight-line depreciation can be made as long as the component is in reality used.\(^\text{101}\) Adjusted network value being the basis for the reasonable rate of return calculation, is calculated by using the ‘average


\(^{97}\) The Regulation Methods, 25.


\(^{99}\) The Regulation Methods, 93-94. Here, the smart grids are specifically mentioned.

\(^{100}\) Kaisa Tahvanainen, Samuli Honkapuro, Jarmo Partanen, Satu Viljainen, ‘Experiences of modern rate of return regulation in Finland’ (2012) 21 Utilities Policy, 32, <http://dx.doi.org/10.1016/j.jup.2012.01.001> accessed 17 October 2016. The article evaluates the regulation methods from the second surveillance period (2008-2011) but the same principle applies to the current methods were the straight-line depreciation is part of the investment incentive (The Regulation Methods, 64).

\(^{101}\) The Regulation Methods, 64.
age’ of the components\textsuperscript{102}, so the depreciations do not affect this value. The value is also based on the listed component values, not on the real ones, so DSO are incentivised to make these investments more economically as they get the return for the listed values. Thus, this ‘efficiency’ does not immediately have positive effects in the customer tariffs, but in the company’s actual return.\textsuperscript{103}

New investments in network increase the asset base for which the reasonable rate of return is calculated. As the requirements for the security of supply and decreasing outages in distribution have become stricter\textsuperscript{104}, many of the DSOs have announced the need for comprehensive investments\textsuperscript{105}, meaning especially underground cabling.\textsuperscript{106} The Regulation Methods encourage the investments that improve the security of supply\textsuperscript{107} and they can be also made at a more rapid pace than the security of supply requirements of Electricity Market Act actually demand. The separate security of supply incentive increases this effect.\textsuperscript{108}

Cambini et al. (2014) have examined the connection between different DSO-related factors on smart grid investments in Europe.\textsuperscript{109} According to their analysis on pilot project investments, the Finnish RoR-model would be an encouraging one. The investments in smart grid projects have been higher in Finland than in many other European countries, even when excluding the smart meter investments. However, the article does not make a proper difference between DSOs’ investments and other smart grid investments. In the case of Finland, the share of DSOs’ investments of the whole smart grid investments is rather small\textsuperscript{110}, and according to the Consulting

\textsuperscript{102} The Regulation Methods, 33.

\textsuperscript{103} Of course, the Regulation Methods do not affect directly to the tariff in general, but through the limitations of the company return.


\textsuperscript{106} Government Bill 20/2013, 59, 100.

\textsuperscript{107} Quality incentive of the Regulation Methods, 68–78.

\textsuperscript{108} Regulation Methods, 93–96. Security of supply incentive enables the DSOs to write down network assets in certain conditions.


\textsuperscript{110} See, JRC Science and Policy Reports, European Commission, ‘Smart Grid Projects Outlook 2014’
Report analysing the impacts of innovation incentive to the research and development in the earlier surveillance period, the notified R&D costs of all the Finnish network operators (DSOs and the TSO) were around 6 million € of which 4.7 million € could be reduced in the scope of innovation incentive.\textsuperscript{111}

It can be concluded that the Finnish Regulation Methods currently emphasises the security of supply improvements, which is also a key target of the Electricity Market Act (588/2013)\textsuperscript{112}, and encourages investments in these improvements, but is not in particular striving for the further smartening of the grid. The encouragement of investments does not currently make difference between different types of investments, i.e. the smarter investments are not separately incentivised.\textsuperscript{113} The treatment of different expenses in the Regulation Methods may lead to the situation where the smartening is actually not profitable for the DSO, though depending on the fact how the smartening and the followed smart market development do affect to the cost structure. Also the separate acceptance applied to non-listed components may cause precautionary when making investment decisions. The separate innovation incentive explicitly refers to smart grids giving the DSOs possibility to conduct research and development work of which results are public, but at least earlier only few companies have utilised this opportunity.

The pay-back times of investments are long in the electricity distribution sector\textsuperscript{114} and the smartening of the grid does not happen in a few years. Therefore, the earlier acts pushing the implementation of new techniques is required, if the smart grids are wished to be seen in near future. The current Regulation Methods are in force until the end of 2023, and the aforementioned challenges will remain until the new Methods are given. Of course, as will be most probably seen

\begin{flushright}
111 Iivo Vehviläinen, Erkka Ryyänen, Mari Hjelt, Laura Descombes, Juha Vanhanen (Gaia Consulting Oy), Jarmo Partanen (Nestra Oy), ’Energiaviraston valvontamenetelmissä sovellettavan innovaatiokannustimen arviointi’, Loppuraportti, 18 September 2014, 17. The full potential would have been 11 million euros, though here the TSO is included in the calculations. It has to be noted, too, that in the R&D costs are not included demonstration and deployment costs.
112 Government Bill 20/2013, 10–11.
114 See, for example, the component holding times in the Regulation Methods, 103–117.
\end{flushright}
in regards to the investment caps, the changes in legislation may justify the changes in the Regulation Methods during the Surveillance Periods.\textsuperscript{115}

VI. Energy Efficiency Requirements

1. Legislation
One of the main drivers for the development towards smart electricity system is the need for improved energy efficiency, thus energy efficiency legislation could provide one useful instrument to encourage smart electricity system development. The efficiency of the whole electricity system should be improved, not only the efficiency of individual actors separately\textsuperscript{116}. In the Energy Efficiency Directive (2012/27/EC), the overall efficiency refers to ‘the annual sum of electricity and mechanical energy production and useful heat output divided by the fuel input used for heat produced in a cogeneration process and gross electricity and mechanical energy production’.\textsuperscript{117} In the current energy efficiency provisions, the DSOs are regulated in regards to their own operation in some extent but also in their role as one of the actors of the electricity system and in relation to their customers, so a wider, ‘systemic’, perspective can be partly seen in the current legislation.

According to the Electricity Market Act (588/2013), companies in electricity sector, including DSOs, have a task to promote their own and their customers’ efficient and economical electricity use.\textsuperscript{118} When organizing the electricity metering, DSOs have to target to the same and to the promotion of DR.\textsuperscript{119} According to Section 24 a of the Act, the network service pricing or selling terms shall not contain terms which are detrimental for overall efficiency or energy efficiency of electricity production, transmission, distribution and supply. Energy efficiency means ‘the ratio of output of performance, service, goods or energy, to input of energy’ as it is defined in the Energy Efficiency Directive.\textsuperscript{120} Section 24 b states that the pricing shall not hinder the participation of the

\textsuperscript{115} Surveillance Act (590/2013), section 13, para. 1, p. 2. To be exact, the changes can be made to the administrative decision by which the DSOs are bound to comply with the Regulation Methods.
\textsuperscript{116} Samuli Honkapuro, Jarmo Partanen, Juha Haakana, Salla Annala, Jukka Lassila, Lappeenrannan teknillinen yliopisto, ‘Selvitys sähkö- ja kaasuinfrastruktuurin energiatehokkuuden parantamismahdollisuuksista’, Tutkimusraportti, Lappeenranta 28 June 2015, 4. The report handles the potential for energy improvements in Finland and was conducted for the Ministry of Employment and the Economy and the national Energy Authority.
\textsuperscript{118} Electricity Market Act (588/2013), section 1.
\textsuperscript{119} Electricity Market Act (588/2013), section 22.
\textsuperscript{120} Energy Efficiency Directive (2012/27/EC), art 2 para. 1, p. 4.
demand side response to the balancing power markets or purchaser of ancillary services or system services for demand side management or demand response provided by electricity retailers.

The current formulation of the provisions requires that the participation of DR is not hindered by the pricing and contract terms but states nothing about encouraging or enabling of DR measures. The wording can be argued to be rather loose, as DSOs are not directly obliged to contribute to the overall efficiency. In addition to these, there are no provisions stipulating directly the operation of DSOs or their investment decisions. This is the case even the Electricity Market Directive (2009/72/EC) requires that DSOs shall consider ‘when planning the development of the distribution network, energy efficiency/demand-side management measures or distributed generation that might supplant the need to upgrade or replace electricity capacity’. It can be noted that the installation of smart meters was a direct obligation but after that the network development and quality requirements for DSOs take only into account the reliability of the network and security of supply.

2. Energy Efficiency Program
To implement the key article 7 of the Energy Efficiency Directive (2012/27/EC), Finland decided to continue its energy efficiency agreement program as an alternative measure and not to establish an energy efficiency obligation scheme. In this voluntary-based action program, energy efficiency agreements are concluded between, among others, DSOs and the Ministry of

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121 The selling terms of the transmission system operator with system responsibility have to create conditions for the demand response participation but this provision does not apply to DSOs.  
122 According to the Government Bill (182/2014), the earlier state of art was only written to the law, and no changes were expected to occur in practice as there were no special limitations for the tariff models. However, the tariff structure should enable price signals which would direct the demand response. Regarding the energy efficiency of distribution, the tariffs should not encourage to use more electricity, and they should rather be dynamic than stable (32).  
126 Even though the program is voluntary for the companies, they should have incentives to comply with it. If the company does not conform to the efficiency target and the agreement, it can be discharged from the program and the aid granted for the energy efficiency measures can be collected back (the Act of Accession for the companies, 1).
Economic Affairs and Employment.¹²⁷ The new contracting period of the scheme will begin in 2017.¹²⁸

To conclude the agreement the company had to set at least 5 %, and in the new contracting period 6 %, energy efficiency target including all the energy consumption of the company.¹²⁹ In addition to this, the DSO should enhance its customers’ energy use by additional energy efficiency measures, like informative billing, services relating to energy efficiency advising and consumption feed-back when it is economically reasonable. The company should also ‘develop innovatively new energy efficiency services and measures for its customers’. The implementation of new technologies and measures in its own operation is not unconditional: DSOs should try to implement new technologies when they are ‘reasonable when taking into account technical, economic, security and environmental aspects’. In procurements, the future energy costs should be taken into account.¹³⁰

Interesting question is, what kind of efficiency services DSOs should provide to their customers’ as the Energy Authority has clearly stated that competed services are out of the scope of network operation. In the action plan, the services are seen to relate to the metering data and billing, not to the load controlling and DR services. According to the yearly report of 2014, DSOs have organized, for example, educations for their customers and provided information on energy efficiency via their customer services¹³¹.

The Finnish program has been described as a successful one.¹³² Whether it will affect the smartening of the grid, is unclear. The action plan requires that a clear efficiency target is set for DSOs’ own energy consumption to which they can themselves influence. As the DSO should

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¹²⁷ The frame agreement applies to ‘energy services’ including also for example district heaters. Here, only the DSO perspective is discussed.
¹²⁸ In the new agreement, the set target is that 80 % of electricity transmitted and distributed to the consumers would be under the program by 2018. The coverage was 88 % already in 2014 so the scheme has been successful in that sense (Motiva Oy, ‘Energiatehokkuussopimukset – Energiantuotannon ja energiapalvelujen toimenpideohjelman vuosiraportti 2014’ (2015) 5).
¹²⁹ The action plan for years 2007-2016, 2, and the draft action plan for years 2017-2025, 2. The target is set for the whole contracting period. The company’s own electricity consumption refers to the amount to which the company may actually effect, for example distribution losses.
¹³⁰ The action plan for years 2007-2016, 5–6.
implement new technologies when it is cost-efficient, the assessment done by themselves, the riskier investments can be abandoned. However, as the distribution losses are in the scope of the target, the company has incentive to minimize them. The distribution losses are on the other hand low, also at the distribution level, and the main efficiency improvement potential is estimated to be gained by using of demand-side flexibility, distributed micro-production and energy storages. As explained, these are not in the scope of network operation.

3. Consumer Actions

The requirement to provide for information and energy efficiency education to the DSO’s customers leaves the responsibility to act to the latter. Even though these programs may effect to the consumer behaviour, the incentives to reduce the electricity use or shift the time of consumption are still rather weak when considering the current electricity prices. In Finland, the electricity prices (including network tariffs and taxes) for industrial consumers are low and for household consumers below the average in the European scale. On the other hand, the consumers have possibility to agree spot-market price linked electricity retail contracts in which the hourly changes in prices could encourage to demand response. Though, in the same time the network tariffs are not encouraging to reduce the consumption during the peak load times of the distribution system. The discussion on network tariffs is ongoing, and transition from energy-based to power-based network tariffs has been suggested as a measure to encourage the flexibility from demand-side and the overall efficiency of the system.

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133 Samuli Honkapuro, Jarmo Partanen, Juha Haakana, Salla Annala, Jukka Lassila, Lappeenrannan teknillinen yliopisto, ‘Selvitys sähkö- ja kaasuinfrastruktuurin energiatehokkuuden parantamismahdollisuuksista’, Tutkimusraportti, Lappeenranta 28 June 2015, 4. The report handles the potential for energy improvements in Finland and was conducted for the Ministry of Economic Affairs and Employment and the national Energy Authority.


135 In the second semester of 2015, the prices were around 0.153 €/kWh for household consumers and about 0.071 €/kWh for industrial consumers (including network tariffs and taxes), see EUROSTAT, ‘Electricity price statistics’ in <http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics>, accessed 17 October 2016.

VII. Discussion

1. Main challenges

The investments in smarter solutions in distribution networks, like ‘smart meters 2.0’ or components enabling self-healing of the grid by different kind of microgrids, can seem to be more or less risky for DSOs in the current RoR-model. On the other hand, there is no obligation to smarten the grid so implementation of smarter solutions relies on the voluntary actions of DSOs. The network development targets focus on the improvement of security of supply, and when the DSO is able to comply with these requirements by investing in traditional solutions smartening of the grid will probably not happen. Regarding the innovation work, the DSOs have not been very active, in spite of the separate incentive applied in the Regulation Methods.

The systemic benefits could be bigger than the benefits for the separate DSOs\textsuperscript{137} which is the argument why the current situation is not optimal. On the other hand, the Finnish system with the accurate metering data could already enable the growth of smart markets. From this perspective, incentivizing of the possible smart market actors, i.e. consumers, retailers and, maybe in future, aggregators\textsuperscript{138}, would be an important step towards a smarter electricity system.

As the role of the DSOs is strictly interpreted, they are not the ones to develop or kick-start the markets in Finland. In the case of storages, the situation could be different. If and when the amount of connected distributed energy sources increases, the ‘local balancing’ may become necessary also in Finland. From this perspective, the operation of the electricity storages could also be included in the network operation, at least not excluded from it in absolute terms. The concept of network operation as it is now does not necessarily respond to the future needs.

When it comes to the other market players, the incentives to change the consumption and market behaviour are currently low because of the current electricity prices and the fact that dynamic share of the price is not high if it exists. The consumers, referring now especially to the smaller ones, are likely to be uninterested in their electricity consumption if the prices and network tariffs do not provide proper signals on the state of the electricity system. In the energy efficiency provisions,

\textsuperscript{137}In Vinzenzo Giordano, Gianluca Fulli, ‘A business case for Smart Grid technologies: A systemic perspective’ (2012) 40 Energy Policy, 252, the authors observed the business cases of smart meters.

the object is often to affect the behaviour of electricity consumers, but the current tools do not apply to them directly.

2. Possible Solutions
a. Proposed solutions in literature
The current strict interpretation of the network operation may prove to be restricting in the future. In particular, the discussion on the energy storage operation by network operators is ongoing 139. The division to different kinds of storage use is suggested in some contexts: DSOs could be allowed to operate a storage as long as it is purely used to support the network operation, not to participate in the competed markets 140.

To address the challenges relating to the Regulation Methods, one part of the solution could be a transition to total expenses (TOTEX) -based calculation when defining the reasonable rate of return. This would mean, of course, that the model would be changed radically. Radical changes to the regulation model have earlier been abandoned as they would decrease the predictability of the regulation which is one of the corner stones of the regulation 141. A less radical solution could be the different treatment of the different kind of capital expenses. In this case, the model would allow higher return to the ‘smart investments’ than traditional ones, like in the Italian system 142. This would encourage also more innovative investments, though the consumers would suffer from the increased tariffs.

Considering especially the demand side flexibility and increased overall efficiency of the system, the network tariff structures could be evolved 143. If the electricity prices would vary strongly according to the level of consumption, the encouraging effect in the consumer side could be seen. The power based network tariffs could support this effect. As a result, the demand for the smart

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143 See supra footnote 136.
markets could be increased, as the optimisation of the electricity use would be more profitable than today. Also by the energy taxation, the customers could be motivated to take actions.

b. Smart Certificate System
One additional solution to address part of the challenges could perhaps be a certificate system basing on the acts of smartening the grid or contributing to smart markets. The certificate systems have been earlier applied to improve energy efficiency as well as to increase the share of renewable energy.\footnote{144} In a ‘smart certificate system’ the certificates could be earned by the supplier providing services that enable consumer actions in demand side flexibility or energy efficiency, or by DSOs by smartening their electricity networks. The obligation to buy the certificates could be assigned for either DSOs or electricity suppliers.

As suppliers are acting in the competed markets they would have an external push to collect certificates efficiently, and therefore it would probably be more efficient to assign them with the obligation to buy or gather certificates (a certificate quota). Suppliers could earn their own certificates by creating new services for their customers, or by purchasing certificates from DSOs. The certificate prices would directly raise the price of electricity but the competition between suppliers would improve the efficiency of the system. The concept of the certificate system is demonstrated in Figure 3.

Suppliers are not regulated in the same extent than DSOs by the Energy Authority, and the system would cause administrative costs. Also political resistance would probably emerge because the system would intervene to the ‘freely functioning markets’. On the other hand, the Swedish renewable energy certificate system, for example, is in a corresponding way intervening the markets\footnote{145}. The price of the electricity for the final consumers would naturally increase as a result of the system, but the transition towards more sustainable electricity system has to be in any case financed by some. The certificate quota for electricity suppliers could possibly be an efficient measure to divide these cost for all electricity consumers.


\footnotetext{145}{Lagen (2011:1299) om elcertifikat, chapter 4, section 1.}
Through a certificate system, economic connection between different market actors, which is partly lost in the result of unbundling regulation\textsuperscript{146}, could be (re)constructed. The common sphere of interest would be, however, limited to the smartening of the electricity system so distortion in competed markets should not emerge. The scope would cover both the grid and market aspects, and the market based mechanism would direct the measures to be taken where it is the most cost-efficient. In the case of energy efficiency schemes, the certificate systems have been functioning well\textsuperscript{147}.

In addition to the strengthened ‘cooperation’ between the market actors, the system would promote the smart markets, i.e. the emergence of new services by using consumption data. By selling the certificates to suppliers, DSOs could also finance their smarter investments. Even though the criteria for achieving the certificates should be clear, there should be also room for rewarding of completely new technologies and innovations. The innovations can be difficult to be encouraged by legal measures as the target and the character of the end result is not known.\textsuperscript{148} This problem might be diminished by the well-considered criteria\textsuperscript{149}. Changes to the current rate of return regulation should be made to ensure that DSOs would not pass through the costs which are already compensated by the suppliers.

The establishment of the system would require a paradigmatic change in electricity market legislation. Regarding the DSO regulation, the key targets have been in the unbundling, network reliability and consumer protection. These targets will probably remain in the centre of the legislation but addressing of future challenges should also gain stronger position in the ‘every-day regulation’ of DSOs and otherwise in electricity market legislation. The certificate system would not solve the possible disparities of the current and the future role of the DSOs which should be separately considered. A proper definition for electricity storage operation, whether it is electricity

\textsuperscript{149} The criteria could be set in terms of increased energy efficiency, flexibility and better penetration of renewable energy sources.
purchasing and supplying or a new separate action and in which conditions, would be an important step to be taken, too.

VIII. Conclusions
This article has examined the current legal and regulatory challenges relating to the smart electricity system development in Finland. Finland has been one of the forerunners in smart grid development in the European scale, but the comprehensive smartening of the electricity system is still future. Smartening of the markets and grids is not recognized as a key target at the level of legislation. The challenges from the smart market and grid development point of views are different, and the encouraging measures should take the both into account.

The concept of the network operation cannot necessarily respond to the future needs. In the economic regulation of DSOs, the development of networks to address future challenges and to support the achieving of climate targets are not key objectives. Some structures in the rate of return model may discourage the smart grid development, though also encouraging parts can be found. The energy efficiency legislation and the energy efficiency program are currently rather loose instruments and do not provide for a strong guidance for DSOs, nor to their customers, to reduce or shift the use of electricity and thus make the electricity system more efficient.

In this article, a separate certificate system has been preliminary suggested. The system could promote the smartening actions both in the network development and in the markets. The lack of incentives and direct obligations could be solved by assigning the electricity suppliers with an obligation to buy ‘smart certificates’. A smart certificate system could provide a more systematic perspective to the smart grid development and create a common ‘sphere of interest’ for different actors in the markets. However, it would not solve the problems related to the future role of the DSOs and, for example, the questions on the legal status of energy storage operation. Also the effects of the certificate system to the rate of return model should be analysed separately. Further research is needed in these areas.
Figure 1. Legal and regulatory framework studied in the article.
Figure 2. The key points of the Finnish Regulation Methods discussed above.
Figure 3. Suggested smart certificate system. Supplier would have the obligation to gather smart certificates either by providing services for its customers or by buying certificates from DSOs.