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Legal Influence on the Service Continuity Provisions of Modern Power Systems

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I. Introduction

The dynamic changes in technology confront legal scholars with new phenomena, and new technological solutions which pose new issues to be resolved or regulated. However, a nexus of legal and technical experience is necessary to look for optimal answers to these challenges.[1] One of the major changes happens now in the power system. Paper deals with the phenomenon of decentralization of power system through sharing the control of energy production, and energy transfer. On the one hand the state shares it with lower level administration, ie. with local authorities, or communities. On the other hand it has started to share it with individuals-prosumers, or with group of individuals by allowing subsidiary small-scale production, and transfer of energy which can eventually in near fu-

1 That is why Stanford Law School has started joint-degree program: JD/MS degree in Law and Electrical Engineering.

ture be transformed into a blockchain of smart homes. The paper gives an overview on a legal and technical framework in the light of discussion about pros and cons of centralized, and decentralized power systems critical infrastructure and the challenge of digitalization of power system as such.

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The ongoing debate over energy autarky envisages it as a way to enhance sustainable development through transformation of energy system.[2] The concept of energy autarky is based on decentralization of energy system, and splitting it into local energy resources. Usually it has much in common with renewable energy resources. However, it does not have to be limited only to this dimension. One can learn much more from flourishing phenomena of blockchain processes.

The idea of energy autarky is to be achieved through the cooperation of numerous small energy units. Applying blockchain processes to a power system is not a mere idea. Just recently Korean Electric Power Corporation has announced the program to develop a blockchain-based microgrid. The program is called „KEPCO Open MG Project" within which will be applied the „Future Micro Grid".[3] Even before blockchain phenomenon erupted, the idea of decentralization of power system has been on the agenda, for example in the United Kingdom. It was the way to democratization of power system. Nowadays decentralization of power system is still one of the future challenges,

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2 M. Muller, A. Stampfli, U. Dold, T. Hummer, *Energy autarky: A conceptual framework for sustainable regional development*, "Energy Policy" 2011, vol. 39, p. 5800–5810; C. Brosig, E. Waffenschmidt, *Energy Autarky of Households by Sufficiency Measures*, "Energy Policy" 2016, vol. 99, p. 194–203.

3 Korea Electric Power Corp developing blockchainmicrogrid: https://www.offgridenergyindependence.com/articles/15889/korea-electric-power-corp-developing-blockchain-microgrid (last access 03.12.2018).

just like decarbonization, deregulation and digitalization of power system.[4] Applying new phenomena of blockchain process to power system, deals both with its decentralization, and digitalization. Both are bottom-up processes which enables energy consumers to take part not only in monitoring their power usage, and storage, but also in offering their power producing capacities into the market which means a broad deregulation of the energy market.[5]

Autarky of energy system is usually seen as a political dream to be more independent, and less vulnerable to political impact of energy producers, and suppliers.[6] However, as debate on energy autarky goes, it becomes clear that one of the way to be more safe in terms of energy supply, is to cooperate with many energy producers, and providers, and not to limit the energy chain to one, or to main supplier.[7] It is true in regard to the inner structure of power system of a country as well.

However, there are some obstacles which can have negative impact on the security of power system. Technical experts claim that decentralization and digitalization of power system can cause limited visibility of power system, limited control over private distributed energy units, limited predictability of demand and supply of energy, and limited coordination of numerous individuals and private energy units: mainly smart homes.

From legal point of view the question is how far regulation can go in to control the distributed power system, and how much it has to protect privacy, and freedom of energy consumers and prosumers. Without doubt much depends on effective cooperation at the local level, and on trust, which is one of the key factors of blockchain processes.[8] Broad range of above-mentioned issues will be taken on the example of security of power system infrastructure, and challenges that it can face. Today the power system infrastructure seems to be well defined, and regulated. Figure 1 represents energy system with the energy as the end-product, and the most important object of the power system security measures. All elements like resources necessary to set the system into motion, wanted side-effects: by-products and unwanted side-effects: pollution – are important for the security, and that is why they have not only technical definition but also legal definitions and legal sanctions that regulate lawful way of conducting power system.[9]

However, in near future every home can become an element of critical power infrastructure. Our paper will briefly examine main aspects of the issue of decentralization of power system and provide conclusions in the interdisciplinary perspective.

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4 *Stable grid operations in a future of distributed electric power. White Paper*, International Electrotechnical Commission, Geneva 2018, p. 3.

5 Ibidem, p. 28.

6 *The Geopolitics of Power Grids. Political and Security Aspects of Baltic Electricity Synchronization*, E. Tuohy, T. Jermalavičius, A. Bulakh, H. Bahşi; A. Petkus, N. Theisen, Y. Tsarik, J. Vainio, International Centre for Defence and Security, Tallinn 2018.

7 Energy 2020, *A strategy for competitive, sustainable and secure energy*, p. 8, https://ec.europa.eu/energy/ sites/ener/files/documents/2011_energy2020_en_0.pdf (last access 3.12.2018).

8 K. Werbach, *The Blockchain and the New Architecture of Trust*, Massachusetts 2018, p. 1–2.

9 J. Timmerman, C. Deckmyn, L. Vandevelde, G. Eetvelde, *Towards Low Carbon Business Park Energy Systems: Classification of Techno-Economic Energy Models*, Towards low carbon business park energy systems: Classification of techno-economic energy models, Energy, Volume 75, 2014, p. 68–80.

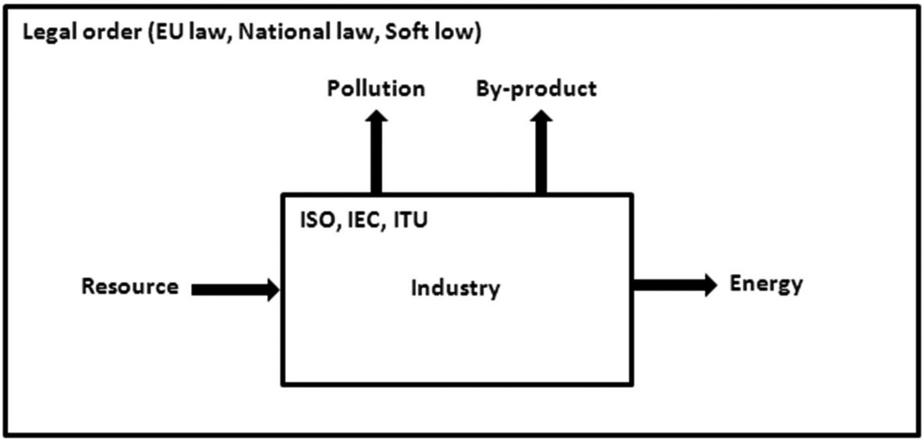


Fig. 1. Simplified representation of energy systems.

II. On the border between technical standards and legislative acts

Power systems are the part of compound and complex critical infrastructure.[10] That is why they are more vulnerable to situations of endangerment. Protection of power system deals with the situation when infrastructure layer is exposed to various kinds of endangers. In Figure 2 regular operations as well as situation of endangerment are shown.

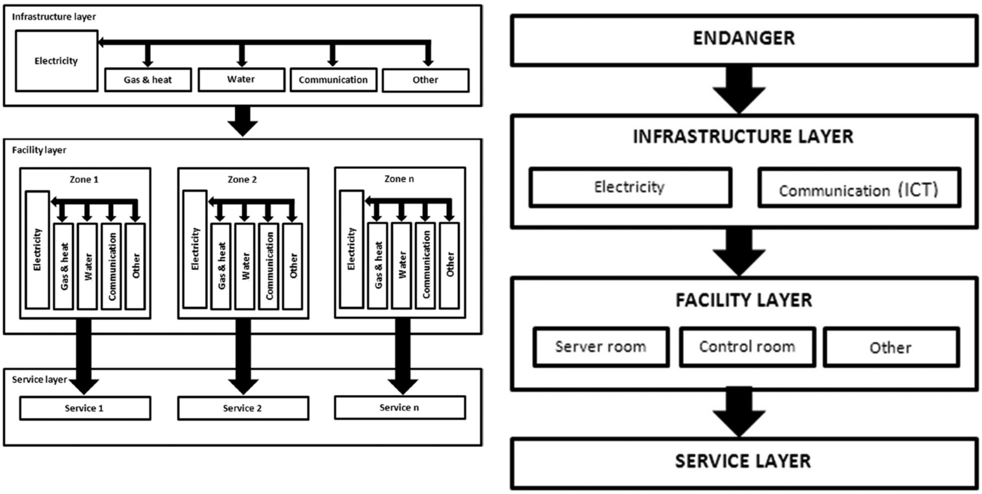
Among types of risks that should be taken into consideration are those resulting from the forces of nature, from the end of life cycle of equipment – its durability, from accidents and unforeseen cases – on safety and logistical levels, and as well from social changes both political and legal – new geopolitical situations or new legal standards.[11] An overview of typical risks to power systems is illustrated in Figure 3.

Protection of power systems and the provision of their service continuity are key issues when making decisions in situations of endangerment of critical infrastructure. Moreover, these issues are not only limited to the technical rules. On the one hand we do have technical standards that guide experts and engineers, like ISO, IEC and ITU standards. On the other hand we cannot forget about legal aspect of the whole issue. Thus, holistic approach to protection of power systems shall include the analysis of legal rules and their application on both European, and national levels, as well as should take into consideration soft law which dominates on international level.[12] Legal norms can promote and make technical standards applicable in more cases. Moreover, what both tech-

10 M. Dunn, Understanding Critical Information Infrastructures: An Elusive Quest", in: Myriam Dunn and Victor Mauer (eds.); The International CIIP Handbook 2006: Analyzing Issues, Challenges, and Prospects (Vol. II) (Zürich, Forschungsstelle für Sicherheitspolitik, 2006), pp. 27–53.

11 Y. Shiwen, H. Hui, W. Chengzhi, G. Hao, F. Hao, *Review on Risk Assessment of Power System*, "Procedia Computer Science" 2017, vol. 109, p. 1200–1205; H. Patrik, C.J. Wallnerström, J. Rosenlind, J. Setréus, N. Schönborg, Poster CIRED2010 RCAM Risk JS 1Juni2010ver4 (2013); W. Fu, *Risk assessment and optimization for electric power systems*, https://lib.dr.iastate.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=13683&context=rtd (last access 3.12.2018); E. Filiol, C. Gallais, *Critical Infrastructure: Where we stand today?* (in:) S. Liles (ed.), *Proceedings of the 9th International Conference on Cyber Warfare and Security*, West Lafayette 2014, p. 47–57.

12 A. Farid, B. Jiang, A. Muzhikyan, K. Youcef-Toumic, *The need for holistic enterprise control assessment methods for the future electricity grid*, "Renewable and Sustainable Energy Reviews" 2016, vol. 56, p. 669–685; C. Saldarriaga, R. Hincapie, H. Salazar, *A Holistic Approach for Planning Natural Gas and Electricity Distribution Networks*, "IEEE Transactions on Power Systems" 2013, vol. 28, p. 4052–4063.



Regular operation

Situation of endangerment

Fig. 2. Overview on critical infrastructure operations

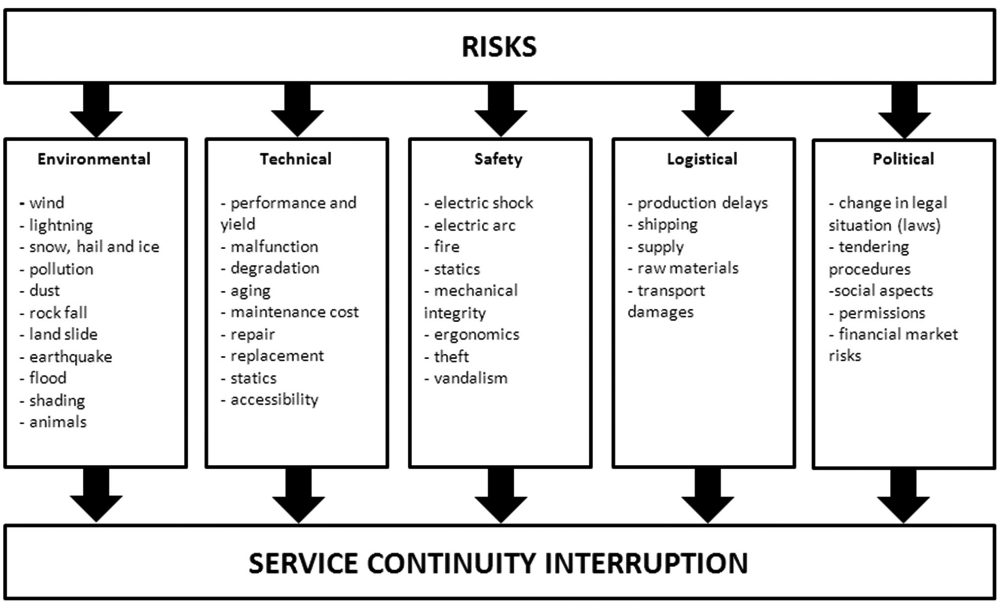


Fig. 3. Selected risks of power systems.

nical standards and legal rules have in common is a normative character which binds anyone who wants to follow successfully the prescriptions. It is important to highlight that in principal technical standards are not mandatory, but they can be followed deliberately. It is so according to both Polish Normalization Committee standpoint,[13] and to art. 5 subsec. 5 of Statute on Normalization of 2002.[14] Legislator can make a technical norm applicable mandatory only by regulating it in other statute, however it must be clearly stated that it overrides a common principle that technical norms are only soft norms, and not peremptory norms. The way in which legislator decides to promote a technical norm is crucial. It can refer to a specific norm using the code number or it refers generally prescribing to comply with Polish Norms or European Norms. However, when legislator refers to a specific norm it can either pick a norm using only its name or code number regardless of date when it was defined, or it can refer to a version of the norm from a specific date. Like, in the Energy Effectiveness Act of 2016 the legislator in art. 36 exempts from the obligation to conduct energy audit every 4 years if a company is applying the Polish Norm regarding system of energy management, requirements, and recommendations. The legislator has referred to the norm only by indicating its name, even though it has also its own number PN-EN ISO 50001. This way of reference is much more flexible, since it means that applicable is the most recent version of technical norm. However, in the Energy Law Act of 1997 the Polish legislator has not even referred to specific technical norms invoking numerous times only a duty to follow customer service quality standards, and fuel, gas and energy quality standards.[15] The latter way of referring to technical norms by picking up the norm from specific date makes the reference in legal act very stable, and clear, however, when technical norm is updated, also the reference in statute has to be updated which means that statute has to be amended, otherwise it does not represent the state-of-the-art. It is quite clear that both general references, and direct references to technical norms without picking up the norm from specific date, seem to be the most optimal way of co-ordinating technical norms in legal acts. However, it is not the only way both legal and technical norms can influence each other. The legislator shall not be limited only to following, and copying into the statutes or other legal acts what technical committees have agreed to. Sometimes, legislator fails even to complete rather this simple task which levels down the power system protection.[16] Even more important is to create a regulatory context which encourages the following of standards, and policies developed at an international level. One of the examples is promoting

Moreover, what both technical standards and legal rules have in common is a normative character which binds anyone who wants to follow successfully the prescriptions.

13 Stanowisko Rady Normalizacyjnej PKN w kwestii dobrowolności stosowania Norm z 28 października 2010 r. por. https://wiedza.pkn.pl/web/wiedza-normalizacyjna/stanowisko-pkn--w-sprawie-dobrowolnosci-pn (last access 1.12.2018)

14 Article 5 (4) Act of 12 September 2002 on standardization (Journal of Laws 2002 No. 169 item 1385): The application of Polish Standards is voluntary.

15 Energy Law Act of 1997, eg. art. 3.16b; art. 7.7.

16 E. Siwy, *Dostosowanie przepisów polskich w zakresie jakości energii elektrycznej do wymogów Unii Europejskiej*, „Śląskie Wiadomości Elektryczne" 2003, no. 1, p. 31–32.

decentralization of energy production, and transmission which is referred to as distributed generation. In recently discussed draft of „Polish Energy Policy of Poland until 2040" there is a proposal of development of distributed energy, energy clusters, and energy co-operatives. Moreover, in the recently amended Act on Renewable Energy Resources (OZE) in 2016 and in 2018 there has been added a new provision which defines energy cooperatives, and set technical rules which liberates them from some formal duties, like seeking approval of tariffs, of development policy, etc. (art. 2.33a; art. 38b OZE).[17] In order to constitute a closed distribution system, and to have more flexible mode of operation, an energy cooperative has to distribute energy only to its members, the number of which cannot amount to 1000, and members have to be bound by „comprehensive agreement", and the distribution system cannot be connected with neighboring countries. Although energy cooperatives could have been established on the general principles of conducting a cooperative, there is only one successful example of it – „Nasza Energia" created in 2014 close to the city of Zamość.[18] Now, legislator decided to introduce a specific regulation in the Act focused on renewable energy. Perhaps, it will encourage citizens to establish such cooperation particularly in rural areas. For sure, it is one of the elements of stable, legislative measures which are crucial for developing local energy market as it has been studied in recent comparative research.[19] More developed decentralized energy generation has been already conducted via energy clusters which are still growing in Poland. These are the first steps to effective decentralization of energy sector. The second goal of the Draft of Polish energy policy is to enhance the importance of individuals in terms of consumer and prosumers. That is why, the Ministry of Energy plans to develop smart grid, and to encourage to invest in smart homes.[20] Till 2026 ca. 80% of family units should have smart meters, and future legislative effort should be directed towards energy consumers. They will be engaged in generation, selling or DSR services not only as prosumers – which are already covered by energy policy, but also as local energy communities, like inhabitants of block of flats, etc.[21] This direction has been recently confirmed, and

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17 *Ustawa o odnawialnych źródłach energii* Dz.U. z 2015, poz. 478 z późn. zm.

18 M. Błażejowska, W. Gostomczyk, *Warunki tworzenia i stan rozwoju spółdzielni i klastrów energetycznych w Polsce na tle doświadczeń niemieckich*, „Problemy Rolnictwa Światowego" 2018, t. 18, nr 33, z. 2, p. 26.

19 M. Błażejowska, W. Gostomczyk, *Warunki tworzenia…*, p. 31; S. Saintier, *Community Energy Companies in the UK: A Potential Model for Sustainable Development in "Local" Energy?* „Sustainability" 2017, nr 9, 1325.

20 *Polityka Energetyczna Polski do 2040 roku*, Ministerstwo Energii, wersja 23.11.2018, Warszawa 2018, p. 19.

21 *Polityka Energetyczna…*, p. 27.

one can expect that the OZE Act will be amended in order to extend the group of prosumers by adding to it small and large enterprises, as well as units of local government.[22] From the point of view of legislator it will be a challenge to a centralized sector of energy. Acceptance of players on lower level of power system, like enterprises, cooperatives, local authorities has to be followed by more flexible way of managing power system, and its units.[23] Only this can make decentralization of power system effective, and economically viable. When deregulation grows, more important will be the turn to technical standards, and soft law recommendations which should be widely promoted, and controlled.

When one considers legal dimension of power system protection one of the most important issues is the structure of property rights. On the one hand, it influences the development of distributed generation. Recent researches point out that the development of energy cooperatives depends on the attitude towards private and communal property.[24] On the other hand, it becomes decisive in terms of power system infrastructure who owns the power systems infrastructure – and further who holds the information about technical characteristics, about endangers and risks experienced on the spot, who is financing and deciding about the protection technologies. From the legal perspective we can form power system as public property governed by the state or by the state-owned enterprise; secondly as private property that usually is given a state permit to create and conduct power systems; thirdly as public-private property where we have representatives both of the state and private companies. Usually that structure results from the decisions made in the very early stage of creating power system unit. Thus, there are public and private investors: one side gives money, the other technology, one invests to gain high return, the other takes risks and receives necessary funds to start the project. Property structure becomes crucial in the situation of endangerment – then a question arises – how does the ownership of a power system infrastructure influence the decisions – whose interest prevails, the private individual or the common good? How to compel private owners to comply with technical standards? These questions could be answered by International Electrotechnical Commission white papers, and guidelines.[25] In the time of blockchain process the property structure can extend enormously. It is no more the state which will be responsible for creating power system infrastructure from the very early stages. It will rather control who can add its own unit (e.g. home) to the critical infrastructure network. The most important challenge for power system as such, and for power system infrastructure deals with providing service continuity while there is limited visibility of grids, installations in smart homes, limited control over the application of the state-of-the-art technologies, and security measures, limited predictability of demands of energy supply due to increasing number of IoT, and devices that need electrical energy. The last issue posed by IEC deals with higher interconnectedness of energy infrastructure, and resulting limited coordination of the energy market. Legislator should answer how to assure a proper flow of energy, to distribute in a proper manner stored energy to locations where there is lack of it, and enhance energy market regulations which can reduce negative effects of delays, and errors of prosumers.[26] Interconnection between property types of infrastructure is shown in Figure 4. It is evident that the legal attention shall take a holistic approach with different restrictions in light of property types of power systems.

Power system infrastructure depends much on the electricity network. The infrastructure of network impacts the operation of network which is the key factor to help the supply meet the demand. That is why the topic of provision of power system infrastruc-

22 http://seo.org.pl/powiekszenie-katalogu-prosumentow/ (last access 22.02.2019).

23 W. Skomudek, M. Swora, *Wpływ inteligentnych sieci na system regulacji podsektora elektroenergetycznego*, „Pomiary Automatyka Robotyka" 2012, nr 9, p. 64.

24 M. Błażejowska, W. Gostomczyk, *Warunki tworzenia…*, p. 26.

25 Various analysis, and reports are available at https://www.iec.ch (last access 3.12.2018).

26 M. Niemimaa, J. Järveläinen, *IT Service Continuity: Achieving Embeddedness through Planning* (in:) J. Guerrero, *Proceedings of the 8th International Conference on Availability, Reliability and Security (ARES)*, Washington 2013, p. 333–340.

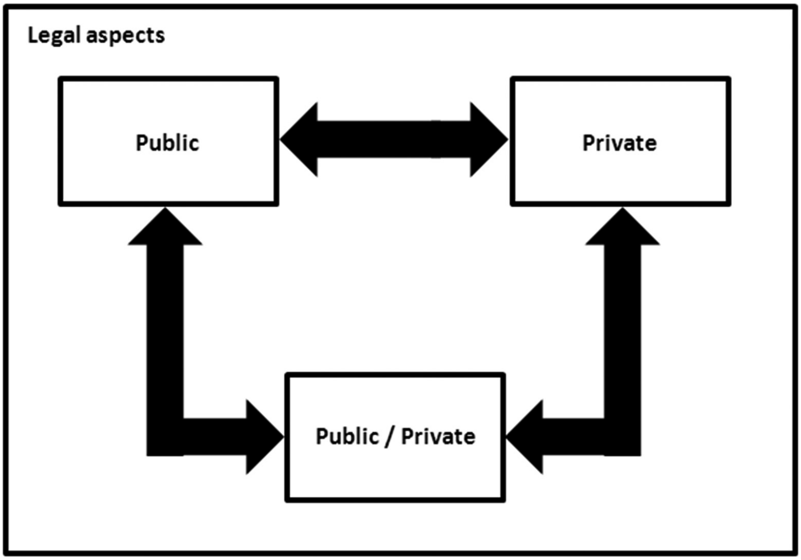

Fig. 4. Legal framework of power systems

ture should be taken into consideration by the Polish legislator and Polish government. Thus, it should be considered how to enhance the effectiveness of electricity network, how to shape the electricity network, how to take care about its infrastructure.

III. Power systems structure – centralized v. polycentric

The service maintenance needs to be allowed to consider the power system at the infrastructural level as a kind of good that is endangered – a victim – that is exposed to harm and damage that comes from the outside. Both the centralized and the polycentric power systems could be endangered. Schematic representation of the infrastructure that can be endangered by an external source of damage is shown in Figure 5.

In principal, power systems can be formed in two different ways which influence its durability and perseverance to the endangers. Traditional structure of electricity sector is based on high centralization and strict connection between the elements of the infrastructure. Smart structure of power system on the other hand is polycentric and decentralized. There are several centers of the power structure, so we create a highly interconnected system, which transform the way electricity is produced, transmitted, and supplied.

One should notice that this twofold character: centralized or decentralized must be reflected in legal regulations – how to deal with various entities responsible for different elements of a complex power system.[27] Traditionally, electricity is generated in large power plants, transferred through transmission and

27 H. Daquan, Z. Liu, X. Zhao, *Monocentric or Polycentric? The Urban Spatial Structure of Employment in Beijing*, Sustainability 2015, vol. 7, p. 11632–11656; K. Carlisle, R. Gruby, *Polycentric Systems of Governance: A Theoretical Model for the Commons: Polycentric Systems of Governance in the Commons*, https://onlinelibr ary.wiley.com/doi/full/10.1111/psj.12212 (last access 3.12.2018); E. Ostrom, Polycentric Systems as One Approach for Solving Collective-Action Problems (September 2, 2008). Indiana University, Bloomington: School of Public & Environmental Affairs Research Paper No. 2008-11-02. Available at SSRN: https://ssrn.com/abstract=1936061 or http://dx.doi.org/10.2139/ssrn.1936061; G. Blicharz, T. Kisielewicz, *Service continuity of critical energy systems in the light of present legal experience*, (in:) D. Kuchta (ed.), *Decisions in situations of endangerment: research development*, Wrocław 2016, p. 221–236

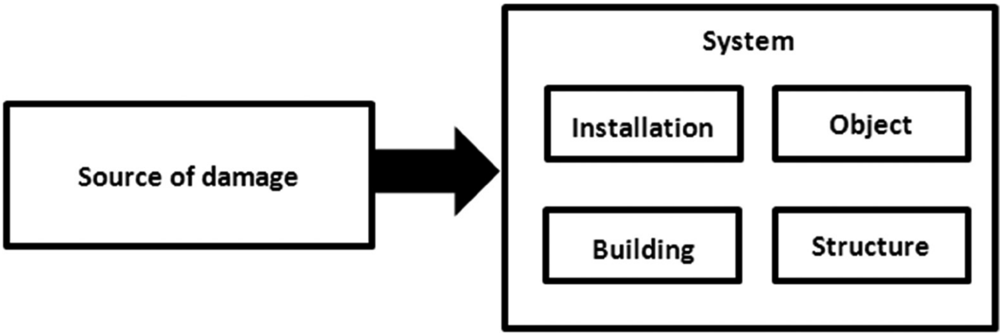

Fig. 5. Schematic representation of the infrastructure that can be endangered by an external source of damage

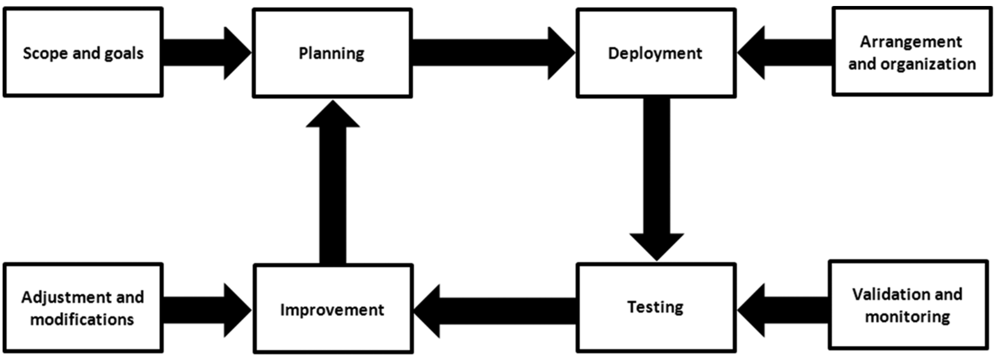

Fig. 6. Simplified scheme on service continuity provision of power systems.

distribution networks and delivered to end users in the residential, commercial, industrial and transport sectors. Digitalization opens up the opportunity for millions of consumers as well as producers to sell electricity or provide valuable services to the grid. Connectivity is the key factor. It permits the linking, monitoring, aggregation and control of large numbers of individual energy-producing units and pieces of consuming equipment. A simplified Deming cycle[28] for the service continuity is shown in Figure 6.

There are two meanings of decentralized energy systems. In the first one it signifies the energy system which is based on a large number of small generating facilities. In the second, decentralized system means that there are different sources of energy supply, e.g. renewable energy, etc.[29] In the UK there was a strong movement towards decentralizing the power system structure – that it will belong exclusively neither to state, nor to big companies. Consumers organized into a group could have become a decision unit in terms of

28 E. Luiijf, M. Klaver, *Critical infrastructure awareness required by civil emergency planning* In: *Critical Infrastructure Protection*, First IEEE International Workshop on IEEE 2005, p. 8.

29 E.D. Rown, J.M.P. Cloke, J. Harrison, *Governance, decentralisation and energy: a critical review of the key issues*, Loughborough 2015, p. 7.

power supply, and transfer.[30] The economic and technological arguments promoting this approach were based on the premise that there is too much waste of energy from the generating plant to the end-user (waste in distribution due to expanded power system). The lack of power due to unbalanced demand for energy that does not meet the supply capabilities generates enormous losses that are counted even in billions of dollars.[31] However, what the US report reveals, the problem does not lie only on the side of the energy producers. There is usually enough or even more power generated than the actual demand. Losses of power appear during the energy transition. Network structure and quality imperfections cause in the USA that more than 50% of generated energy is lost on the way to the energy consumers. US report of 2010 showed huge losses in distribution/transmission: only 39,97 quads out of 94,6 quads produced, were actually delivered to and used by consumers or end-users.

The idea of decentralized power system was connected in the UK with the promotion of low carbon energy sources. The effect that was said to be achieved has been called – democratization of energy.[32] In the UK the power system infrastructure is more complex than in Poland. Thus, it is more open to projects of decentralization of power system and of managing the power system through cooperation of numerous units, than through one-subject management (central one). There are small and medium RE generation plants, district heating systems and CHP initiatives which are household-scale technologies for heating, cooling, and electricity generation.[33] Due to that, consumers have more control over consumption, and this approach can reduce system-wide losses. Putting production in the hands of many small producers is one of goals that are considered to be achieved.[34] There are presented two ways in which modern digital tools can drive a power system: towards centralized management through Big Data or towards a network of small-scale intelligent producers, so called smart homes. Due to digitalization smart homes will be able to produce, collect, and share energy, and create a kind of energy network – an energy blockchain. This approach is not only inspired by the success of blockchain phenomena in other markets, e.g. cryptocurrencies, investments, or services. The idea to use blockchain phenomenon to power system has been recently analyzed by the experts from PwC, Ernst&Young, and presented as a solution for future power systems in the MIT report.[35]

There are some arguments in favor of decentralized energy power system. It is more efficient, more sustainable, and more suited. Since e.g. energy is generated locally, there are less losses between the power supply center and end-users. Secondly, decentralized power system is more accessible, and that is why less dependent on one structure or supply network. Thirdly, it is more secure, since any breakdown affects less number of users, than in a big centralized structure.[36] Many scholars point out that the decentralization of a power system within a country is all about security, just like the diversification of power supply sources from other countries.[37]

However, there is no clear proof or argument that decentralized system is always better than centralized.

30 E. Melville, *Persistent problems of polycentric governance as a tool for improving UK energy system governance*, http://hdl.handle.net/10535/10366 (last access 21.11.2018), p. 4.

31 *Electric Grid Security and Resilience Establishing a Baseline for Adversarial Threats*, ICF International 2016, p. 52.

32 Ibidem, p. 14.

33 J. Roberts, F. Bodman, R. Rybski, *Community Power: Model Legal Frameworks for Citizen-owned Renewable Energy*, London 2014, p. 18.

34 Ibidem, p. 19.

35 *Blockchain – an opportunity for energy producers and consumers?* PwC 2016 https://www.pwc.com/gx/en/ industries/assets/pwc-blockchain-opportunity-for-energy-producers-and-consumers.pdf (last access 2.02.2018); M. Orcutt, *How Blockchain Could Give Us a Smarter Energy Grid*, https://www.technologyreview.com /s/609077/how-blockchain-could-give-us-a-smarter-energy-grid/ (last access 24.01.2018); *Overview of blockchain for energy and commodity trading*, https://www.ey.com/Publication/vwLUAssets/ey-overview-of-blockchain-for-energy-and-commodity-trading/%24FILE/ey-overview-of-blockchain-for-energy-and-commodity-trading.pdf (last access 4.12.2018).

36 Ibidem, p. 20–22.

37 K. Verclas, *The Decentralisation of the Electricity Grid – Mitigating Risk in the Energy Sector*, https://www.aicgs.org/publication/the-decentralization-of-the-electricity-grid-mitigating-risk-in-the-energy-sector/ (last access 4.12.2018).

It depends on the context, and situation.[38] Firstly, the security of decentralized energy system depends on the organization of small units, small producers, and how they meet security requirements. Second issue is how small producers are controlled. If small producers are interconnected on local, regional or state level, as it usually is, any breakdown of one producer will affect more than its own area, however, it will still be easier to stop the breakdown to pass on other areas, and to avoid a crisis on state level. Thirdly, decentralized energy system is less dependent on the geopolitical situation, however only if the imported energy comes from different sources, so the energy supply is diversified. Usually, dependence on geopolitical situation can be limited if decentralized energy system means a set of multiple producers of renewable energy. Although, decentralized system does not have to be based on renewable energy, there is a strong connection between these phenomena. Fourthly, decentralization can make energy system less vulnerable to the errors made by central management of power system. Decentralized system means that energy producers, and providers consist of small-scale units, which belongs either to communal ownership, or private owners, or to public entities.

Many scholars point out that the decentralization of a power system within a country is all about security, just like the diversification of power supply sources from other countries.

IV. Conclusions

The paper gives an overview on selected problems of service continuity provision. In particular interdisciplinary analysis underlined that in order to improve the safety of power systems and provision of service continuity both technical and legal rules should be taken into account. Legal analysis shows that both technical and legal norms and standards should be interconnected and should enhance each other to be followed by the power system operators. Legal dimension broadens the technical studies by introducing the tool that can promote new technologies through soft law and political decisions.

The preliminary results of ongoing interdisciplinary researches focus on power systems protection can be classified in three main areas, namely interdisciplinary area, technical area as well as legal area. The interdisciplinary achievements underlined that protection of power systems in technical and legal framework can be properly analyzed thanks to coordination and cooperation of trained experts only. In addition it is necessary to stress that the experts skills development is possible thanks to ongoing coordination to the policy and lines of operation regarding power systems protection. The technical achievements demonstrated that proper protection of traditional and centralized power systems is based on developed safety solutions (methodologies), whereas smart and decentralized power systems, in principal enhance reliability when external threats occur. New technologies in centralized and decentralized power systems need to be tested in real conditions to assess and improve their regular operations. The legal analysis showed that service continuity provision of power systems can be achieved thanks to coordinated application of IEC, ITU, and ISO standards both on international, European, and national levels. Moreover diligent and proper formation and application of legal rules aligned

38 C.R. Kager, W. Hennings, *Sustainability evaluation of decentralised energy production*, „Renewable and Sustainably Energy Reviews” 2009, vol. 13, p. 583–593.

to the best technical standards increase effectiveness and efficacy of power systems protection.

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