The first step in removing communication and organizational barriers to stakeholders' interaction in Smart Grids: A theoretical approach

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Abstract. This research is the first step in scientific work on the formation of organizational and communication system stakeholders` interaction in Smart Grid. This theoretical research studies the cooperation of stakeholders under the logical and meaningful process of initiation, design, implementation, and development of Smart Grid projects. According to researches analysis in this area and the best practice approaches to the development of Smart Grids, a stakeholder` interaction matrix has been formed. The peculiarity of the developed matrix is taking into account the stages and directions (key aspects) of the Smart Grids development. It forms the basis for a systematic analysis of the problem under study. So the designed matrix will be used as a component of the formation of the stakeholders` interaction logical-structural scheme. The development of this scheme is an intermediate stage in modeling the interaction of stakeholders. The research results presented in this paper are the first theoretical step in a multi-stage study of stakeholder interaction.

1 Introduction

The transformation of the energy sector is due to new challenges to the energy system functioning. It has several vectors. One such vector is smart grids development. The advantages of this energy system change direction are the formation of a controlled, highly efficient system of production, distribution, transportation, and consumption of electricity. Also, a significant advantage of smart grids is the implementation of the distributed energy generation principle.

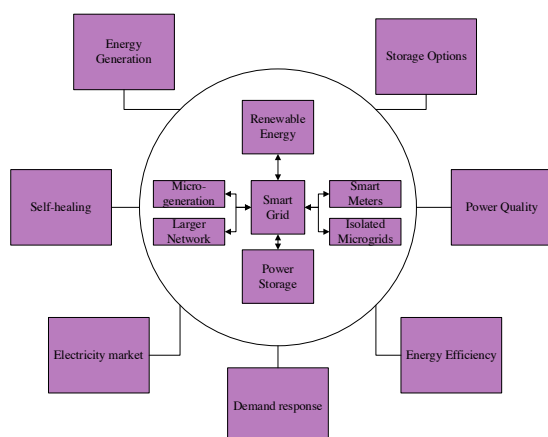The schematic diagram of a smart grid is shown in Figure 1.

Fig. 1. The schematic diagram of a smart grid [1]

There are two components of the smart grid development organization. One element is the formation and implementation of international, state, and regional policies in this area. Another element is the preparation and implementation of smart grid projects. Both components are interdependent. Regulatory acts affect the design and selection of smart grid projects that must meet specific criteria. At the same time, implemented and potential projects that apply for scientific and technological advances and innovations can affect national and international energy policy. New technologies that increase the economic and technical efficiency of smart grids can lead to adjustments or significant changes in the regulatory framework for regulating this area. Thus, the organization of system activities for the development of smart grids requires the coordinated actions of many stakeholders. At the same time, the interaction of stakeholders should take place within the framework of a balanced organizational and economic mechanism. The generalized scheme of stakeholders` cooperation in the process of smart grid development and functioning is shown in Fig. 2 [2]. This scheme proposed by the U.S. Department of Energy.

The formation of a balanced stakeholders` interaction system will solve some related problems. In particular, the activation of drivers for the development of the smart grid will have a positive impact on the level of cooperation in the energy sector, including in the renewable energy area [3]. The potential effect of this is to increase green investment [4].

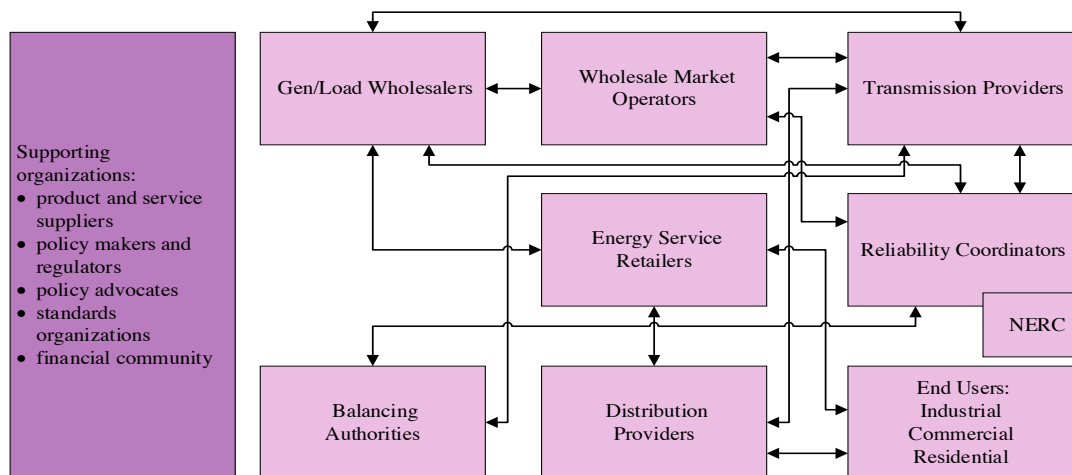[*] Corresponding author: lyudmila.sager@gmail.com

Fig. 2. Stakeholder Landscape

Besides, stakeholders` interaction systems can be used to create a model of the socio-ecological-economic development of the administrative territory [5].

2. Methods

To the research aims, non-statistical methods, including analysis and deduction, were used. The research is based on the analysis of secondary information, in particular, official smart grids development reports and scientific research in this area. Analysis of the components and processes of the smart grid development was taken as the basis for the design of a stakeholders` interaction system. This approach is appropriate for theoretical research aimed at determining the structure and relationships between stakeholders. This study is the initial stage in the scientific work on modeling the stakeholders` interaction in the smart grids development process.

3. Results

Regulations regulate all critical areas of smart grid development. In the EU, in particular, the EU Directives [6-8], European Commission recommendations [9-13] and the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions [14-17] are used for this purpose. These provide the first component of regulating the stakeholders` interaction in smart grids.

Following the smart grid development directions defined by normative legal acts and strategic documents, the next stage is the preparation and implementation of the project. At this stage, there is forming a complex system of relationships between stakeholders. The specifics of the project determine the final list of stakeholders. The mechanism and framework of interaction significantly depend on the algorithm of project preparation and implementation. There is a list of systematic approaches to the organization of smart grid development based on systems for assessing smart grid development [18]. IBM Smart Grid Maturity Model [19-21], EU Smart Grid Assessment Benefits Systems [22], and EPRI Smart Grid Construction Assessment Indicators [18] are the most suitable for systematization of smart grid development. These systems should be selected based on research to compare the evaluation systems of smart grids [18]. The use of these evaluation systems allows us to create a network of indicators. The implementation of these indicators requires the stakeholders` interaction. Thus, there is an opportunity to form a structural and logical scheme stakeholders` interaction during every project stage. However, to develop such a scheme, it is first necessary to identify stakeholders involved in the smart grid development. It is appropriate to take an approach in which the identification of stakeholders will be related to the processes in which they are involved.

IBM Smart Grid Maturity Model allows us to design stakeholders` interaction system. And involve to this system five levels Smart Grid Maturity (Traditional level, Exploring, Investing, Integrating, Optimizing, Innovating) and Smart Grid Domains (Strategy and Regulatory, Technology, Organization, Societal and Environmental, Grid Operations, Value Chain Integration, Work and Asset Management, Customer Management and Experience).

The list of operations (processes, goals, and results) according to this IBM Smart Grid Maturity Model is shown in Table 1.

Table 1. The list of operations (processes, goals, and results) in Smart Grid

Processes/Aims/Results	Code	Level	Processes/Aims/Results	Code	Level
Developing the first SG vision	A	0; 1	Collaboration with external stakeholders	2R	4
Support for experimentation	B	1	Environmentally driven investments (aligned with SG strategy)	2S	4
Informal discussion with regulators	C	1	Environmental scorecard/reporting	2T	4
Funding likely out of existing budget	D	1	Programs to shave peak demand	2U	4

Processes/Aims/Results	Code	Level	Processes/Aims/Results	Code	Level
Initial strategy/business plan approved	E	2	Ability to scale distributed generation units	2V	4
Initial alignment of investments to vision	F	2	Tailored analytics and advice to customers	2W	5
Distinct SG set-aside funding / budget	G	2	Managing distributed generation	2X	5
Completed SG strategy and business case incorporated into corp. strategy	H	3	Exploring new sensors, switches, comms. devices and technologies	2Y	1
SG governance model deployed	I	3	Exploring outage and distribution mgmt. linked to sub-station automation; Safety and physical security	2Z	1
Mandate/consensus with regulators to make and fund SG investments	J	3	Building a business case at a functional level	3A	1
Corp. strategy expanded to leverage new SG enabled services or offerings	K	3	Initial distribution to sub-station automation projects	3B	2
SG drives strategy and influences the corporate direction	L	4	Sharing data across functions/systems and Implementing control analytics to support decisions and system calculations	3C	3
External stakeholders share in strategy	M	4	The new process being defined due to increased automation and observability	3D	3
Optimized rate design/regulatory policy	N	5	Integration into enterprise processes	3E	4
Articulated need to change: Executive commitment to change	O	1	Grid employs self-healing capabilities (optimized rate design/regulatory policy is included)	3F	5
Articulated need to change: Culture of individual initiatives and discoveries	P	1	Conducting value analysis for new systems and exploring RAM (Remote Asset Monitoring)	3G	1
Articulated need to change: Knowledge growing; possibly compartmentalized	Q	1	Exploring proactive/predictive asset maintenance and exploring using a spatial view of assets	3H	1
Organizing more around operational end-to-end processes and Matrix teams for planning and design of SG initiatives	R	2	Developing a mobile workforce strategy	3I	2
Evaluating performance and compensation for Smart Grid	S	2	Component performance and trend analysis	3J	3
Org. is adopting a matrix or overlay structure	T	3	Efficient inventory management utilizing real asset status and modeling	3K	4
Culture of collaboration and integration	U	3	Optimizing the use of assets between and across supply chain participants	3L	5
End to end grid observability allows organizational leverage by stakeholders	V	4	Research on how to reshape the customer experience through SG and Broad customer segmentation	3M	1
Significant processes restructuring	W	4	Piloting AMI/AMR	3N	2
Collaboratively engage all stakeholders in all aspects of transformed business	X	5	Modeling of reliability issues to drive investments for improvements	3O	2
Exploring strategic IT architecture for SG	Y	1	High degree customer segmentation and common customer experience	3P	3
Identifying uses of technology to improve functional performance	Z	1	Outage detection at a substation	3Q	3
Developing processes to evaluate technologies for SG	2A	1	New interactive products/services	3R	3
Tactical IT investments aligned with strategic IT architecture	2B	2	Usage analysis within pricing programs	3S	4
Common architectural vision and commitment to standards	2C	2	Customer management of their end to end energy supply and usage level	3T	5
IED connectivity and business pilots and Implementing information security	2D	2	Mobility and CO2 programs	3U	5
SG impacted business processes aligned with IT architecture	2E	3	Identifying assets and programs within a value chain to facilitate load management programs and identifying distributed generation sources and existing capabilities to support	3V	1
Common architectural framework	2F	3	Develop a strategy for a diverse resource portfolio	3W	1
Implementing SG technology to improve performance	2G	3	Introducing support for home energy management systems	3X	2
Enterprise business processes optimized with strategic IT architecture	2H	4	Redefine value chain to include entire eco-system	3Y	2
Real-world aware systems — complex event processing, monitoring, and control	2I	4	Pilot investments to support the utilization of a diverse resource portfolio	3Z	2
Predictive modeling and near real-time simulation	2J	4	Integrated resource plan includes new targeted resources and technologies	4A	3
Enterprise-wide security implementing	2K	4	Enabling market and consumption information for use by customer energy mgmt systems	4B	3
Autonomic computing, machine learning	2L	5	New resources available as a substitute for market products to meet reliability objectives	4C	3
Environmental compliance	2M	1	Energy resources dispatchable/tradable, utility realizes gain from ancillary services (e.g., power on demand)	4D	4
Renewables program	2N	1	Portfolio optimization modeling expanded for new resources and real-time markets.	4E	4
Established energy efficiency programs for customers	2O	2	Coordinated energy management and generation throughout the supply chain and coordinated control of entire energy assets	4F	5
Segmented & tailored information for customers — including environmental and social benefits	2P	3	Dispatchable recourses are available for increasingly granular market options (e.g., LMP – Locational Marginal Pricing)	4G	5
Programs to encourage off-peak usage	2Q	3			

Each operation in the framework of smart grid development was assigned a code using the letters of the English alphabet. The level to which these operations belong is also indicated.

A list of stakeholders has been identified based on the selected tasks that should be done to smart grid development (Table 2).

Each stakeholder is assigned a digital code. The combination of operation codes and stakeholders makes it possible to trace in which operation at which stage of the project each stakeholder is involved. For example, A1 means stakeholder with code 1 is engaged in process A; 2A3 implies that the stakeholder 3 is engaged in process 2A. The results of structuring stakeholders` interaction according to the processes in which they are involved are shown in table 3.

The list of stakeholders may vary depending on the specifics of the project. It is also true for smart grid development operations.

Table 2. A list of stakeholders in Smart Grid

Stakeholders	Code
Project initiator	1
Public authorities (state government)	2
Local authorities (local government)	3
International institutions	4
Project executor	5
Public, non-governmental organizations, including international	6
Research institutions	7
Project organizations	8
Financial and credit organizations	9
Market regulator	10
Project customer	11
Gen/Load Wholesalers	12
Wholesale Market Operators	13
Transmission Providers	14
Energy Service Retailers	15
Distribution providers	16
End-Users: Industrial, Commercial, Residential	17
Supporting organizations: product and service suppliers	18
Shareholders	19
Territorial community, population	20

Table 3. Stakeholders` interaction system

The Smart Grid Maturity Model` Level		Strategy, Management &Regulatory	Organization & Structure	Technology	Societal & Environmental	Grid Operations	Work & Asset Management	Customer Management & Experience	Value Chain Integration
5	Innovating – Next Wave of Improvements	N2, N10, N11, N12-16	X1-4, X6-19	2L7, 2L11-18	2W11, 2W17, 2W18, 2X10, 2X11, 2X12-18	3F2, 3F10, 3F11, 3F18	3L11, 3L10-18	3T11-17, 3U2, 3U4*, 3U6, 3U10, , 3U11, 3U17, 3U18	4F9-18, 4G3, 4G10-17
4	Optimizing – Enterprise-Wide	L11, M2*, M3, M4*, M6*, M7-10, M12-19,	V2, V3, V4*, V6*, V9, V11-V19, W11	2H11, 2I11-18, 2J7, 2J11, 2K7, 2K18	2R2, 2R3, 2R4*, 2R6-18, 2S2, 2S3, 2S4, 2S9, 2S11, 2T2, 2T3, 2T4*, T6, 2T10, 2T19, 2U11-17, 2V11, 2V17	3E11	3K11, 3K17, 3K18	3S11-18	4D10-17, 4E9, 4E11, 4E18-19
3	Integrating – Cross-Functional	H5, H11, I11, J10, K12-18	T11, U2, U3, U4*, U6*, U7-19	2E5, 2E11, 2E18, 2F5, 2F11-18, 2G5, 2G11	2P4*, 2P6, 2P11, 2P17, 2Q11, 2Q17, 2Q18	3C5, 3C11-18, 3D11, 3D18	3J5, 3J7, 3J8, 3J11	3P11, 3P17, 3Q5, 3Q11-16, 3R11, 3R18	4A11, 4A18, 4B11-17, 4C11, 4C17, 4C18
2	Functional Investing	E1*, E5, E9, E11, F2, F3, F4*, F5, F8, F9, F10, F11, G9, G5, G11	R5, R8, R11, S2, S5, S11,	2B9, 2B11, 2C10-17, 2D5, 2D11	2O11, 2O17, 2O18	3B5, 3B9, 3B10, 3B11, 3B18	3I5, 3I8, 3I11, 3I18	3N5, 3N8, 3N11, 3N17, 3N18, 3O5, 3O7-9, 3O11	3X5, 3X7, 3X8, 3X11, 3X17, 3X18, 3Y5, 3Y7, 3Y11
1	Exploring and Initiating	A2, A3, A4*, A6, A7, B1*, B5, B7, B8, B11, C1, C2, C3, C5, C8, C10, C11, D1, D5, D8, D9, D11	O2, O3, O4*, O10, P6-8, P11, P17, Q7, Q8, Q11	Y7, Y18, Z7, 2A5, 2A7, 2A11, 2A18	2M2, 2M3, 2M6, 2M7, 2M17, 2M19, 2M20, 2N11, 2N17, 2N18	2Y5, 2Y7, 2Y11, 2Y18, 2Z5, 2Z7, 2Z11, 2Z18, 3A5, 3A11	3G5, 3G7-9, 3G11, 3H5, 3H7-9, 3H11	3M6-8, 3M11, 3M17	3V5, 3V7-9, 3V11, 3V18, 3W7, 3W9, 3W11, 3Z9, 3Z11
0	Default level (status quo)	A2, A3, A4*, A6, A7							

*optionally

4 Conclusions

The formed matrix of stakeholder interaction in smart grids development is the first step to the research of communication and organizational barriers. These barriers should be broken for smart grids projects development and its scaling. In the future, the matrix should become more detailed to include all necessary processes and interactions for different kinds of projects.

After that, it will be placed as a base on the logic-research scheme "stakeholder-operation-interaction". Currently, there are different approaches to the development and implementation of energy efficiency projects [23]. Therefore, the use of a logical-structural scheme will reveal the inefficiency of stakeholder interaction. That is, it will identify organizational and communication barriers to break them. Creating a balanced stakeholders` interaction system will help to solve two problems. 1. The formation of a comprehensive mechanism to regulate smart grid

development. This is relevant in countries where such a mechanism does not exist. 2. Increasing the efficiency of stakeholder involvement in the smart grids development processes, i.e., the use of hidden reserves to scale energy innovations. This is relevant for countries where a level of smart grid development above average.

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