Perfecting Business Processes In Electricity Grids By The Use Of Innovative Technology Of Demand Side Management In The Framework Of The General Conception Of Smart Grids

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***Abstract*- The paper will present research on increasing the efficiency of business processes in electricity grids, basing on the use of the innovative technology of demand side management in the framework of the conception of Smart Grids. Being presented for the introduction in smart grid system, the innovative method and device of DSM, are based on regulation of voltage in immediate vicinity to consumers.**

***Index Terms*-- Smart Grids, Business Process Reengineering, Demand Side Management, Innovative Technology, Energy Efficiency.**

I. INTRODUCTION

Represented an innovative technology of demand side management (DSM) [2], which can be used to power electrical equipment, lighting networks, communications systems, automation and remote control, residential and public buildings in order to control the quality of electricity substation consumer optimization of electrical and conservation of electric power.

The core consists in a method according to which the voltage of loading is regulated not by a power part of a network, but by electromagnetic connection of winding of volt-additional transformer with the currents which are 15-20 times lower than power current. The capacitance of the regulated device is not more than 5% of the loading capacitance.

The innovative device of DSM [3, 4, 5] has been developed and produced by the firm LLC "AVEC" (Novosibirsk, RF) under the trademark NORMEL™®© [6]. The innovative technology of DSM has been successfully introduced in hundreds of enterprises. The introduction of innovative technology of DSM in power grids solves the following problems: a) to save material and financial resources by 10–50%; b) to save electricity by 5 –25%; c) to provide operation of the equipment responsible for manufacturing science-intensive products, etc. [7, 8, 9, 10].

The experience of introducing innovative technology of DSM showed that it is possible to solve several global technical problems, namely:

1) the stability of work of synchronous generators at power stations increases, that is, their resistance to short circuits, variations of voltages and other transition regimes, and, thus, the stability and reliability of energy grids;
2) the use of innovative technology of DSM allows to meet in practice the standards of power quality, as a set level of voltage is supported automatically;
3) the power consumption by customers is reduced on average by 5-25 % with a normal work of the equipment;
4) the service life of equipment, household appliances and illuminating devices increases;
5) losses in electric grids are reduced not less than by 10 %.

The experience of introduction showed that with the systematic mass use of innovative technology of DSM the efficiency of electric grids considerably increases on the whole.

Let's carry out research concerning the influence of the innovative technology of DSM on business processes of generating, network and sales electricity companies and electric power consumers.

II. THE EFFECT OF THE INNOVATIVE TECHNOLOGY OF DSM ON THE WORK OF ENERGY PROVIDERS

The accumulated statistical data demonstrate stable high estimations of the most important technical parameters determining the significance of the innovative technology of DSM on the side of consumers of electric power.

Moreover, the research showed that it is not the only effect from the introduction of innovative technology. It is seen also on the systematic level on the condition of its mass introduction. Firstly, the innovative technology of DSM leads

to the simplification of internal business-processes of generating, network and supplying companies. As it will be shown below, the cost of these business-processes is considerably reduced. Secondly, mass production will lead to the development of electro technical industry, creation of working places, thus it will give a long term social effect. Thirdly, there will be simplified technical regulations, norms and standards, which function in the sphere of energy production and determine the level of the organization of external business-processes.

Further, we'll turn out attention particularly to the influence of technology on internal business-processes of energy companies. Mass introduction of the innovative technology of DSM on the side of consumers of electric power 0.4 kV can influence significant processes of the work of generating, network and supplying companies, first of all due to the possibility of refusing from the procedure of regulating the voltage of transformers, used for supporting a normal level of consumers' electric power. Let us consider in details the procedure of regulating transformers.

Most of supply transformers 10\0.4 kV or 6\0.4kV are equipped, according to the standard, with devices switches of the number of winding turns without excitement (STWE). Switching is realized manually on three phases simultaneously. In a typical network company the number of such transformers may be dozens and hundreds. The procedure has a seasonal character and is carried out twice a year by a team of minimum two people. During the time of switching over the customer is de-energized for 5-10 minutes. Besides, during the switch over there can occur interruption in the work of technological equipment, water and electricity supply. The total cost of the procedure together with losses from de-energizing make up a considerable sum. The procedure is planned and complicated, requires manual work, as it is not automatic. It demands specially prepared brigades of highly qualified specialists and specialized transport.

Besides, there is a procedure of regulating transformers on load TCUL. The device TCUL is installed at district sub-stations on transformers 110\10 kV и 220\10 kV.

Mass introduction of the innovative technology of DSM removes the necessity of carrying out such works and makes unnecessary the production of transformers equipped with systems of STWE and TCUL.

III. An example of the effect of the innovative technology of DSM on business process of a network company

As it was shown above, mass introduction of the patented method and device DSM on the low side will directly influence the efficiency of electric energy consumption. This influence can be measured quite simply. But, in addition, the method influences business process of generating, network, sales electricity companies. First of all, the changes will concern the business processes connected with maintenance of transforming substations.

Let's build models AS-IS and TO-BE of a business process of a network company. In Fig. 1 there is presented a context diagram of the level A-0 for a business process of a typical network company.

Here and further there is used the notation of the methodology of Structured Analysis and Design Technique (SADT) and the standard of functional modeling of the USA IDEF0 [11].

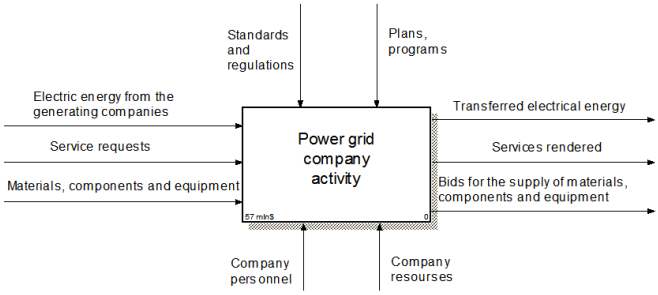


Fig.1. Context diagram A-0 of the model AS-IS for a business process of a network company

The notation is especially useful for our case, as, in contrast to the standard IDEF3, for example, it goes beyond the frames of modeling technological processes only and allows to solve tasks of reorganizing business processes and determining their cost.

Context diagram in Fig.1, without revealing the internal structure, describes its interaction with external environment. The main function of the company "Productive activity of network company" is reflected by a rectangular block.

Border arrows determine external material, energetic, financial, informational, human flows. As is seen from the given diagram, the activity of a network company is in transforming inputs (electric energy received from generating companies, demands of services from energy market and materials necessary for the industrial process) into outputs. In the model in Fig. 1 outputs are allotment of electric energy, rendered services, orders for supply of materials, complete units and equipment, necessary for future activity. In accordance with the standard IDEF0 all inputs are directed to the left plane of the rectangular block presenting the function. The outputs are always connected with the right plane of the block.

The upper plane of the rectangular block is designed for external prescribing descriptions, controls. In the offered model (Fig.1) these are normative and regulatory materials, as well as prognosis, plans, programs, developed by overhead organizations: parent network companies, structures of System Operator [12, 13, 14, 15]. Contrary to inputs, controls can't be transformed, changed by the network company and are obligatory to fulfill.

The lower plane of the rectangular block is designed for describing mechanisms used by the network company in the process of functioning. In the presented model (Fig.1) it is administrative and managerial personnel, land, buildings, constructions, industrial and technological equipment, the park of automobile and special techniques, used by the company.

The model of business process in the methodology SADT is an interconnected set of diagrams. In the right lower angle of the rectangular the number of Activity is put. In accordance with the standard, the only block in the context diagram is given the number 0 (Fig.1). Other diagrams of the

model are built with the help of a formalized procedure of decomposition.

Fig. 2 presents the authors' decomposition of Block 0 of the context diagram of the network company model, built on the basis of a survey of specialists in the topical area, (the staff of the network company) according to the methodology SADT. For compactness and visibility (these are important requirements of methodology SADT) the authors, playing the role of a system analyst, combined all the main functions into three blocks: planning and control (1), production and service (2), accounts (3).

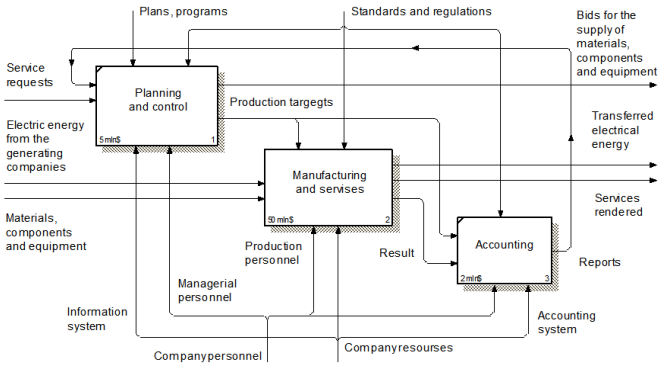


Fig. 2. Diagram of decomposition A0 of the model AS-IS for the higher level of business process of a network company

In accordance with the methodology SADT all border arrows migrate to the diagram of decomposition. The system analyst must connect these border arrows to new blocks (1) – (3) (Fig.2). After this, internal arrows are determined. They model internal connections "output-input" (e.g. "Results"), "output-control" (e.g. "Industrial buildings"), feed-back. Thus, for example, there appeared an obvious feed-back "Reports" on the input to the block "Planning and control" from the block "Accounts", which is absolutely necessary for controlling functions (Fig. 2).

According to the authors, the introduction of the innovative technology will influence, first of all, the function "Production and services", presented by Block 2 in Fig. 2. That is why the authors carried out the further decomposition of Block 2. presented in Fig. 3.

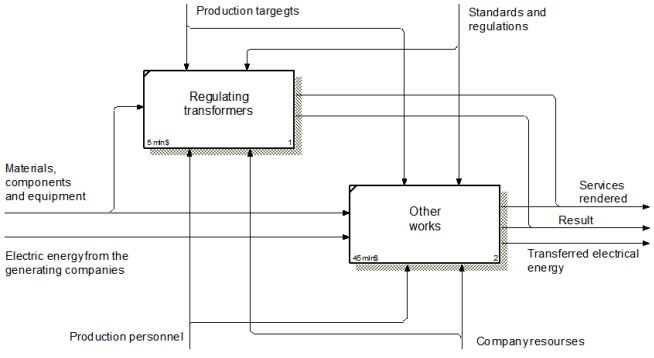


Fig.3. Diagram of decomposition A2 of the activity model AS-IS "Production and services" of a network company

In the diagram of decomposition A2 of activity "Production and services" of a network company, the authors singled out the function "Regulation of transformers", which is especially interesting in the assessment of the influence of mass introduction of the patented method and device DSM on the efficiency of network companies. All other activities and services are included for simplicity into Block "Other activities", such as:

- power transmission and distribution of electrical energy;
- providing power equipment operation in accordance with valid normative requirements, timely qualitative maintenance of the equipment, technical repowering and reconstruction of power assets, as well as the development of electrical network complex;
- operation and maintenance of power objects which are not on asset lists of a network company on contracts with owners of these power objects;
- provision of services on power transfer;.
- provision of services on check-out, maintenance and technical service of protective relays and automatic equipment;
- provision of services on carrying out routine checks of energy and electro-technical equipment with the purpose to find out its real state;
- provision of services on testing protective means, electrical tools, appliances in stationary testing laboratories;
- provision of services on determining places of cable failure and measuring the resistance;
- expert appraisal and project coordination of customers' grid connection.

Methodology SADT allows to get exact cost values of all these activities and, therefore, of the whole process. They are calculated on the basis of cost-effectiveness analysis, which supplements the software for methodology SADT. The cost of works is presented in the left lower angle of each block. To calculate the costs it is necessary to determine exactly cost centers (rent, salary), duration and frequency of works. However, such a detailed investigation is a complicated, time-consuming research task going beyond the scope of this work. In this article there is only made some preliminary estimation for a statistically average regional network company. An average cost of the process "Other activities" was about 45 mln USD, and the process "Regulation of transformers" - 5 mln USD (Fig. 3).

Thus, we have received a business-process model of the activity of a network company AS-IS (Fig.1-3), that is the situation before a mass introduction of the patented method and device DSM. As we see, the total cost of business-process As-Is is 57 mln USD (Fig.1).

After the introduction of the method and device DSM a reorganization of business-process is to take place. As a rule, the reorganization presupposes a drastic change of functions and connections. A mass introduction of the patented method and device DSM makes unnecessary the procedures connected with the regulation of voltage levels on windings of power reducing transformers of a network company. Therefore, one may state that dramatic changes in business process of the network company will not happen. With such reorganization the network company does not spend any additional money, for example, on purchasing new equipment, use of additional resources and staff retraining. That is why there is no necessity to carry out a radical and expensive procedure of Business Process Reengineering.

They will need only a mild Business Process Improvement. That is, in the diagram of decomposition A2 of the activity "Production and services" of the network company, the block "Regulation of transformers" will simply disappear with the introduction of innovative technology of DSM. The business process model of a network company with the diagram changed in such a way is called TO-BE (Fig. 4).

After the reengineering the cost of the process "Production and services" will be 45 mln US $ a year. The cost of the total business process activity of one network company will reduce from 57 to 52 mln US $ a year.

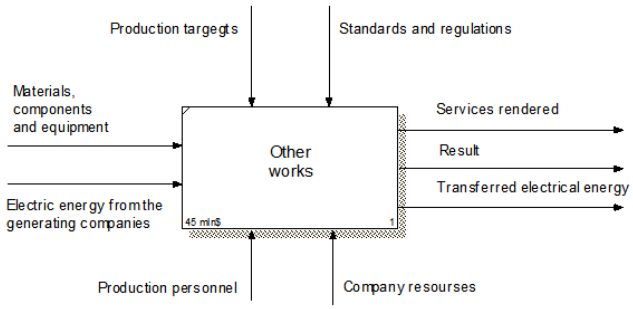


Fig. 4. Model TO-BE. Diagram of decomposition A2 of activity "Production and services" of a network company as a result of mass introduction of innovative technology of DSM

In our opinion, additional expenses will be required to change energy standards and regulations (border arrow "Normative and regulating materials" in Fig. 1-3). However these are not internal, but external business processes, going beyond the scope of efficiency appraisal of a separate network company.

We have considered an approach to the appraisal of the growth of economic efficiency under the influence of the use of innovative technology of demand side management only for network companies. An analogous appraisal can be also received for generating and sales energy providers.

IV. Conclusions

The models AS-IS and TO-BE of reorganized processes were built. It was shown that the introduction of the offered innovative technology requires only business process improvement and simplification of separate sub-processes, which up to now have demanded special attention due to high expenses on their service and high technological risks. It is shown that reengineering of these sub-processes, being the result of the introduction of innovative technology of DSM, will lead to a considerable reduction of their costs (on the average by 8-10%) and to the increase of the efficiency of electric grids functioning on the whole.

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