Managing the Introduction of Innovative Energy Saving Technology of Demand Side Management in Regions of the World

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Abstract — **The work considers questions of evaluating the efficiency of introducing innovative power saving technology on the example of the technology of NORMEL™, which allows to solve effectively the tasks of Demand Side Management. The offered simulation model, in the authors' opinion, will allow formalizing and making a more accurate evaluation of efficiency of introducing innovative technologies.**

Keywords — technological innovation; demand side management; energy efficiency; simulation models of innovations; system synamics.

I. Introduction

Managing the introduction of innovative energy saving technologies allows to control the energy efficiency of enterprises and organizations and, practically, to carry out capital investments, which present a transformation system having at the input invested resources, such as capital, materials, labor force, that are transformed into valuable market products and services with a relatively larger costs than those of initial investments. In the process of realizing these projects, the following things are expected: saving expenses for energy consumption, reducing ecological pressure on environment, as well as all other benefits connected with target investments into the development of regions of the world.

The most important task when introducing innovative methods and technologies of Demand Side Management (DSM) in Grid System is prognostication, evaluation of performance and management of introducing innovative technology. In [12, 13,14,17,18,19] the invention is presented which is an innovative energy saving technology, that allows to manage the consumption of electric energy, improving its quality in accordance with requirements of International Standards. The invention has been patented in the RF, CIS, EU, USA, Ukraine and other countries [4, 5, 6, 7, 8, 9, 10, 11]. The carried research shows that with the mass introduction of the patented innovative method and device of DSM into Smart Electric Grids the largest effect, connected with the increase in energy efficiency of the energy system, can be achieved if the electric power is transferred to the customer by the energy-supplying organization at the maximum value of voltage permitted by International Standards for the norms of power quality [1, 2], and the customer uses it at the minimum voltage value, permitted by these Standards. On the one hand, such regulation allows to provide normal functioning of customers, on the other hand, the consumers will not use "extra" capacity, and the losses will be minimal. Therefore, one of the tasks of reducing the consumption of electric energy and the increase in energy efficiency of energy systems consists in regulating consumers' voltage. This task is typical of most countries of the world, which requires the development of strategic models for introducing innovative technologies. It gives grounds for the conclusion that the use of this invention allows to manage energy saving effectively, and the interest to the invention demonstrated in the world testifies to the appearance of a principally new innovative energy saving technology.

The device has been developed, introduced and produced on an industrial scale by the scientific production enterprise LLC "AVEC" (www.normel.ru), Novosibirsk, under the trademark NORMELTM. The order portfolio of the enterprise is growing fast which gives evidence of a serious potential of the world market. The mass usage of the innovative energy saving device of Demand Side Management can lead to the increase in efficiency of the consumption of electric energy in the world by 30-40% [3, 15, 16].

When introducing innovative technologies into the world market, the producers inevitably face tasks of reliable prognostication, planning and managing the process of their introduction. The history of introducing innovative products is either absent, or is quite insufficient with regard to the required horizon of planning and one can hardly use traditional methods based on the models of time series, neural networks, presupposing the analysis of large arrays of retrospective information on the stage of strategic planning. To model the introduction of innovative technologies, the paper researches simulation models based on the knowledge of systemic laws, compensating the absence of the history of concrete innovations.

II. Model Of Introducing Innovative Technology Of Demand Side Management

The paradigm of system dynamics is used in this paper for simulation modeling. The solution to the task of introducing innovative products with the use of system dynamics is based on works of Frank M. Bass who offered and tried out the model of expansion curve on eleven groups of long use consumer goods of electric technical industry without repeat purchasing [20]. A simple demonstration model of this task has been realized and is available in the system of simulation modeling Any Logic [21].

In this paper, this model was taken as a basis, adjusted to the process of introducing the innovative technology under question. The first moment of the development of the model concerns the necessity of simultaneous modeling at several markets at once. Let us define these markets as the territory of the subjects of the Commonwealth of Independent States (CIS) and the People's Republic of China (PRC) where historically branches of industry are concentrated which have the potential for producing high technology products due to the innovative transformation of existing production complexes in the frames of perfection and balanced development of technologies and economic relations. For example, in the process of innovative transformation of national economies of the CIS decisions should be found which will allow to bring their industrial complex on a higher technological level of production, permitting, on the one hand, to meet the needs of the domestic market, on the other hand – to increase the presence of high technology products of the CIS and the PRC at the world markets. Thus, for example, in Fig. 1, Market 1 presents the multitude of small enterprises of the CIS, Market 2 – the PRC. The markets can influence one another, which will be considered below.

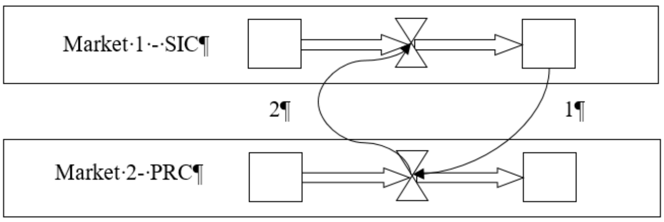

Fig. 1. Markets of consumers of innovative energy saving technology.

A variant of the system dynamics model of introducing innovative energy saving technology simultaneously at two markets of the PRC and the CIS is presented in Fig. 2 - the PRC (upper part) and the CIS (lower part). In the model, the number of potential customers and the number of customers who purchased and installed the innovative devices are presented by clusters. Next to the clusters in Fig. 2, their initial values are shown. According to expert judgment of the authors, the enterprise LLC "AVEC" is able to equip a large part of small enterprises at the markets in question with the device NORMEL™, namely, up to 3 million small enterprises in PRC and up to 240,000 small enterprises in the CIS.

The number of small enterprises which installed new devices at the beginning of modeling is chosen as equal to 0.

The connection between clusters is the flow of purchases and the installment of devices, transforming potential customers into the users of products. The factors influencing the clusters and the flow are traditionally presented by advertisement and female radio. The regulated parameter for the factor of advertisement is its efficiency (the level of 1% was chosen), and for female radio it is the size of population (3000 and 240 thousand small enterprises), the frequency of contacts (100 contacts a year) and the force of persuasion (2%).

The first feedback in the model is negative, balancing, self-correcting. The strengthening of the factor "Purchasing under the influence of advertisement" increases the number of customers and decreases the number of potential users. It limits the growth of the factor and results in its reduction. The second feedback in the model is also balancing: the increase in purchases under the influence of female radio increases the number of customers and decreases the number of potential customers. It also limits the growth of the factor and results in its reduction. The third feedback in the model is positive, reinforcing. The increase in purchases under the influence of female radio increases the number of customers who made purchases. It leads to even a larger number of purchases under the influence of female radio and, with time, to the drop in the share of influence of advertisement on the flow of purchases. (Fig. 2).

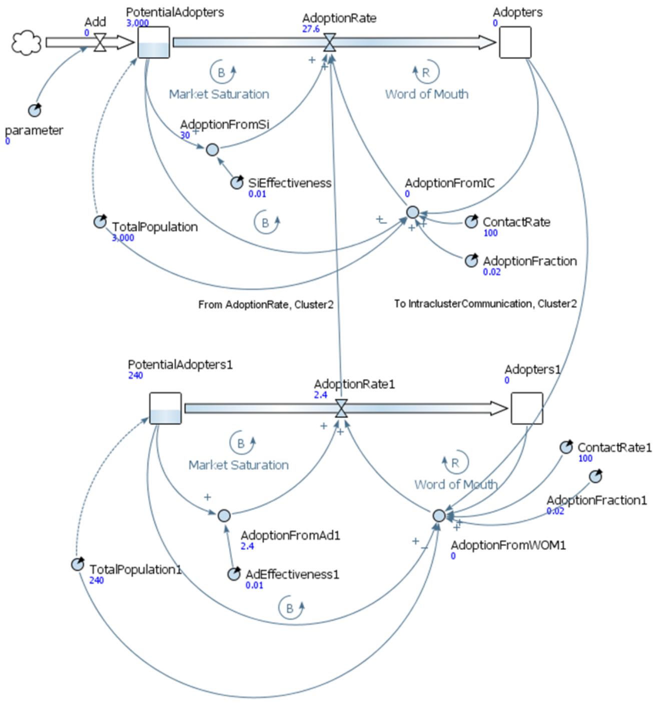

Fig. 2. The system dynamics model of introducing innovative technology.

The functional dependences between the elements of the model in the diagram are usually not shown, that is why we will present them separately. The purchase flow is determined as derivative with time of the number of the potential customers with negative sign and the number of customers with the plus sign:

$$\frac{d(PotentialAdopters)}{dt} = -AdoptionRate\,;$$

$$\frac{d(Adopters)}{dt} = AdoptionRate.$$

The model presupposes the following conditions:

1. Advertisement and female radio influence the purchase flow additively and with a similar weight, i.e. the purchase flow

is the sum of purchases under the influence of advertisement and purchases under the influence of female radio:

$$AdoptionRate = AdoptionFromAd + AdoptionFromWOM.$$

2. Purchases under the influence of advertisement, which "innovators" make, when a new product is launched, are the product of parameters of the effectiveness of advertisement and the number of potential customers:

$$AdoptionFromAd = PotentialAdopters \times AdEffectiveness.$$

3. Purchases under the influence of female radio which are made by "imitators' are the product of the number of customers, the number of contacts, the force of persuasion and the share of potential customers in the entire population:

$$A\ddot{e}doptionFromWOM = = Adopters \times ContactRate \times AdoptionFraction \times \times PotentialAdopters / TotalPopulation.$$

The current results of the experiment are constantly reflected on the elements of the diagram. In Fig. 2, the values of parameters in the first step of the experiment are shown. The final results of the work of the model are presented in Fig. 3. The upper graph presents the prognostication of introduction in the PRC, the lower – in the RF.

With the independent modeling of markets, if, for example, a producer plans to fill Market 1 with the innovative product in approximately 5 years, then with chosen parameters their production program must take into account the fact that the peak of introduction is expected by the middle of the third year of the project (maximum of the curve AdoptionRate), and the production must be ready for that.

Besides, the producer company of the innovative product can increase the number of potential users (TotalPopulation). It can be done by several ways. It is, for example, the initiation of repeat purchases, entrance to new segments of the market, replacement of competitors' traditional products. Such measures require changes in the whole model.

In the model, it is additionally taken into account, that enterprises of one market can count the statistics of introductions of the other enterprise. As a result, introducing technology in the PRC stimulates the introduction in the RF. That is why the peak of introductions in the RF will come earlier: not by the middle of the third year, but by the end of the second year of the project (lower graph in Fig. 3).

Besides, in the conditions of limited resources of production the growth of introductions at Market 2 has negative influence on the flow of introductions at Market 1 (connection (2) between flows AdoptionRate of Markets 1 and 2, and connection (1) from Adopters of Market1 to AdoptionFromWOW of Market 2 in Fig.1-2). That is why the peak of introduction in Market 1 comes later: not by the middle of the third year, which happens with independent modeling, but by the beginning of the fourth year (upper graph in Fig.3).

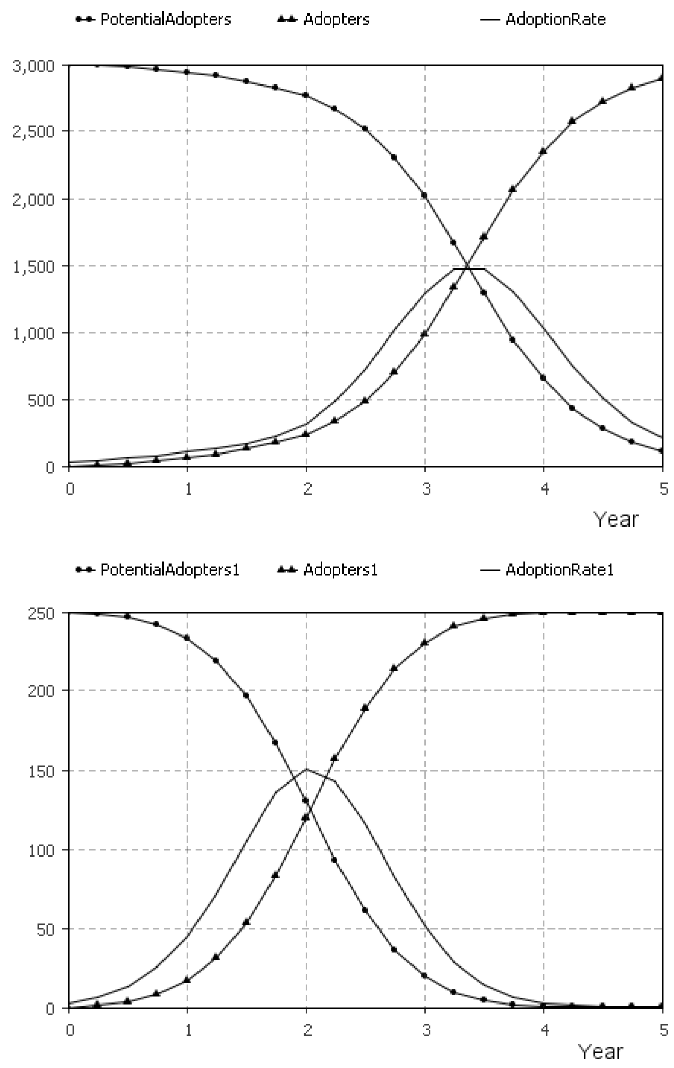

Fig. 3. The results of the simulation of introducing the innovative product.

III. Conclusions

The presented model realizes simple assumptions and kinds of connections. They can be developed up to the necessary level of complexity and adequacy of the model. Besides, the model allows to generate a necessary assembly of implementations for manifold statistic analysis, for appraisal and management of risks in the course of realization of the project for introducing the innovative energy saving technology in old industrial regions of CIS and Northern-Eastern Asian regions.

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