OPTIMIZATION PROBLEMS IN ELECTRIC NETWORKS WITH RENEWABLE ENERGY IN THE SMART GRID CONCEPT

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Modern global trends to decentralize power consumers that are associated with increasing cost of traditional fuel and manifested in the increasing proportion of distributed electricity production from renewable energy sources (RES), lead to complications planning regimes of electric power systems (EPS) and their operational management [1-2]. In addition, the combination of the mentioned above processes with economic power engineering reform - implementation of bilateral agreements - virtually prevent to organize the effective functioning of the EPS without improving their information infrastructure with a gradual transition to the concept of intellectual power networks (Smart Grid) [3].

Current trends in world power generation industry development are directed on electric networks modernization. Most of the world industrially developed countries comprehend the necessity of increasing the power efficiency in the context of global warming problems. So, they stimulate development of alternative and renewable energy, as well as increase of automatic optimization and control in electric networks, improvement of relay protection facilities etc. [4].

Development of power generation industry set the problem of gradual transition from traditional technologies that expect use of electric networks centralized generating to basically new solution that is directed to wide application of distributed energy sources and active networks able to provide services on transfer, keeping and transformation of electrical power. Active electric systems are able to adapt quickly to variable needs of interested parties – owners, consumers, vendors. They are considered to be the key element of infrastructure of the future “intellectual” power systems. At present all the aspects of creating “intellectual” power systems are

viewed within the Smart Grid concept, the most known and popular concept for electric networks modernization [3–4].

Such a concept is characterized by bilateral electrical energy and information streams for creating automated, widely branched distribution grid. Within it, information exchange goes on between communication domains of generating, transfer, distribution and consumption of electric power that are physically presented by systems of production automation and control for each domain [5]. Besides bilateral electrical energy streams and information exchange, this concept provides implementation of current control, protection and functioning optimization of all interacting elements. Those elements include powerful generators and renewable energy sources that are connected with industrial consumers, energy-storage units as well as end users using to main and distributed networks.

It is worth to accentuate that Smart Grid is not just new energy technologies, but also modern information and communication technologies for billing, e-commerce, access and administration control in the networks of various scale, data modeling and storage, virtualization, computer safety, distributed information computing, collection, processing and transfer real-time [6]. In fact, Smart Grid should be considered not as a single technology, but as a complex approach and methods of creating large-scale “intellectual” enterprises that function on base of new technologic platform and provide a wide range of services with use of information and power technologies.

Specialists think [7] that use of modern management technologies together with wide use of new information and communication technologies will give the possibility to support supply and demand in “intellectual” power systems on the level of a single device. Smart Grid will enable users to take part in power system functioning consciously, at that using assets in power generation industry will improve, economic efficiency will increase, as also quality of electric power and stability of power systems against unendorsed external influence. Finally, transition to “intellectual” power systems will push to development of new types of production and services, and formation of new markets.

Principles of Smart Grid operation consist in integration and automation of generation, transfer and consumption processes. In general case Smart Grid technologies are understood as a set of software and hardware tools that contribute increase of electric power transfer efficiency. Efficiency is comprehended as:

- decentralization of functions generating and controlling electric energy and information streams in a power system;
- reducing of expenses for arranging power transmission system;
- rapid elimination problem;
- possibility to transfer electric power and information in two directions that is considered an important condition for the concept of distributed power generation industry and use of renewable energy.

Electric network based on Smart Grid concept unites two subsystems:

- electric power transfer subsystem;
- information exchange subsystem.

So, besides conventional power lines, information connections that join all participants of electric power market are introduced. Modern implementation of Smart Grid elements in many countries give the possibility to affirm that technologically such systems create preconditions for highly efficient use of RES for solving both local (maximization of profits from their exploitation) and systemic (increasing of region electric network functioning quality) tasks. According to Smart Grid concept, all the participants and organizers of power exchange process in EPS may be distributed between fields of expertise or the so-called domains. Main domain functions related to work of renewable energy in distributed grids are shown on fig. 1.1.

Domain “Distributed generation” joins power stations, including RES of various types that deliver electric power to distributed electric grids. Its main job is to increase efficiency of electric power production by such sources. Special complexities occur on the way of optimizing wind farms and solar power plants as their modes are defined by stochastic influence of the environment. At this it is almost impossible to store primary energy (as, for example, in case of small hydro

power plants).

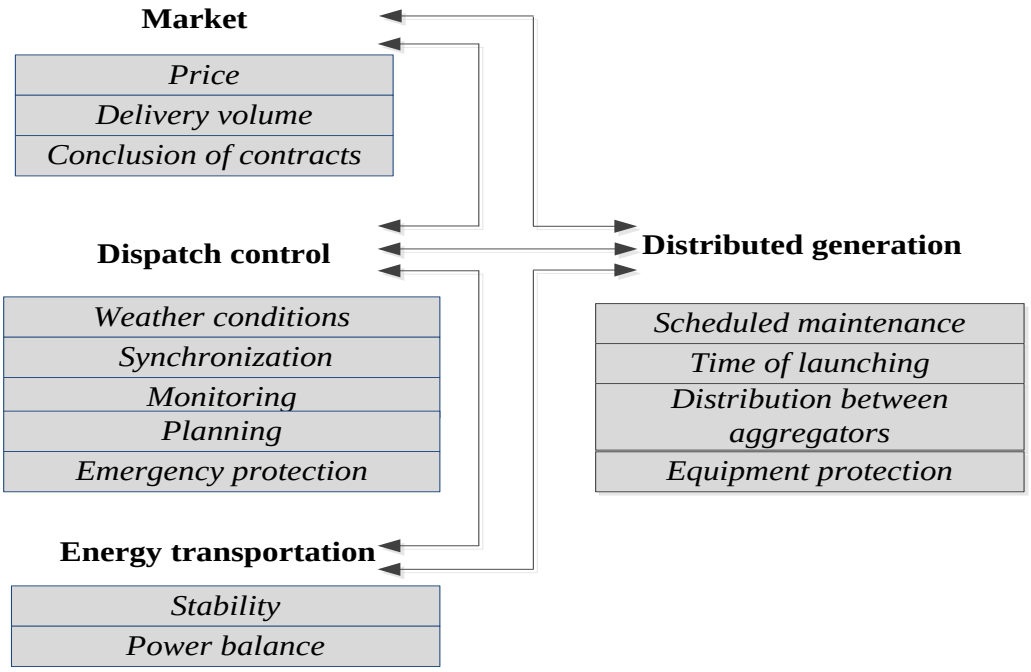

Figure 1.1 – Main functions of separate Smart Grid domains related to power generation due to renewable energy

The described domain relates to information streams with domains of control, power market functioning arrangement, and also with energy transportation domain. Information connection with the last one is the most important as the transportation domain functionally fulfills, together with other domains, data collection and processing, equipment protection, operating optimization and other.

Information connections allow to take into consideration operational specialties of different power stations that use RES, especially WF (wind farm) and SPP (solar power plant), where the process of electric power production has a number of technical and organizational peculiarities. Information connections with the domain “Market” allow to coordinate tasks of EPS with affirmed delivery volumes of electric power by terms of bilateral contracts, power market conjunction, correcting prices on electric power supplies and other system services.

To increase technical and economic efficiency of renewable energy sources and distributed electric networks joint exploitation, it is necessary to solve tasks that

allow to increase production of energy by RES, decrease electric power losses in distributed electric power systems and raise its quality. With the aim of renewable energy sources efficient exploitation and their efficient use in electric networks of power systems, it is necessary to take into account and study in the future their peculiarities and new features that arise in the result of joint work of these networks in the composition of electric power systems using the Smart Grid concept.

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