

## Ecological aspects of development of nuclear power industry of Ukraine

**Mykhailo Sychov**

*Candidate of chemical sciences,  
Associate professor of the Chair of quality and life safety  
Odessa State Academy of Technical Regulation and Quality,  
Odessa, Ukraine*

**Leonid Kolomiets**

*D.Sc. in engineering, professor,  
Chancellor of Odessa State Academy of Technical Regulation and Quality, Odessa, Ukraine  
E-mail: odivt@list.ru*

### Abstract

Questions of ecological safety at realization of Energy strategy of Ukraine till 2030, negative impact on environment and human health in a zone of projects implementation of this strategy, questions of social responsibility of the government at design, construction and work of such power objects and need of primary development of nuclear power which has ecological advantages and significant own resources in its area as main direction of power supply of Ukraine, are considered.

Key words: ENERGY STRATEGY, OVERHEAD TRANSMISSION LINE, ENVIRONMENT, ENVIRONMENT PROTECTION, ELECTROMAGNETIC FIELDS, SANITARY AUDIT OF TECHNOGENIC POLLUTION, NUCLEAR POWER, URANIUM ORES, GOVERNMENT RESPONSIBILITY

Statement of a problem in general view consists in consideration of further aspects of development of power industry at extremely difficult situation in the field of generation of electropower, created in 2013-2014 in Ukraine and use for this purpose of raw material resources. In a new way there arise a question of solution of environmental problems of power indus-

try connected with performance of Power strategy of Ukraine for the period till 2030, further creation of the new and integrated electric networks of high and ultrahigh voltage, optimum and corresponding to the legislation of our state solution of questions of ecological and social safety, protection of inhabitation and preservation of natural objects condition, respon-

sibility of authorities [1].

Analysis of the developed power situation in Ukraine, lack of sufficient level of own traditional raw material resources for generation of electric power, change of balance in its production and consumption shows the necessity of revision of present electricity generation pattern and realization of schemes of electricity transmission of energy from existing and new generating objects. Lack of necessary volumes of organic fuel in the form of coal and natural gas, dependence of Ukraine on import of these energy products, insufficiency of alternative types of power raw components (wind and solar energy, water resources, plant fuel resources) sharply raise a question of increase in weight of nuclear power, building of the new generating objects, definitions of conditions of safe operation of already existing power units of the NPP, their reasonable location on the territory of Ukraine and a condition of transfer of the electric power from the existing NPP to the consumers of Center and South of the country.

Integrated power system of Ukraine (IPS) is one of the largest power associations in Europe. In IPS of Ukraine annual power generation in 2010-2012 years was 192 billions kW · h per year that exceeded consumption level and allowed to export 7.8 billions Kw · h. In 2014 the situation with power generation in Ukraine significantly changed, it worsened due to military operations in the east of the country. Lack of significant amount of coal of native deposits, which is the fuel for most of thermal power plants of Ukraine, put the country power industry into a difficult situation, especially considering winter conditions of 2014-2015. The problem of the Crimea also significantly affected the balance of intake of energy resources in the form of gas and development of its deposits on the shelf of the Black and Azov seas. One of the main tasks for electrical power branch is ensuring of effective and reliable functioning of IPS of Ukraine and need of import of coal and electric power from the neighboring countries, first of all from Russia, and also creation of conditions for the planned integration of a power system of Ukraine to European power systems (ENTSO-E). The ideology of such integration was the basis for Power strategy of Ukraine for the period till 2030. If in Power strategy of Ukraine the advantages were sufficient reserves of coal and raw components of nuclear fuel and ores of constructional metals: uranium, zirconium and titan, than the circumstances developed in the country in 2013-2014 force to consider advantage in the form of development of nuclear power. In 2005-2012 the electric power output on the NPP

made 47.9% annually of total production 182.2 billions Kw · h. It is planned during the subsequent periods for ensuring steady work of Ukrainian IPS to observe standard conditions of delivery of capacities and formation of transit trunks of 750 kV towards the southern direction from Khmelnytskyi NPP and Zaporozhian NPP and northern - from Rivne NPP to the center and East of the country. Electric power production volumes at NPP have to increase both due to introduction into service of new power units of NPP, and due to reconstruction of operating with extension of life at least for 15 years. Thus in 2030 in operation there will be 9 power operating units, and production of the electric power on NPP in 2015 will make-110.5 billions Kw · h, in 2020 - 158.9 billions Kw · h, in 2030 - 219.0 billions kW · h. Depending on a choice of platforms for new nuclear power plants the total amount of air-lines of an electricity transmission (ETL) has to increase by 1200-1500 km.

New stretches of ETL and schemes of their passing can have negative consequences from impact of electromagnetic fields on people and on biogeocenosis and its violations. Results of environmental assessment and consideration of a number of projects on passing of the ETL which are carried out by the National Ecological Center of Ukraine (NECU) [2] prove it. Negative consequences, which can take place at implementation of these projects, are confirmed also by researches of scientists of many countries [3-6]. More detailed contents of this analysis and conclusions of NECU, consideration of negative impact of electromagnetic radiations from the ETL on people and on biogeocenosis in general is shown in work [7].

Projects on development of nuclear power industry have to improve an ecological situation in the country, reduce discharging from thermal power plants, save organic fuel and gradually replace it on nuclear on the NPP. For production in 2030 of 219.0 billions kW · h of electric power, one should have 29.5 GW of rated capacity with coefficient of the used power at the level of 85%. Construction of new capacities of the NPP during the period till 2030 is defined by the number of current power units, which will be able to be in operation during this period taking into account extension of term of their operation for 15 years. By 2030 in operation there should be 9 operating power units of the NPP: 7 power units with prolongation over set term - No. 3, 4, 5, 6 of Zaporozhian NPP, No. 3 of the Rivne NPP, No. 1 of Khmelnytskyi NPP, No. 3 of Southern Ukrainian NPP and 2 power units, which were put into operation in 2004 - No. 2 of Khmelnytskyi NPP and No. 4 of Rivne NPP. Until

the end of 2016 it was planned to put into operation power units No. 3 and No.4 of Khmelnytskyi NPP. During 2027-2030 it was planned to begin construction of 6.5 GW of new capacities of the NPP for their implementation after 2030 [8].

Viewing of made decisions in power strategy requires an immediate assessment of operating conditions of power supply system of Ukraine, assessment of a condition of development and assimilation in operation of power units on the basis of experience both of our country and others, which operate the NPP. All decisions have to be proved by existence of own raw material resources of uranium and ores of constructional materials, stability of work of the NPP and opportunities of Ukraine for creation of power capacities on the NPP, technical, financial and environmental problems of power. Important factor is also that the nuclear power reduces negative load on environment, quantity of dust, acid and metal noxious emissions from the stations burning coal. Of course, the nuclear power has the examples of the danger caused not only by insufficient technical solutions, but also a human factor. Real sizes of emissions from NPP of Ukraine into environment make 10% of the set limit in 1 mSv/year. Ecological consequences from thermal power plants at the same time (dust, chemical and radioactive emissions) are much higher.

Therefore the basis of ecological safety during the work of NPP should be [9]:

- Experience of world nuclear power and operation of reactor installations with water under pressure, that is the PWR/BBEP type, with a choice of single power of new power units 1000 - 1500 MW each;
- Timely replacement and decommissioning of the power units, which exhausted their life time;
- The prevention of experiments and an additional equipping of working power units, guaranteed control of nuclear reaction and the heat sink in installation;
- Improvement of the monitoring system of reactors operation, control and forecast of a radiation situation;
- Periodic reevaluation of influence of the NPP on environment and establishment of more rigid norms on radiation safety;
- Development of national strategy of executing with wastes of radioactive materials and constructions of reliable storages.

Providing the NPP with own uranium and organization in Ukraine of own nuclear fuel production, overcoming of crisis on production of own uranium, for what our country has the prospects, largest in Europe, as one of the main producers of own uranium of the operating and new deposits, is problematic task

for today. Ukraine is a leader among the countries extracting uranium. In the territory of Ukraine there is one of the world's largest uranium-ore provinces [10] in the Kirovograd area. Production of own natural uranium makes 500-800 t per year that meets requirements of the native nuclear industry only for 30%. The remained Ukraine buys in Russia, but intends to provide itself with own uranium for 100%.

Therefore one of the most important tasks of our uranium industry is the increase in production of a concentrate of natural uranium, at least, till meeting all the requirements of the domestic NPP. Because of quite low content of uranium in ores, deposits of Ukraine have a number of peculiarities, which provide competitive capacity of production of own uranium concentrate:

- Big uranium deposits that allows to apply high-performance production systems;
- Modern, advanced technology of elimination of uranium compound from ore rock based on their processing by sulfate or bicarbonate alkaline solutions directly in underground layers, considerably reduces the quantity and activity of wastes in the environment and promotes improvement of ecology (this leaching method is accepted by IAEA as the most ecologically pure and safe)
- Acting technologies of production of uranium, its transfer to liquid compounds in underground layers, allow to receive also in addition significant amounts of valuable chemical elements: molybdenum, rhenium, selenium, vanadium, scandium, lanthanides that 2.5 times reduces cost of uranium production;
- The method of uranium production allows to reduce environmental pollution and negative ecological consequences;
- High strength of the bearing strata, allows to pass excavations without fastening and to pass clearing blocks of large volumes;
- Small water inflows to excavations;
- Rather simple measures of radiation protection thanks to the small content of uranium in ores;
- Capital investments in development of the uranium mining industry are tens times less than the expenses necessary for adequate development of coal mining. For example, putting in operation of Novokonstantinovskiy mine, largest in Europe, will allow to make from the extracted uranium 46 billions Kw • h of electric power annually. Production of such quantity of electric power on thermal power plants requires introduction of 28-30 coal mines with a capacity of production about 1 million tons of coal per year each. Of course, there is a problem of organization of storages of uranium production wastes

and improvement of environmental protection, for what the number of programs of the Cabinet of Ministers of Ukraine is approved and the corresponding scientific justifications and technical solutions on measures of protection of the population and environment are required.

Explored resources of natural uranium in Ukraine allow to provide development of nuclear power more than for hundred years, and in case of transition to the use of reactor installations on fast neutrons the potential of native uranium stocks will 60-70 times increase. Thus strategy of creation in Ukraine of own nuclear fuel production has to be focused on:

- Development of uranium production for meeting the requirements of NPP of Ukraine in concentrate of natural uranium;

- Development of zirconium and its alloys and components for the fuel elements (TFE)

- Construction of plant on production of TFE.

All the projects planned in Power strategy of Ukraine can't be still executed today, but they should not be postponed considering further European integration of our country and real partnership in power branch. The planned strategy usually requires basic changes and revision of separate projects, including sources of generation of electric power. It is obvious that absence of large objects of hydropower, raw fuel organic resources sharply raises a question about accelerated further development of nuclear power for what in Ukraine there are considerable raw opportunities both on uranium deposits, and sufficient ore developments of constructional metals - titan, zirconium and others.

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