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INTEGRATION IN THE USE OF GEOTHERMAL, SOLAR AND WIND ENERGY

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ABSTRACT

The energy sector of the USSR and later on that of Russia rested on and has been founded on a powerful system of the centralized electricity and heat supply making use of conventional energy sources and is associated with considerable transportation expenses and losses. The price advance on conventional energy sources, that has been observed lately, opens the door to the arrangement of competitive conditions for energy supply on the basis of unconventional and renewable energy sources. Integration, in the use of a number of kinds of renewable and non-conventional energy in a single power supply system, is one of the feasible tendencies to solve the issues. A worthwhile and highly efficient power complex is possible to set up comprising a geothermal circulating system (GCS), windpower plant, and solar station,which results in the removal of drawbacks of any of energy sources.

Power engineering in the twenty first century inevitably will entrust humanity with a monumental task. It will force the resolution of the problem of rational and environmentally friendly conversion of sources of renewable and nonrenewable energy. The strategy of development of the human will rely on the idea of the balanced coexistence of an individual and his environment. The industrial and technological revolutions that took place in the 20th century as well as the informational revolution that is under way based upon intensive use of natural resources of combustibles. Conscious awareness of environmental friendliness, sustaining ecological balance and environmental management were stated in basic documents adopted by international forums that took place in Rio de Janeiro, Kyoto, Harare, etc. and emerged by the end of the millennium.

The energy sector of the USSR and later on that of Russia rested on and has been founded on a powerful system of the centralized electricity and heat supply making use of conventional energy sources and is associated with considerable transportation expenses and losses. This strategy generated the concept “grantor regional area” and “recipient regional area” in accordance with their power potential. Increasing autonomy of several provinces and regions in Russia in terms of political, economic and industrial development govern the formation of indigenous energy policy, too.

The major aspects of the regional energy policy can include the following regulations, viz:

1) achieving a balance between reasons of federal and regional bodies of power, enterprises of the fuel and energy complex and energy supply consumers in reference to the ways and rates of development of interrelated fields, i.e. economics- energy sector-ecology (human environment);
2) well-defined segregation of duties, rights and responsibilities for energy management between federal and regional bodies of power, delegation of the powers that they need to ensure reliable no-break energy and heat power supply of the territory;
3) rational use of local fuel and energy resources and the ones the region is supplied by;
4) development of the local source of power supply owing to the use of unconventional and renewable energy sources.

The price advance on conventional energy sources, that has been observed lately, opens the door to the arrangement of competitive conditions for energy supply on the basis of unconventional and renewable energy sources. To develop a project of involving unconventional and renewable energy sources (URES) into the regional energy budget it is efficient to highlight the following basic stages of implementation of the objective, viz:

- determination of demands of the regions for thermal power and electric energy of various potential function;
- data analysis about basic sources of fossil fuel, thermal power and electric energy;

- appraisal of all resource categories of unconventional and renewable energy sources,
- zoning and mapping of the regional area in terms of spacing of these reserves, economic and ecological expediency of their use;
- analysis of production scheme and URES conversion scheme with due regard to the specific character of the region;
- location of prospective priority of construction sites of URES plants aggregated technical-and-economic assessment of their parameters and performance with due regard to socio-economic factors.

The complexity of involving URES into the regional energy budget depends on the individual for each region structure and its resource base. Even after appraisal of the possible ratio of URES in the regional energy budget the question what sources of renewable energy are to be used to take the place of remains undetermined.

The energy sector development on the basis of URES depends on solution of a number of problems among which the following seem to be major, viz:

- recovery of energy source of low density and soft concentration and as a result a high specific material requirement and its high cost;
- necessity for approval of generation process and energy demand on the basis of renewable sources and a high scale of overlapping due to a random character of energy input.

Integration, in the use of a number of kinds of renewable and non-conventional energy in a single power supply system, is one of the feasible tendencies to solve the issues mentioned. Such an approach arises from the following, on the one hand, URES are of the same origin and they have general geophysical processes, the cyclicity of which, in the short run, depends on the revolution of the earth round its axis and round the sun, while, in the long term, it is dependent on the processes on the sun proper. The relationship between the occurrence of the solar cycle and many earth met ocean processes that are contiguous to each is given notice to as the basis by a number of researchers. The results of abundant measurements have shown, that phenomena caused by insolation in atmosphere and in hydrology account for 90% of the ones that really took place. These data confirm visually the presence of correlation between phenomena under consideration and their common nature.

However, despite the common genetic nature of nascence, solar and wind energy differ greatly. First of all, they have diverse crude energy input and a considerable proportion of random component (Fig. 1). Typical time sequences can be associated with during which one energy source, i.e. geothermal energy can operate as a guaranteed producer (which has uniform input), and the others, viz. solar an wind power should be considered as random ones. If they are combined it may result in damping solar and wind power fluctuations.

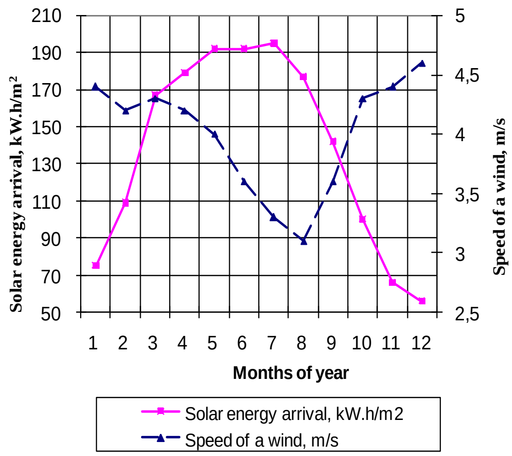

Figure 1:Character of arrival wind and a solar energy for conditions of Northwest region

Power complex schemes on the basis of URES should provide for an optimal selection of power installations that will generate and redistribute energy in accordance with the power consumer schedule and thus there should be an energy storage device.

A very challenging and efficient power complex with thermal energy storage can be activated as a result of using a geothermal circulating system (GCS), windpower plant, and solar station. This combination guarantees balance of any of energy sources, viz:

- temperature potential of the heat transfer medium increases due to the completion of heating in solar thermal collectors or electric heating-water converter plants, running on windpower;

- auxiliary power consumption is recovered by the operation of wind-electric sets;

- thermal energy storage in a geothermal collector and production induced controllability of the GCS compensate variability of solar energy and windpower input.

However, solar energy, windpower and hydraulic energy differ greatly. Primarily, they have a diverse condition of input of crude energy and availability of a considerable random power component.

A worthwhile and highly efficient power complex is possible to set up comprising a geothermal circulating system (GCS), windpower plant, and solar station,which results in the removal of drawbacks of any of energy sources. The potential function of a geothermal transfer medium increases due to the completion of heating in solar thermal collectors or electric heating-water converter plants, running on windpower. Auxiliary power consumption is recovered by the operation of wind-electric sets. Thermal energy storage in a geothermal collector and production induced controllability of the GCS make up solar energy input instability.

The system of heat supply to the Yaroslavl region has been accounted as an example of implementation of such a power complex. In this region, solar energy is characterised by the total input of about 1650 kWh/m^2 per ann. According to the long-term observations data, obtained at a standard height of a 10 meter weather cock, the wind conditions in the Yaroslavl region are approximately 4mps. The input of crude solar energy and windpower, in the course of a year, are opposite in phase.

Power complex capacity has been rated to be 5 GJ/h which meets the demand of a settlement, town housing development, village, etc. On the basis of performance of a geothermal power plant and the transfer medium temperature, which are required at the input of the heat supply system, there were calculations made and determinations given for the area of solar thermal collectors, which added up to as much as around 1000 m^2. Over a period of spring, summer, and autumn seasons they are able to generate approximately 320 MWh or $1{,}15 * 10^{6}$ GJ of thermal power.

A wind electric plant with an overall wattage of about 500 kW is used for auxiliary power consumption of the complex and completion of transfer to the medium heating in wintertime. In accordance with a windblast curve, and due to adjustment of data in terms of hub height, the aggregate energy yield may reach approximately 1.1 million kWh per ann.