UOT 338.28

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PROJECT MANAGEMENT IN THE FIELD OF GEOTHERMAL ENERGY (ON THE EXAMPLE OF THE DE-OCCUPIED TERRITORIES OF AZERBAIJAN)

Abstract

The article discusses practical proposals for the implementation of a project to create geothermal stations or an integral geothermal complex for generating heat in the liberated territories of the Republic of Azerbaijan.

Keywords: *Green energy, geothermal stations, project management, efficiency, project.*

INTRODUCTION

The success of the restoration of the territories of the Republic of Azerbaijan liberated from occupation and their reintegration presupposes the creation of the necessary economic conditions. A particularly important condition for the sustainable socio-economic development of such territories is the provision of a reliable energy base, taking into account alternative energy resources and the creation of "green energy" zones. The solution of these tasks can be facilitated by the development and implementation of promising projects for the use of geothermal sources, which are rich in the region of Nagorno-Karabakh. According to the Ministry of Energy of Azerbaijan, the reserves of thermal water in the Nagorno-Karabakh region are more than 3 thousand cubic meters, and in Shusha - 412 cubic meters per day [1].

Important prerequisites for the development of green energy in Azerbaijan are Decree of the President of the Republic of Azerbaijan No. 2620 dated May 3, 2021 "On measures related to the creation of a green energy zone in the territories liberated from the occupation of the Republic of Azerbaijan" as well as the further development of partnerships with Ukraine within the framework of the Memorandum of Understanding in the field of energy and environmental protection of Ukraine [2], readiness to implement specific projects in areas of mutual interest of countries [3].

At the same time, it is important to choose a specific project management approach, which allows you to identify risks and carefully control the implementation of the project [4].

Basic material and results.

The purpose of the article is to develop practical proposals for the implementation of a complex project for the construction of geothermal stations or an integral geothermal complex in the liberated territories for heat generation, using project management technologies.

The implementation of strategic goals for the construction of geothermal stations or an integral geothermal complex requires effective management of projects and programs at various stages of their life cycle.

The practical implementation of the proposed project requires the following tasks:

– conducting geological and hydrological searches with the task of reliably confirming the possibility of using geothermal energy in the region and determining the location of geothermal stations;

– development of the project and carrying out its technical examination to determine safety compliance, economic feasibility and environmental acceptability;

– purchase of equipment, materials and services necessary for construction;

– construction and control of work performance;

– putting the station into operation, carrying out the necessary tests and setting up the equipment;

– organization of maintenance and repair of equipment, ensuring its efficient operation throughout the entire service life;

– ensuring the economic efficiency of the station and achieving the goals for heat generation.

To achieve the goal of creating a geothermal station, various project management methods can be used: the traditional (waterfall) approach, when the requirements for the project and its goals are clearly defined, there is experience in implementing similar projects; flexible approach, when project requirements may change during the course of work, and you need to quickly respond to changes in external conditions; PRINCE2 (PRojects IN Controlled Environments). This approach can be useful if the project has a large budget, a high degree of risk, or requires strong risk management, allowing it to be adapted and applied to the needs and challenges of a specific scenario. It is important to choose a project management method that best suits the specific conditions of the project [4, 8]. In addition, it is important to ensure timely and effective communication between team members, as well as to set clear goals, metrics and work plans to ensure the successful completion of the project.

The implementation of the proposed project includes several important stages.

1. Evaluation of the effectiveness of project management for the construction of a geothermal plant should include an assessment of the achieved results of the project, the implementation of work on schedule and within budget, as well as the satisfaction of the customer and project team members.

Some specific metrics that can be used to evaluate the effectiveness of project management are:

–successful completion of the project within the time schedules and budget;

–the level of quality of the product/service created within the framework of the project;

–satisfaction level of the customer and project members;

–degree of achievement of the project objectives and fulfillment of customer requirements;

–risk management level and decision-making level;

–degree of use of project resources and budget management;

–quality of communication and cooperation within the project team.

Both quantitative and qualitative metrics can be used to evaluate the effectiveness of project management. In addition, it is important to conduct regular project evaluations and adjust work plans as necessary to ensure the successful completion of the project within the time schedules, budget and quality of the product/service.

2. Based on the search data that were made by Azerbaijani scientists regarding geothermal energy in the de-occupied regions and the territory of the Republic of Azerbaijan, methods for using geothermal energy to generate heat (heating buildings and structures) can be as follows:

– use of groundwater through water intake and drainage;

– use of the heat of the soil mass with the help of horizontal and vertical geothermal collectors at a depth below the depth of seasonal freezing;

– use of geothermal probes arranged by means of vertical drilling to depths of up to 400m;

– the use of load-bearing structures in direct contact with the soil body and groundwater.

The use of groundwater by means of water intake and drainage is associated with high requirements for the reliability of the system and high environmental requirements for the quality of groundwater after it has passed through the heat pump and/or heat exchanger system. Horizontal collectors, as a rule, are used in low-rise individual construction. Geothermal probes are mostly produced at depths from 50 to 200 m and are used both for individual construction and for larger buildings.

In addition to heating, geothermal energy can also be used to cool the building in summer. The ground mass can also be used for heat storage. A schematic diagram of the use of geothermal energy is shown in fig. 1. However, due to the comparatively high subsoil temperature in the Nagorno-Karabakh region, this possibility should be studied in further stages.

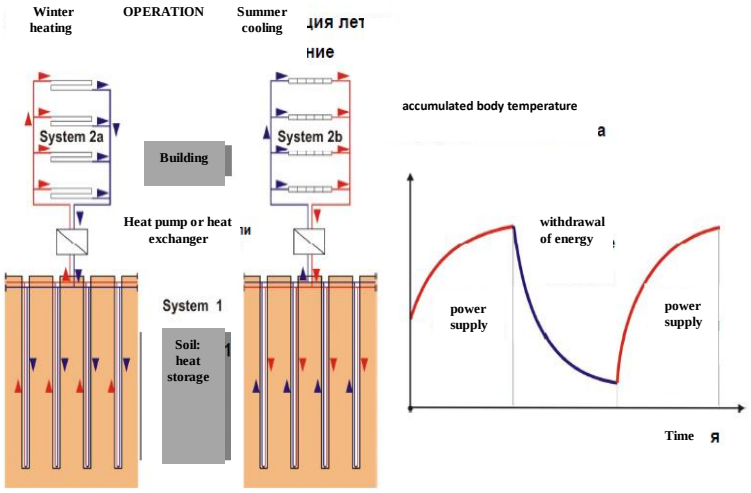

Figure 1. Schematic diagram of the use of geothermal energy

3. The methods of using geothermal energy listed above can be used both for already built buildings with an appropriate adjacent territory, and for new construction. In new construction, it is especially effective to use load-bearing structures that are in direct contact with the soil massif and groundwater, such as laying pipes under the foundation slab or installing energy piles (fig. 2, fig. 3).

Figure 2. Laying pipes under the foundation slab

Figure 3. Energy pile

Bored piles, bored-injection piles, driven and other types of piles can be used as energy piles. In addition, to obtain geothermal energy on a similar principle, as well as energy piles, excavation barriers, such as secant piles, diaphragm wall, etc., can be used.

4. When designing small geothermal complexes used only for heating and with a power of less than 30 kW, as well as with the simultaneous presence of simple engineering and geological conditions, the design, for example, in Germany, is carried out on the basis of available collections and empirical values [9]. When designing geothermal complexes with a power of more than 30 kW, it is necessary to carry out analytical calculations and numerical simulation based on the thermophysical properties of soils [10]. In the future, in stages, the design of geothermal complexes with a capacity of more than 30 kW in difficult engineering and geological conditions during the construction of new buildings is considered.

5. In order to determine the energy loads of a building, first of all, the purposes of using geothermal energy are determined, i.e. heating only or cooling only, or heating and cooling depending on the season. After that, a summary load schedule is compiled on a monthly basis, and the main and peak loads are determined. By using a geothermal heat pump, the base loads are most efficiently covered. At the same time, it should be noted that for residential buildings, heating/cooling and hot water supply account for about 70% of the total energy costs of the building.

The efficiency factor is chosen as the design goal, i.e. how many units of thermal energy are produced by the heat pump using the energy of the earth per unit of electricity consumed. Currently, when designing the use of geothermal energy, a factor of at least 1:4 is taken into account, i.e. for one unit of electricity spent, 4 units of energy are received for space heating or cooling [10].

In addition, the number of hours of operation of heat pumps per year and their maximum power are determined.

6. The terms of reference for the performance of engineering and geological surveys should take into account and sufficiently study the factors that are necessary for the design of the use of geothermal energy, such as:

- stratigraphic structure of the soil body;
- natural temperature of the existing soil body;
- groundwater (level, speed and direction of flow, chemical composition).

Particular attention should be paid to the study of hydrogeology since the speed and direction of groundwater flow are of particular importance when designing the use of geothermal energy.

7. In addition to conducting classical engineering-geological surveys, it is necessary to obtain the thermophysical characteristics of soils.

These quantities are:

- specific heat C [J/(kg*K)];
- soil thermal conductivity λ [W/(m*K)].

These determinations are carried out in laboratory conditions using equipment specially designed for such tasks. For the practical solution of the problem, the most successful are field tests that take into account the real conditions in the soil massif. For these tests, a Geothermal Response Test (GRT - geothermal testing of soil heat transfer, fig. 4), which determines the effective thermal conductivity of the soil λ_{eff} and coefficient of thermal resistance of the well R_b [11].

When modeling complex geothermal systems with a capacity of more than 30 kW in Europe, the above field tests are used as standard GRT.

8. Calculation and modeling are carried out on the basis of the thermal values of soils obtained as a result of laboratory and field tests, taking into account the hydrogeological conditions at the construction site (fig. 5).

As a result of the calculation, the following parameters of the geothermal complex are determined:

- geometrical parameters of heat exchange elements (distances between them, quantity, depth);
- diameter, wall thickness and thermal parameters of tubes used for heat exchange;

– quality and thermal parameters of well filler;
– hydromechanical and thermal characteristics of the fluid used for heat transfer;
– volume of fluid used for heat transfer (rate, quantity).

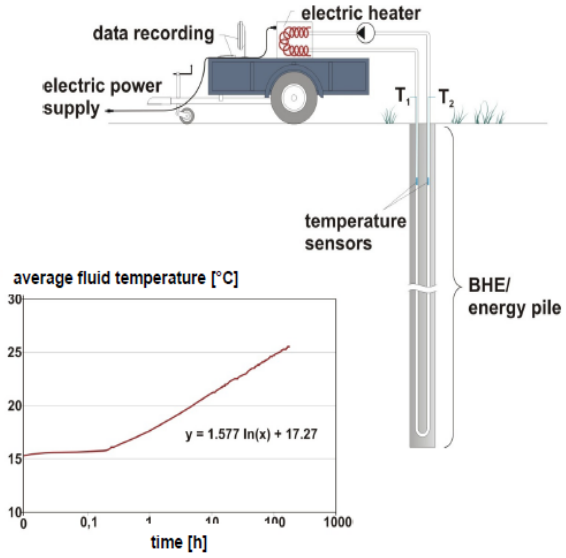

Figure 4. Scheme of the Geothermal Response Test and the graph obtained as a result of the test

The calculation is carried out for the entire time of using the geothermal complex and determines not only the amount of energy received, but also the impact of receiving geothermal energy over the time on the soil body.

Currently, there are methods of analytical calculation for relatively simple cases. Software packages such as Earth Energy Designer (EED) or EWS use line source theory and g-functions.

In complex engineering-geological conditions and for complex problem statements, modeling is used using finite element, finite difference and finite volume methods.

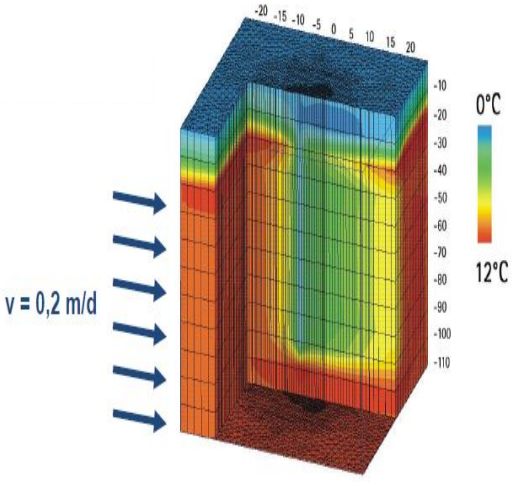

Figure 5. Modeling of a geothermal probe in three-dimensional space, taking into account the speed of the flow of groundwater

CONCLUSIONS

One of the main directions in the course of the economic development of the liberated territories, President of the Republic of Azerbaijan Ilham Aliyev identified the transformation of the liberated territories into a "green energy" zone [12].

The use of geothermal energy has great potential, both in terms of protecting and preserving the environment, as well as in terms of commercial and industrial applications. Today, the use of geothermal energy is expedient not only from a technical, but also an economic point of view. The use of surface geothermal energy is not a pilot or experimental project, and its implementation in European countries has reached the level of proven technology, which is used in many large facilities.

The efficiency of geothermal energy systems depends primarily on professional design, including special surveys, and professional construction and equipment adjustment work.

The application of geothermal technologies also requires political incentives for these projects, starting with the creation of a legal and regulatory framework and ending with concessional financing for such projects.

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Geotermal enerji sahəsində layihələrin idarəedilməsi (Azərbaycanın işğal edilmiş ərazələrinin timsalında)

Xülasə

Məqalədə Azərbaycan Respublikasının işğaldan azad edilmiş ərazilərində istilik istehsalı üçün geotermal stansiyaların və ya inteqrasiya olunmuş geotermal kompleksin yaradılması layihəsinin həyata keçirilməsi üzrə praktiki təkliflərdən bəhs edilir.

Açar sözlər: *Yaşıl enerji, geotermal stansiyalar, layihənin idarə edilməsi, səmərəlilik, layihə.*

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РОЗВИТОК ТРАНСПОРТНО-ЛОГІСТИЧНОГО КОМПЛЕКСУ УКРАЇНИ В УМОВАХ РЕІНТЕГРАЦІЇ ЗВІЛЬНЕНИХ ТЕРИТОРІЙ

Анотація

Ця стаття присвячена аналізу проблем та перспектив розвитку транспортно-логістичного комплексу України в умовах реінтеграції звільнених територій. Автори розглядають зміни, що сталися у галузі транспорту під час конфлікту, та виявляють основні проблеми, які потрібно вирішувати для забезпечення розвитку транспортного сектору. У