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Energy Management Systems (Enms) Reforms of Georgia

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Abstract:** Two important laws adopted by the Parliament of Georgia are one of the major steps made towards approximation with the European Union. Georgia has taken some steps to get closer to EU standards, including in the energy sector. Law on Energy includes many aspects that correspond to the new model of the market and related relations. Law of Energy Efficiency of Buildings along with a reduction of greenhouse gas emissions has many other positive effects, including employment growth, development and innovation of technologies in the construction industry, reduction of air pollution and water and soil contamination, improved human health and comfort level, reduced energy bills, etc. In this study implemented a decision making model to receive the results in handling the uncertainty associated with the power system development process. In the process of rating evaluation elements of the influence of these characteristics, attribution functions, and corresponding weighting coefficients were revealed. Finally, have been identified facilities that can do less harm to the environment, namely less impact on climate, geology, water, air, and soil quality, while encouraging the construction of medium and small hydropower plants, as well as solar, wind, and waste power plants. With properly selected energy facilities, Georgia will have a chance to successfully join the EU electricity system and harmonize with EU laws.

***Keywords:** Energy Management, Energy Efficiency, Power Engineering.*

1. INTRODUCTION

By implementing these laws, Georgia is strengthening her energy ties with the EU and considerably increasing her contribution to energy saving, energy security enhancement, and climate change control efforts. Besides, the laws are conducive to implementing construction and renovating buildings by the EU standards which are critically important in light of the

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current challenges in the Georgian construction sector. This is a set of measures that Georgia must implement to improve energy efficiency and which provided a basis for adopting the two new laws. Energy efficiency policy and investments which will promote improved services to customers, reduced energy consumption by insulated buildings and, in the long run, a more competitive economy. The study identifies linguistic variables that do not have a clear quantitative assessment. To meet the electricity shortage during the study period, it is necessary to develop capacities working on local renewable resources. It should be noted that Georgia is quite limited in terms of its production of fuel and energy resources and is completely dependent on the import of oil products and natural gas. Therefore, the development of such a structure for the Georgian power system, which will meet the growing demand for electricity at a minimum cost, especially in the autumn-winter period, is gaining special urgency [1].

2. METHODOLOGY

Because it is necessary to have a comprehensive assessment of each energy construction site and compare alternatives with each other, a multivariable decision-making algorithm is used. First, we need to explain how many fuzzy terms we need for each variable. This is a simple procedure. The program contains 9 linguistic variables, and each variable has its phase terms (values) [2], whose syntax is represented by the corresponding semantic forms of fuzzy values. Clicking the "Edit Term" button will bring up the term editing interface. In "Input / Output Source" we choose which category of variables we want to edit (in, out), in "Variable" we choose the variable (for the input category "Finance", "GHG", "Social Impact", etc. For the output - "HPP", "Solar Power Plant", "Nuclear Power Plant", etc.). Then all the fuzzy terms associated with the variable in question (if any) will appear in "Term's Name". From here we can change the term name and numeric value. In practice, Fuzzy linguistic variables are used when there are multiple input and multiple output variables. The first step is to determine the alternatives, and evaluate, and comparison between them. In the study, the evaluation of alternatives can be made by linguistic data. Mathematically we can define a universe of n alternatives as:
$A= [a_1, a_2,..., a_n]$, And the set of "Multi" objectives as $O=[o_1,o_2,..., o_n]$.
Qualifying objects are:
High capacity (100 MW>above) regulating reservoir HPP; Medium capacity (15-100 MW) natural runoff HPP; Small capacity (up to 15 MW) HPP; Solar power plant, when an active solar energy system, with complex converting devices, are used to receive electricity; Wind power plant, when wind kinetic energy is used to generate electricity; Biomass Power plant operating on municipal solid waste; Natural gas-fired Thermal Power Plant, when the chemical energy of organic fuel is used to obtain electricity; Local coal-fired Thermal Power Plant; A nuclear power plant when energy obtained by splitting the nucleus of natural Uranium, Thorium or Plutonium [3].

3. RESULTS OF THE STUDY

Each type of power plant has positive and negative aspects: construction of a hydropower plant causes wetlands, villages, and agricultural land areas to be flooded. The operation of the

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thermal power plant causes the release of carbon dioxide and other greenhouse gases into the atmosphere, resulting in climate change on Earth and global warming. The operation of a wind farm is related to noise and interruption of TV and radio waves, etc. Modern methods of probability theory fail to take into account the aspects of uncertainty presented, thus, the use of "fuzzy logic" allows an optimal decision to be made by processing incomplete information about different objects and using tools based on a combination of indeterminate sets [4]. Investment / financial need for a power plant construction project - The cost of designing rgy facilities in modern conditions is quite high and depends on geographical, and climatic conditions, terrain complexity, and other important factors. The specific capital costs per unit of installed capacity of wind, solar, geothermal, biomass, and small capacity hydropower plants - 3,500$ per kW, for medium and large capacity hydropower plants - 2,000$, for coal and fuel oil thermal power plants - 2,500$ per kW, for gas turbine power plant - 2,300$ and a nuclear power plant - 2,600$ per kW [5]. Greenhouse gas emissions - During the combustion of organic fuels, carbon dioxide, methane, and nitrogen dioxide are released into the atmosphere from thermal power plants [6]. In addition, hydropower plants also have the potential for global warming, which has an annual or multi-year regulation reservoir. This is due to soil, algae, wastewater, and debris accumulated on the seabed, which undergoes decay and, consequently, emits greenhouse gases. Social impact - Social impact is mainly related to the population living in the surrounding areas and their discomfort, for example, the operation of a wind turbine causes noise and interruption of TV and radio waves. The construction of a large HPP regulating reservoir often requires flooding of valleys, forests, and agricultural lands and the area may include settlements, historic buildings, churches, and cemeteries, hence the great resistance of the local population as well [7].. Geological impact – the construction of different types of power plants, and the development of their infrastructure cause landslides and erosion of local soil, Slope drilling can lead to the destabilization of a rock mass [8]. In addition, after the creation of a hydroelectric reservoir, the surrounding land will be transformed into a wetland area. Climate impact - Climate change and global warming are the most pressing problems facing the entire world, which is closely linked to the functioning of energy facilities. In particular, during the operation of the thermal power plant, as a result of the combustion of organic fuel, carbon dioxide and other greenhouse gases are released into the atmosphere, while the reservoir of the hydropower plant changes the local microclimate. The consequences of climate change are increased humidity, increased average winter temperatures, fog, and melting glaciers. Impact on flora and fauna -Energy facilities have some negative impacts on the biological environment, local flora, and fauna. Most animals and birds are forced to leave their habitat due to dust, noise, and other negative factors. There is also an electromagnetic field generated in power transmission lines and cables and bird mortality [9].Impact on water quality - Surface and groundwater pollution related to the construction - operation of energy complexes. The hydropower plant, which has a multi-regulated reservoir, degrades surface water quality due to the biodegradation of flooded vegetation. Energy oil and gas pipelines are also at great risk because their accidental leakage from pipelines will spread to deeper layers of soil and could spread throughout the water area. Impact on soil quality - Deterioration of soil quality is related to energy activities. It takes months or years to restore soil quality [10]. The reservoir of the hydropower plant covers water and makes the pastures, pastures, arable lands, and soils of different endemic crops unsuitable for agricultural use. Impact on air quality-Air pollutants

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include nitrogen oxides, sulfur dioxide, carbon dioxide, solid particles, ozone, and others. Sulfur dioxide emissions are caused by thermal power plants operating on fuel oil or coal. Their exhaust, the smoke generated during combustion, worsens the air quality of the surrounding area and the region as a whole [11]. The main source of carbon emissions is the burning of oil and coal. In addition, there are volatile emissions from oil, and gas pipelines in the event of an accidental leak or inefficient operation. Landfills for solid household waste also cause significant pollution of soil, water, and air and adversely affect human health. After processing the variables, we enter a question in the computer program: Given the objective function, which variable has the greatest impact on the outcome? (On choosing a power plant). Rating evaluations are presented in such a way as to determine which variable has the most impact on the final result [12**]**. Based on the expert assessment, the relevant matrix is compiled (Table 1). Appropriate quantitative value is given to the variables developed in the next step, and a hierarchical structure is built where the first level is the main goal, the second level is the weighted average values of the variables, and the third level is alternative selection facilities [13]. The next step is to determine the elements of the influence of these characteristics on the rating evaluation, the attribution functions, and the corresponding weighting coefficients [14]. Parameters that contain elements of uncertainty are expressed as x_n. The set of parameters has the following form: $\{x_1, x_2, x_3, x_4, x_5, ... x_n\}$.

The next step is to ask about the relation of the selected facility to each variable:
- Which facility needs more investment (x_1)?
- From which facility will more greenhouse gas emissions be emitted (x_2)?
- Which facility has the most geological impact (x_3)?
- Which facility has more climatic impacts (x_4)?
- Which facility has the most social impact (x_5)?
- Which facility has the most impact on flora and fauna (x_6)?
- Which facility has the most impact on water quality (x_7)?
- Which facility has the greatest impact on soil quality (x_8)?
- Which facility has the greatest impact on air quality (x_9)?

After entering the mentioned information into the program and assigning quantitative values to the fuzzy linguistic variables, we obtained the following matrix (Table 2) [15]. The rating points assigned to the facilities are processed (Table 3).

Table 1. Matrix of evaluation variables and energy facilities to be chosen

Name	FIn.	GHG	Geol.	Clim.	Soc.	Fl/Fn	Wat.	Soi.	Air	Sum
LHPP	14	5	20	15	10	10	10	8	8	100
MHPP	27	4	18	13	5	7	10	8	8	100
SmHPP	40	4	12	10	5	9	6	8	6	100
SolPP	35	3	10	5	13	15	4	10	5	100
WindPP	38	3	8	6	11	15	3	10	6	100
BioPP	35	5	5	9	4	8	10	13	11	100
NGTHPP	14	20	5	10	5	8	8	10	20	100
CoalTHPP	23	22	3	8	4	4	14	8	14	100
NuclPP	30	8	7	5	8	8	12	10	12	100

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Table 2. Matrix of weighted average values of the variables and energy facilities

Level 2	FIn.	GHG	Geol.	Clim.	Soc.	Fl/Fn	Wat.	Soi.	Air	
Weight	0.13	0.13	0.09	0.15	0.08	0.09	0.11	0.10	0.13	
Level 3										Composite Weight
LHPP	0.06	0.12	0.18	0.15	0.34	0.36	0.16	0.31	0.13	0.183
MHPP	0.05	0.04	0.06	0.04	0.09	0.07	0.05	0.07	0.04	0.054
SmHPP	0.10	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.03	0.042
SolPP	0.10	0.02	0.02	0.03	0.05	0.06	0.07	0.06	0.04	0.051
WindPP	0.09	0.02	0.03	0.03	0.12	0.11	0.06	0.06	0.03	0.056
BioPP	0.06	0.04	0.02	0.03	0.03	0.06	0.07	0.07	0.04	0.047
NGTHPP	0.06	0.19	0.04	0.19	0.08	0.09	0.17	0.10	0.23	0.137
CoalTHPP	0.32	0.41	0.49	0.35	0.10	0.10	0.17	0.12	0.30	0.280
NuclPP	0.15	0.14	0.11	0.15	0.16	0.13	0.20	0.15	0.15	0.150

Table 3. Rating points for energy facilities

Facilities To be selected	Average weighted value%	Rating score 1 to 100
Large Hydro Power Plant	0.183	18.3
Medium Hydro Power Plant	0.054	5.4
Small Hydro Power Plant	0.042	4.2
Solar Power Plant	0.051	5.1
Wind Power Plant	0.056	5.6
Bio Heating (waste) Power Plant	0.047	4.7
Thermal Power Plant (nat. gas)	0.137	13.7
Thermal Power Plant (coal-fired)	0.280	28
Nuclear Power Plant	0.150	15

An appropriate graph is made, which shows the percentage of each power plant (Figure 1.).

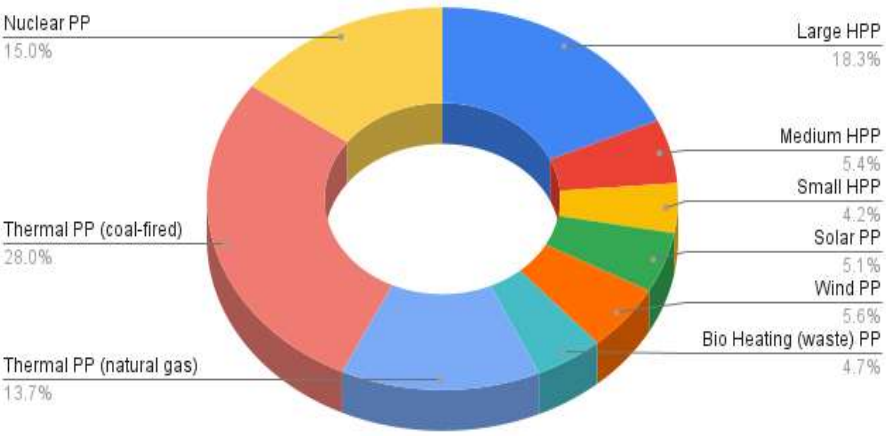

Figure 1. Specific weights of the environmental impact of objects

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The study revealed the most negative impact facilities, namely: Thermal power plants (coal-fired); Large hydropower plants (with regulating reservoirs) [16]. Nuclear power plants. Thus, those power plants with a rating score of more than 14 were excluded (figure 2) [17]. Thus, facilities that can cause less damage to the environment were identified, in particular, characterized by less impact on the quality of climate, geology, water, air, and soil. Thus, it is advisable to build the following facilities: Medium and Small Hydropower Plants, Solar, Wind, and Waste Power Plants [18]. To ensure the basic capacity in Georgia, it is necessary to operate a thermal power plant, so it is advisable to develop the capacity of a relatively low-carbon natural gas Thermal Power Plant [19].

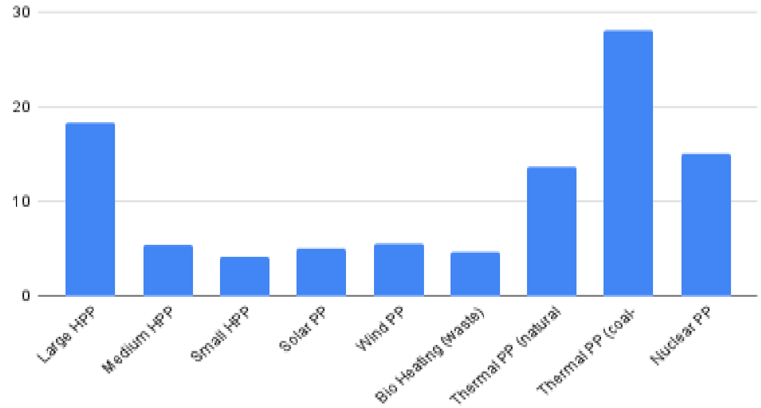

Figure 2. Power Plants with a Rating Score of More than 14 were Excluded

4. CONCLUSION

Existing scientific knowledge is embedded in the operational decision support system, which allows the advice given to energy policymakers to be equally good for all stakeholders. The stability of the power system is conditioned by the provision of coverage of basic, semi-peak, and peak loads. The world community is look for unconventional, renewable energy sources to replace fossil fuels such as coal, natural gas, and oil with renewable energy sources. The generating capacities of the Georgian electricity system can no longer meet the growing electricity demand. Given the uncomfortable processes (conflicts, military operations) in the region and in the world as a whole, Georgia needs to meet its energy facilities. The achievement of goals will promote the implementation of economically and environmentally sound energy demand management practices; a decrease in dependence on the import of energy resources and an increase in energy security that will help reduce currency draining out of the country; improvement of both outdoor ecological and indoor climate conditions of buildings that is one of the drivers of better healthcare, heightened productivity, and improved learning process and student development in educational establishments.

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