The Scenario of the Transition of the City of Kutaisi to Using 100% Renewable Energy by the year of 2050

Stanford University (USA) scientists led by Professor Mike Jacobsen, have developed a model of the world power system that by the year of 2050 will operate solely on renewable energy sources (RES): „100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World". As we can see the rest of the countries did not find the relevant initial statistics, legislative framework, etc., on the basis of which the ways of transformation and the expected results could have been described. This model envisages generating up to 80% of the world's energy production from renewable energy sources by 2030, and up to 100% by 2050. Especially noteworthy is the fact that we are talking not only about electricity, but also about the general energy consumed by humankind. The solution proposed by the scientists is very similar to the "GOELRO plan" and involves full electrification. That is, all areas and sectors that consume energy (transport, heating / cooling, industry, agriculture, etc.) must be electrified. In the last 5 years, $ 1.5 trillion has been spent worldwide on the implementation of the renewable energy sources.

1. 47% of this amount was spent on solar power plants;

2. 35%- on wind energy

3. 17% - on hydroelectric power plants (HEP);

4. 1% - On the rest

With these percentages, 1 million megawatts of new renewable capacity was generated, which was distributed as follows:

1. Solar generation -42%;

2. Wind energy 33%;

3. Hydroelectric power plants 20%;

4. Another 5%.

The figures presented confirm the importance of the decisions made in the 21st century on renewable energy sources and it also confirms the existence of a development spiral that has undergone a transformation in energy, starting with the use of firewood by humankind, then coal, water, oil, gas, atomic energy, and today RES, which has no other alternative. The resources of Georgia and in particular of Western Georgia, the good will and willingness of the government to use nature, for which it is ready to seek appropriate investments, are a precondition for the transition to Kutaisi entirely by electricity generated by 2050. Renewable energy resources of Georgia, and in particular of Western Georgia, the good will and willingness of the government to use what was given by nature, for which it is ready to seek appropriate investments, is a prerequisite for the city to fully switch to energy generated entirely from renewable energy sources. There is a close link between energy consumption and economic development. The city of Kutaisi, the second largest city in Georgia, consumes a large amount of energy in general and it must be provided with sustainable energy supply

for the relevant economic development of the 21st century. In December 2019, the Parliament of Georgia adopted these two laws for consideration: the law “on electricity generation in Georgia “includes 93 objects, of which 86 hydroelectric power plants are, 6 are thermal power plants and 1 is a wind generating facility. Due to the above, Georgia is on the list of rare countries where hydrogen generation, in general, far exceeds other sources. For example, while in Norway 97% of electricity comes from hydroelectric power plants, in Georgia this figure is 77%. Therefore, we can say that in Georgia, the electric power industry is not really in the forefront of the atmosphere of pollution sources. Accordingly, in the list of goals set in the memorandum signed between Kutaisi City Hall and the International Climate Organization "350.org", energy efficiency issues are in the first place. It should be noted that with the collapse of the central heating system, a lot of non-energy saving means were used for heating. At the same time, the existing housing stock has been built and is still being built from non-energy efficient materials, which has led to the fact that today 1 square meter of heating in Georgia consumes twice or even4 times more energy than one in EU countries. Such wasteful consumption of energy puts heating processes in one of the first places among CO2 emission sources, especially since we know that natural gas is used as the main means of heating. However, it would be appropriate to review the following table to determine which fuel (energy source) generates more CO2 emissions and how much innovative technologies reduce these emissions

№	Energy Source	Old Technologies	Innovative Technologies	%
1	Coal	966	130	86
2	Oil	900	800	12
3	Natural Gas	688	439	36
4	Sun	278	99	65
5	Biofuel	61	31	49
6	Wind	47	28	40
7	Water	23	4	83
8	Nuclear Power	21	9	82
9	Sea Energy	------	9	100

In terms of energy efficiency in general, following issues must be considered, for example, based on the decision of Kutaisi City Hall: Resolution on production and use of energy efficient building materials (establishment of clay, shale, basalt quarries in the suburbs of Kutaisi); conducting energy audits of the housing fund and especially of the buildings included in the budget sphere; creating an energy passport for these buildings and developing energy saving programs for individual buildings. With such an approach, we will know the rational parameters of heating, ventilation, hot water and electricity supply of the building, which will allow us to assign a separate building to the appropriate energy efficiency class. At present, there are 9 energy efficiency classes (A-J). The task of Kutaisi City Hall is to carry out any construction (restoration, reconstruction, overhaul, etc.) with "A" class energy efficiency, which allows saving up to 60% of the above parameters. Integrity requires knowledge of the full area of the Kutaisi Housing Fund and data on natural gas (SOCAR Georgia Gas is supplied to Kutaisi) and electricity (supplied by Energopro) throughout the year and during heating and other periods. Knowing these data and using the empirical equation that the combustion of 1000 m3 of gas causes CO2 emissions for 1.6 tons, allows us to judge with a high probability of approximation the total amount of CO2 in Kutaisi. Knowing these data and using the empirical equation that the combustion of 1000 m3 of gas causes CO2 emissions for 1.6 tons, allows us to judge with a high probability of approximation the total amount of CO2 in Kutaisi. Based on the above-mentioned memorandum, the necessary measures must be taken to switch Kutaisi lighting to energy efficient means; economical energy consumption in municipal and communal areas; upgrading existing vehicles to reduce CO2 emissions and purchasing hybrid and electric vehicles (here, of course, we have to determine the commissioning dates of the electric car factory under construction in Kutaisi, the main parameters of the product, especially the capacity of the batteries, with the data of their charging energy costs) and similar measures should be requested by the City Hall for distribution and public transport of citizens (bus, minibus, etc.) provision of citizens. It is generally necessary to quantify the total fleet (including transit traffic) and the annual fuel consumption (grid input). With the established empirical equation (3 t of CO2 emissions are released into the atmosphere when 1 t of gasoline is burned), we calculate the real amount of transport emissions; Thermodermodification (warming) of buildings and facilities in the municipal and budgetary spheres, hospitals, kindergartens, schools and higher education institutions. Warming processes can be done with locally produced materials, such as basalt (here, as in other such situations, marketing research should be conducted and the optimal, both local and foreign manufacturers - suppliers should be identified). In general, it is necessary to review the Environmental Impact Assessment (EIA) reports of enterprises in Kutaisi (if new ones are developed) to determine the types of greenhouse gases and general objective data. Based on the above, the necessary measures for the first stage of Kutaisi transition to 100% to using 100% renewable energy for the year of 2050 (for example, until 2030) can be divided into three, necessarily to be done areas (points):

1. Energy efficiency measures,

2. Maximum spatial and quantitative increase of biosphere areas and plantations,

3. Large-scale introduction of renewable energy sources.

As for the development of the biosphere, (point 2) Kutaisi, as a representative city of modernity, contacts all the problems related to the development of the city and the increase of traffic flows. Today,

parks and squares in Kutaisi are surrounded by roads, which pollute the air and worsen the ecological situation. To solve these problems, it is necessary to introduce different methods of planting, which will shape the landscape of the city as a whole. At the same time, when planting streets and squares, the main thing is to return Kutaisi to its usual exterior and to take into account the all-round visibility of the roads. Moreover, to solve the aesthetic problem of the city, the correct combination of architectural buildings and landscaping should be considered. Greenery should have a utilitarian function; primarily it is protection from dirt, clutter and noise. The role of green plants in protecting against emissions is due to the variety of plants. The varieties of trees that thrive in western Georgia should be used here as a recommendation: lime, thorn tree (acacia), poplar tree, chestnut. These varieties effectively clean the air and enrich it with oxygen, absorbing the lead that is released during the combustion of gasoline. In general, it should be noted that the amount of CO2 accumulated in the planet's biosphere (forests, green plants) is much higher than in the atmosphere, where the amount of CO2 is 850 billion tons. The biosphere still copes with the amount of CO2 in the atmosphere, but deforestation, without slaughter, fires, emitting more than a billion tons of CO2 into the atmosphere throughout the year. It should be noted here that 400-600 thousand metric cubes annual cutting is allowed in Georgia, but in reality 2-2.5 million metric cubes are cut. As for Kutaisi, sanitary-protection zones should be built between the industrial and residential districts (precincts), which should be planted perpendicular to the wind directions. Aeration regimes must be observed in the city. Kutaisi City Hall should ensure 50-70% of the total area of the city. Such measures fully meet the requirements of the "Kutaisi Environmental Strategy 2020-2025", namely:

"... The increase in the scale of construction use of collective use spaces, the view of environmental problems not from a strategic, but from a local point of view (one-time tasks), has broken the logic and balance of urban development, thus exacerbating existing contradictions. This unfortunate and dangerous process has become the main goal of updating the Environmental Action Plan and developing a new strategic vision. ”

In order to fulfill the third point (large-scale introduction of renewable energy sources), the amount of solar insolation in Kutaisi in the morning, afternoon and evening must be determined first. These data should be reviewed at all times of the year. In addition, the date of commissioning of the solar photovoltaic panels factory under construction in Kutaisi, all the parameters of its products, with the warranty period of operation and prices, must be determined. The list of pre-project works should include the determination of the geographical location of the above-mentioned municipal, budget buildings, and the spatial "freedom". Studies should be conducted to study the shape and angle of inclination of the roofs of buildings in order to make the operation of the installed solar panels or solar water heaters collectors as cost-effective as possible. Hybrid heating systems (natural gas + collectors) and hot water supply through solar collectors should be considered. Along with the sun, the use of wind should be given an important place in the types of renewable energy sources, especially since Georgia has 4 years of experience in operating wind farms. As mentioned above, in the world, along with the sun, wind is also the leader in the development of renewable energy sources. However, especially in urban conditions, wind speeds, directions, landscape, its spatial "freedom", etc. should be taken into account. That is, Kutaisi must be supplied with energy generated by properly distributed renewable energy sources. Here we mean the maximum avoidance of the use of transmission lines, where electricity losses are 12-15%.The installation and operation of windmill-like installations near the city of Gori is perfectly permissible in the suburbs of the city, but in the twenty-first century there have been numerous innovations based on intellectual property. For example, Bill Becker (USA) wind turbines, which can be installed on the roof of all residential buildings. As is well known, there are several types of

winds: winds that are related to the degree of global warming; Winds associated with the general circulation of the atmosphere over mountain massifs; Storms, etc. The circular movement of air masses in Kutaisi must be accurately determined and the above-mentioned turbines must be installed, which have no sound and electromagnetic radiation and are protected from accidental collisions of fauna and humans.

See. Figure 1

Figure 1: Bill Becker wind turbines,

In fact, the memorandum signed between Kutaisi City Hall and the International Climate Organization "350.org" on the transition of 100% renewable energy to renewable energy by 2050, gives realistic goals and ways of implementation.

As the literary and informational research shows, full-scale switching to renewable energy sources is possible not only in the electricity sector, but also in the electricity, heat supply and in transport sectors as a whole. Preliminary calculations show that, from an economic point of view, 100% switching to renewable energy sources is in stiff competition from traditional systems. The combination of the above-mentioned measures will allow us to minimize greenhouse gas emissions in Kutaisi by 2050 and, according to the memorandum, be able to adapt to the local climate and plan it.