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**CLIMATE CHANGE AND THE USE OF ENERGY RESOURCES
IN GEORGIA**

**David Mirtskhulava, DScTech, Professor,
Chair of the Board of the Georgian National Committee for High Dams**

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Modern scientific theory of climate change has been developing intensively throughout the 21st century. An increase in the average temperature of the Earth's surface by 0.8 ° C since the middle of the previous century has been accompanied by melting glaciers, rising world oceans, and warming seawater. The reason for these processes is the growing greenhouse effect caused by the increase in CO₂ concentration in the atmosphere, which is related to human activity and should be mentioned here first - the use of fossil fuels in the energy sector.

Insurance companies around the world are witnessing a steady increase in the number of natural disasters and natural disasters - floods, hurricanes, hail, droughts, natural fires and so on. The damage from these disasters exceeds \$ 5 trillion.

The anticipated devastating effects of climate change determined the decision that became the basis for the 189 states to join the Paris Agreement, which aims to limit the rise in average temperatures to 2 ° C, and at best to limit them to 1.5 ° C.

Today, the EU is the most active in the world in the fight against climate change. It is well known that in 2019 the EU announced a new initiative of the "European Green Rate", which aims to achieve zero emissions of greenhouse gases (carbon neutrality) by 2050 (Fig. 1).

To this end, it is planned to invest 1 trillion euros in the "green transformation" of the European economy and not only the European economy, including the development of renewable energy, green hydrogen, electricity, green construction, closed-loop economy and environmentally friendly agriculture.

Importantly, the "European Green Course", even though the document has already been adopted, is not a 100% well-written plan or roadmap, it is a more ideological framework document. It should be noted that this document considers the implementation of the "European Green Course" as a perspective for the development of the anti-crisis economy. Investments in the creation of "green" infrastructure, "green" jobs, which should help overcome the current economic crisis.

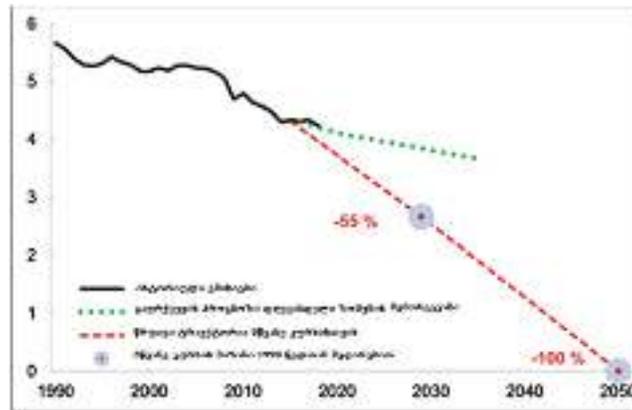


Fig. 1. Trends and forecasts for greenhouse gas emissions in the EU countries in 1990-2050 (Source: EEA).

On April 8, 2021, the Government of Georgia adopted Resolution №167 of the UN Framework Convention on Climate Change under the Paris Agreement - Georgia's Renewed National Defined Contribution (NDC), Georgia's 2030 Climate Change Strategy and Georgia's 2030 Climate Change Strategy Approval of the 2021 - 2023 Action Plan.

The goal of the contribution defined at the national level of Georgia is to promote the sustainable development of the country, within which the climatic, environmental, social, economic challenges are equally considered. The contribution defined at the national level of Georgia is as follows:

1. Georgia has an unconditional commitment to reduce the total national greenhouse gas emissions by 35% by 2030 compared to 1990 levels.
2. Georgia makes a conditional commitment to reduce total national greenhouse gas emissions by 50-57% by 2030, compared to 1990 levels, if it receives international support. A 50% reduction will be needed if the world follows a 2°C global average temperature increase scenario, and in the case of a temperature limitation scenario of up to 1.5°C, a 57% reduction compared to 1990 levels will be required.
3. Taking into account the contribution made at the national level of Georgia, the 2030 Climate Change Strategy and Action Plan are being prepared to identify climate change / mitigation measures that will help Georgia meet both its unconditional and conditional commitments and achieve its targets.

Georgia undertakes commitments to continue to study the possibilities of adapting various sectors of the country's economy to the negative effects of climate change, as well as to

plan and implement appropriate adaptation measures by mobilizing local and international resources for those sectors that are particularly vulnerable to the negative effects of climate change.

To achieve the long-term vision for 2030, which is to reduce greenhouse gas emissions by 35% for all sectors of the economy compared to 1990 levels, the Climate Strategy and Action Plan for each sector sets the following goals:

- A 15% reduction in greenhouse gas emissions in the energy generation and transmission sector by 2030, compared to the baseline scenario forecast;
- By 2030, greenhouse gas emissions in the transport sector will be reduced by 15% compared to the baseline forecast;
- Promoting the development of low-carbon approaches in the building sector through the promotion of climate-friendly and energy-efficient technologies and services;
- Promote the development of low-carbon approaches to the industrial sector by 5% to reduce greenhouse gas emissions by 2030 compared to the baseline scenario;
- Promoting the low-carbon development of the agricultural sector by encouraging the services of climate-friendly and energy-efficient technologies;
- Promoting the low-carbon development of the waste sector by promoting climate-friendly and energy-efficient technologies and services;

By 2030, the carbon sequestration capacity of the forestry sector will increase by 10% compared to the level recorded in 2015.

According to the results of the benefits of climate change mitigation measures and various international studies, the long-term will improve: economic situation, air and water quality, public health, number and quality of jobs, quantity and quality of biodiversity, number of new and clean technologies integrated into everyday life.

Customs duty on carbon footprint

In September 2019, 65 countries and the EU announced an ambitious goal of carbon neutrality by 2050. Numerous countries claim to receive customs duties on carbon footprints in the near future. Carbon footprints will become an important feature of products and services.

The steps taken towards “green future” by many countries and the environmental agenda are closely linked to trade, investment, new technologies and they are actually becoming an instrument of fierce economic competition. For example, the "European Green Rate" will create a very large barrier to products produced in Russia, China and many other countries. Such "customs duties on carbon" may be introduced in the near future in the United States, then in Asia and South America.

The reality is that if a product is designed to be made using the electricity generated by a coal or gas thermal power plant, it will have to pay a carbon tax on that product. It should be noted that this tax will not be included in the budget of a particular country, but would be transferred to a special global fund and will be spent on special climate programs.

The fact is that this will greatly increase the cost of production and products made in "dirty" energy countries will be much more expensive, and this applies to any product, be it clothing or fixtures. Here we want to look especially at natural gas, which has always been considered as a clean fuel, but according to the regulations laid down in the Paris Agreement, it is more harmful than coal because it emits more greenhouse gases into the atmosphere during its combustion.

Compared to the countries of the region (Azerbaijan, Turkey, Russia, Armenia), the products made in Georgia will have much less carbon footprint, because the energy in these countries is much more dependent on the production of gas, fuel oil, coal.

Given this factor, Georgia actually has an obvious advantage over its neighbors listed above. Almost 80% of our generation comes from renewable energy and hydropower plants. For example, one of our country's export products will be more competitive than any other similar product.

Air pollution situation in Georgia

Atmospheric air pollution is caused by both human-made and anthropogenic factors. The main anthropogenic sources of pollution are: transport, energy, factories, agriculture etc. Air pollutants include: nitrogen oxides, sulfur dioxide, carbon dioxide, particulate matter.

According to 2015 data, the rate of greenhouse gas emissions in Georgia is 17.6 MW CO₂ eq. Greenhouse gas emissions are generated in seven sectors: Energy: Energy Generation and Transmission, Transport, Buildings, Industry, Agriculture, Waste Management, and Forestry Sector.

The source of nitrogen oxides is automobile exhaust, natural gas combustion, exhaust during the generation of thermal power plants, and so on. It is known that during chemical reactions, a large part of nitrogen oxide in the air is oxidized and converted to nitrogen dioxide.

The source of sulfur dioxide emissions is the combustion of sulfur-containing fuels. During combustion, the sulfur present is oxidized and converted to sulfur dioxide. Power plants running on fuel oil or coal are the source of this emission, while the use of diesel fuel also emits large amounts of dioxide.

The source of carbon dioxide emissions are oil and coal combustion, metallurgy, internal combustion engine malfunctions.

Solid particles are one of the major pollutants in the air, they differ in chemical composition, size and origin. The cause of the emission of these particles is vehicles, industrial processes, etc.

One of the main sources of lead pollution is vehicles. Exhaust gases are found in the form of solid particles of lead oxides, fluorides, nitrates, chlorides and others. Ground-level ozone is obtained as a result of photochemical reactions of hydrogen nitrogen oxides and oxygen. The quantitative ratio of ozone to primary pollutants in the air varies according to location and temperature.

Atmospheric air protection issues are regulated by the Law of Georgia on Atmospheric Air Protection (1999) and relevant by-laws. Considering the limit values for ambient air quality, emission limit values - emission limits for each harmful substance are set individually for large industrial facilities that may pose a threat to humans and the environment.

Atmospheric air pollution from other stationary facilities is regulated by relevant technical regulations. From August 1, 2018, the air quality in Georgia will be assessed according to modern European standards.

The challenge for the largest cities in Georgia is pollution with nitrogen dioxide and particulate matter.

Improvements in NOX in recent years have been driven by, on the one hand, an increase in customs and excise duties on used cars and fuel, and, on the other, by a country-wide tax policy that encourages the import of hybrid and electric vehicles. Of particular note is the support for the development of electric vehicle charging infrastructure.

The underdevelopment of pedestrian and bicycle transport infrastructure and public transport remains a challenge for the transport sector.

Atmospheric air pollution from the industrial sector, although in most cases local, is still a major problem. In this regard, disproportionately small and, consequently, ineffective sanctions due to air pollution are noteworthy.

A significant proportion of particulate matter pollution is related to the importance of firewood consumption in the home.

The transport sector is growing very fast. In 2015, almost 70% of passenger transport activity was made up of private cars, most of which were older models and certainly environmentally inefficient. The share of buses, minibuses and railways, including the metro, was 13%, 14% and 4%, respectively.

In 2015, the share of greenhouse gas emissions from the transport sector was up to 24%. Within which the percentage redistribution of shares was: emissions of passenger cars - 88%, buses - 5% and minibuses - 6%. The share of freight transport, consisting of trucks, railways and off-road vehicles (mainly agricultural machinery), accounted for the remaining 32% of the sector emissions, with the largest share (29%) coming from heavy goods vehicles.

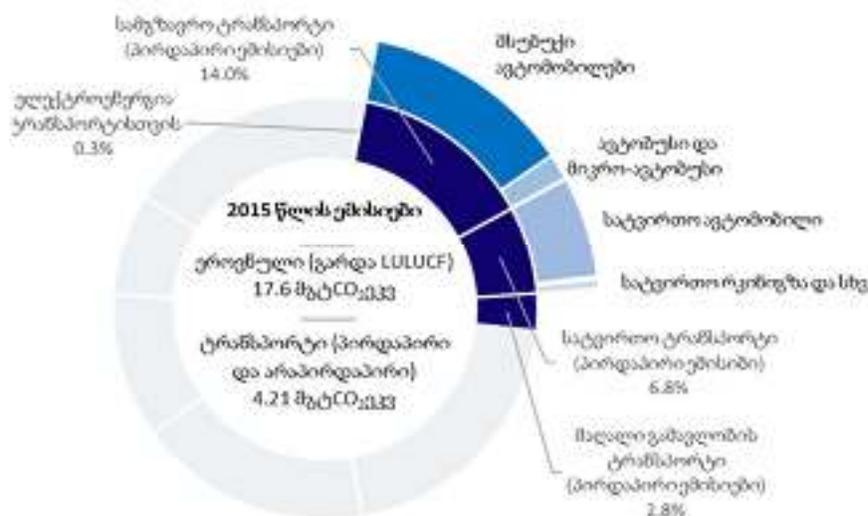


Fig. 2. Detailed breakdown of greenhouse gas emissions in the transport sector by 2015 (PROSPECTS +, Ministry of Environment Protection and Agriculture of Georgia, 2019).

Compared to European countries, transport activities in Georgia are low, but this figure is expected to increase in the future. According to the baseline scenario, by 2030, emissions in the transport sector are expected to increase by approximately 71% (up to 7.11 MW CO₂ eq.) (Fig. 3) This will be mainly due to the steady increase in passenger transport. From 2015 to 2030, passenger activity is expected to increase by almost 60% and freight activity by 240%.

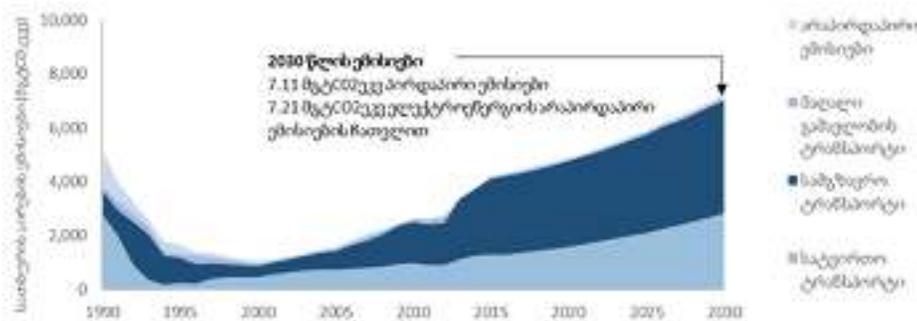


Fig. 3. Greenhouse gas emissions forecast for 2030 (modeling performed by sector experts, later integrated into the LEAP model), (Ministry of Environment Protection and Agriculture of Georgia, 2019).

The second largest contributor of greenhouse gases after the transport sector is the energy, energy generation and transmission sector.

In 2015, the share of this sector in total greenhouse gas emissions was 21% (3.65 MW CO₂ eq) (Ministry of Environment Protection and Agriculture of Georgia, 2019). Volatile emissions of CO₂ and CH₄, while a small proportion of emissions were generated by nitrogen oxides.

Volatile emissions from oil and gas transmission and distribution accounted for approximately 56% of the sector, while the share of fuel combustion in the electricity generation sector was 44% (Fig. 4).

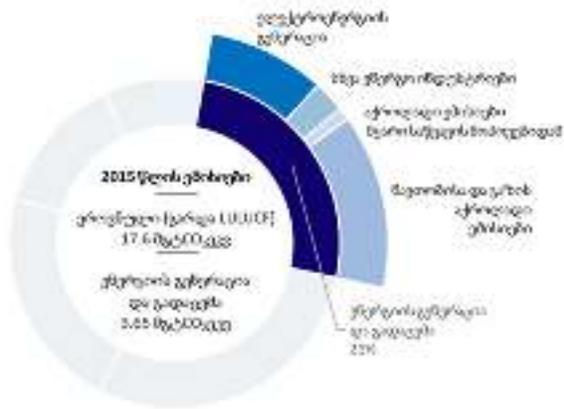


Fig. 4. Detailed breakdown of greenhouse gas emissions in the energy generation and transmission sector by 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

The electricity generation sector consists of hydro, wind and the total generation capacity of Georgia is 4,179 MW. In 2019, renewable energy would generate 76.09% of Georgia's electricity generation, while the remaining 23.9% would be generated by thermal power plants.

The high share of hydropower in the total balance of electricity generation in Georgia determines its seasonality, due to which it is possible to export excess electricity in summer and the need to import in winter in the absence of electricity.

Losses in gas supply accounted for 6.1% of total, final gas consumption (Geostat, 2019). The increase in emissions in this sector is due to the extraction of solid fuels, volatile emissions from oil and gas. The increase in demand for electricity is due to the growth of activities related to GDP, tourism and cryptocurrency (especially in Abkhazia) and the use of air conditioners in summer.

Imported energy resources during the winter months, thermal power plants create significant barriers to the development of low-carbon approaches in the future. Another source of greenhouse gas emissions is buildings, and this is due to their low energy efficiency.

As of 2015 data, energy demand for buildings accounted for approximately 18% of energy-related emissions and 11% of the country's total greenhouse gas emissions. (Fig. 5), (Ministry of Environment Protection and Agriculture of Georgia, 2019).

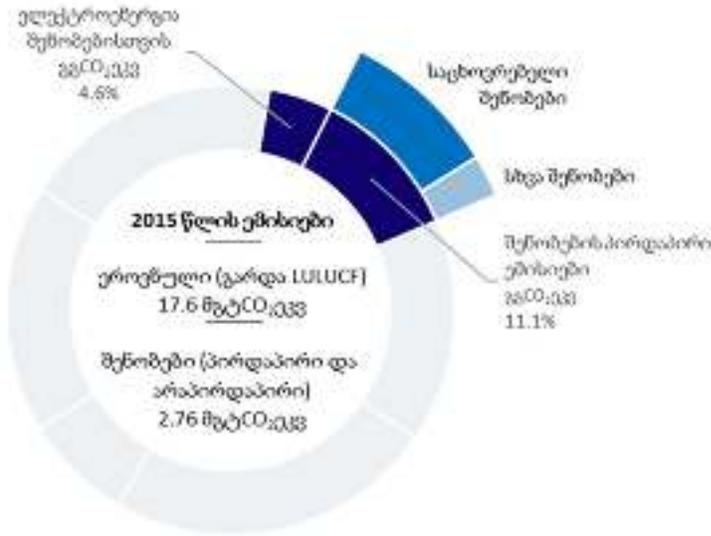


Fig. 5. Detailed breakdown of greenhouse gas emissions in the building sector by 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

Energy demand in buildings is significant by 2030, which will lead to a significant increase in greenhouse gas emissions. Under the baseline scenario, by 2030, emissions from energy demand in the building sector are likely to be twice as high as in 2015.

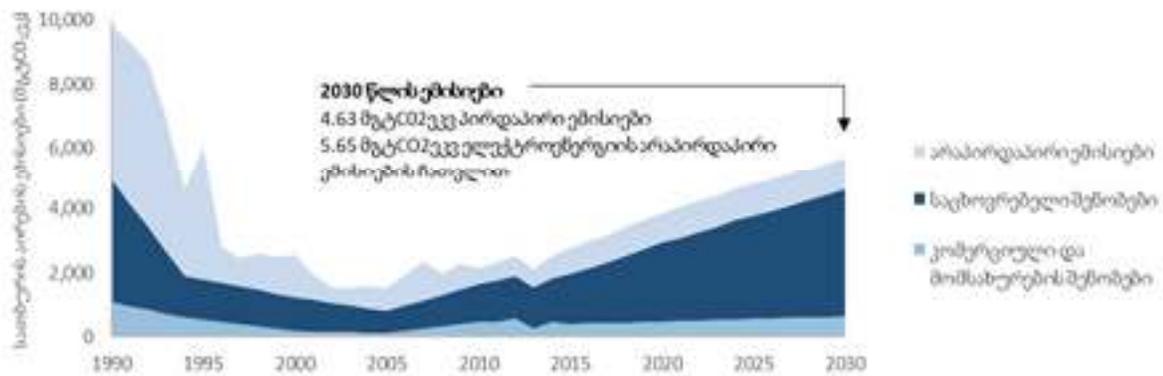


Fig. 6. Greenhouse gas emissions forecast for 2030 (modeling was carried out by LEAP), (Ministry of Environment Protection and Agriculture of Georgia, 2019).

In 2015, industry accounted for about 18% (3.12 MW CO₂ eq) of greenhouse gas emissions. Electricity-related emissions accounted for about 35% of total industrial emissions,

while the remaining 65% were emissions from the manufacturing process. These emissions accounted for 24% in the production of non-metallic minerals, 23% in the chemical industry and 14% in the production of cast iron and steel (Fig. 7).

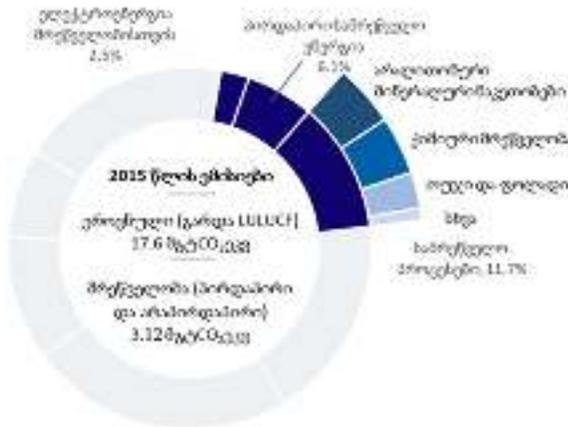


Fig. 7. Detailed breakdown of greenhouse gas emissions in the industrial sector by 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

In 2015, according to the National Greenhouse Gas Report, approximately 19% (3.31 Mt CO₂ eq) of greenhouse gas emissions in the agricultural sector came from Fig. 8.

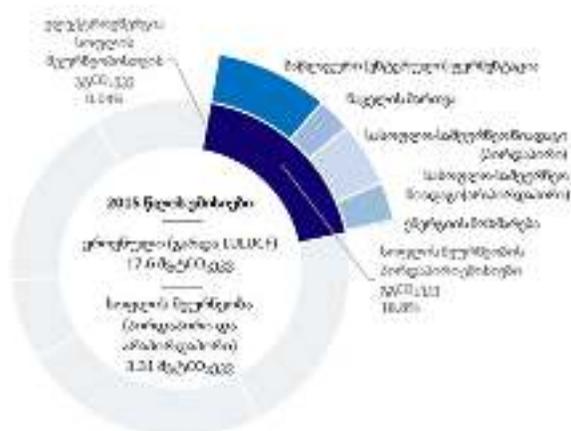


Fig. 8. Detailed breakdown of greenhouse gas emissions in the agricultural sector by 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

Greenhouse gas emissions are also related to the waste sector. In 2015, greenhouse gas emissions (1.39 MW CO₂ eq.) Accounted for approximately 8% of total emissions. **Fig.9**

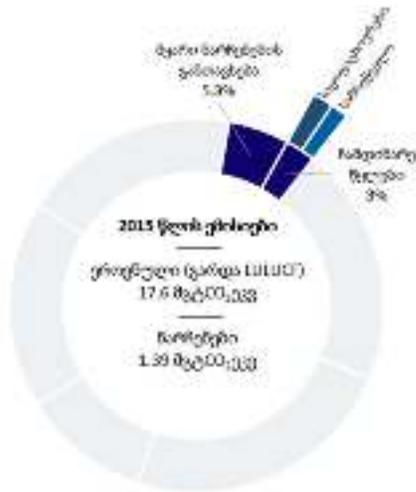


Fig. 9. Disruption of greenhouse gas emissions in the waste management sector by 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

Almost 43.5% of the territory of Georgia is covered by forest, of which 95-98% is natural forest. The total area of the Georgian Forest Fund is 3,023,261 ha, of which about 500,000 hectares are so-called. The last representative of its type in the temperate zone is "pristine forests" (Geostat, 2019).

In 2015, net (net) absorption from the forest sector accounted for approximately 32% of total greenhouse gas emissions (-5.62 MW CO₂ eq.) In 2015, emissions from the forest sector amounted to 1.08 MW CO₂ eq. The absorption was 6.71 MW CO₂ eq. **Fig.10**

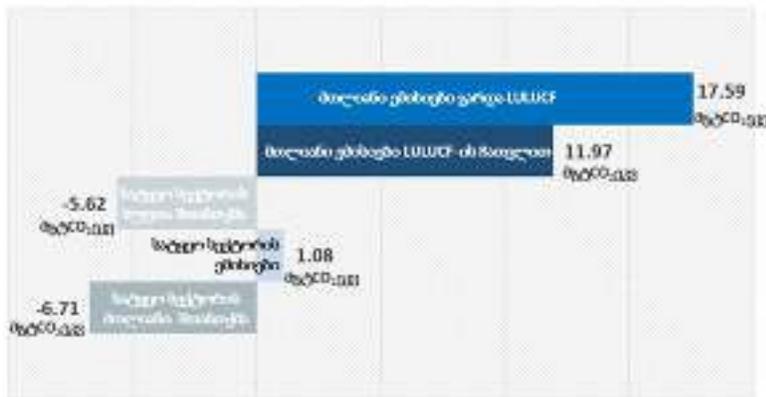


Fig. 10. Emissions and absorption rates for greenhouse gases in the forest sector for 2015 (Ministry of Environment Protection and Agriculture of Georgia, 2019).

Environmental Agenda and Coronavirus Pandemic

The coronavirus pandemic has not pushed environmental issues into the background. On the contrary, in many countries the pandemic has taken environmental problems to a much higher level and made it a matter of national security. Therefore, environmental protection is not only a matter of moral and ethical point of view, but also the most important task of the state in terms of national security and long-term economic expediency.

Realizing this, many states link the solution of problems with the protection of the ecological environment as well as the solution of social problems and technological progress, the state aspires to develop clean technologies and pursue ecological goals.

Environmental and climate agendas can complement both consolidation functions. Different - countries with different values, political and economic development models, different foreign policy orientations can create a platform for dialogue and be able to cooperate on environmental and climate issues.

Environmental and climate issues are particularly important in international relations, both globally and regionally. Georgia's environmental policy is not active enough and does not meet the current challenges; in particular, unfortunately, the growing importance of the environment in the global or regional economy, in international relations is less taken into account.

Today's agenda, a combination of environmental, economic and technological directions, does not find adequate reflection in strategic planning. Against the backdrop of the global

economic crisis, many countries around the world view the “green” agenda as a key tool in their anti-crisis strategy.

The "green way" in their view is a radical technological upgrade, structural transformation of the economy and thus increase the competitiveness of the country's economy, which is considered a way to overcome the pandemic crisis in countries.

Georgia, with its natural potential, primarily with renewable energy resources, especially hydro potential, as well as wind and solar resources, can be the initiator of the development of "green road" "green technologies" in the region.

"Green" technologies continue to develop in the region and globally, hydrocarbons will gradually lose their status as strategic goods. This means that the role of Caspian hydrocarbons in the global economy and world politics will inevitably diminish hence the role of Georgia as an important transit country.

In the new conditions, such challenges create the need for a new environmental policy, which will activate and implement the "clean" development for the country.

The 4th Energy Transition and Energy Sector Transformation

The main direction of energy development can be mentioned by the phrase - the world is included in the so-called. The 4th energy transition phase, which consists of the extensive development of renewable energy sources and the gradual, gradual replacement of fossil fuel generation stations with the facilities of this generation.

Energy transitions into the energy system will lead to significant structural changes. Historically such changes have been caused by access to different types of fuel. Today's agenda is defined by climate change: reducing greenhouse gas emissions and decarbonisation. Decarbonisation of energy companies is done by increasing the share of renewable energy generation in the energy balance, increasing energy efficiency.

For example, the French EDF - by 2030 plans to double the share of renewable energy generation as well as intensify the development of "non-hydrocarbon" generation in international energy markets. There are similar trends in Germany, the Netherlands and the EU countries as a whole, China, South Korea, Japan.

The main renewal of the traditional country in the energy sector of Georgia by 2030, along with hydropower resources, is planned to integrate 1300 MW wind power and 500 MW solar power plants.

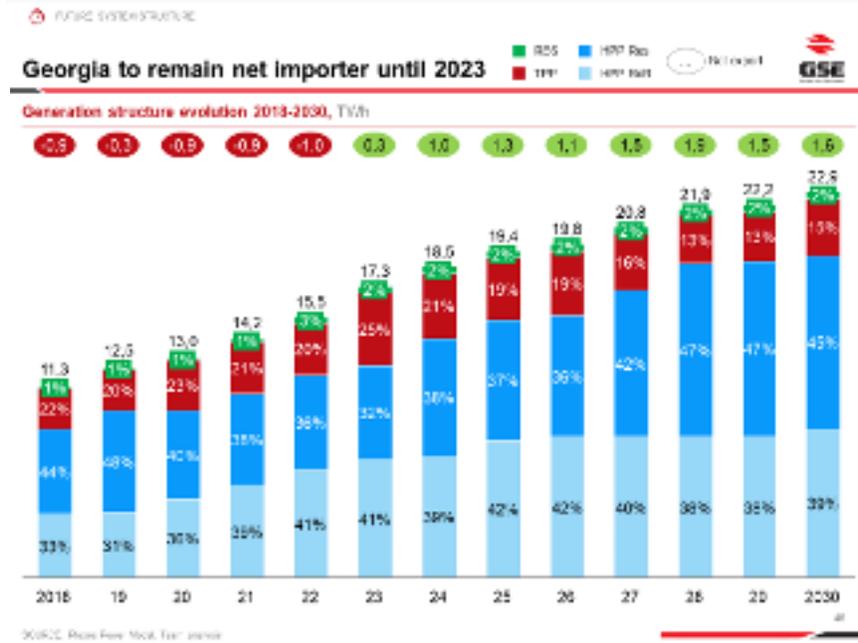


Fig. 11. Predicted consumption of Georgian energy system until 2030 (McCensey 2018).

Green hydrogen and its development prospects in Georgia

As mentioned above, a deep decarbonization policy is being actively pursued to ensure the sustainable development of the world. This primarily involves replacing fossil fuels with environmentally friendly alternatives. Within the framework of the energy transition, the development of ecologically clean energy resources, the lobbying of climate neutrality policies and the formation of public opinion oriented towards environmental protection are being intensively carried out.

All of this serves the purpose of mitigating climate change, protecting the global ecosystem, and the sustainable development of the global economy.

To achieve these goals, renewable and zero pollution energy resources are being developed intensively. Among them, the priority is occupied by green, ecologically clean

hydrogen. The so-called Green hydrogen, which is an environmentally friendly fuel with particularly high potential. It is extracted through renewable energy resources.

In the process of obtaining and subsequent combustion of green hydrogen there is no release of any substance harmful to the environment and health, the result of its combustion is distilled water. Consequently, the "life cycle" of green hydrogen is related to the processes of neutral climatic influences.

Based on the positive ecological value of green hydrogen, scientists around the world have been developing the method of extracting hydrogen by the green method for many years. This method is related to the chemical process of water electrolysis, which requires a special electrolysis device and electricity generated by a renewable energy source.

Accordingly, the main determinant of the market price of green hydrogen is the prices of the electrolysis plant and the renewable electricity generation. As the global demand for green hydrogen grows, electrolysis technologies are being actively refined. In addition, technological progress also reduces the cost of producing renewable electricity.

Consequently, these current trends in the energy sector are pushing us towards a downward trend in the market price of green hydrogen, which will significantly change the nature of the global energy market. The priority of ecologically clean energy, technological advancement and consequently increasing access to clean energy resources will make it possible for green hydrogen fossil fuels (hydrocarbons) to face serious market competition in the near future.

Georgia, with its rich renewable energy resources (primarily hydro resources), can be part of this effort. Developing hydrogen production projects using green energy will not only alleviate carbon dioxide emissions, but also significantly improve Georgia's energy independence parameters and it will create a domestic source of fuel, and reduce dependence on imported natural gas. It is noteworthy that today, 80% of locally produced electricity is generated from renewable energy sources.

As a result of this indicator, in terms of clean electricity production, today Georgia is one of the greenest countries in the world and faces great opportunities. With the right approach, Georgia has all the necessary natural conditions to become one of the important partners in the formation of the world green hydrogen market.