

Analysis of the Utilization of Various Energy Sources in Georgia

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Abstract: The main sources of green energy (GE), considered as the cleanest forms of energy or types of renewable energy sources (RES), are wind, water, sun, and earth. While the world, particularly in the most developed countries, has made significant progress in adopting and applying the various forms of green energy (GE), in Georgia this field is in its initial stage and it is not possible to predict when the first major positive developments will be made. This paper presents an analysis of total energy supply (TES) in Georgia for the period 2000-2021. The value of the continuous annual growth rate (CAGR) for TES in Georgia for this period is 7.23.

Keywords: Energy, Green energy (GE), Sustainable energy (SE), Clean energy (CE), Wind energy (WE), Renewable energy (RE), Renewable energy sources (RES), Total energy supply (TES).

1. Introduction

Energy is the capacity of a body or system to accomplish work. There are different forms of energy, namely kinetic, potential, thermal (also known as heat), internal, electrical, chemical, elastic potential and many others.

Electricity, a fundamental aspect of nature, is among the most widely utilized forms of energy. Globally, there is a growing trend towards generating electricity from renewable energy sources (RES) due to environmental considerations. The consumption and production of energy worldwide are steadily increasing each year, closely linked to the continual growth of the global human population. Currently, the overwhelming majority of global energy production, (exceeding 80%) comes from non-renewable sources, leading to adverse environmental effects. To address this, sustainable development principles advocate reducing reliance on fossil fuels in energy production and consumption. Consequently, there is a persistent need to substantially increase the use of renewable energy sources (RES) in the future. This shift is imperative due to the diminishing reserves of non-renewable energy sources and their escalating environmental impact observed in recent years. [38-39].

The largest portion of global energy consumption currently goes to industry, accounting for approximately 50%. Transport follows with approximately 25%, while households and the commercial sector together consume the remaining 25%. China and India are currently witnessing the most substantial growth in energy consumption on a global scale, encompassing all forms of energy. Among developed countries, the USA saw the largest rise in energy consumption, while the EU experienced a decrease of approximately 2 [%] in energy consumption. All these facts indicate that the most effective solution to address this situation lies in increasing the utilization of renewable energy sources (RES) and green energy (GE). [1,5,9-10,18-19,22,24,29]. Research and studies detail the current status and future prospects of developing and implementing various types of green energy (GE) across different countries worldwide [3,25-26,34-36,38,42].

Currently, many of the world's most developed countries have significantly advanced the adoption of various forms of green energy (GE). In Georgia, however, this field is still in its early stages, and it is uncertain when significant progress will be

achieved. Nevertheless, Georgian state authorities have formulated a strategy aimed at increasing the utilization of renewable energy sources (RES) by 2040 [12,20,33,39].

2. Classification of Natural Energy Sources

Considering the time possibility of exhaustion, natural or primary sources (forms) of energy can be divided into (Fig. 1) [13-15,17,28,30-32,39-42,45-46]:

1. Non-renewable energy sources (NRES):
 - Fossil fuels (coal, oil, natural gas, oil shale);
 - Nuclear fuels;
2. Renewable energy sources (RES):
 - Water power (energy of water currents, sea currents and waves, tides);
 - Biomass and biogas, including wood and waste;
 - Solar radiation energy;
 - Wind energy;
 - Earth's internal heat (geothermal energy);
 - Tidal energy;
 - Wave energy.

Renewable energy (RE) is that form of energy that is renewable (naturally replenished) and produced from sources that are constantly renewed, meaning that this form of energy is created from natural sources (sun, wind, rain, waves, geothermal heat and similarly).

There are different types and categories of renewable energy sources (RES) (Fig. 1). According to the time of creation, renewable energy sources (RES) are divided into two main categories:

- traditional renewable energy sources such as biomass and energy from large hydroelectric plants and
- "new renewable energy sources" such as solar energy, wind energy, geothermal energy and the like.

In addition to renewable energy (RE), the following terms are often used in the literature: green energy (GE), sustainable energy (SE), and clean energy (CE). The question arises as to whether there is a difference between GE, SE, CE, and RE, and what is the difference.

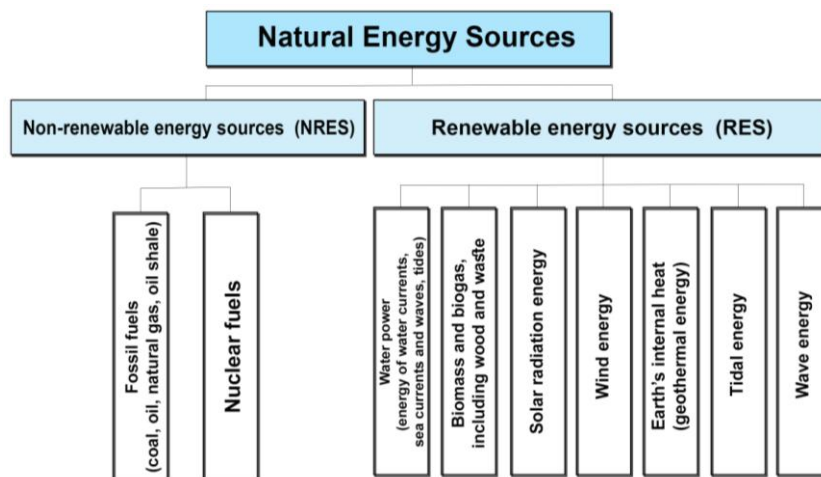


Fig. 1. Division of natural or of primary sources (forms) of energy, considering the time possibility of depletion

Renewable energy sources (RES) in the last thirty years represent a new trend in the use and production of various forms of energy in all areas.

The production of wind energy has been increasing significantly over the last 20 years. Figure 2 shows the graph of wind energy

(WE) generation (including both onshore and offshore wind sources) in [TWh] globally and by regions for the period 1965-2022 [42].

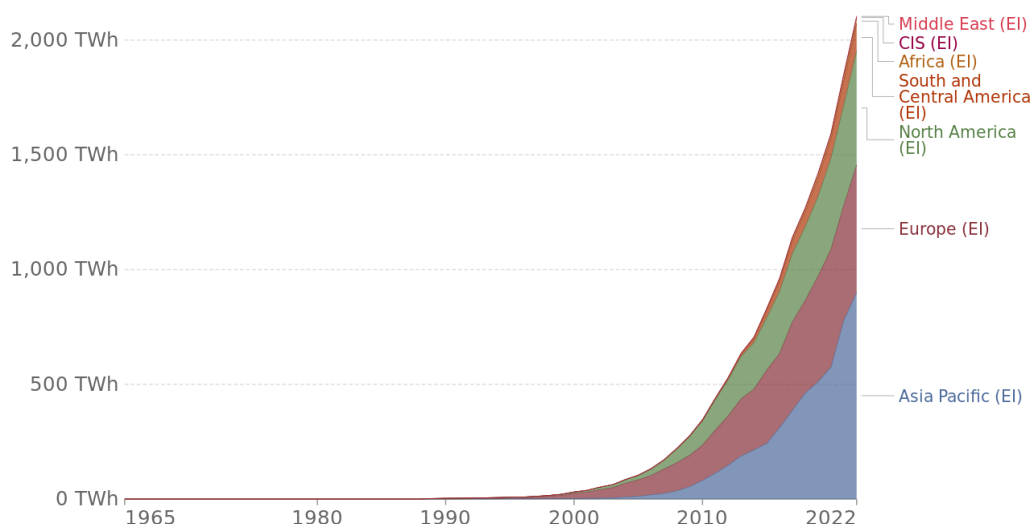


Fig. 2. Wind energy (WE) generation by regions for the period 1965-2022 [42]

3. Analysis of the Use of Energy in Georgia

The energy sector in Georgia is mainly based on hydropower and firewood, in addition to fossil fuel imports. It is also an important transit country for the region, with major oil and gas pipelines passing through its territory.

Reports for the annual use of all types of energy in the world and by regions and countries are given in the annual publication World Energy Outlook (WEO) [43, report for 2023], published by International Energy Agency (IEA), from Paris (France).

The analysis of the use of all types of energy in regions and countries is presented in papers [4,6-8,11,21-22,27,37,44].

The analysis of wind energy utilization is shown in papers [2,16].

The value of total energy supply (TES) in Georgia for the 2021 is 215596 [TJ].

Figure 3 shows graphical representation of the evolution of total energy supply (TES) in Georgia for the period 2000-2021 [12].

In Figure 4 a comparative analysis of the evolution of total energy supply (TES) in Georgia for the year 2000 and year 2021 is shown.

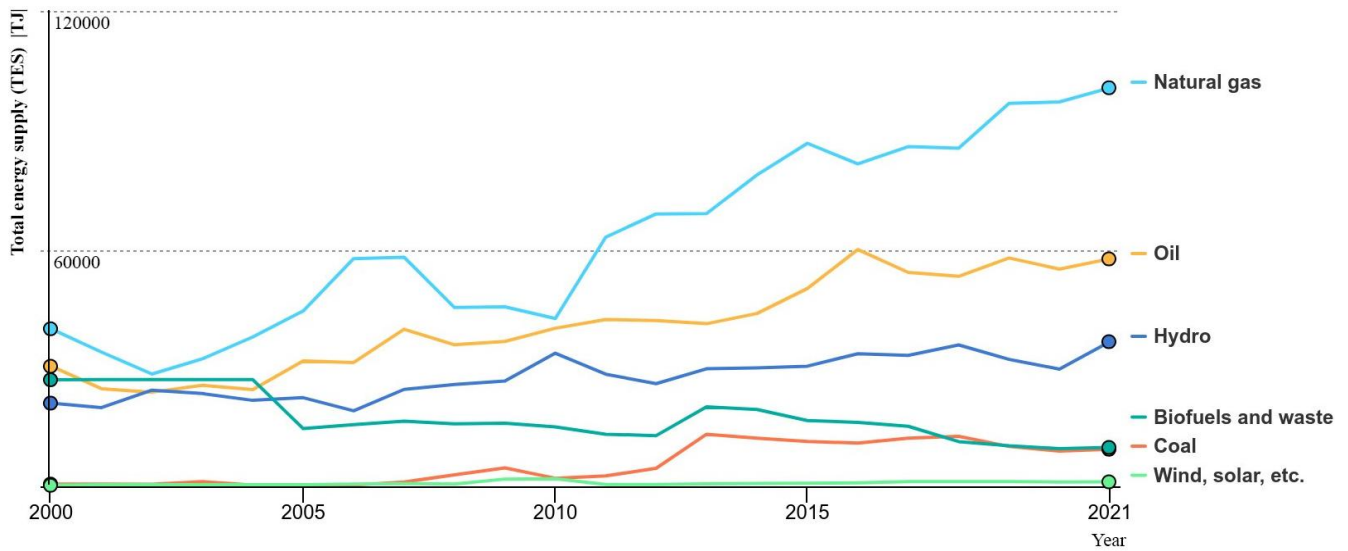


Fig. 3. Graphical representation of the evolution of total energy supply (TES) in Georgia for the period 2000-2021 [12]

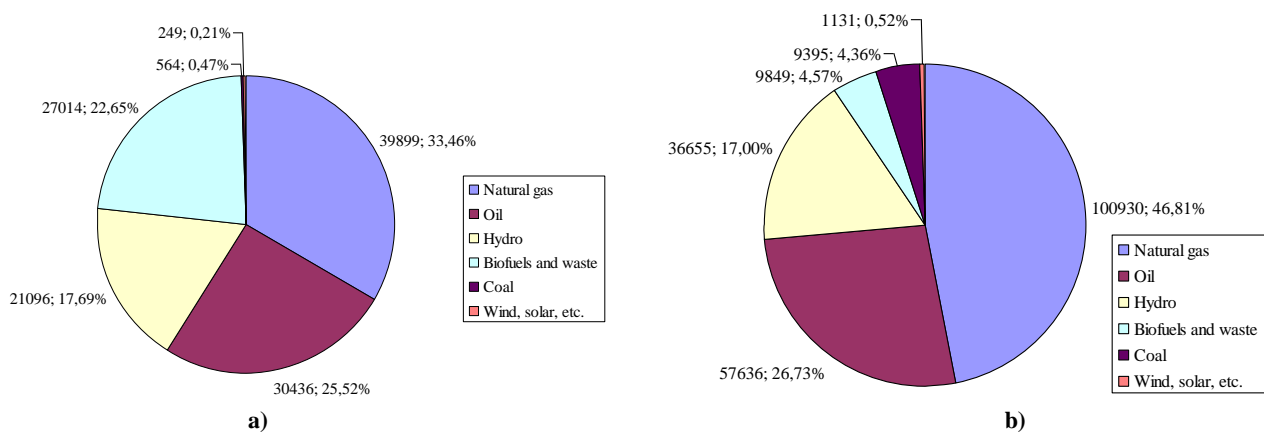


Fig. 4. Comparative analysis of the evolution of total energy supply (TES) in Georgia for the year 2000 (a) and the year 2021 (b)

Table 1 shows the total energy supply (TES) in Georgia for the years 2000 and 2021 by different forms of energy with the calculated value for the continuous annual growth rate (CAGR) for this period.

From Table 1 and Figures 3 and 4, it can be concluded that the total energy supply (TES) in Georgia for the year 2021 is from the following forms of energy: natural gas has 100930 [TJ] or

46.81 %, nil has 57636 [TJ] or 26.73 %, hydro has 36655 [TJ] or 17.00 %, biofuels and waste has 9849 [TJ] or 4.57 %, coal has 9395 [TJ] or 4.36 % and wind, solar, etc. has 1131 [TJ] or 0.52 %, retrospectively.

Table 1. Table representation of total energy supply (TES) in Georgia for the 2000 and 2021 by different forms of energy

Different Forms of Energy	2000		2021		CAGR [%]
	Value [TJ]	[%]	Value [TJ]	[%]	
Natural gas	39899	33.46	100930	46.81	4.31
Oil	30436	25.52	57636	26.73	2.95
Hydro	21096	17.69	36655	17.00	2.54
Biofuels and waste	27014	22.65	9849	4.57	-4.48
Coal	564	0.47	9395	4.36	13.64
Wind, solar, etc.	249	0.21	1131	0.52	7.12
Total	119258		215596		7.23

4. Conclusion

Fossil fuels such as coal, oil or gas are a group of non-renewable energy sources that are decreasing in number (slowly disappearing) and also cause undesirable consequences for the environment, and their harmful influence has become more and more pronounced in the last few years. Whereas, renewable energy sources (RES) and green energy (GE) will not disappear because they are naturally renewable and at the same time do not have a

harmful impact on the environment. Renewable energy sources (RES) and green energy (GE) are predicted to become economically competitive with conventional energy sources over time.

The greatest increase in total energy supply (TES), with the largest continuous annual growth rate (CAGR), in Georgia for the period 2000-2021 is attributed to coal (CAGR=13.64%). Conversely, the decrease in total energy supply (TES) in Georgia for the same period is seen in biofuels and waste (CAGR=-4.48%).

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