International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 3, Issue 10, pp 46-50, October - 2019

Global Electricity Consumption, Sustainable Generation and Renewable Energy

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***Abstract* - Human been society needs to use external energy for the all types of activities, and Electricity is widely used resource and a multifunctional kind of energy, that launches of mechanical motion, lighting, heating, transportation etc. Any process, extracting electricity from fossil fuels (minerals, coal, oil and gas), pollutes the environment. Most alternatives to fossil fuels are renewable resources (resources that can be replenished rapidly by nature), which are usually polluting the environment less. Global Energy market showed acceleration in the growth of electricity consumption and Electricity demand is projected to rise steeply over the coming decades. The environmental, geo-political, and economic aspects of producing Electricity are stressing pressure to decide what the right mix of energy to fuel is in the future.**

Keywords: Electricity Generation, Electricity Consumption, Greenhouse Gases, Renewable Energy Resources.

I. INTRODUCTION

Modern Energy industry is inseparable from the use of natural resources. In addition, the use of any technology in the energy sector, whether coal-fired or gas-fired power plants, nuclear power plants or wind turbines, the use of bio-fuel for cars also have some negative impact on the environment. "*Earth's environment has been a bountiful source of resources as well as a remarkably stable life support system that has allowed human civilisations to develop and flourish.*" [1].For today, mankind has to get used to the idea that the negative impact on the environment and human health will always be in the energy sector, and we have to be worry how to minimize possible environmental risks.

Among these, the key role is played by the legal regulation of environmental requirements established by countries in the energy sector to make right mix sources of energy to fuel the future. "*In 2015, countries adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals. In 2016, the Paris Agreement on climate change entered into force, addressing the need to limit the rise of global temperatures.*" [2]. Various aspects of Global Electricity's generation and consumption feet to 4 of 17 Sustainable Development Goals, such as "*Clean, accessible water*", "*Affordable, clean Energy*", "*Responsible production and consumption*", and "*Climate action*" [2]. The experience of various countries shows that with a proper assessment of emerging environmental risks, as well as proportionality of measures taken, a balance is achieved between the desire to develop energy and the desire to minimize the harm to nature [3].

This paper will address the Electricity Generation aspects of powering the future and analyzing Global Electricity Consumption as for 2016 and sustainability of the Global Electricity Demand up to 2040 by Sectors of human been activities and by type of sources to produce the electricity.

II. SUSTAINABLE ELECTRICITY GENERATION AND CONSUMPTION

Our civilization is a civilization of electricity. Every modern person understands that the most convenient energy for use in industry and at home is electrical.

The share of electricity in the world energy balance is growing steadily. The prospects of electricity are not in doubt. Will grow both the volume of its production, and the share in the global final energy consumption. Electricity hampers hydrocarbon fuel in both transport and heat production.

Fig. 1 shows the Global Electricity Consumption for the time period of 1980 – 2016. (Statistical data for the plots taken from Statistical Review of World Energy. http://tools.bp.com/energy-chartingtool#/st/bio_fuels/electricit [6]). All graphs for the essay made using Origin-8 program.

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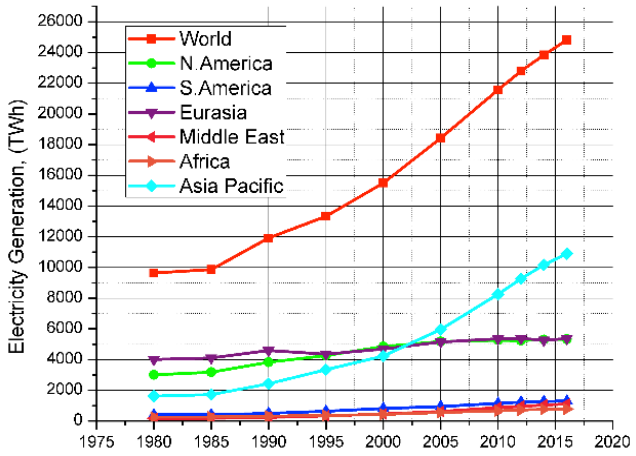

Figure 1: Statistical Review of World Energy: Electricity Consumption for the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy. Electricity. [6])

Plots on Fig. 1 shows that Electricity generation in Global scale increased significantly from 9800 TWh in 1980 to 25000 TWh in 2016, and it increased 1.6 times since 2000. Most forecasts of the development of world electricity markets are based on hypotheses about the increase in the world population [4], [5]. Graphs above proof the confidence of these hypotheses: the generation of the electricity in Asia Pacific (including China) for the last 30 years increased from 2000 TWh to 11000 TWh - more than 5 times!

The increase in the world population also making differences in the structure of the Electricity consumption and requires a separate consideration. Fig. 2 shows Global Electricity Consumption as for 2016, and Global Electricity Demand expected in time frame until 2040 by various Sectors of human been activities. (Statistical data for the plots taken from Exxon Forecasts Growth in Global Energy Demand [6], [7], [14]).

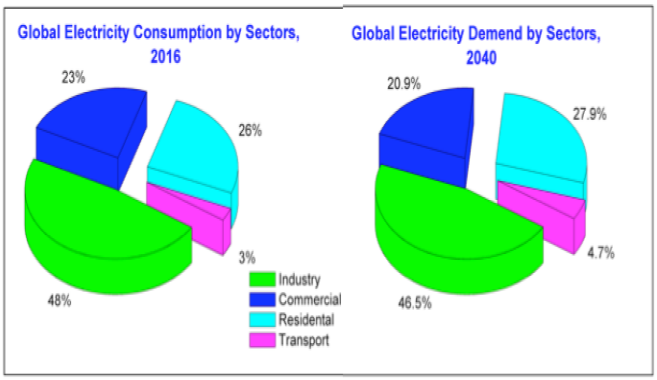

Figure 2: Global Electricity Consumption (2016) and expected Demand (2040)) by Sector (Data used from Exxon Forecasts Growth in Global Energy Demand) https://instituteforenergyresearch.org/analysis/exxon-forecasts-growth-in-global-energy-demand/

Graphs above shows, that today about 70% of Global electricity used for the industrial and commercial needs, 26% used in residential sector, and only 3% in transportation. In future industrial and commercial application of electricity expected slightly decrease, but increasing to 28% residential use and 4.7% in transportation.

Electricity is a net final product, while the most shares of energy emissions of greenhouse gases is still associated with its production. Ecological and climatic considerations and the need to combat global warming are encouraging governments to stimulate the reduction of greenhouse gas emissions in the energy sector. In the global energy industry, the importance of highly efficient and environmentally friendly technologies of electric generation is increasing, and countries that have such technologies receive additional bonuses in the economy, international trade and competition. For these reasons critically important the sources where the electricity produces from Fig. 3 presented Global Hydroelectricity Consumption for the time period of 1965 – 2016, and Fig. 4 shows Global Natural Gas production for the time period of 1980 – 2016. (Statistical data for the plots taken from Statistical Review of World Energy Electricity [12]).

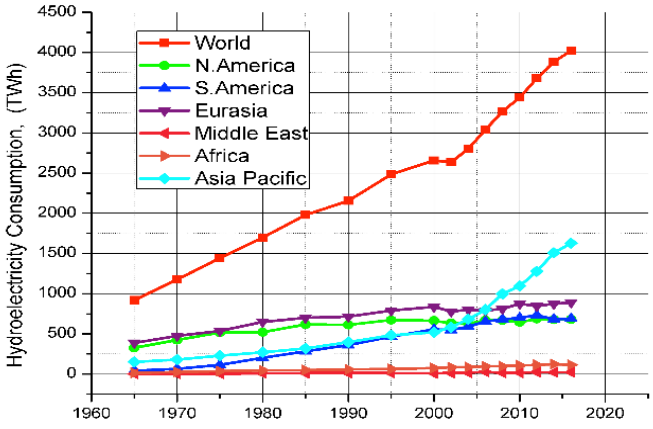

Figure 3: Global Hydroelectricity Consumption for the time period of 1965 – 2016. (Statistical information used from Statistical Review of World Energy. Natural Gas. [12])

The main advantages of hydropower are obvious. Of course, the main advantage of hydro resources is their renewability: the water supply is practically inexhaustible.

At the same time, the hydro resources are significantly ahead of other renewable energy sources and are able to provide energy to large cities and entire regions. In addition, it is possible to use this energy source quite simply, which is confirmed by the long history of hydropower.

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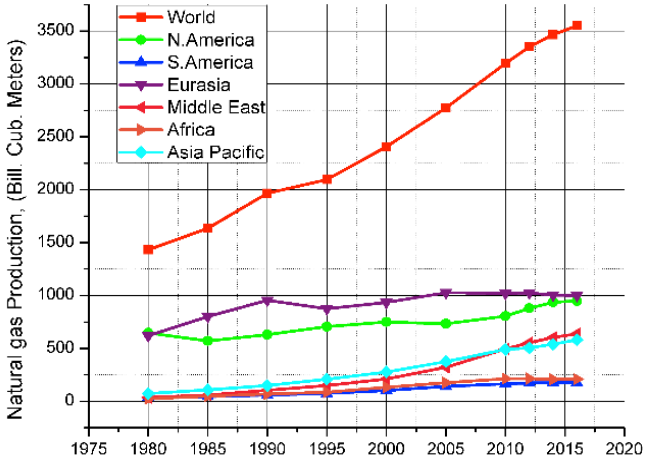

Figure 4: Global Natural Gas production for the time period of 1980 – 2016. (Statistical information used from StatisticalReview of World Energy. Natural Gas. [9])

Fig.3 shows gradually increase Hydroelectricity Consumption in global scale. For example, it increases for 1.6 times from 2000 to 2016. Natural Gas (Fig.4) uses as fuel for power stations and it still in high demand in Global scale; its production growing, but not as significant as Hydroelectricity Consumption.

Nuclear and Renewable are other sources for the production of Electricity. Fig. 5 shows dynamics of the Global Nuclear Consumption, and Fig. 6 presenting Global Renewable Consumption for the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy. Renewables. [11]).

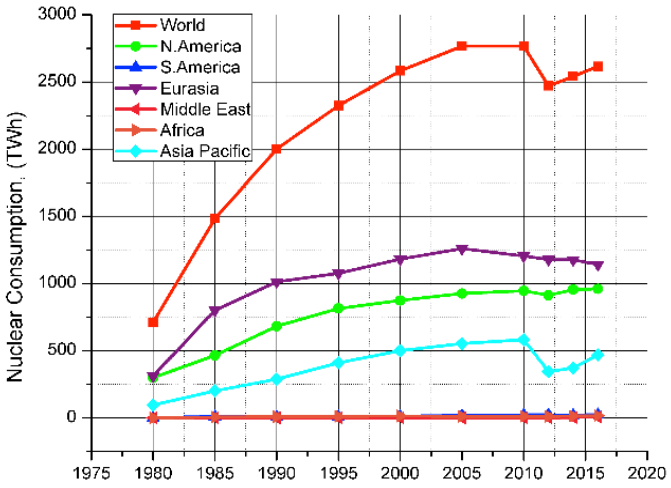

Figure 5: Global Nuclear Consumption for the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy. Renewables. [11], [13])

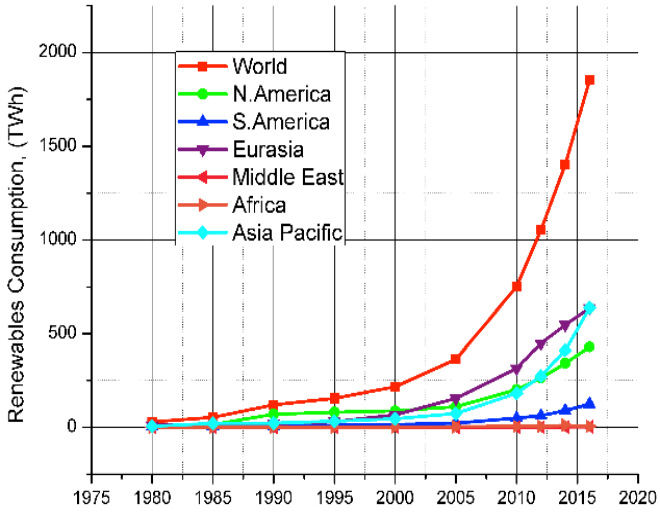

Figure 6: Global Renewables Consumption for the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy. Renewables. [11])

Nuclear Power Plant (NPP) is used atomic (nuclear) energy to generate electricity. The generator of energy here is an atomic reactor. The heat released in it as a result of the chain reaction of fission of the nuclei of some heavy elements, is converted into electricity. NPPs operate on nuclear fuel (uranium, plutonium, etc.), the world's reserves of which are much higher than those of organic fuels. This is one of the reasons why some technically advanced countries produces this type of electricity.

But it is very sensitive and, sometimes, dangerous process! Fig. 4 shows degradation of Global Nuclear Electricity consumption by more than 500 TWh in 2011, when happened Fukushima nuclear disaster in Jupon. The most Environment friendly ways to produce Electricity are Renewables (Fig. 6). The share of electricity produced on the basis of RES will grow in the world not so much for environmental / regulatory, but for economic reasons, because that energy based on renewable sources, which does not have a fuel component and is characterized by low specific operational costs, has a deflationary character. RES will eventually become cheaper and more efficient, while hydrocarbon generation technologies do not have comparable potential to reduce capital costs and the cost of electricity. But, unfortunately one of the main sources to produce electricity today is Coal and Natural gas (mentioned above).

Fig.7 presented the dynamics of the Global Coal (Million Tons), and Fig. 8 shows Global Oil Production (Thousand Barrels per day) for the time period of 1980 – 2016.

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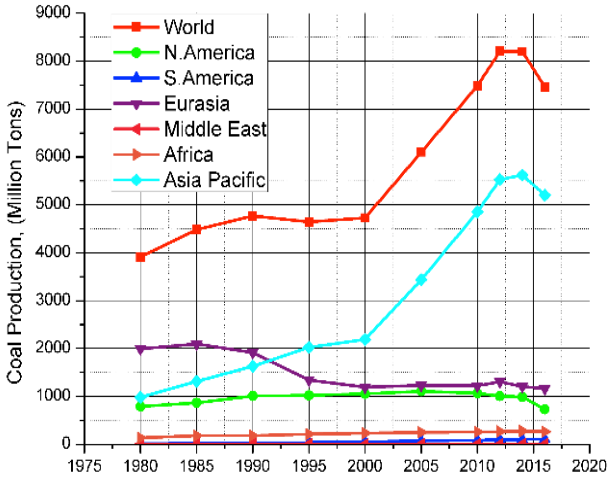

Figure 7: Global Coal (Million Tons) Productions in the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy [10])

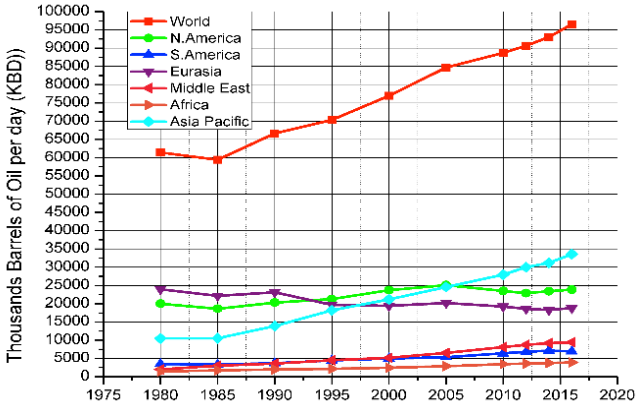

Figure 8: Global Oil Productions (Thousand Barrels per day) in the time period of 1980 – 2016. (Statistical information used from Statistical Review of World Energy [8])

Most amount of the Coal in Global scale goes for the production of electricity. Plots on Fig. 7 shows that production of the coal varies from continent to continent, but Globally it slightly decreases since 2014. Different situation with Oil: even though Global production of Oil goes up, its shear in electricity production not more than 5%.

III. SUSTAINABLE GLOBAL ELECTRICITY DEMAND

Based on above presented information and analysis and using some statistical information from 2017 Outlook for Energy: A View to 2040 [15], and analytical source Exxon Forecasts Growth in Global Energy Demand [14] was prepared graphs showing Global Electricity Consumption (2016) (Fig. 9) and expected Demand (2040)) by Type of Fuel (Fig. 10).

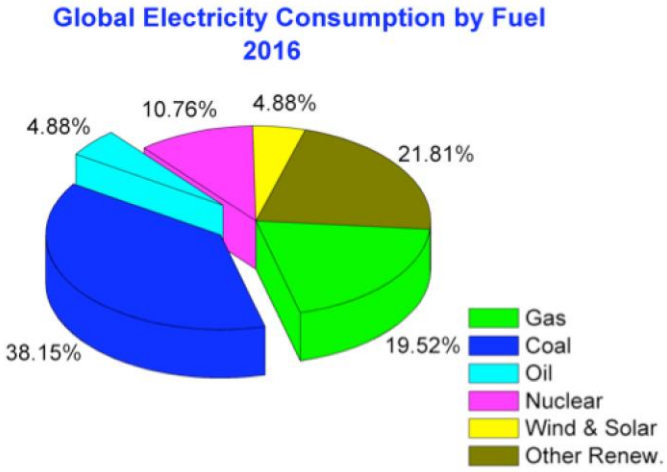

Figure 9: Global Electricity Consumption (2016) by Type of Fuel (Data used from Exxon Forecasts Growth in Global Energy Demand [14], [15])

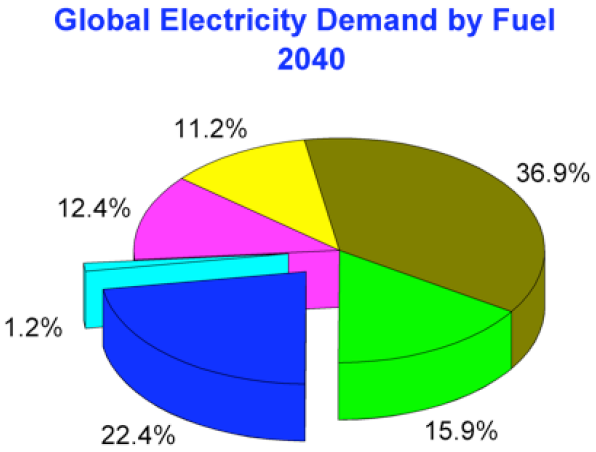

Figure 10: Global Electricity expected Demand (2040)) by Type of Fuel (Data used from Exxon Forecasts Growth in Global Energy Demand [14, [15]])

Fig. 9 showing Electricity consumption by the type of Fuel as for 2016. We can see Coal and Oil produce more the 43% of electricity Globally, and including Natural Gas – almost 63%! In future, use of Coal for the electricity production will vary by region. Most possible those in India and China and in some developing countries in Southeast Asia coal for electricity will likely continue to increase. But, fortunately, Global Electricity Demand expected to reduce rate of fossil sources and increase amount of Electricity produced from Renewable sources (RES) (Fig. 10). Total electricity produced from fossil by 2040 expected to be no more than 40%. More than 48% of Global electricity expected to be produced from Renewables (RES), and around 12% - from Nuclear Power Stations.

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IV. CONCLUSIONS

1. The share of electricity in the world energy balance is growing steadily. The prospects of electricity are not in doubt. Will grow both the volume of its production, and the share in the global final energy consumption.
2. Nonrenewable sources of electricity (such as oil, coal, and natural gas) unfortunately will significantly remain due to their affordability and flexibility to process.
3. The share of electricity produced on the basis of Renewable Energy Sources (RES) will grow in the world for environmental and regulatory (UN Sustainable Development Goals), but also mainly for economic reasons, because that energy based on renewable sources, which does not have a fuel component and is characterized by low specific operational costs. RES will eventually become cheaper and more efficient and more sustainable, while hydrocarbon generation technologies do not have comparable potential to reduce capital costs and the cost of electricity.

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Citation of this Article:

Shehret Tilvaldyev, Arturo Paz Perez, Bennet Gabriela Ornelas Rodriguez, Manuel Alejandro Lira Martinez, Alfredo Villanueva Montellano, "Global Electricity Consumption, Sustainable Generation and Renewable Energy" Published in *International Research Journal of Innovations in Engineering and Technology (IRJIET)*, Volume 3, Issue 10, pp 46-50, October 2019.

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