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Module 0:
Introduction to Renewable Energy Sources

by Gürsu Municipality

Global Warming

Global warming is the long-term warming of the world climate system with the onset of the industrial age (between 1850 and 1900), particularly due to fossil fuel burning, which increased levels of heat-trapping greenhouse gases in the earth's atmosphere.

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What is Greenhouse Effect?

- As is known, greenhouse is a type of big bell glass used in agricultural activities. The sun rays that come in the daytime heat the inside of this bowl, and the glass bell glass prevents this heat from escaping, so the inside of the greenhouse remains warm even at night when there is no sun.
- The Earth's atmosphere has a similar feature.
- If it were not neither water vapor, methane (CH_4), nitrous oxide (NO), ozone (O_3) nor CO_2 gases, our world would be a desert covered with glaciers.
- These gases, referred to together with water vapor, are *greenhouse gases*.
- Greenhouse gases catch the sun rays reaching the earth and prevent them from escaping out of the atmosphere just like in agricultural greenhouses.
- The lack of greenhouse gases will cool our world, while their excess will warm our world.

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Global Warming

- Changes observed in Earth's climate since the early 20th century are mainly due to human activities, particularly the use of fossil fuels, which increase heat-trapping greenhouse gas levels in the Earth's atmosphere and raise the Earth's average surface temperature.

- These human-induced temperature increases are called *global warming*.

- Natural processes and internal variations (eg cyclic ocean formations such as El Niño, La Nina) and external forces (eg volcanic activities, variations in the energy level of the sun) can also contribute to climate change.

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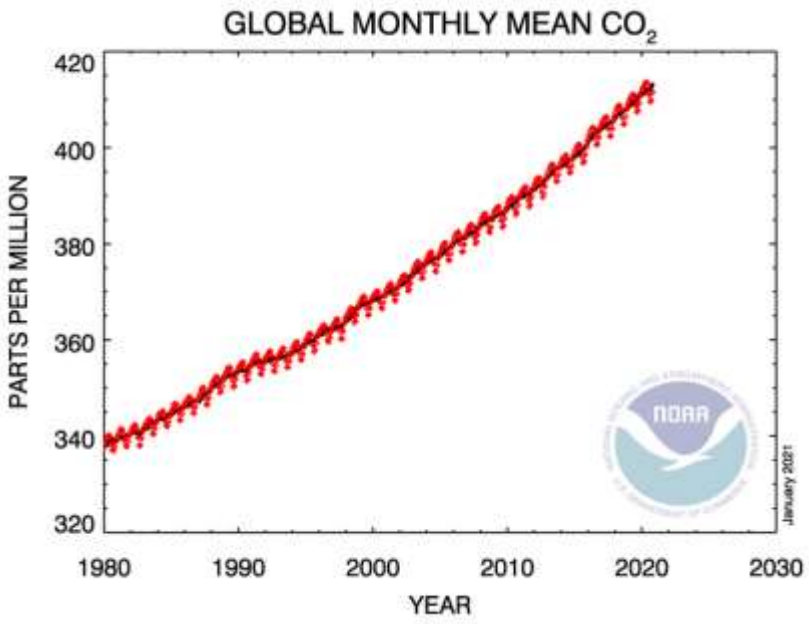
CO_2 Rate in the Atmosphere

- Figure shows the change in the amount of CO_2 in the atmosphere between 1980 and 2020. While the atmospheric CO_2 level was measured as 284 ppm as of 1832 in the pre-industrial period, this rate increased to 338 ppm in 1980. The rise from that year to the present is more striking. The Global Monitoring Laboratory determined the CO_2 rate in the atmosphere as 409.23 ppm in October 2019 and 411.53 ppm in October 2020. According to the data obtained from Boğaziçi University Climate Change and Policy Application and Research Center, it has doubled in the last few centuries and has increased by 1% every year since 1950.



Global Monthly Mean Karbondioxide.
Source: National Oceanic and Atmospheric Administration/Global Measuring Lab.

Other Greenhouse Gases

- Nitrogen oxide is formed during agricultural and industrial activities and the burning of solid wastes and fossil fuels. This gas, which also comes out of the exhaust of cars and causes environmental pollution.
- Since the increase in CO_2, NH_3 and NO gases will increase the world temperature, the increase in the amount of water vapor in the atmosphere is an inevitable result. Chlorofluorocarbon (CFC) gases destroy ozone. Most of these gases are products of the 1950s and are used today in refrigerators, air conditioners, sprays, fire extinguishers and production of plastics.

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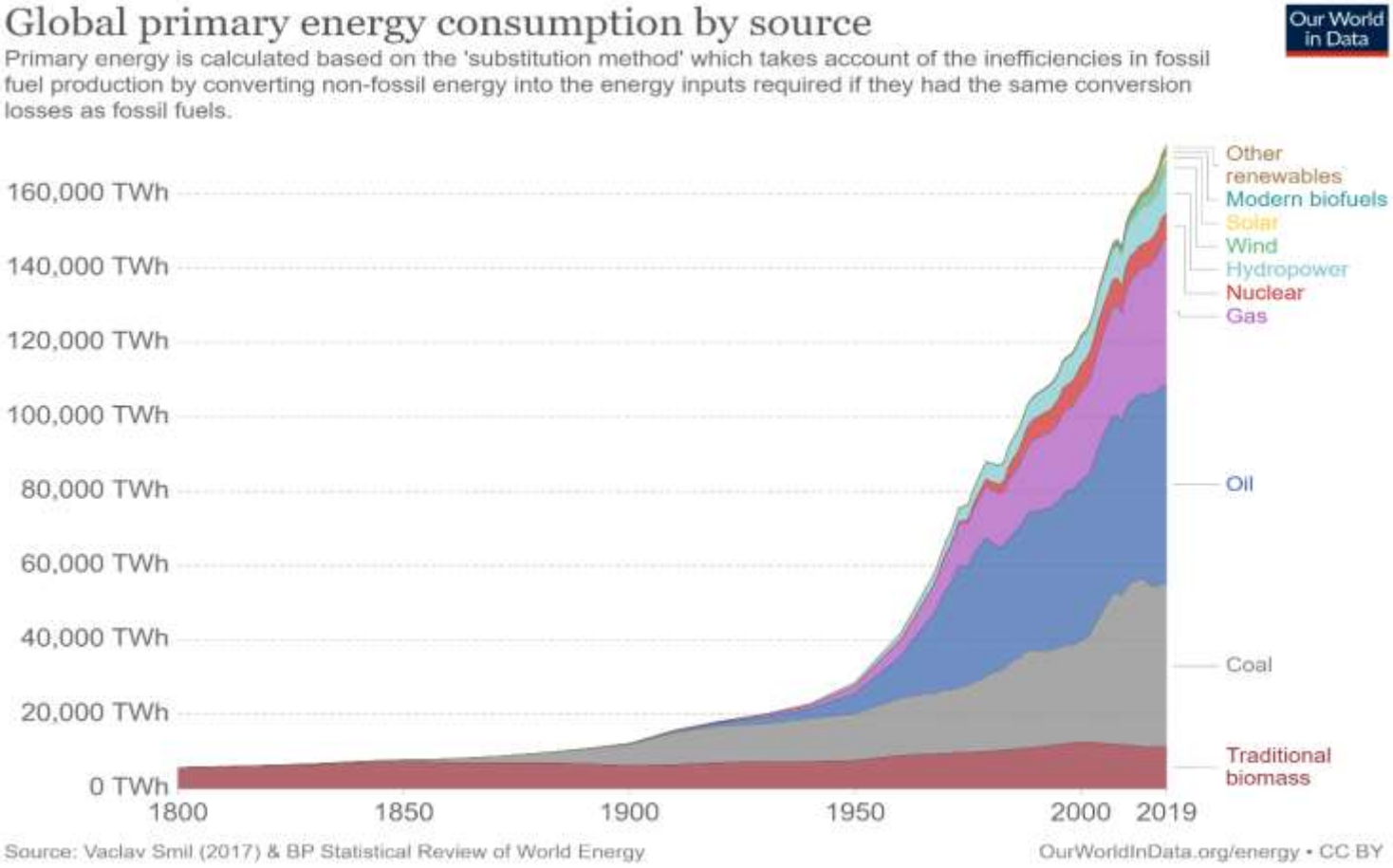
Energy Consumption by Source



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Energy Consumption in 2019

Resource	Consuption (TWh)	Rate (%)	Rate by 2018 (%)
Oil	53610	33,1	-0,2
Gas	39305	24,2	0,2
Coal	43860	27,0	-0,5
Renewables *	8055	5,0	0,5
Hydro	10445	6,4	0,0
Nuclear	6915	4,3	0,1
Total	162190		

Source:https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/year-in-review.html)

(*): Renewables exept hydro

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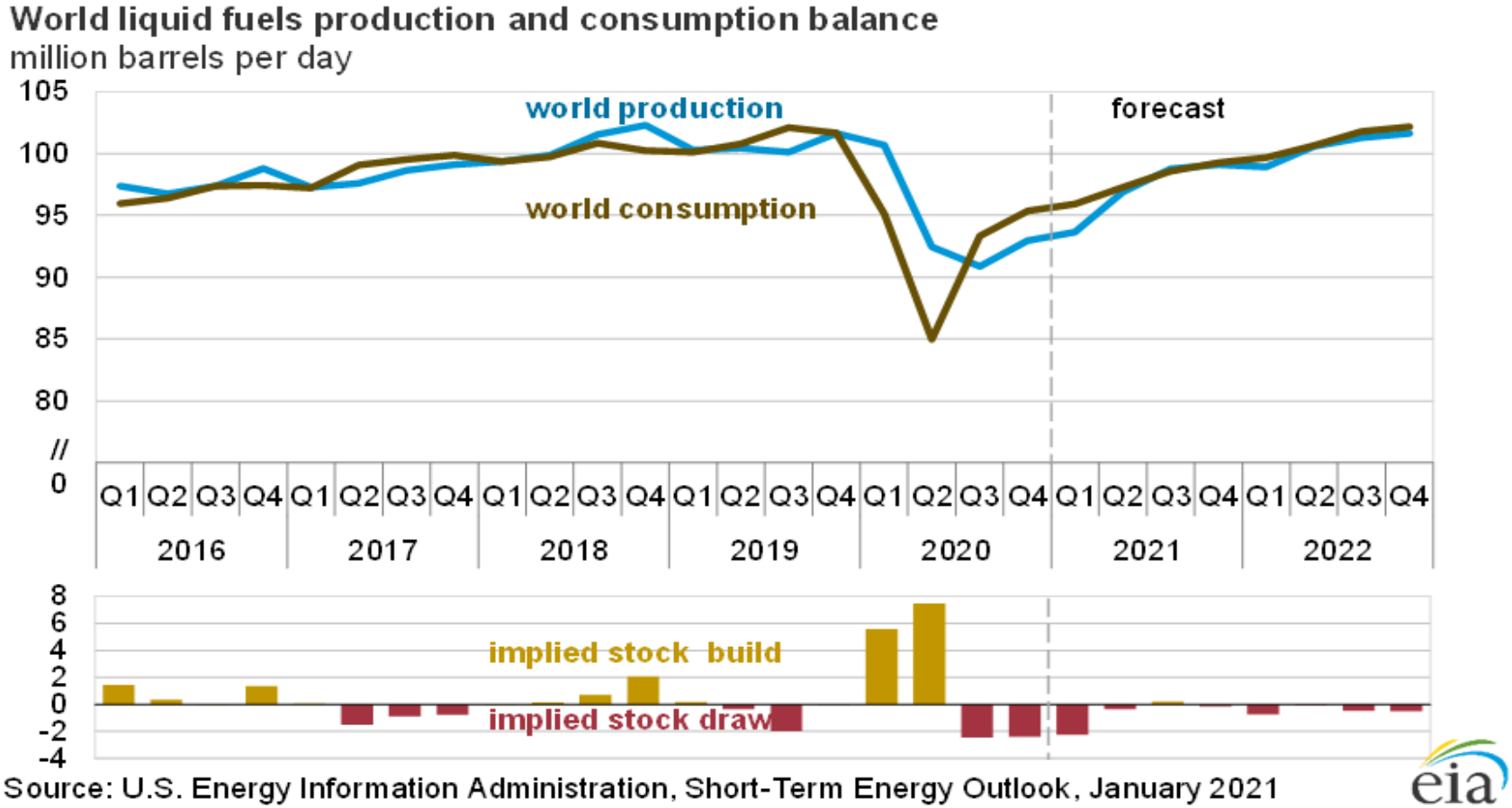
Liquid Fuels Consuption/Production: Past and Predictions



Source: U.S. Energy Information Administration, Short-Term Energy Outlook, January 2021

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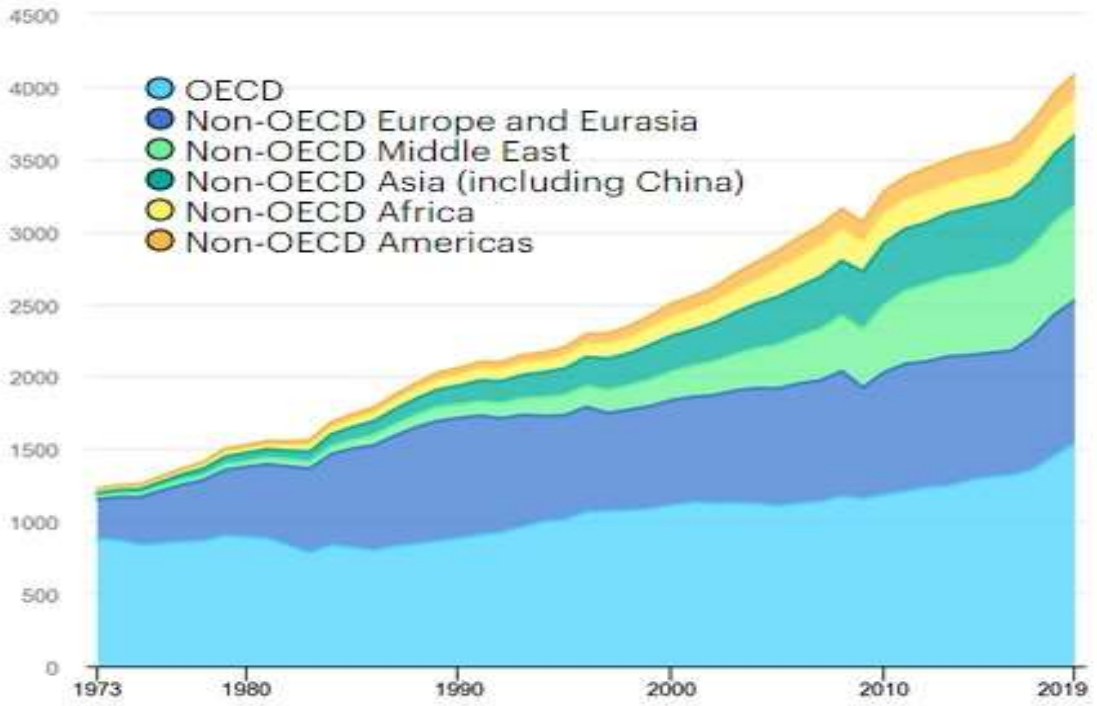
World Natural Gas Production by years



Source: https://www.iea.org/data-and-statistics/charts/world-natural-gas-production-by-region-1973-2019

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Coal, oil and gas formation

- Energy sources consisting of organics that have remained under the rocks and ground underground for millions of years and fossilized because of heat and pressure are called fossil fuels. The most important feature of these fuels is that they contain hydrocarbons and high levels of carbon. With these features, fossil fuels have a limited amount in certain parts of the world. This limited amount of fossils found in the world is called a reserve.
- Fossil fuels are classified as coal, oil and natural gas. 70% of the world's fossil fuel reserves consist of coal, 14% oil, 14% natural gas and 2% other fossil resources.
- Considering the distribution of fossil fuels to the world, it is seen that liquid and gas reserves are concentrated in certain parts of the world, coal reserves show a more regular distribution and coal production takes place in more than 50 countries.

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Coal, oil and gas formation

- **Coal** consists mostly of carbon, hydrogen, oxygen and small amounts of sulfur and nitrogen. Coal is the oldest energy source after wood. It is thought that houses were consumed for heating purposes in England in the 9th century.
- **Oil** consists of residues of marine plants and animals after decay. After these residues decay for millions of years, only oily substances remain. This oily substance, left under the mud and large layers of rock, turns into oil. Petroleum is a mixture of solid, liquid and gaseous hydrocarbons in different proportions. Petroleum is a compound composed of hydrogen and carbon with a small amount of sulphur, it has no average formula.
- **Hydrocarbon-based natural gas** is found in large volumes in the form of gas, compressed underground in the cavities of porous rocks or above oil deposits. It is colourless, odourless and lighter than air. Its formation is the same as that of oil.

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Potential sources of energy

- Scientists and the international community agree on the impact of fossil fuels on climate change. Therefore, alternative sources to fossil fuels are being developed and new sources are being questioned.
- Parties to the Paris Climate Agreement will shut down coal-fired thermal power plants in their countries by 2031. For this reason, intensive studies are carried out on sustainable energy before the fossil fuel reserves are exhausted.

							Average annual percent change	
Region	1990	2000	2012	2020	2030	2040	1990-2012	2012-2040
OECD	**42.2**	**48.7**	**45.5**	**45.8**	**45.5**	**46.1**	**0.3**	**0.0**
Americas	20.6	24.3	23.2	24.4	24.3	24.6	0.5	0.2
Europe	14.0	15.6	14.1	13.7	13.7	14.0	0.0	0.0
Asia	7.6	8.8	8.2	7.7	7.5	7.5	0.4	-0.3
Non-OECD	**25.0**	**29.0**	**44.8**	**54.5**	**63.6**	**74.8**	**2.7**	**1.9**
Europe and Eurasia	9.3	4.4	5.3	5.8	6.2	6.1	-2.5	0.5
Asia	6.6	12.5	21.5	26.7	32.2	38.9	5.5	2.1
Middle East	3.3	4.5	7.7	10.0	11.3	13.2	3.9	2.0
Africa	2.1	2.5	3.6	4.5	5.5	6.9	2.6	2.4
Americas	3.8	5.0	6.7	7.5	8.5	9.6	2.7	1.3
Total world	**67.2**	**77.7**	**90.3**	**100.3**	**109.1**	**120.9**	**1.4**	**1.0**

In figure above, it is observed that the increase in the use of liquid fuels in OECD countries between 2012-2040 is close to zero. Liquid fuel consumption is expected to be 1.9 percent in countries outside the OECD and 1 percent worldwide.

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Solutions for sustainable energy

- Sustainable energy is the energy produced and used to meet today's needs without compromising the ability of future generations to meet their own needs. For this reason, the energy obtained from fossil fuels is not sustainable.

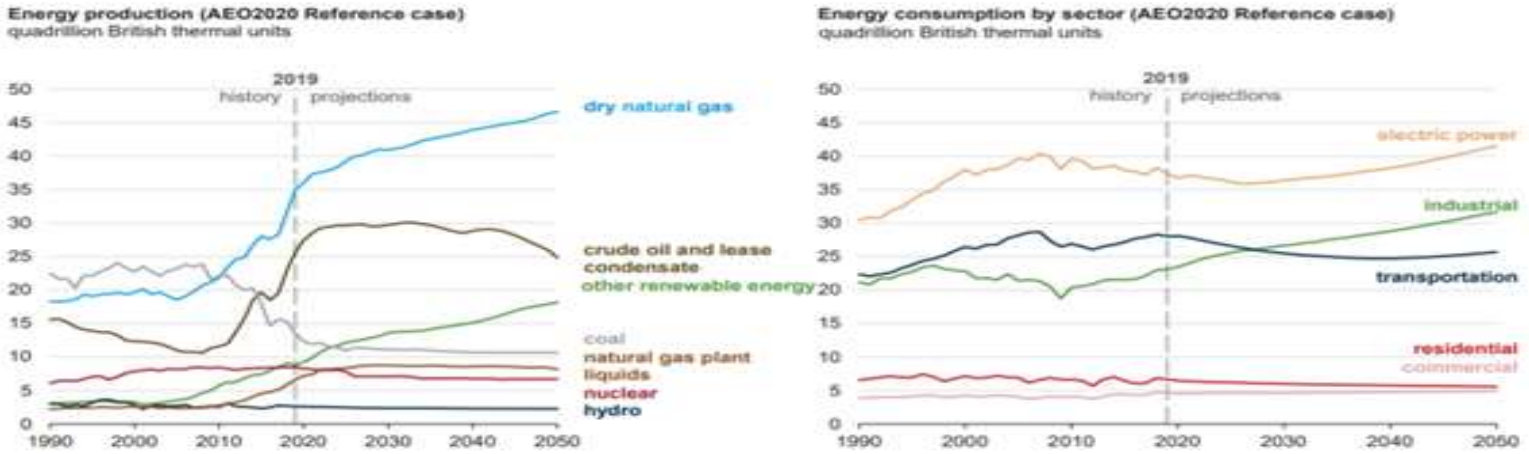

Figure above shows that U.S. energy production grows significantly, but consumption grows moderately under the AEO2020 Reference case assumption of current laws and regulations. Source: EIA

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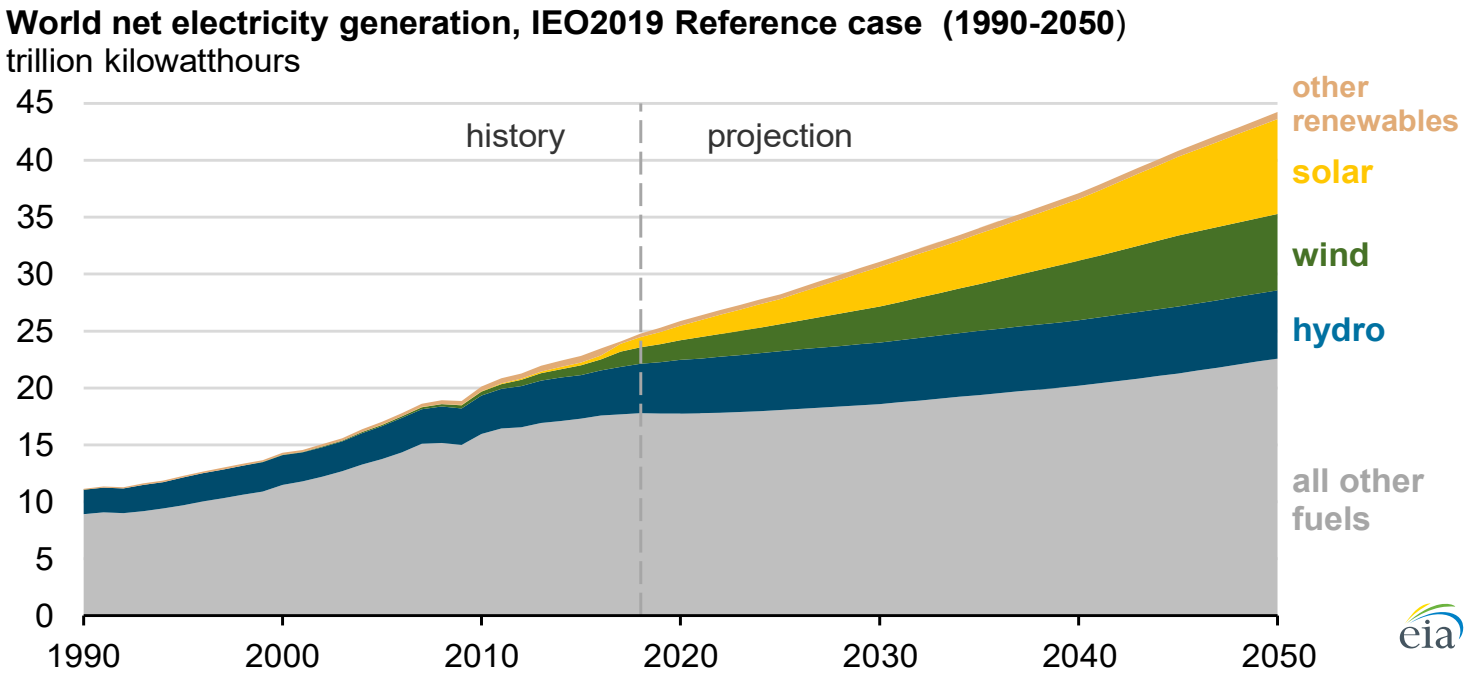
Solutions for sustainable energy, tackling with global warming



In Figure above, it is observed that the increase rate of electrical energy production to be obtained from fossil fuel energy sources in the world will decrease in the future. It is predicted that the amount of electrical energy to be obtained from renewable energy sources will triple the current generation in 2050.

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Definition of renewable energy, renewable and non-renewable energy resources

- The energy potential of renewable resources is constantly renewed through natural processes or human activities. These resources can be counted as solar energy, wind energy, thermal energy, energy obtained from oceans and biomass energy.

- Non-renewable energy resources are resources that are depleted with their use. Fossil and nuclear fuels are non-renewable resources.

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Introduction to biomass energy

- Biomass energy can be expressed as energy obtained from living or previously lived organisms. The most common biomass materials are plants such as corn, soy, etc. These plant types are also called energy crops. In addition to this, forest, field, and animal wastes are among the materials from which we can obtain biomass energy.
- Biomass energy has a great potential among renewable energy sources, and it is a source that can provide continuous energy, not discrete like wind and sun. Biomass is a domestic resource, increasing local production and employment. It does not cause an increase in CO_2 in the atmosphere because it emits as much carbon dioxide as it takes from the atmosphere in case of combustion, and theoretically it is a fuel that does not contribute to the greenhouse effect in case of renewal of forest and plant assets.

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Introduction to solar energy & photovoltaic energy

- Solar energy is the energy that is formed mainly by the synthesis of hydrogen atoms and is the result of thermonuclear transformations in the sun. The sun is the main source of earth energy. It transports 15 thousand times the energy we consume from the sun to the world every day. It is humanity's biggest and most efficient energy source. It is estimated that the sun provides the amount of energy to our planet within an hour, corresponding to the annual energy consumption of all humanity.
- Solar energy is used actively or passively. Passive techniques include positioning buildings in relation to the sun, utilizing heat-absorbing materials (thermal mass) and natural hot air flow. Among the active techniques, water heating systems, which are widely used in solar countries, and the use of photovoltaic systems that convert energy from the sun directly into electrical energy.

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Introduction to solar energy & photovoltaic energy

- The energy emitted by the sun is defined as Solar Energy (SE). Solar energy potential depends on geographic location.
- Photovoltaic effect is a phenomenon that expresses the generation of electromotive force on the semiconductor material exposed to sunlight.
- It was introduced in 1839 by the French physicist Edmund Becquerel, who discovered that some materials exposed to sunlight generate small electric currents. These principles have been applied to photovoltaic solar panels.
- In the course of time, their technology has improved, and the panels have become smaller and cheaper.
- Direct current electricity is obtained by the photovoltaic effect. However, since the electricity type in use is AC, it is necessary to use devices that convert DC electricity into AC electricity, called inverters. Benefiting from SE continuously, for example night time there is no sun, batteries can be used for storage electric energy while sun is on the sky.

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Introduction to wind energy

- Human beings have benefited from wind energy for centuries. The most striking in the beginning are the windmills remembered from the Cervantes novel.
- These mills have been used for centuries by converting wind energy into mechanical energy, for example in the Netherlands to protect agricultural land from floods and to process agricultural products in general.
- In the current period, wind energy is an important resource in electrical energy generation. The mechanical energy obtained from the wind learned in the past centuries is now converted into electrical energy with the help of generators.
- Today, many countries still have large untapped wind potential.

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Introduction to geothermal energy

- Geothermal energy is the natural heat found on earth. The groundwater passing through hot rocks in various depths of the earth's crust carries this temperature and forms a reservoir by collecting in a certain area.
- Hot water, steam and gases, including chemicals in these reservoirs, are called geothermal.
- Geothermal energy also includes exploiting these geothermal resources and using them direct or indirect ways. The heat energy obtained from these sources and some of the hot rocks that do not contain water is called geothermal energy.
- Geothermal resources can be directly utilized as heating. Within this, the use of space heating (houses, agricultural greenhouses, etc.) is also spreading in food drying processes. In addition, depending on the potential of the resource, the energy of geothermal water can be converted into electrical energy through power plants.

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Introduction to hydroelectric energy

- Although it is expressed as obtaining electrical energy with the help of hydroelectric power plants, the flow of water is a source of mechanical energy in itself. For example, water mills have been used for various purposes since ancient times.
- Hydroelectricity is the use of hydropower to generate electrical energy.
- For the hydroelectric power plant, a water reservoir is required first.
- A reservoir of this type is obtained by building a dam on a river. The water in the reservoir is released to the stream bed at a lower distance with the help of the dam in a controlled manner. The kinetic energy obtained in this way provides motion energy to the turbines. This mechanical energy obtained is converted into electrical energy with the help of generators.

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Introduction to biogas energy

- The term biogas basically refers to the production of usable gas from organic wastes.Biogas is the conversion of organic matter into carbon dioxide and methane gas under the influence of microbiological flora in an oxygen-free environment.
- Since biogas acquisition is basically based on the decomposition of organic substances, plant wastes or animal fertilizers can be used as basic materials.
- The use of chicken manure is important for agriculture because it causes salinity in the soil. This unusable fertilizer becomes useful when it is converted into biogas. Today, the use of biogas spreads from covering the heating and kitchen expenses of a single house to generating electricity.
- Biogas is produced in three stages called hydrolysis, acid formation and methane formation.
- In the first stage, wastes are made soluble with enzymes provided by microorganisms. In the second stage, acid-forming bacteria are activated and small-structured substances such as acetic acid are obtained. In the last stage, methane-forming bacteria convert these substances into methane gas in an oxygen-free environment.

Resources & Links

Ackermann, Thomas & Prevost, Thibault & Vittal, V. & Roscoe, Andrew & Matevosyan, Julija & Miller, Nicholas. (2017). Paving the Way: A Future Without Inertia Is Closer Than You Think. IEEE Power and Energy Magazine. 15. 61-69. 10.1109/MPE.2017.2729138.

Öztürk, Mustafa. "Hayvan Gübresinden Biyogaz Üretimi". Çevre ve Orman Bakanlığı. 7 Mayıs 2007

Tolun, F., Saran, M., Demir, E Geothermal Energy in URESA Handbook, Sonçağ, Ankara, Turkey

History of Hydropower | Department of Energy". energy.gov. Retrieved 4 May 2017.

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Resources & Links

https://climate.nasa.gov/resources/global-warming-vs-climate-change/#:~:text=Global%20warming%20is%20the%20long,gas%20levels%20in%20Earth's%20atmosphere.

https://www.eia.gov/outlooks/ieo/

https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf

https://www.osti.gov/servlets/purl/1296780/

https://mahb.stanford.edu/library-item/fossil-fuels-run/

https://en.wikipedia.org/wiki/Hydropower

https://www.nationalgeographic.org/encyclopedia/biomass-energy/

https://energypedia.info/wiki/Wind_Energy_-_Introduction

https://tr.wikipedia.org/wiki/Biyogaz#cite_note-oz-1

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