

Plugging into the Future:An Exploration of Electricity Consumption Patterns

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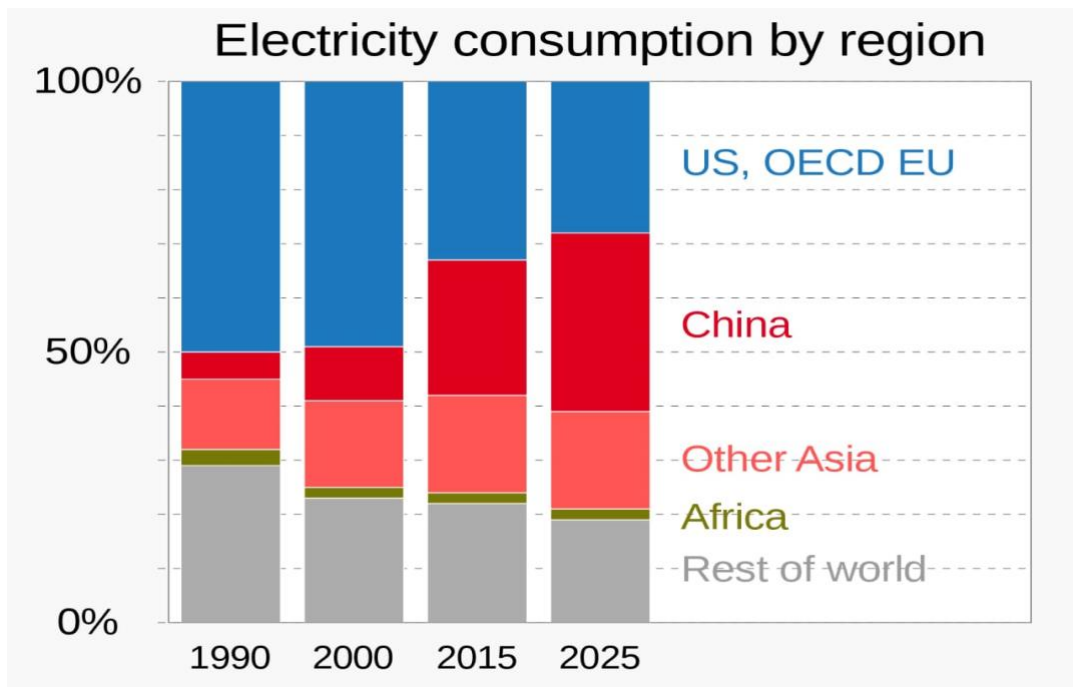
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An Exploration of Electricity Consumption Patterns

Introduction

Electricity consumption represents the amount of electrical energy that has been consumed over a specific time, in units of Wh (or kWh), electricity demand represents that rate at which electrical energy is consumed for a needed output rating, in units of W(or kW).

Electric energy consumption is energy consumption in the form of electrical energy. About a fifth of global energy is consumed as electricity: for residential, industrial, commercial, transportation and other purposes. Quickly increasing this share by further electrification is extremely important to limit climate change, because most other energy is consumed by burning fossil fuels thus emitting greenhouse gases which trap heat.



Overview

Electric energy is most often measured either in joules (J), or in watt hours (W·h). $1 \text{ W} \cdot \text{s} = 1 \text{ J}$ $1 \text{ W} \cdot \text{h} = 3600 \text{ W} \cdot \text{s} = 3600 \text{ J}$ Electric and electronic devices consume electric energy to generate desired output (light, heat, motion, etc.). During operation, some part of the energy is lost depending on the electrical efficiency. Electricity has been generated in power stations since 1882. The invention of the steam turbine in 1884 to drive the electric generator led to an increase in worldwide electricity consumption. In 2019, total worldwide electricity production was nearly 27,044 TWh. Total primary energy is converted into numerous forms, including, but not limited to, electricity, heat and motion. Some primary energy is lost during the conversion to electricity, as seen in the United States, where 61% was lost in 2019.

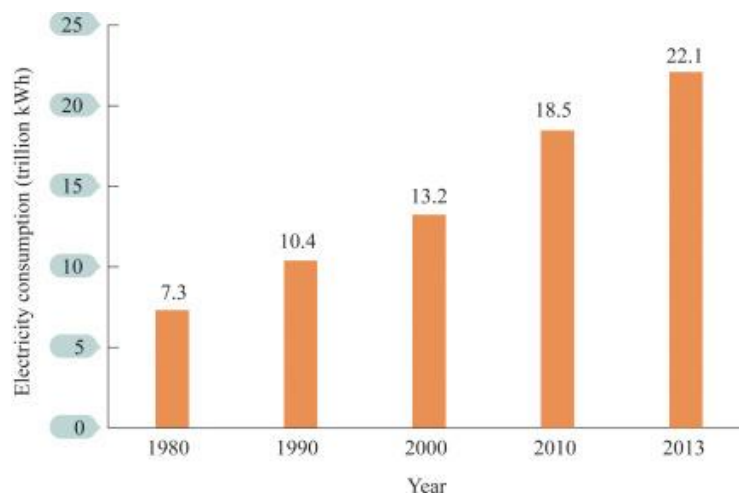
Electricity accounted for 19.7% of worldwide final energy consumption in 2019, while oil was 40.4%, coal was 9.5%, natural gas was 16.4%, biofuels and waste were 10.4%, and other sources (i.e., heat, solar thermal, and geothermal) were 3.6%. Total final electricity consumption in 2019 was split unevenly between the following sectors: industry (41.9%), residential (26.6%), commercial and public services (21.2%), transport (1.8%), and other (8.5%; i.e., agriculture and fishing). Since 1973, final electricity consumption has decreased in the industrial sector and increased in the residential, commercial and public services sectors.

Purpose

- For lighting,
- Heating
- Cooling
- Refrigeration
- Operating appliances
- Computers
- Electronics
- Machinery
- Public transportation systems.

World electricity consumption

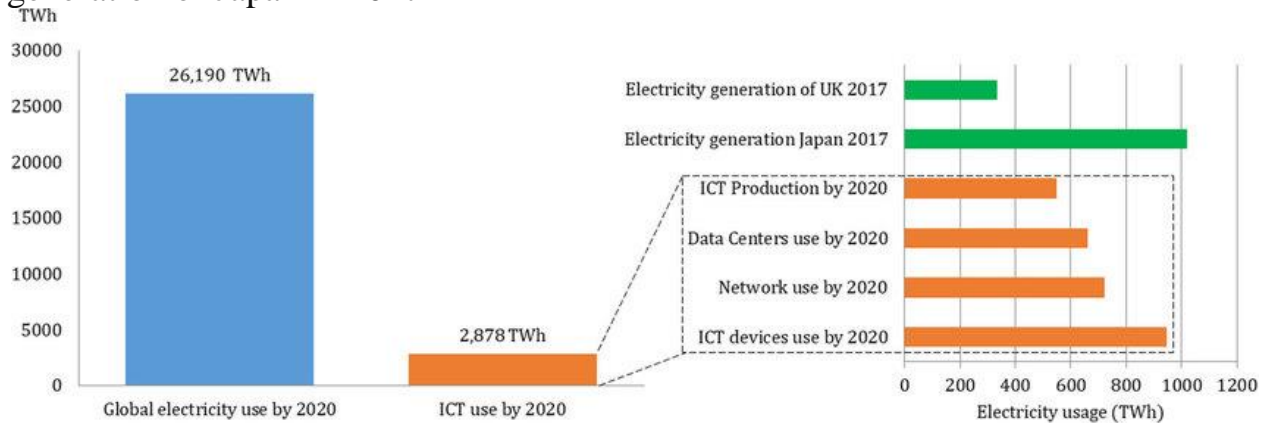
The table lists 45 electricity-consuming countries, which used more than 21,000 TWh. These countries comprise about 90% of the final consumption of 190+ countries. Final consumption to generate World electricity Consumption this electricity is provided per country. The data is from 2022.



In 2019, OECD's final electricity consumption was 9,672 TWh. The industrial sector consumed 41.9% of the electricity, the residential sector consumed 26.6%, the commercial and public services sectors consumed 21.2%, the transport sector consumed 1.8%, and the other sectors (e.g., agriculture and fishing) consumed 8.5%. In recent decades, consumption in the residential and commercial and public services sectors has grown, while industry consumption has declined. More recently, the transport sector has witnessed an increase in consumption with the growth in the electric vehicle market.

Information technology for electricity consumption

Electricity consumption of the information and communication technology (ICT) sector. Expected consumption of electricity by 2020 of the ICT sector accounts for 11% of the Global use of electricity. For comparison, the electricity usage of Data Centres and Network exceeds the electricity generation of United Kingdom in 2017, and the ICT device usage is comparable to the electricity generation of Japan in 2017



Energy meters and data collection techniques

There are different types of energy meter available and some make monitoring energy usage easier and faster.

You can use the data to:

- quickly identify unexpected or excessive energy use
- highlight opportunities for reducing costs

When you read an energy meter, you should bear in mind that electricity is measured by the number of kilowatt hours (kWh) passing through the meter, while gas is measured by the volume delivered to your site.

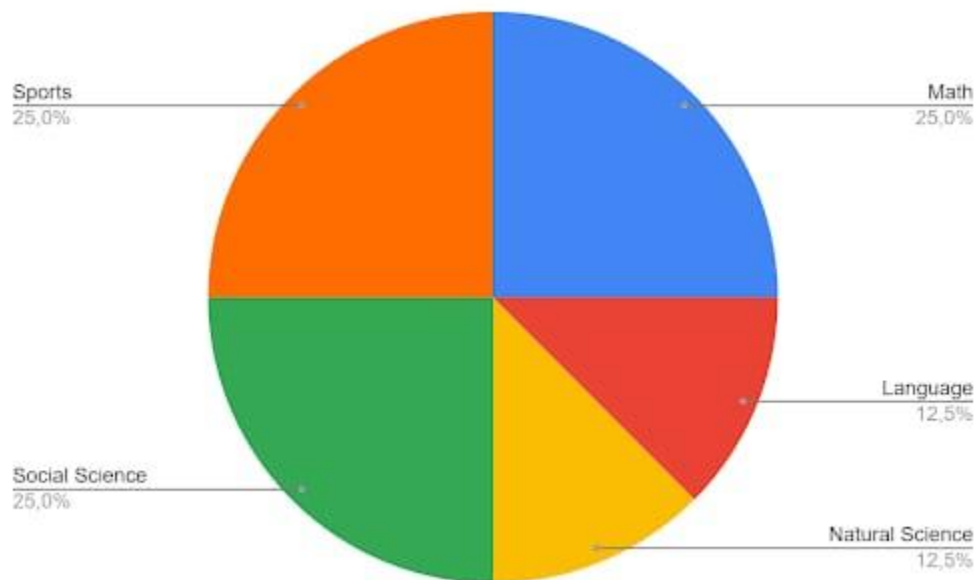
Types of energy meter

There's a wider range of energy meters and data collection techniques for electricity than for other utilities. Electricity consumers have more opportunities to get accurate billing and easy access to their consumption data to identify waste.

As well as on-site meters, other metering options you could consider include:

- smart meters
- sub-meters
- automated meter reading
- building energy management systems suitable for large energy users

Data visualization

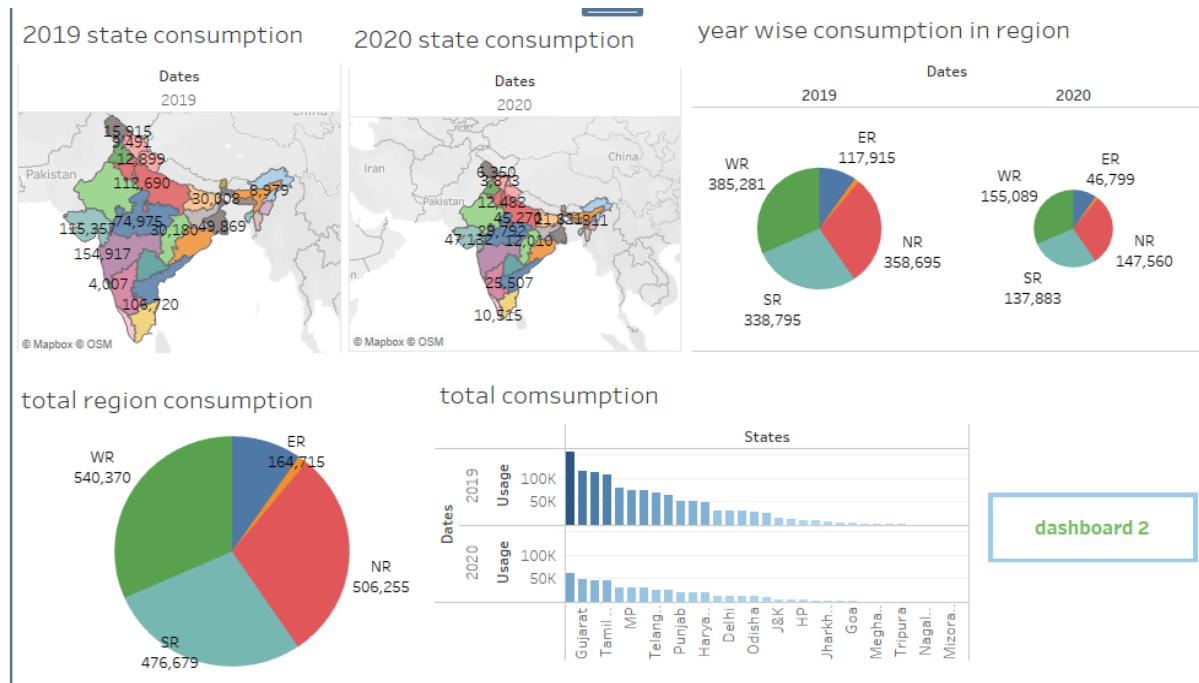


The pie chart is a pictorial representation of data that makes it possible to visualize the relationships between the parts and the whole of a variable. For example, it is possible to understand the industry count or percentage of a variable level from the division by areas or sectors. The recommended use for pie charts is two-dimensional, as three-dimensional use can be confusing.

Like a pie chart, the total of the data that make up the segments must equal 360°, or the sum of the values of the circumference must always be 100%. To calculate the percentage of a pie chart, it is necessary to: categorize the data, calculate the total, divide the categories, convert the rates and calculate the degrees.

Dashboard

A dashboard is a graphical user interface (GUI) that displays information and data in an organized, easy-to-read format. Dashboards are often used to provide real-time monitoring and analysis of data, and are typically designed for a specific purpose or use case



Electricity sector in India

India is the third largest producer of electricity in the world. During the fiscal year (FY) 2021–22, the total electricity generation in the country was 1,719 TWh, of which 1,484 TWh was generated by utilities.



The gross electricity consumption per capita in FY2019 was 1,208 kWh. In FY2015, electric energy consumption in agriculture was recorded as being the highest (17.89%) worldwide. The per capita electricity consumption is low compared to most other countries despite India having a low electricity tariff.

The Indian national electric grid has an installed capacity of 416.0 GW as of 31 March 2023. Renewable energy plants, which also include large hydroelectric power plants, constitute 40.7% of the total installed capacity. India has a surplus power generation capacity but lacks adequate fuel supply and power distribution infrastructure. The average capacity factor of thermal power plants is below 60% against the norm of 85%.

India's electricity sector is dominated by fossil fuels, in particular coal, which produced about three-quarters of the country's electricity. The government declared its efforts to increase investment in renewable energy. The government's draft National Electricity Plan of 2022 states that the country does not need any more fossil fuel power plants in the utility sector until 2027 besides those currently under construction. It is expected that non-fossil fuel generation contribution is likely to be around 44.7% of the total gross electricity generation by 2029–30.

Advantages & Disadvantages

Advantage

- It is a clean, safe, cheap and convenient source of energy
- Lower maintenance cost
- More efficient
- No tailpipe emission
- We all know that it can be set up in many sizes
- It doesn't require as many employees
- Reduces greenhouse emission
- Makes barely any pollution compare to other ways of creating or generating electricity
- Relatively low maintenance cost
- Hydroelectric station are inexpensive to operate
- Hydroelectricity produces no gas emissions or waste
- A station can operate and run for long periods of time
- It is renewable

Disadvantage

- More expensive than gasoline
- Loss of fish species
- Sometimes messes up wildlife
- Dependent on precipitation
- More power plants and more pollution
- Damming can cause loss of land suitable for agriculture as well as recreation
- Cost for construction
- Change in river or stream quality
- An electric vehicle is not completely emission free
- In electricity, there are a limited number of feasible sites for a large number of dams
- Hydroelectric natural seasonal changes in river and ecosystems can be destroyed

Future scope

Looking forward, increasing energy efficiency will result in less electricity needed for a given demand in power, but demand will increase strongly on the account of: Electricity outlook Economic growth in developing countries, and Electrification of transport and heating. Combustion engines are replaced by electric drive and for heating less gas and oil, but more electricity is used, if possible with heat pumps. As transport and heating become more climate-friendly, the environmental effect of energy consumption will be more determined by electricity.

The International Energy Agency expects revisions of subsidies for fossil fuels which amounted to \$550 billion in 2013, more than four times renewable energy subsidies. In this scenario, almost half of the increase in 2040 of electricity consumption is covered by more than 80% growth of renewable energy. Many new nuclear plants will be constructed, mainly to replace old ones. The nuclear part of electricity generation will increase from 11 to 12%. The renewable part goes up much more, from 21 to 33%. The IEA warns that in order to restrict global warming to 2 °C, carbon dioxide emissions must not exceed 1000 gigaton (Gt) from 2014. This limit is reached in 2040 and emissions will not drop to zero ever.

The World Energy Council sees world electricity consumption increasing to more than 40,000 TWh/a in 2040. The fossil part of generation depends on energy policy. It can stay around 70% in the so-called Jazz scenario where countries rather independently "improvise" but it can also decrease to around 40% in the Symphony scenario if countries work "orchestrated" for more climate friendly policy. Carbon dioxide emissions, 32 Gt/a in 2012, will increase to 46 Gt/a in Jazz but decrease to 26 Gt/a in Symphony. Accordingly, until 2040 the renewable part of generation will stay at about 20% in Jazz but increase to about 45% in Symphony. An EU survey conducted on climate and energy consumption in 2022 found that 63% of people in the European Union want energy costs to be dependent on use, with the greatest consumers paying more. This is compared to 83% in China, 63% in the UK and 57% in the US. 24% of Americans surveyed believing that people and businesses should do more to cut their own usage (compared to 20% in the UK, 19% in the EU, and 17% in China). Nearly half of those polled in the European Union (47%) and the United Kingdom (45%) want their government to focus on the development of renewable energies. This is compared to 37% in both the United States and China when asked to list their priorities on energy.

Application of electricity

Electricity is a very powerful innovation of science. Electricity is widely used in all sectors like entertainment, engineering, healthcare, transport and communication, household, outdoors, office, commercial, space, and fuel. The ways in which electricity is used in these fields are:

- Entertainment activities like watching television, listening to music from an MP3 player, and playing movies on DVDs, VCRs, and VCDs, all require the use of electricity.
- The use of electricity is very essential in the healthcare sector like the use of electricity in an operation theatre and for running medical devices and machines.
- Electricity is even required for the construction of buildings and structures like building houses, welding of materials, and installing windows and gates.
- Travelling long distances is also possible because of electricity.
- Electricity is used to light the roads, heat water in a pool, the lawnmower is used to cut grasses and also uses electricity and water sprinklers also use electricity.
- A vast range of household appliances like toaster, refrigerator, washing machine, microwave, dishwasher, and electrical chimney uses electricity.
- Electricity is used in factories for running heavy machinery.
- Electricity's are widely used in offices for running air conditioners, lights, coffee machines, lifts, biometric scanners, and ID card readers.
- Electricity is even used as a fuel for electric cars.
- Electricity is also used for running satellites and probes which are sent from the earth for space expeditions, for example, the Apollo mission for the landing of humans on the moon also used electricity.

Conclusion

Exploring electricity consumption patterns applications is a great way to become more aware of how we are using energy and identify areas where we can make changes to reduce our energy consumption. By tracking our energy usage in real-time, we can adjust our habits and make smarter choices that lead to a more sustainable future. Whether it's through smart home devices, energy monitoring apps, or professional energy audits, there are many tools available that can help us become more energy-efficient and reduce our carbon footprint.