Energy Literacy for Youth - ELY

Fact Sheets - Contents

The ELY Fact Sheets is for the trainers. It is part of the ELY Training Material helping the trainers.

The ELY Training Material consists of 14 methods in 4 Modules

The ELY Training Material includes: Contents, Handbook (37 pages) , Facilitator Material (116 pages) and 12 Fact Sheets (46 pages).

All material is available in English, Danish, Czech, German, Polish Spanish, Turkish, and Arabic

Project partners: Open Plan Foundation (project lead), MigLAB, YEE - Youth and Environment Europe, and INFORSE-Europe.

The website of the ELY project is: https://energyliteracyforyouth.eu/

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FACT SHEET – Solar Energy

About this Fact Sheet: This fact sheet explains what solar energy is and how we use it. It shows why solar power is important for climate protection and for fair access to energy. Solar energy is clean, safe, and can help people everywhere. Clean and safe energy should be available to all people, not only a few.

What Is Solar Energy?

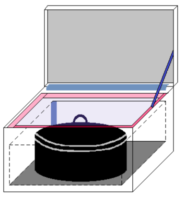
The sun gives the Earth much more solar energy than we can use. Solar energy is renewable, which means it will not run out for billions of years. People have developed many ways to collect sunlight and use it for heat and electricity.

How Does Solar Energy Work?

Technology	How It Works
Solar Photovoltaic (PV) Panels	These panels are made of special materials called semiconductors to turn sunlight into electricity (most of the semiconductors are made of silicon from sand). When light hits the cells, it moves electrons and creates electric power. The electricity can be used immediately, stored in batteries, or sent to the electric grid. Modern PV panels convert about 25% of sunlight or more into electricity.
Solar Thermal Collectors	These systems use sunlight to heat water or air. The hot water can be used for showers, washing, or heating homes. Usually, the hot water is stored in water tanks for use at night or on cloudy days. A solar collector converts around 40% of sunlight into heat.
Passive Solar Heating	Buildings can be designed to use sunlight through windows to heat rooms naturally. Large south-facing windows and shading prevent overheating in summer while keeping warmth in winter. Such designs can save 20–50% of a building's heating demand (more effective in Central Europe than in Northern Europe).

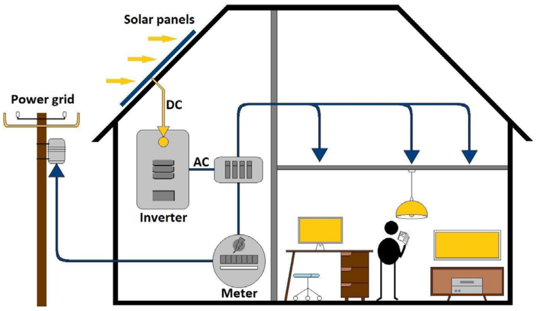
Other Uses of Solar Energy

Solar mirrors create steam for industrial processes or to generate electricity.
Greenhouses trap sunlight to grow plants that need warmth.
Solar cookers and ovens use sunlight to cook food.
Solar dryers are used to dry crops such as fruit, herbs, and grain.



How Is Solar Energy Used? – Examples

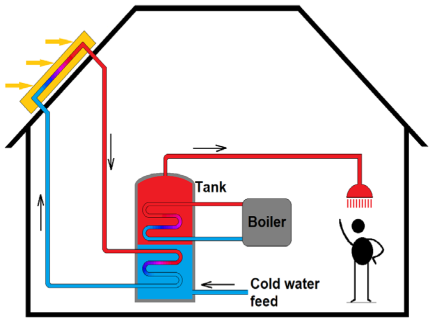
Solar Cell – Photovoltaic (PV)



Family houses: 12 m^2 of PV panels can produce around 3,000 kWh/year in Northern Europe, enough for a typical home.
Flats: 4 m^2 of balcony PV panels can generate about 1,000 kWh/year.
Schools or apartment blocks: often have 100–1,000 m^2 of PV on roofs.
Solar farms: can cover many hectares and supply electricity to thousands of homes and businesses.
Off-grid homes: 0.1–10 m^2 of PV with batteries provide power where no grid exists.
Small PV panels: power calculators, streetlights, water pumps, and satellites.

The solar PV panels work best by facing towards the south, but placing them on an east-west roof also has advantages as it gives a more even production during the day.

Solar Thermal Collectors



There are two main types of solar thermal collectors:

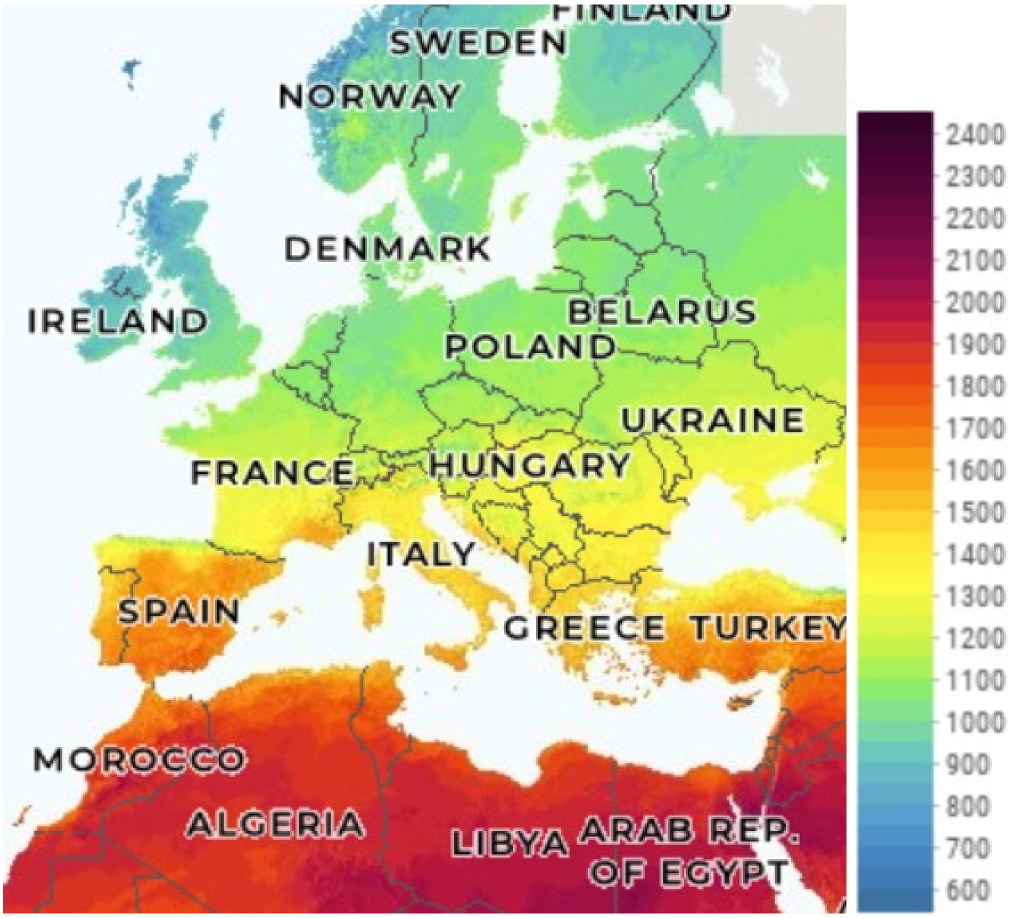
Type	Description
Flat-plate collectors	A dark box with pipes and a glass cover. Sunlight heats the pipes and water inside.
Vacuum tube collectors	Pipes are placed in glass tubes without air. These are more efficient in cold climates with less sun.

Solar thermal collectors are used on homes (3–5 m^2), larger buildings like apartment blocks and schools (20–60 m^2), and solar fields for district heating (1,000–45,000 m^2). They work best when tilted toward the sun (35–45° in Europe).

How Much Solar Energy Is There?

Every year, the Earth receives enough solar energy to power the world many times over. Sunlight is strongest near the equator and more evenly spread throughout the year. With batteries and hot water storage, people can use solar energy day and night.

See how much solar energy your area receives in kWh per m² per year.



Source: Global Solar Atlas https://globalsolaratlas.info/map

Solar Electricity Developments

Solar panels (PV) are now the cheapest way to produce electricity in most of the world. In 2024, the global installed capacity reached 2, 500 Gigawatt (GW, millions of kW), a 33% increase from 2023 (IRENA, 2025). The EU now has 338 gigawatts (GW) of solar panels, providing 11% of its electricity. China leads globally with 887 GW. The EU aims to produce 30 GW of PV panels per year by 2030 to cover around 1/3 of the EU's own demand for PV panels while the rest is imported from China.

Benefits and Drawbacks of Solar Energy

Benefits	Drawbacks
Endless, renewable energy source	Solar power is not constant – there is no sun at night and less in winter.
Available across Europe	For dark periods, energy systems need other sources, energy storage, and demand that can be reduced.
Can be installed on roofs, unused land, between crops (agri-PV) and on other surfaces.	

A Bit of History

- 1500 BC: Egyptians used polished copper to focus sunlight and make fire.
- 300 BC: Greeks, Romans, and Chinese used mirrors to light torches.
- 100 – 600 AD: Romans oriented buildings with sun-facing windows.
- 1800s: First greenhouses built from glass in botanical gardens (palm houses, orangeries).
- 1839: Edmond Becquerel, French scientist, discovered the photovoltaic effect in France.
- 1870s: French Foreign Legion starting to use solar box cookers in Africa.
- 1905: Albert Einstein explained the photoelectric effect (Nobel Prize, 1921).
- 1940s: Maria Telkes, American scientist, was called the "Solar Queen" because of her several solar inventions. She invented a solar evaporation distiller of seawater to make drinkable water for sailors and pilots at WWII. She built the first solar-heated house.
- 1940s: Katherine Burr Blodgett, American scientist, invented the nonreflective "invisible" glass crucial for solar PV panel efficiency, eyeglasses, and microscopes.
- 1958: *First satellite* powered by solar cells.
- 1960s: Transparent plastic sheets became available and used for greenhouses at smaller farms.
- 1970s: Barbara Kerr and Sherry Cole, Arizona, USA, developed a simple solar box cooker. It spread worldwide to substitute fuel wood. Also used in refugee camps.
- 1970s: Oil crises led to more solar research and development.
  Widespread use of solar heating for hot water (especially in Greece, Spain, Israel). Also Do It Yourself.
- 1978: *First calculator* powered by solar cell.
- 1979: Solar water heating panels installed on the White House in Washington DC, USA.
- 1980s: *First large-scale* solar power plants, and solar water heating systems for district heating.
- 2000s: Growth of solar installations driven by policy push, incentives as fix price for the electricity, tax exemptions, and mandatory regulations for new buildings. (solar heater growth in Austria, Denmark, Spain)
- 2004: EU launched the Solar Europe Program.
- 2010s: Europe (especially Germany, Spain) led solar cell installations, mass production in China, significant price drops, and rapid growth of installations worldwide. (See price/capacity graph in Annex).
- 2024: Solar energy became a significant global electricity source with fastest growth in China.

Records

World's largest solar power plants: Xinjiang, China (2024) – 5 GW; Golmud, China (2019) - 2.8 GW;
Bhadla, India – 2.2 GW, 57 km^2 (57 million m^2 – size of London).
Europe's largest solar cell plant: Núñez de Balboa, Spain (2020) – 500 MW, 10 million m^2.
World's largest solar water district heating plant: Silkeborg, Denmark (2016) - 156,000 m^2.
In 2024, over 500,000 balcony solar cell systems were installed in Germany.

Sources & More Information

Global Solar Atlas. https://globalsolaratlas.info/

Our World in Data. https://ourworldindata.org/grapher/solar-electricity-per-capita?time=latest

Solar GIS. https://solargis.com/resources/free-maps-and-gis-data

International Solar Energy Society (ISES). https://www.ises.org/

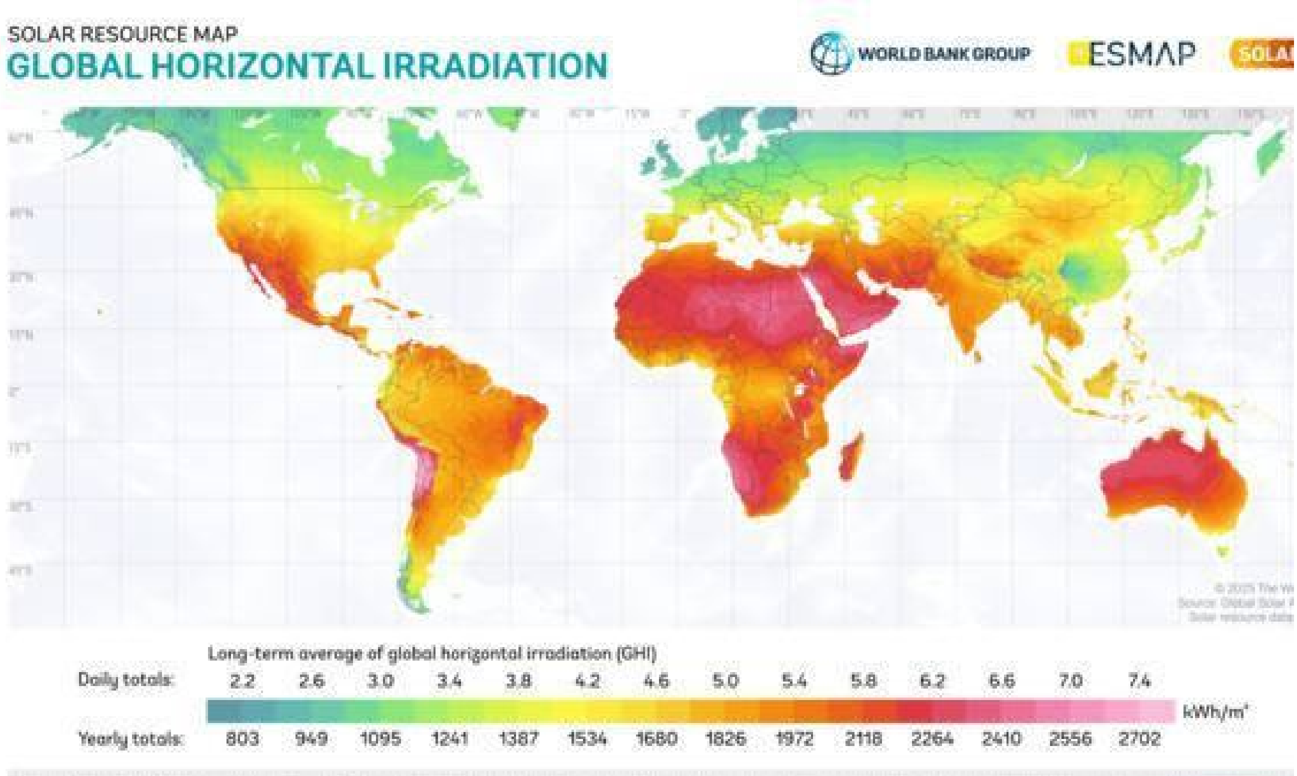
International Renewable Energy Agency (IRENA). https://www.irena.org/

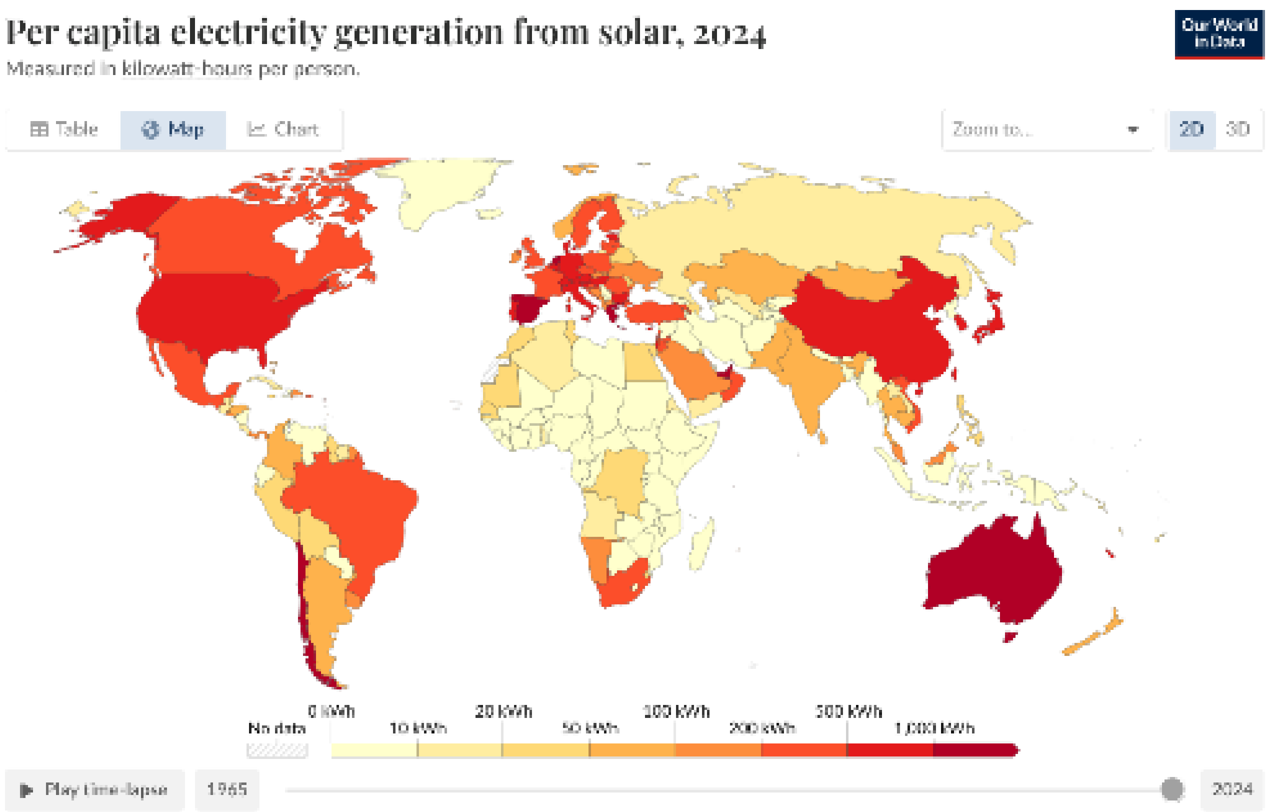
Solar Cookers International. https://www.solarcookers.org/

INFORSE Europe, DIERET on Solar Energy. https://www.inforse.org/europe/dieret/Solar/solar.html

ANNEX 1. Comparism of the World's Solar Potentials with Production

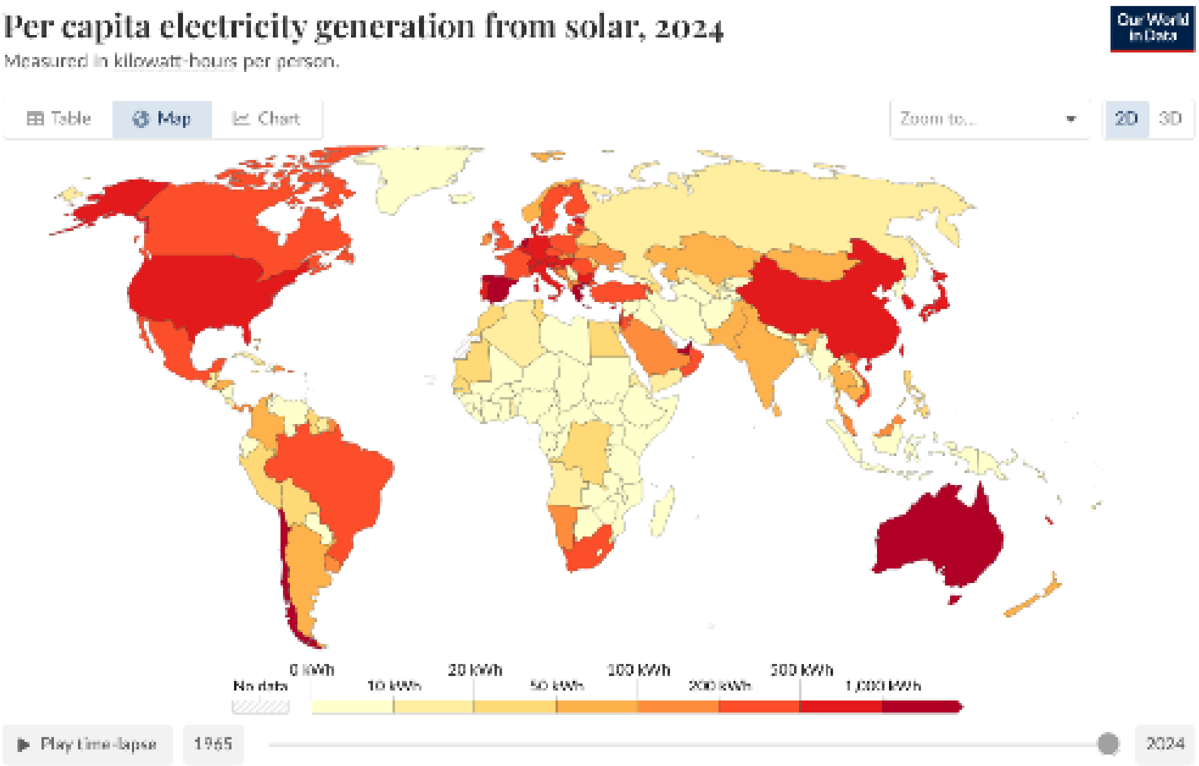
Source: Solar GIS and Our World Data.

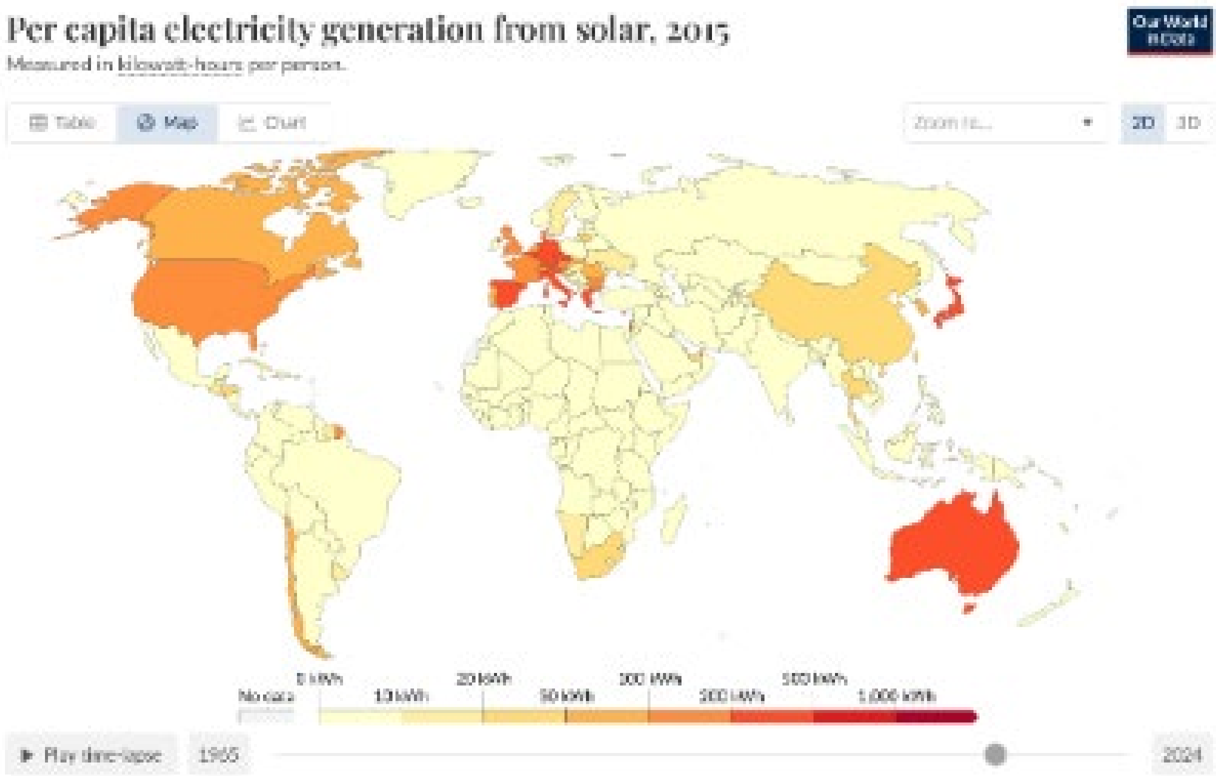




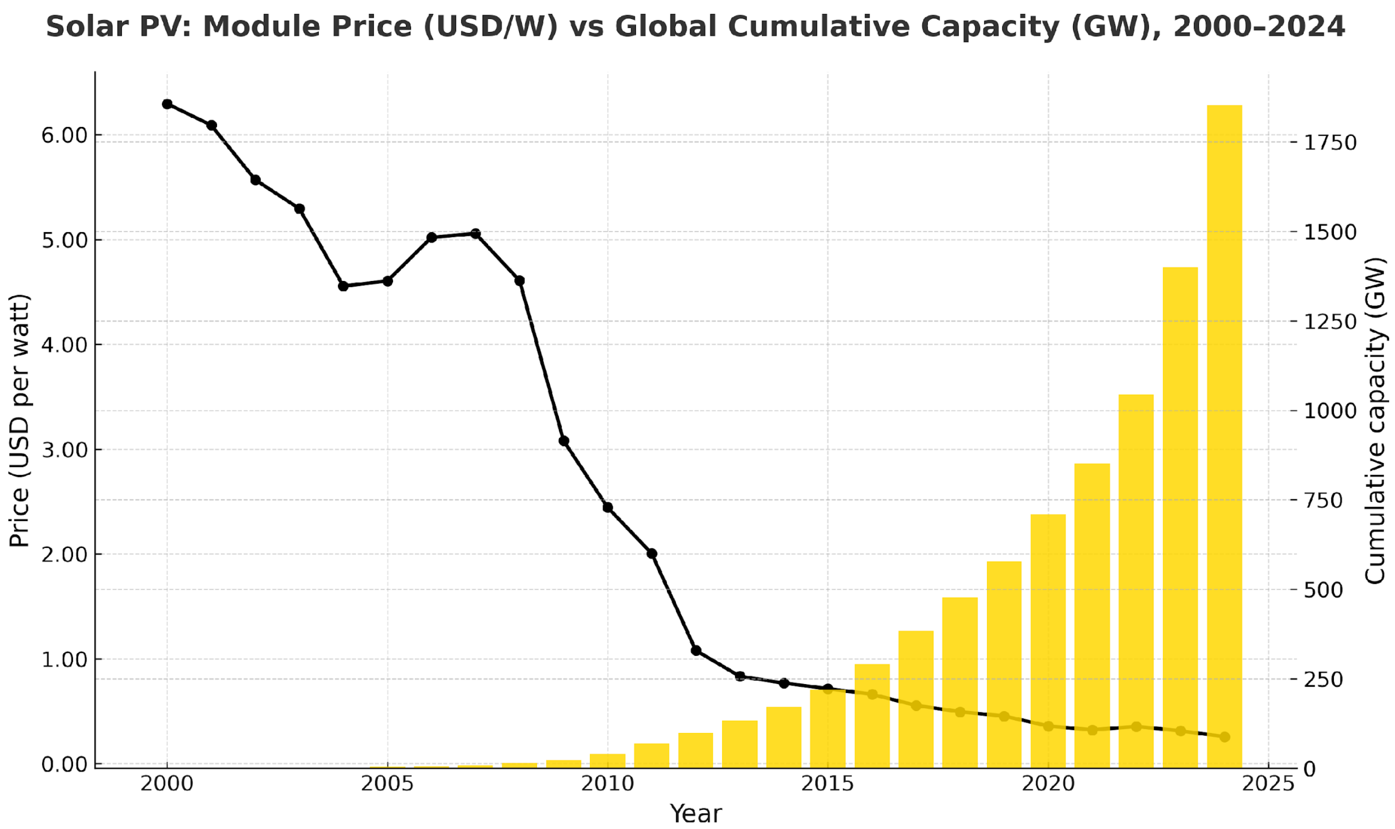
ANNEX 2. Comparism of Solar Electricity Generation in kWh/person in 2024 vs 2015

Source: Our World Data.

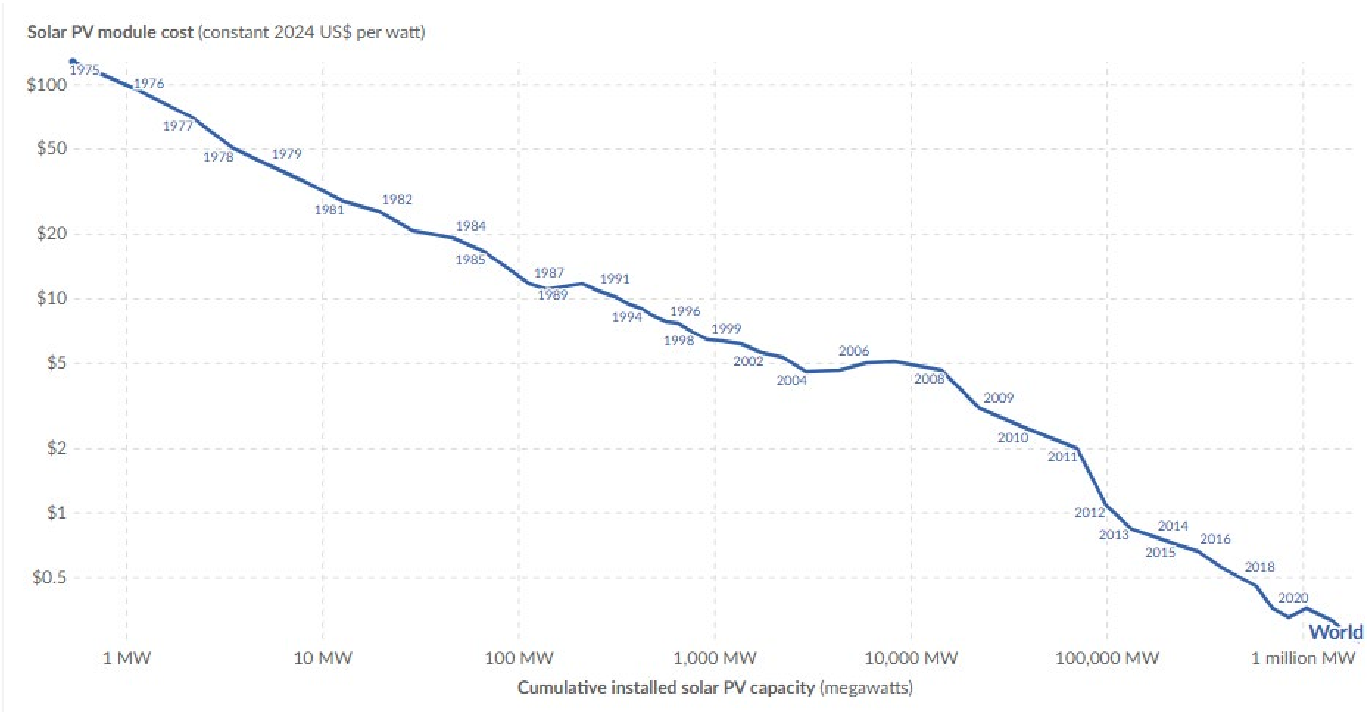




ANNEX 3 Comparing Solar Power Prices vs Capacity. (Source: Our World In Data)



Solar PV panel prices (USD /W), vs Cumulative Capacity adjusted by inflation (1975-2024)



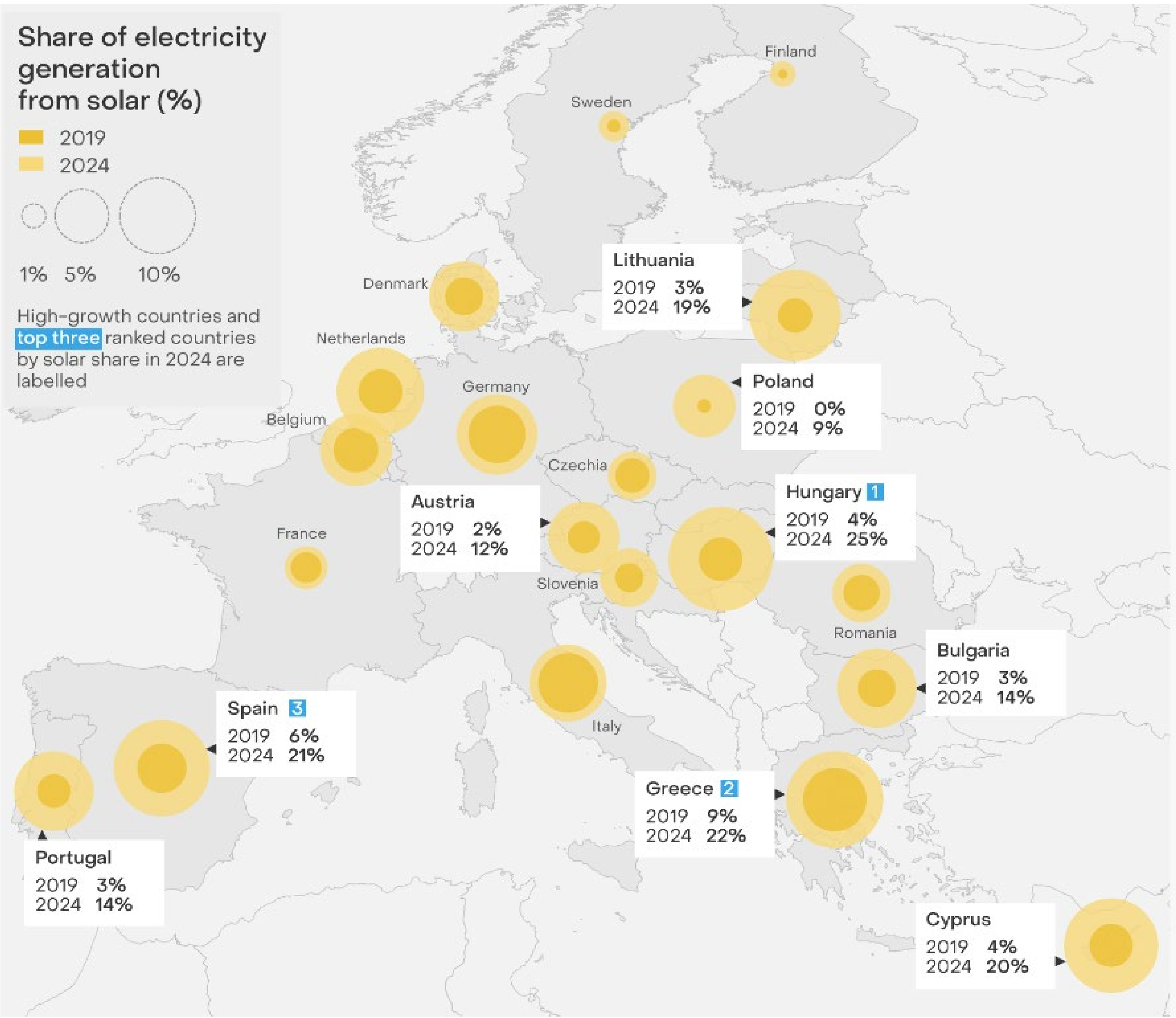
Sources: [*https://ourworldindata.org/grapher/solar-pv-prices-vs-cumulative-capacity*](https://ourworldindata.org/grapher/solar-pv-prices-vs-cumulative-capacity)
https://ourworldindata.org/data-insights/solar-panel-prices-have-fallen-by-around-20-every-time-global-capacity-doubled

ANNEX 4: Maps of solar power and solar thermal development in Europe

EU Map: Share of electricity generation from solar (%), 2019, 2024.

In 2024, all EU countries saw **growth** in both solar generation and installed capacity compared to the year before. 16 EU countries generated more than 10% of their electricity from solar in 2024, three more than in 2023. Note: Hungary (25 %).

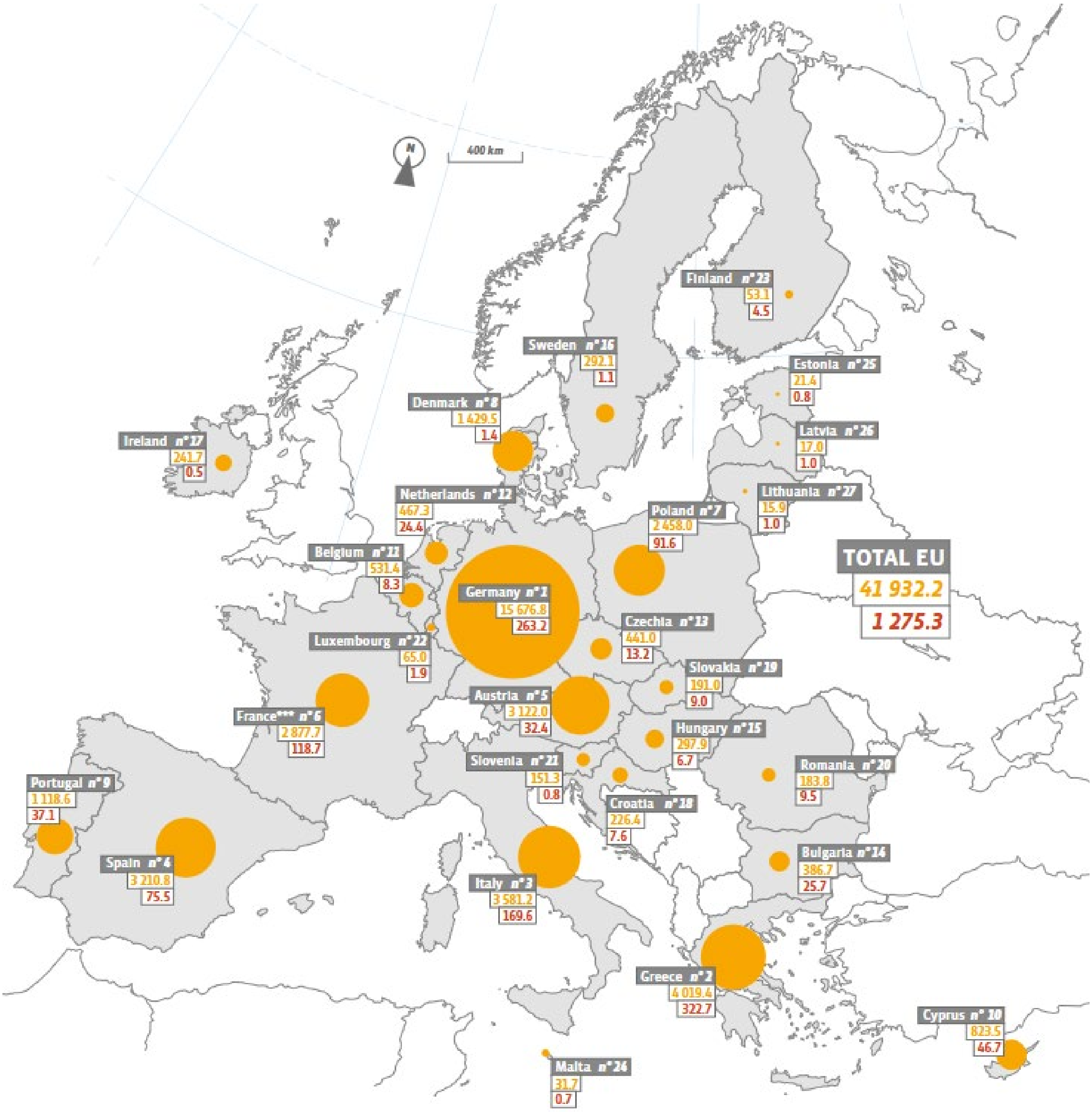
Innovative solutions are also emerging for solar beyond roofs and fields: **PV on balconies** boomed in Germany, policymakers are becoming aware of the vast unlocked potential for **agri-PV - vertical solar PV.**



https://ember-energy.org/app/uploads/2025/01/EER_2025_22012025.pdf

EU Map: Solar Thermal Collector Development in the EU

The EU map shows the installed capacities in 2023, and the increased annual capacity in year 2023. (MWh). For orientation 1000 MWh is about 1.5 million m 2 (as Portugal).



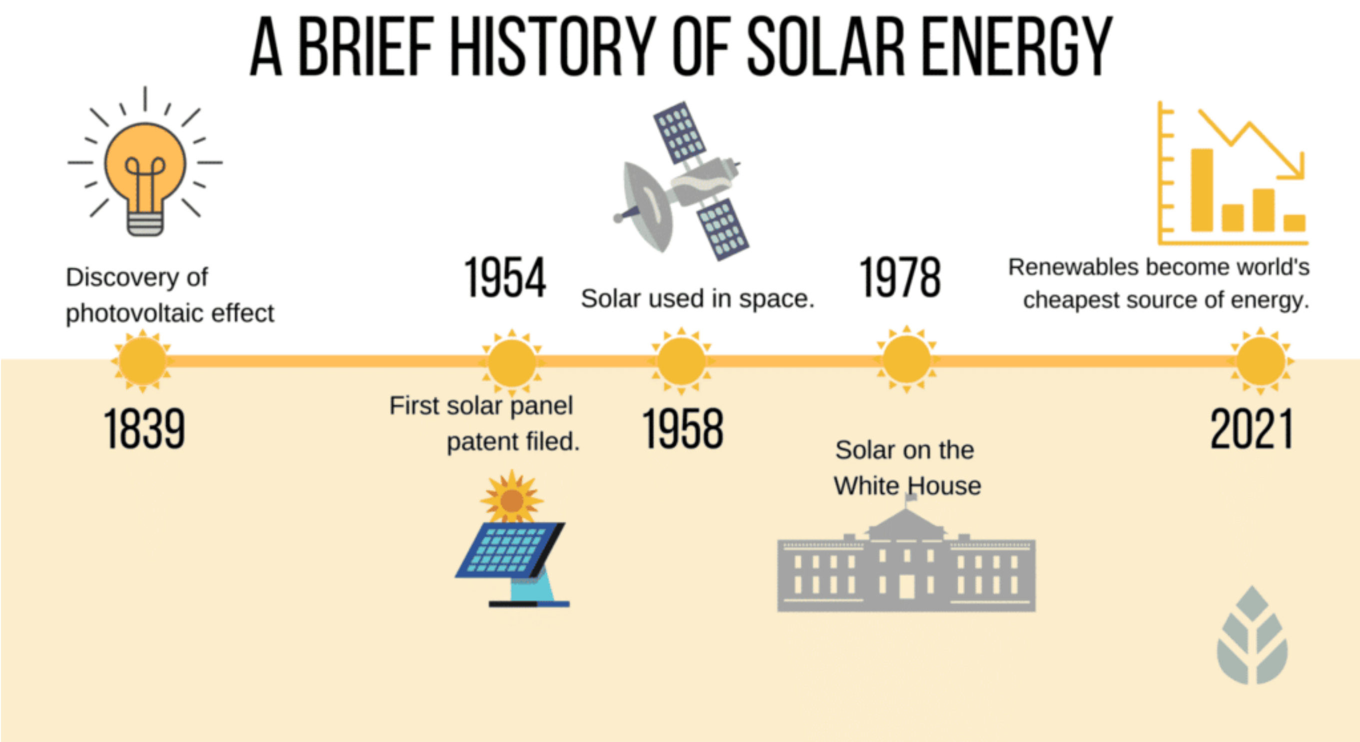
https://www.eurobserv-er.org/pdf/solar-thermal-and-concentrated-solar-power-barometer-2024/?tmstv=1719582758

Solar thermal collectors provide hot water to houses in the bathroom for showers, radiators, and swimming pools. They are on the roof of the houses or fields which provide heat through district heating. The hot water is stored in water tanks at the district heating and at the houses. New innovation is storing the heat at lakes. The development has been driven by building regulations (especially at warmer climate countries and cities), financial supporting programs and do-it-yourself movement in the 80s-90s, as well as large collector fields used for district heating.

Annex 5: A Brief History of Solar Energy - Illustration

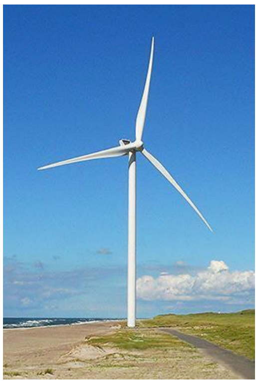
Illustration is a simplified version dated in 2021 by Ecowatch.

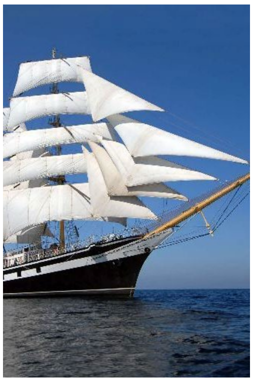
See more details in the Fact Sheet for customization.



Source: https://www.ecowatch.com/solar/solar-history

FACT SHEET – Wind Energy





What Is Wind Energy?

The wind can be used for sailing and to make power to produce electricity, grinding grain, pumping water, and other things. Wind energy is clean and renewable, - it will not run out.

How Does a Windmill Produce Energy?

The wind pushes the blades (wings) of the turbine. The blades are shaped like airplane wings, so they catch the wind well. This makes it possible to convert up to 30-40% of the energy of the wind into useful energy.
The spinning blades (also called the turbine) turn a shaft inside the windmill.
The shaft drives a generator, converting motion into electricity.
The electricity is sent to the grid and used in homes, schools, businesses, etc.

Types of Windmills

Most windmills are on land, but there are also offshore windmills in the sea. Most are large constructions, but there are also small ones for local use for instance for a house.

Type	Size and Power	Use
Onshore (Land)	Up to 150 m high, about 3 MW generator, 5 GWh electricity per year.	Enough for 2,000 homes.
Offshore (Sea)	Up to 250 m high, up to 15 MW generator, 50 GWh electricity per year.	Enough for 20,000 homes.
Small windmills	Up to 25 m high, 0.1-25 kW generator.	For farms, single houses, boats, remote installations.

The Success of Windmills

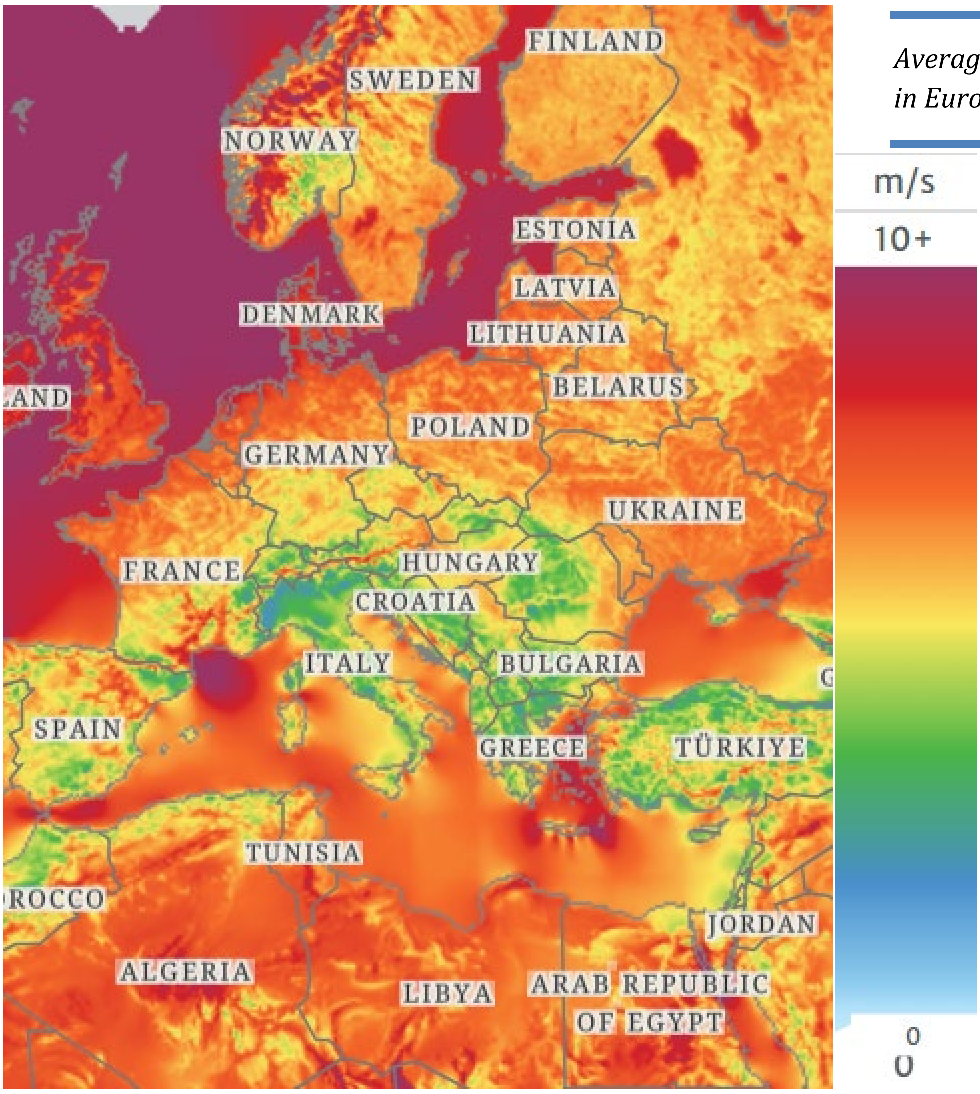
In windy areas, wind power is the cheapest form of electricity. It is especially useful in northern countries where there is little sunshine in winter. By 2024, the EU had 231 GW of wind power, 10% offshore, covering 18% of its electricity needs. Globally, China leads with 521 GW. Most large windmills are made by European and Chinese companies.

Wind in Europe – Partner Country Snapshots

Country	Electricity Share	Installed Capacity and Notes
Denmark	58%	7.5 GW capacity; leader in offshore developments
Germany	28%	73 GW capacity; strong onshore and offshore developments .
Poland	15%	10 GW capacity; major offshore plans in the Baltic Sea.
Czechia	1%	Small but growing capacity, mostly in Bohemian Highlands.

Wind Potential

Wind speed is highest at the coasts, on hilltops, and in open plains. See how strong the wind is in your area:



Average wind speed at 100 m height in Europe and North Africa in m/s.

Data from the Global Wind Atlas (DTU, World Bank, 2024).
Red and orange areas are best for windmills.
More maps:
https://globalwindatlas.info/en/download/high-resolution-maps/World

Benefits and Drawbacks of Wind Power

Benefits	Drawbacks
Endless and renewable energy.	Makes some noise; houses should be 4 times or more times the total height of the turbine away.
Available all year in many areas.	Can harm birds and bats if not well planned.
Takes little land space – farming continues under turbines.	Very visible in the landscape.
Cheap electricity in windy places.	Needs integration with other electricity sources, energy storages and demands that can be reduced during low-wind periods.
Short energy payback: The energy to produce a windmill is gained back in 3 months by its electricity production	
Recyclable materials: steel and fiberglass recycled in new products.	
Local benefits: can give jobs and shared income for communities.	

A Brief History

- 2000 BC: Wind used for sailing ships.
- 500–900 AD: First windmills in Persia pumped water and ground grain. It had vertical axis, built from mud and wood, the blades were from cloth and palm leaves.
- 13th–18th century: 4-blade horizontal-axis windmills are common in Europe for milling and pumping water. There were 200,000 windmills at the peak. From 10,000 windmills in the Netherlands about 1,000 are still standing and mostly operating or are backups.
- 1850s: Invention: windmills can automatically turn into the wind (Halladay).
- 1890-1900s: Invention of steel blades, which allowed curved designs, capturing more wind. The galvanized steel with zinc coating protected the steel from corrosion. The multi-blade windmills on farms pumped water for irrigation and cut wood at sawmills. There were 6 million windmills in the USA Midwest.
- 1890s: First windmills produced electricity in the USA, UK, and Denmark. (models with 144, 8, 4 blades)
- 1930s-1940s: Small windmills became very popular for rural electricity and water pumping.
- 1950s: Most windmills were replaced by central power from oil and coal and cheap oil.
- 1970s: The oil crisis' high oil and gas prices triggered extensive research with several types of designs. In Denmark, where the oil crises were coupled with a strong anti-nuclear movement, the windmill development got strong. Results: aerodynamic inventions, and use of fiberglass for the blades. The serial production of modern 3-blade turbines started by Danish manufacturers, which become world leaders.
- 1980s: First wind cooperatives in Denmark and fixed price for electricity from windmills. This became a pioneering model and driving force for development. The model got common in Denmark and spread to Germany and across Europe.
- 1990s: Wind energy included in national energy strategies.
- 2000–2024: Global wind capacity grew from 17 GW to 1,130 GW. Wind turbines are getting taller, bigger, and cheaper per kW. From 2010, fast development in China.
- 2025: Wind turbines power millions of homes around the world.

Records and Interesting Facts

Typical onshore turbine: 2–4 MW, 100–150 m high. - Offshore turbine: 6–12 MW, 150–250 m high.
Tested giants: 12–15 MW, about 250 m high. - Blade tips can reach 300 + km/h.
One 3 MW turbine powers around 1,500 homes. - Largest wind farm: Gansu, China – 10,000+ MW.
Key manufacturers in Europe: Vestas (Denmark), Siemens Gamesa (Germany/Spain).
The world's largest and smaller wind turbines are tested at Test & Visitor Centers in Denmark.

Sources and More Information

Global Wind Atlas (DTU, World Bank, 2024). https://globalwindatlas.info
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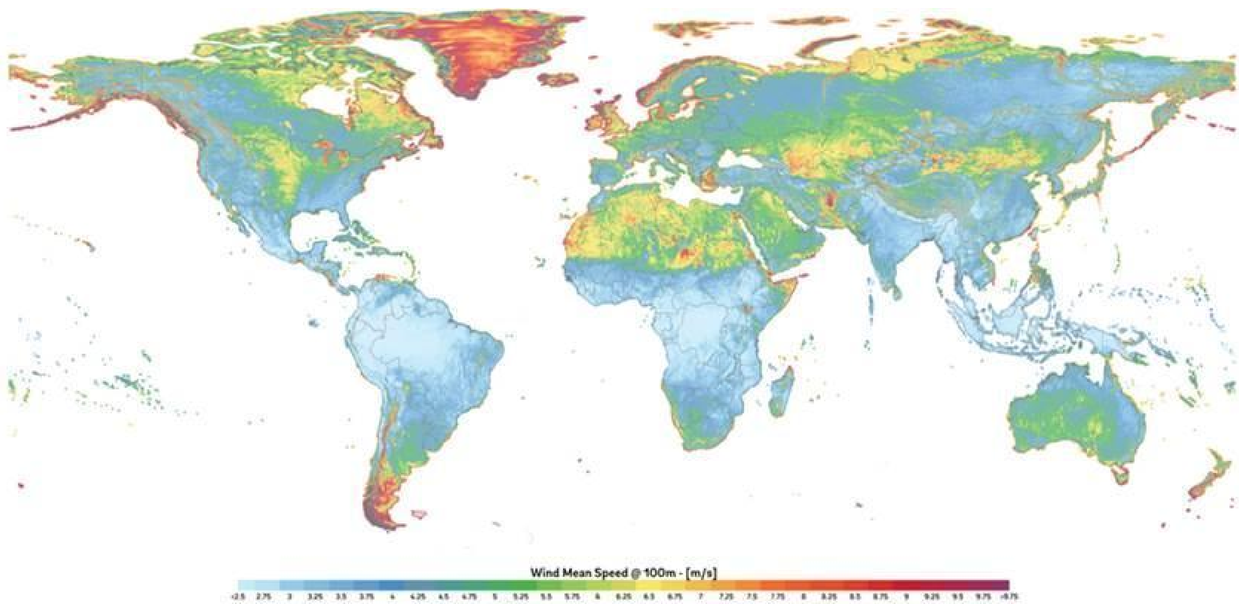
Wind Turbine History in Denmark. https://www.folkecenter.net/wind-turbine-history-in-denmark/
European Wind History https://windeurope.org/about-wind/history/
Big Windmill Test Center (2024) in Denmark. https://www.testcenter.dk/
Small Wind Test Center (2024) in Denmark. https://smallwind.dk

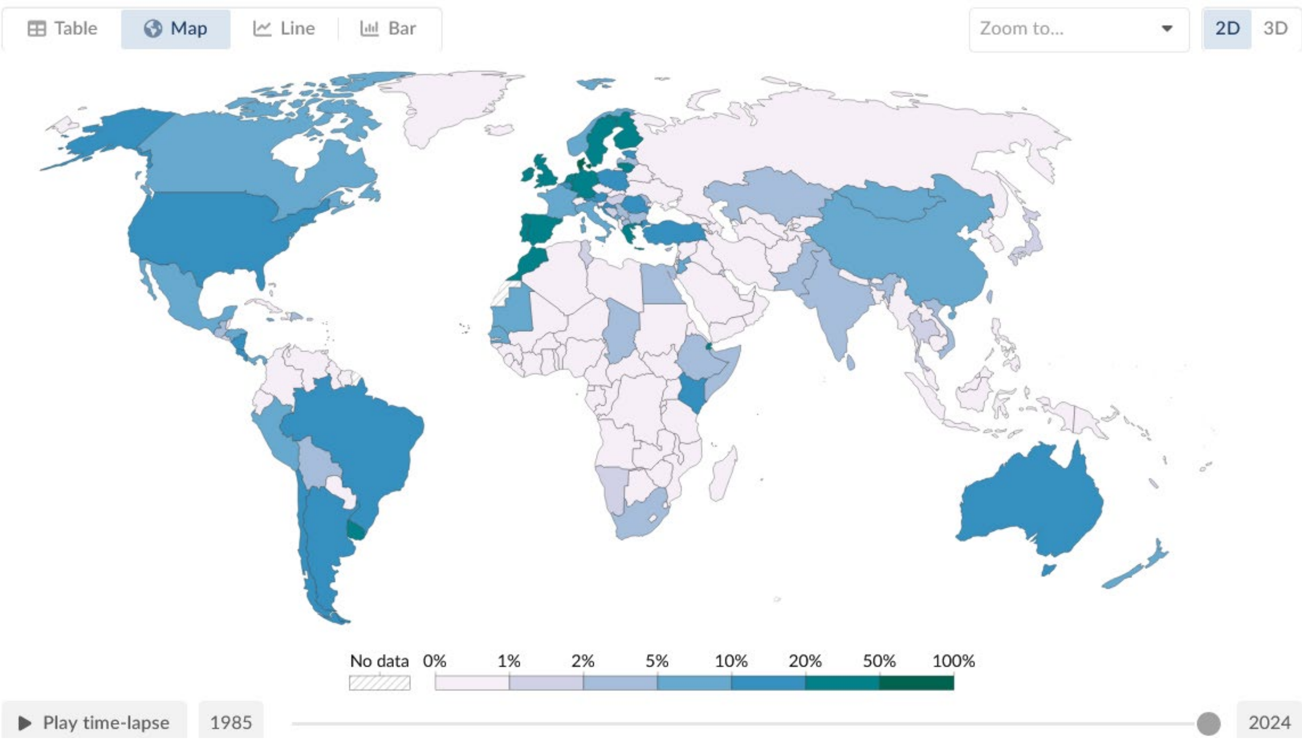
Annex 1: Wind Potential vs Installed Capacity:

Wind Speed map by Global Wind Atlas:



Source/Download: https://gwa.cdn.nazkamapps.com/HR_posters/ws_World.pdf

Share of Electricity Generated by Wind Power, 2024



Source/download: https://ourworldindata.org/grapher/share-electricity-wind (From timeline: 1985-2024)

Annex 2: Windmill History

Windmill development according to timeline. Illustration shows the solution for the task to put the wind mills according to time line.

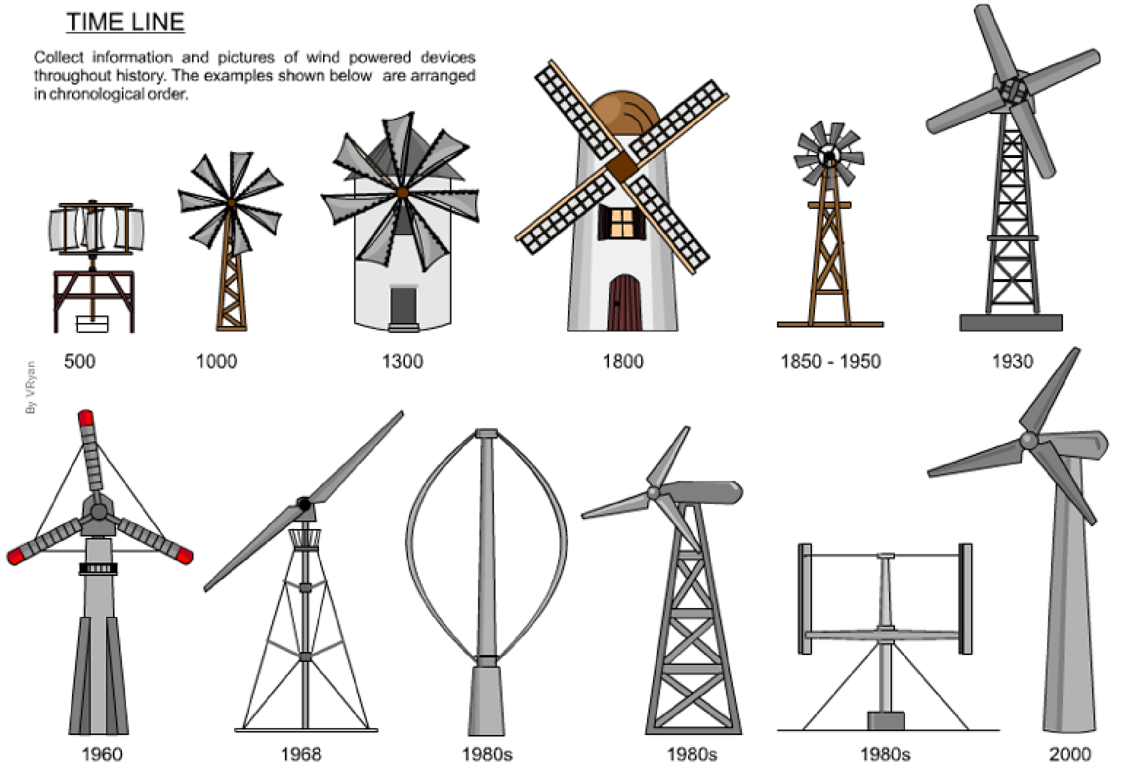
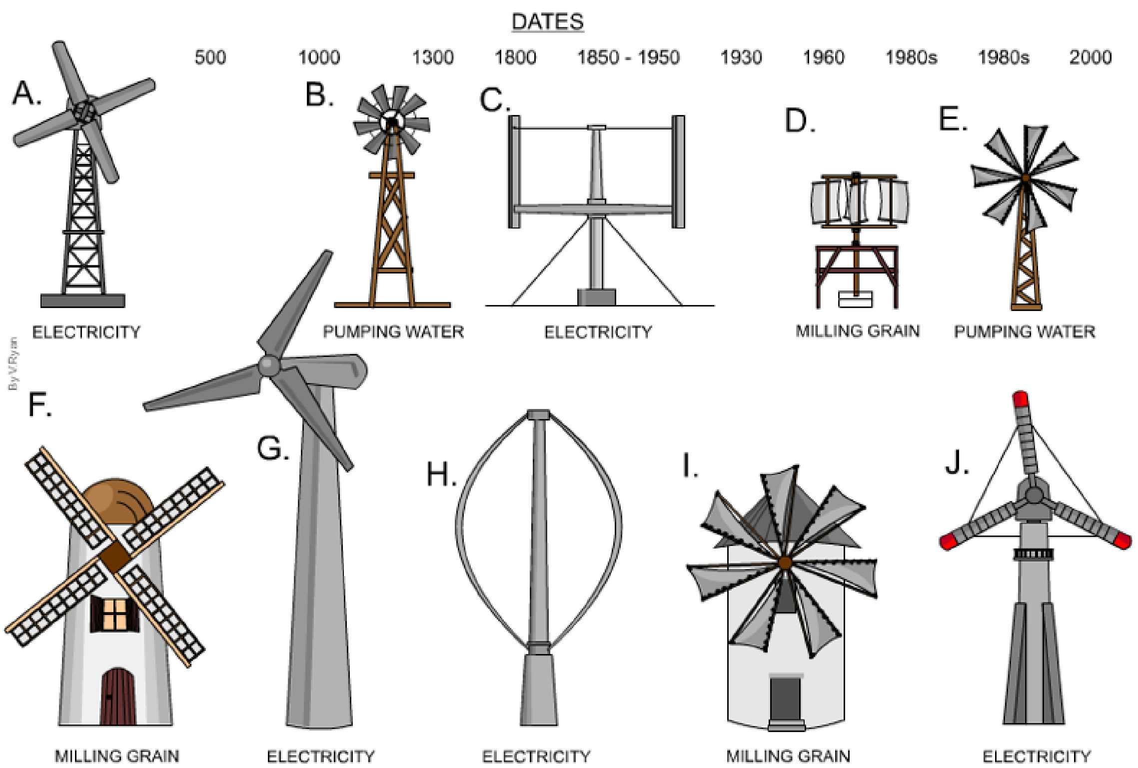


Illustration to the task with explanation of the usage of the windmills, which helps to place them on the timeline.



Source: World Association of Technology Teachers (WATT).

FACT SHEET – Hydropower




What Is Hydropower?

Hydropower means using moving water to make electricity. When water flows from a higher to a lower place, it can turn turbines or water wheels. These turbines drive a generator that produces electricity. Hydropower is one of the oldest and most widely used form of electricity production in the world.

Types of Hydropower

Type	Description
Run-of-River	Uses the natural flow of a river to generate electricity continuously without storing water.
Hydropower with Dams	Lakes or reservoirs and to produce electricity when needed.
Pumped Storage	Pumps water to a higher lake or reservoir when there is extra electricity and releases it when more power is needed.

How It Works

1. Water flows from a high point to a lower point, releasing potential energy.
2. This flow turns a turbine or water wheel, producing mechanical energy in the form of the rotation of a shaft.
3. The rotating shaft drives a generator that turns mechanical energy into electricity.

Why Is It Important?

Hydropower produces 45% of all renewable electricity in the world. It provides 14% of all electricity in the EU and around 90% in Norway. Hydropower plants last for decades — some more than 100 years. They are cheap to operate once built and provide stable electricity for cities and industries.
Pumped storage hydropower is the main method of storing electricity in the EU. It stores 1.5% of total EU electricity, which is much more than all batteries combined.
Small hydro power plants also bring power to remote villages and mountain regions.

Pros and Cons of Hydropower

Pros	Cons
Renewable and endless source of energy.	Can block rivers and harm fish and wildlife.
Produces electricity when needed, covers demand peaks.	Reservoirs can inundate land, forcing people or animals to move when hydro-power plants with dams are constructed.
No air pollution or greenhouse gases during operation.	Water flow depends on rainfall and melting snow, which vary with climate change.
Can be combined with water use for irrigation, regulating of the rivers to make them more suited for ships	Sand or other material flowing in the river can fill up reservoirs, making the hydro-power plants less useful after some years
Cheap to operate and long-lasting.	Not suitable everywhere — needs strong and steady water flow and height differences.

Is It Sustainable?

Hydropower is renewable, but it can cause environmental and social problems. Careful planning can reduce harm to nature and local people. Before building, studies must check water levels, fish routes, and land use. If impacts are too high, projects should be changed or stopped before construction.

A Bit of History

Ancient times: Romans used water wheels for milling grain.
Middle Ages: Watermills spread across Europe for milling and textile production.
1882: First hydroelectric power plant built in the USA.
Today: Hydropower powers entire countries like Norway and Nepal.
Over half of Europe's hydro potential is used; the rest is protected for nature conservation.

Hydropower Around the World

Hydropower is strongest in mountainous regions with large rivers. In flat countries, the potential is much lower, so they rely more on wind and solar energy.

Region / Country	Highlights
Norway, Switzerland	Mountainous regions with high potential.
Denmark, the Netherlands	Flat countries; little hydro potential, rely more on wind and solar.
Africa	Large dams like GERD (Ethiopia, 6,450 MW), Aswan Dam (Egypt, 2,100 MW), and Uganda's Karuma & Bujagali (500 MW). Total capacity ~42 GW; much potential still unused. Micro-hydro powers villages in Rwanda, Tanzania, and more. Lesotho, Uganda, Ethiopia are developing regional plants.
Nepal	Over 11,300 water mills and small hydro plants supply 35,000 homes.
Germany	11,000 MW of hydropower; includes 7,300 small plants and Goldisthal (1,060 MW) pumped storage.
Czech Republic	2,100 MW total; includes Dlouhé Stráně (650 MW) pumped storage.
Poland	2,400 MW capacity, mostly small run-of-river plants; limited expansion potential.

Interesting Facts

Thousands of old water mills in Europe still exist - some are now cultural heritage sites or modernised into small hydropower plants.
Nepal's micro-hydro plants produce around 35 MW, most run by local communities.
In Africa, micro-hydro systems power schools, clinics, and small industries in rural areas.
Europe's largest pumped hydro plant: Goldisthal, Germany (1,060 MW).
Traditional mills are being restored as tourist attractions and energy education sites.

Sources and More Information

European Small Hydropower Association (ESHA): https://www.esha.be/

INFORSE, DIERET on Hydropower: https://www.inforse.org/europe/dieret/Hydro/hydro.html

National Geographic on Hydropower: https://www.nationalgeographic.com/environment/article/hydropower

Global Hydro Power Capacity Map (IEA, 2024): https://www.iea.org/reports/hydropower

Ember (2025): https://ember-energy.org/data/yearly-electricity-data/

FACT SHEET - Biomass Energy



What Is Biomass Energy?

Biomass energy comes from organic materials – trees, plants, animal waste, and even sewage. These materials are renewable because new plants grow again to replace those that are used. Biomass can be burned for heat and electricity or turned into gas in biogas plants. It is one of the oldest energy sources humans have used, for example wood for cooking and heating.

How Does It Work?

Method	Description
Combustion	Burning wood chips, straw, or pellets to produce hot air, water, or steam. Steam can be used to make electricity.
Biogas production	Bacteria break down manure, sewage sludge, and other soft materials in tanks without air. This produces biogas, mainly methane.
Gasification & Pyrolysis	High-temperature methods that turn solid biomass into gas or oil for fuel.

Types of Biomass Fuels

Wood logs, chips, and pellets from forests or wood industries.
Straw and crop residues from farming.
Liquid biomass, such as plant-based oils (biodiesel) or alcohol fuels (methanol, ethanoll).
Animal manure for biogas plants.
Sludge from wastewater plants for biogas production.
Organic waste from food industries, restaurants, and households for biogas.
Energy crops like willow, miscanthus, corn, or rapeseed grown for energy use.

Why Is Biomass Important?

Biomass is an important renewable energy source, especially for heating. It can also provide electricity and gas and balance other renewable sources like wind and solar when there is no sun or wind.

In the EU, 59% of renewable energy used for heating and cooling comes from biomass, equal to 15% of total energy use for heating and cooling. 8% of renewable electricity is from biomass, equal to 4% of all electricity use. About 7% of gas used in the EU is biogas. And increasing share of the biogas is cleaned and sent into the gas network to replace fossil gas.

Because biomass can be stored easily, it is a useful backup for renewable electricity systems. Biogas can be stored underground in gas storages and used when energy from wind or sun is low (Europe has large underground gas storages facilities that today are mostly used for fossil gas).

Biomass Use Around the World

In many parts of Africa and South Asia, people still depend on traditional biomass like wood and charcoal for cooking and heating. This leads to fuelwood scarcity, deforestation, and indoor pollution that give health problems, Women are typically cooking and most exposed to indoor pollution.

In Africa and South Asia, improved solutions include efficient cookstoves, chimneys, biogas plants, briquettes made from wood waste, efficient electric cooking, solar cookers, tree planting, and forest protection. In temperate climates solutions include mainly better home insulation, better windows, efficient stoves and boilers with less pollution, and forest protection. Present overuse of biomass, mainly wood, need to be reduced to sustainable levels.

A Brief History

- Ancient times: People used wood for cooking and heating, and metal production.
- 1700–1900: Wood used alongside coal used in early steam engines and railways.
- 1970s–1980s: Oil crises led to new interest in biomass and conversion from coal and oil to biomass in houses and in power and heating plants.
- 1980s–Now: Focus on fuelwood scarcity and deforestation in many developing countries, as well as women's exposure to smoke, and role collecting fuelwood; promotion of improved stoves, chimney, solar cooking, efficient electric cooking, energy forest plantations, and also fossil gas for cooking.
- 2000s–Now: Growth of biogas, biofuels, and biomass fueled combined heat & power (CHP) systems using straw, woodchips, pellets from wood industry residues (e.g. sawdust from furniture industry). Stronger air pollution rules, filters on chimneys, more efficient boilers. Also overuse of wood in European countries.

Current Biomass Use by Region

Region	Use and Notes
Europe	Leader in modern biomass and biogas technologies (especially Scandinavia, Germany, Austria). In some countries overuse of biomass with less large trees left in forests.
Asia	China and India use biomass for cooking, heating, and biogas production, improved cookstoves are popular.
Africa	Traditional, polluting use of firewood and charcoal still common, but improved stoves are gradually spreading.
Africa & Asia	Some areas face fuelwood scarcity and deforestation, which make desertification more severe.

Why Do People Use Fuelwood When They Have Electricity?

In many countries, mainly developing countries and rural areas, household electricity connections are small and not strong enough for cooking or heating. Cooking and heating often need 2,000–3,000 watts, but many houses can only use 800 - 1,000 watts safely. Electric cookers or heaters would burn the fuses. In some places efficient insulated pressure cookers and small induction hot plates can be used, but they often cannot meet the demand. Also, electricity is often expensive, so people use wood instead or (in Africa) charcoal.

Pros and Cons of Biomass Energy

Pros	Cons
Renewable resource as new plants grow to replace those used for energy.	Limited by how fast plants regrow; overuse causes deforestation.
Uses organic waste materials for biogas and reduces landfill.	If trees in natural areas are cut, it harms nature and biodiversity.
Biogas sludge can be used as fertilizer.	Burning biomass releases CO_2, plants absorb CO_2 when the new plants grow, but that only happens later.
Easy to store and use as backup energy.	Air pollution from small stoves and boilers is harmful to health (particles, tar gases).
Creates local jobs and rural independence.	Land used for energy crops can compete with food production.
	Current overuse of wood reduces the volume of trees in forests (in some countries, also in EU).

Interesting Facts

Germany has over 9,500 biogas plants.
Denmark covers 38% of its gas demand with biogas and plans 100% by 2030. Many towns use straw or wood chip district heating
One cow can produce enough manure for about 3 kWh of electricity per day.
A household biogas plant in India produces 1–2 m^3 of gas from 2–4 cows, enough for the cooking energy needs of a family. Cow dung is used in village biogas digesters.
Finland gets over 40% of its total energy from biomass.

Sources and More Information

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European Biogas Association (EBA): https://www.europeanbiogas.eu/

INFORSE, DIERET on Biomass: https://www.inforse.org/europe/dieret/Biomass/biomass.html

Biogas Danmark Outlook 2024:
https://www.biogas.dk/wp-content/uploads/2024/05/Biogas-Outlook-2024-05-30-WEB-engelsk.pdf

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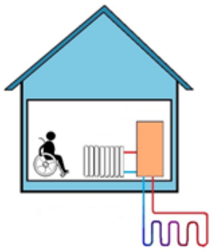
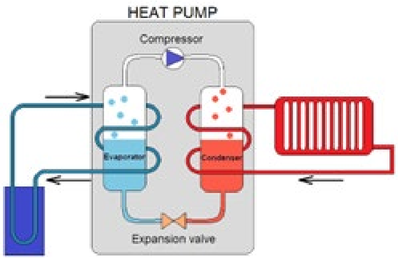
https://www.inforse.org/asia/pdf/Manual_ToT_EcoVillageDev_2018_English.pdf

INFORSE East Africa Catalogue: Local Sustainable Solutions in East Africa(2023)
http://www.inforse.org/africa/pdfs/Catalogue_LocalSustainableSolutions_EastAfrica_March2023_F.pdf

FACT SHEET – Heat Pump





What Is a Heat Pump?

A heat pump is a machine that can heat buildings, air or water. It does not burn fuels like oil or gas but moves heat from a colder place to a warmer place using electricity. It works like a refrigerator: The inside of the fridge is cold, but the back is warm. A heat pump does the same – it takes heat from cold air, water, or ground and moves it into a building.

How Does a Heat Pump Work?

A heat pump works with a special liquid called a refrigerant. The liquid can easily change between gas and liquid. In the cold part, the refrigerant turns into gas and absorbs heat from the outside air, water, or ground. The gas is then compressed by a pump, and sent to the hot part. The gas is then condensed, which produces heat with higher temperature to heat up air or water. After that, the refrigerant cools down, becomes liquid again, and the process repeats. The larger the difference between outdoor and indoor temperature, the more electricity the heat pump needs to work.

Main Types of Heat Pumps

Type	Description and Use
Air-Air Heat Pump	Takes heat from outdoor air and warms the air inside a room. Works best when outdoor temperatures are mild. It can also cool rooms in summer. Saves about two-thirds of energy compared to electric heaters.
Air-Water Heat Pump	Takes heat from outdoor air and warms water for radiators or floor heating. Works best with big radiators or floor systems that need low-temperature water. Can replace gas or oil boilers and save around two-thirds of heating energy.
Ground/Water Source Heat Pump	Takes heat from water pipes buried in the soil or from groundwater. Works efficiently all year round because the ground temperature is stable. Saves around three-quarters of the energy used by traditional heating.

Large Heat Pumps

Large heat pumps can provide heat for entire towns through district heating systems. These systems use large water storage tanks that are heated up when electricity is cheap because of large production of solar or wind electricity. One large heat pump is much cheaper than many small ones, but they need a district heating network to be able to send their heat to houses in a town.

Refrigerants

The liquid in the heat pumps must be able to evaporate from liquid to a gas and condense again at temperatures useful for heating houses and cool down outside air, water or ground. Many types use HFCs (hydrofluorocarbons), which are strong greenhouse gases. If they leak, they harm the climate. New types of heat pumps use natural refrigerants such as CO_2 or propane with much smaller climate impacts.

History and Development

The idea of a heat pump was first described in 1852 by Lord Kelvin. It was first used for refrigeration. In the 1940s, the first commercial heat pumps were sold in the USA. After the oil crises of the 1970s, heat pumps spread in Europe as an alternative to oil and gas heating. Today, they are an important part of the transition to renewable energy.

In 2015, there were 8 million heat pumps in Europe. In 2024, there were 26 million heat pumps, and more than 2 million new units were installed that year. The number is growing fast. Heat pumps are most popular in countries with cheap electricity and small gas networks, like Norway, Sweden and Finland. They are less common in countries where electricity is expensive and gas is cheap, like in the UK or Czech Republic.

Benefits and Drawbacks

Benefits	Drawbacks
Uses renewable heat from air, water, or ground.	Needs electricity to work (but only 20-35% of electric heating).
Can be used almost everywhere – In places where air, water or soil is available to cool down.	Outdoor units that cool air make some noise. (due to ventilators)
Replaces fossil fuel heating systems.	Takes up more space than a gas boiler.
Can be combined with a water tank and use electricity when there is a lot of electricity from renewables like solar and wind.	Ground-source heat pumps need land and digging (but the land, where the heat is collected underground, can be used for gardens and agriculture).
Low running costs (except in countries with very expensive electricity)	Higher upfront cost compared to gas or oil boilers. (except for air-air heat pumps that only can heat one room)

Records and Examples

Norway: 2 out of 3 households have a heat pump, even though Norway is one of the coldest countries in Europe
Sweden: Large heat pumps provide heat for towns through district heating.
Stockholm: One large heat pump produces enough heat for 100,000 homes (Stockholm Exergi, 2024).

Sources and More Information

European Heat Pump Association (EHPA): https://www.ehpa.org/about-heat-pumps/

EHPA Market Data: https://www.ehpa.org/market-data/

Stockholm Exergi: https://www.stockholmexergi.se/om-stockholm-exergi/vara-anlaggningar/hammarbyverket/

Coolproducts: https://www.coolproducts.eu/

FACT SHEET – Energy Savings, Efficiency and Sufficiency

Energy Savings, Efficiency, and Sufficiency

Energy savings with energy efficiency and energy sufficiency are ways to reduce energy use and CO_2 emissions. They help save money, protect the climate, and make energy more available for everyone.

Concept	Meaning
Energy Savings	Use less energy by reducing waste or unnecessary use, using energy more efficiency or reducing the use of energy with for instance less use of lights or heating less.
Energy Efficiency	Do the same job with less energy, like using LED lamps, energy-efficient fridges, electric cars and machines that are more efficient than petrol-driven ones.
Energy Sufficiency	Avoid using energy by doing less of the activities that use energy, for example by driving less by car and maybe bicycle instead, living in smaller homes, or buying fewer new products.

The Role of Energy Savings

Europe and other countries like the USA use a lot of energy. This harms the climate and makes European countries depending on energy imports. This gives us problems as we saw in the energy crisis in 2022, when Russia invaded Ukraine and we had to stop major energy imports from Russia. For both climate and energy security reasons, it is a good strategy to save energy. During the 2022 crisis, the EU reduced gas use by 18% by lowering room temperatures and using more renewable energy technologies like heat pumps

The Role of Energy Efficiency

Energy efficiency has improved a lot in the last 50 years. Modern technologies allow us to use much less energy for the same light, heating, transport etc.

Example	Change in Energy Use
Lamps	LEDs use 12% of the electricity that old bulbs used.
Fridges	New fridges use only one-third of the electricity used 30 years ago.
TVs	Modern TVs use one-quarter of the energy of older models from before 2010.
Standby use	Appliances now use less than 0.5-0,8 W in standby, 10 times less than before EU limits were in place (internet connected equipment can still use 2-8 W in standby).
Houses	New buildings can use only 10% of the energy used by old, unimproved houses from before 1970.
Cars	Electric cars use ¼ of the energy of petrol cars and are cleaner if powered by renewables.

How Energy Efficiency Works

There are many ways to use energy more efficiently, depending on the technology. Governments and EU are encouraging efficiency by setting laws that require products to use less energy and by supporting research into new technologies. The EU supports efficiency through two main regulations: the Energy Label and the Ecodesign regulations. They energy label regulation help consumers to choose better and more energy efficient products while the ecodesign regulation require producers to make better and more energy efficient products.

What is an Energy Label?

To help you choose energy efficient appliances, most electrical products, boilers and stoves in the EU and many other countries come with an energy label. Energy labels show how much energy a product uses.

Label Information	Description
Label Range	A (most efficient) to G (least efficient).
Annual energy use	Shown in kiloWatt-hours (kWh) per year for typical use.
Other details	Noise level, water use, and other information depending on the product.
Scale updates	The A–G scale is updated as products become more efficient, replacing the old A+++ scale (a product with an old A+ label can be less efficient that a new product with a C-label).

Save Energy with Energy Efficiency

A typical household can save about 30% of electricity by switching to efficient products. The biggest savings come from *replacing old* fridges, washing machines, dryers, computers, and routers. Replacing oil or gas boilers with modern systems, including heat pumps, can also save a lot of energy and money.

Saving with Energy Sufficiency – Personal Choice?

In recent decades, Europeans have used more energy because of *larger* homes, *more* travel, and *higher* consumption. Many of us would live just as well with *less* travel, *less* consumption, and *smaller* houses. *Living more simply - with less travel, smaller homes, and fewer new products* - would *reduce energy* use and climate impact. Our consumption is *partly a question of personal choice, partly a question of the way society is.*

- *If we find an education or work far from home* and it is difficult or expensive to find a good place to live near the education or workplace, many will commute far to go to school or work, often by car.
- *If the state subsidizes long commuting,* people will even commute long distances for economic reasons, in spite of the long time it takes. *If nice homes are built large,* people will choose large homes when they can afford it.
- *If products break easily* and are hard to repair, people are forced to buy new products quite often. And
- *If holidays with high climate impacts* with flying or with cruise ships are advertised aggressively, more people will choose holidays with high climate impacts.

Sufficiency also means *ensuring everyone has enough energy for basic needs* such as heating, cooking, lighting, and travel. Many people still live in cold, inefficient homes and cannot afford enough energy for a reasonable comfort. Improving energy efficiency and fair access helps everyone reach a sufficient level of comfort.

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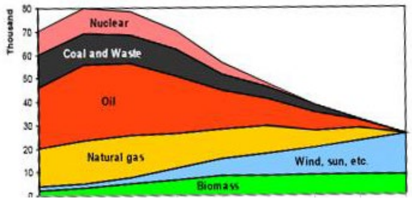
FACT SHEET – 100% Renewable Energy

Context



Today, around 76% of global energy still comes from fossil fuels (OurWorldinData, 2025). Fossil fuels are the main cause of climate change. It is a pressing issue to cut down the fossil fuel use. The most obvious is to change to renewable energy combined with energy savings. Many technologies still waste large amounts of energy, so saving energy is just as important as producing renewable energy.

The Potential

People everywhere use more energy than ever before. Several researchers have analysed how we can transition away from fossil fuels to renewable energy and still have enough energy for a good life for everyone. One of the first researchers was Professor Bent Sørensen (Sørensen, 2000), who developed with other researchers a global scenario with 100% renewable energy The scenario included use of the renewable energy resources that are technically available as well as energy efficiency, and the development of the world population to 9 billion people that all can be served with renewable energy. The target year for the scenario was 2050.

Other scenarios have later with more details confirmed these findings (Global Energy Report). **In these scenarios renewables include wind, solar, hydropower, geothermal, and bioenergy/biogas.** Now researchers from leading energy research institutes agree that a shift to 100% renewable energy is possible worldwide before 2050. (Researchers Agree, 2023).

A 100% Renewable Energy System

In most countries, solar and wind power will provide most of the energy. Because they depend on weather and time, researchers have designed ***'smart energy systems'*** that ***combine different solutions so that energy is always available***. They have shown how a renewable energy system, with most energy coming from wind and sun, can supply all energy needed during the day and during the year. Economic calculations show that it is not more expensive than an energy system with fossil fuels and cheaper than a system relying on nuclear power.

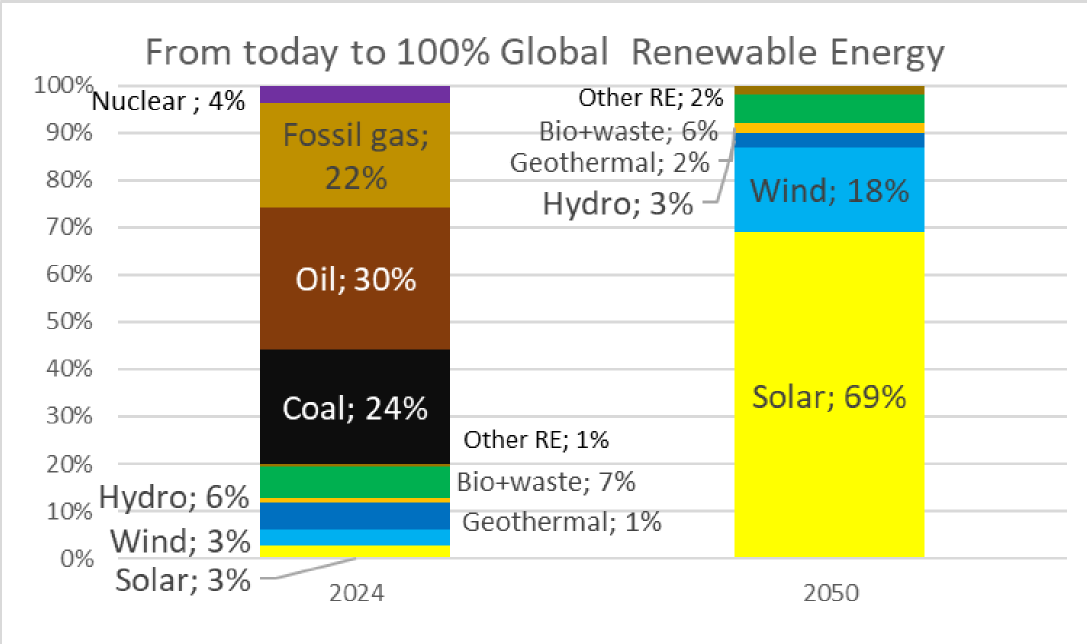
System Element	Role in the Energy System
Energy savings	Use technology that saves energy to reduce demand.
Renewable power	Combine the different renewable energy technologies (wind, solar, biogas, hydropower etc.) and flexible energy use to balance supply and demand.
Heat systems	Produce and store heat when renewable energy is available, using heat pumps and hot water storages.
Flexible electricity use	Consumption of electricity mainly when there is enough renewable energy, e.g., charging electric cars or cooling systems.
Hydrogen production	Produce and store hydrogen when renewable electricity is available to use later.
Biogas plants	Produce biogas, store it and use it when there is little wind and sun.
Hydropower and grid exchange	Produce electricity. Use stored water to help balancing supply and demand.

In some scenarios there are also proposed **batteries** to store electricity, but as batteries are quite expensive, it will be quite expensive to make a large part of flexibility with batteries. And with the above solutions combined, ***batteries are actually not needed***, if the combination of solutions is planned well. However, in recent years there is strong research and development of batteries and the prices are coming down. These elements together can provide energy all year round. Wind and solar power are now the cheapest forms of electricity, making it possible to turn to renewable energy and also reduce costs.

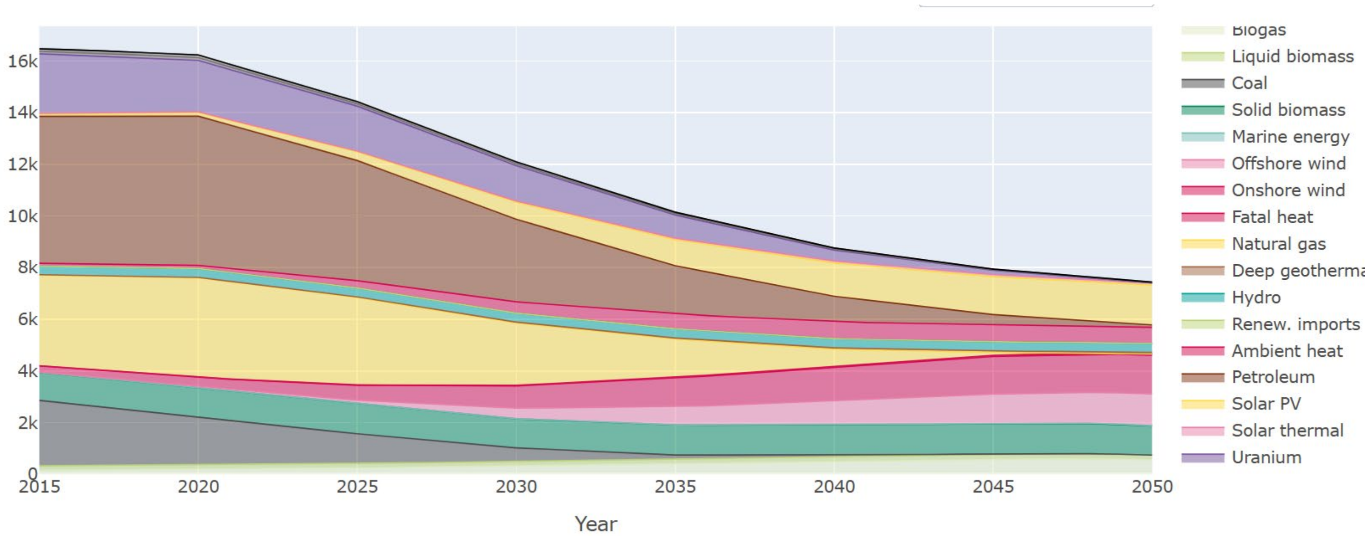
Global Proposals: Global renewable energy plans show that renewable resources can cover all energy needs and help countries to continue to develop. The renewable energy plans also include plans to provide clean energy for the one billion people who still lack it today (Global Energy Report, 2023).

By 2050, *solar* energy is expected to be the main source of global energy, supported by *wind, hydro, and bioenergy.* This is because most people live in sunny regions and solar energy has the largest potential. In colder regions, wind and hydro will play bigger roles to cover the winter demands including heating.

See the sources of primary energy supply in 2024, and in 2050 in the scenario by Global Energy Report.



European Proposals: In Europe, groups such as International Network for Sustainable Energy (INFORSE) and Climate Action Network have developed scenarios for 100% renewable energy before 2050. The CLEVER energy scenario (negaWatt, INFORSE et al., 2023) combines renewable energy, efficient use of energy, and sustainable lifestyles. It shows how the renewable energies can increase and non-renewable energies be phased out. Renewable energy in Europe includes wind, solar, hydro, biogas, biomass, geothermal, and in the future also wave energy. Excess (waste) heat from industries are also contributing. Fossil fuels and uranium for nuclear power are gradually phased out. See the energy sources in 2015-2050 according to the CLEVER Scenario:



Development of EU's primary energy supply to 100% renewable energy according to the CLEVER scenario.

The graph includes energy extracted with heat pumps from air, water and ground (called Ambient heat) and waste energy from industry and society (called Fatal heat).

Record in Transition to 100% Renewable Energy

The world is breaking records in renewable energy growth. The global renewable energy capacity has reached new heights, demonstrating a remarkable progress in the world's transition. 2024 was a record year for renewable energy development. This progress shows that full transition is possible within the next decades (IRENA, Ember, 2024).

Renewable Energy Records in 2024:

- In 2024, 582 GW of renewable electricity was installed - 20% more than in 2023 (IRENA, 2025). (One GW of solar power can produce around 1.5 billion KWh depending on the place and supply electricity to 1.5 million people if they use 1000 kWh each per year).
- In 2024, 91% of all new power plants built used renewable energy. 6% higher than in 2023.
- In 2024, Europe reached 49% renewable power. Countries like Iceland and Norway are already close to 100% renewable electricity. Other countries such as Denmark, Portugal, Austria, and Lithuania have also reached above 80% renewable power.

EU /European countries with ambitious targets in renewable electricity by 2030 (Ember):

100% Denmark, Estonia, Iceland, Albania, Norway
95-83%: Latvia, Austria, Portugal, Luxembourg / Switzerland
80%-78%: Greece, Spain, Ireland, Lithuania, Croatia.
75%-56%: Netherland, Sweden, Italy, Belgium, Finland, Poland, Germany, Romania.

See also ANNEX 1: Renewable electricity share Global Map (2024) and production in 1965-2024.

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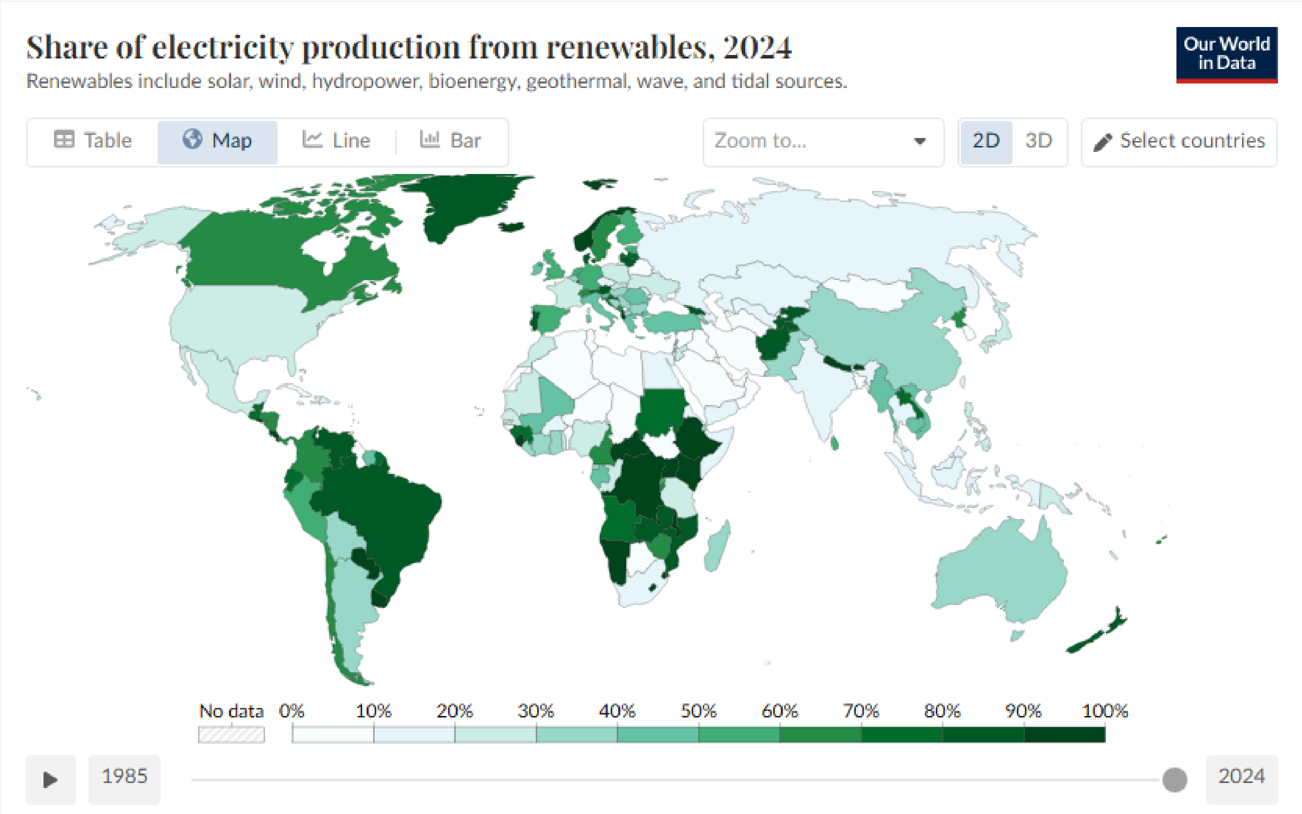
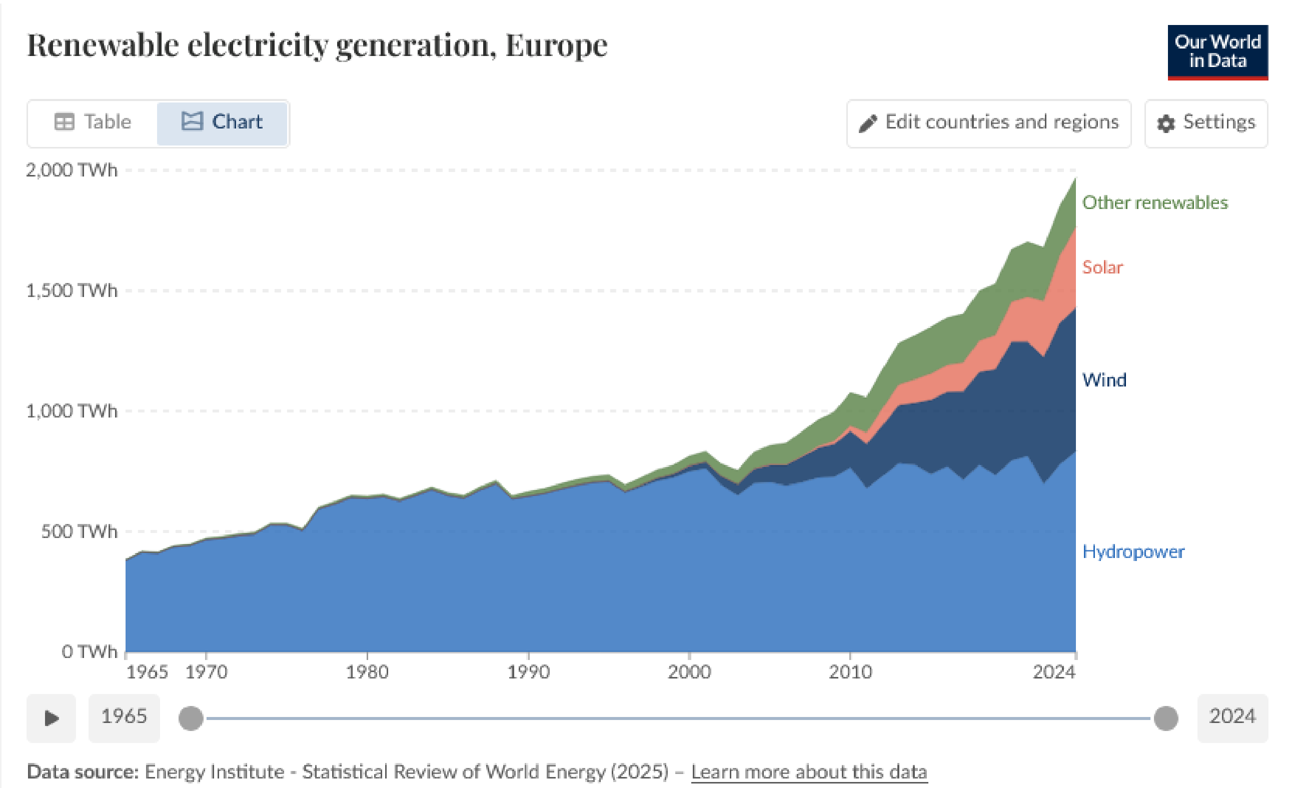
World Map: Share of Electricity production from renewables, 2024 (Our World in Data)



Renewable electricity generaton in Europe, 1965-2024 [TWh]. (Our World in Data)



FACT SHEET – Energy Communities

What Is an Energy Community?

An energy community is a group of citizens who work together to produce, use, and share local renewable energy. Local governments, schools, and small companies can also take part. The goal is for people to have control over how energy is made and used in their area. It ensures that the benefits stay local and that energy is clean, fair, and democratic.

Members of an energy community can produce electricity or heat from renewable energy sources such as solar panels, wind turbines, heat pumps, or biogas. Citizens become "prosumers", both producing and consuming energy. Energy communities can be set up as cooperatives or associations, depending on national laws. All EU countries now allow energy communities, following EU rules. Half of EU citizens could produce their own energy by 2050, meeting around 45% of the EU's total energy demand.

However, some countries make it difficult to start energy communities because of complex rules, financing issues, or competition with big energy companies. Others provide funding and support to help new communities grow.

Why Are They Important?

Benefit Type	Description
Environmental	More renewable energy, less pollution, and less dependence on fossil fuels.
Economic	Lower energy bills, local investment, green jobs, and better heat and electricity in rural areas.
Social	Stronger communities, local pride, more local understanding for renewable energy, and more democratic and decentralised energy systems owned by citizens.

Examples in the EU

There are thousands of energy communities in Europe. Here are some of them:

Brupower (Belgium): Citizens' renewable energy community in Brussels (since 2021). Installs solar panels on shared and public buildings. Members can buy several shares and are both users and shareholders.
https://coop.brupower.be/
Ærø Citizens Energy Community (Denmark): Started in 2022 with local citizens, municipality, and companies to share wind and solar energy. https://aeroebef.dk/
Énergies Citoyennes en Pays de Vilaine (France): Produces electricity for members with solar and wind power. https://www.enr-citoyennes.fr/
Dorset Community Energy (UK): Installs solar panels on schools and community buildings.
https://www.dorsetcommunityenergy.org.uk/
Permatopia Eco-village (Denmark): Eco-village with 90 homes, a wind turbine, and a heat pump system.
https://permatopia.dk/english/

Example from the Global South

SOLshare (Bangladesh) is a solar energy sharing project that connects rural homes with small solar systems. People with solar panels can sell their extra electricity to neighbours who don't have panels. Each house has a smart meter connected to a mobile phone wallet. The project began in 2014-15 and has won international awards. See innovationsolshare.com and www.gshakti.org.

Typical Planning Process: How to Build an Energy Community

Step	Action
1. Gather people	Invite neighbours, schools, or the municipality.
2. Define goals	Decide if the aim is lower costs, more climate action, provide heating / new local jobs.
3. Map resources	Check available sunlight, roofs, or open spaces for solar or wind projects etc.
4. Choose a model	Decide on an organisation form such as a cooperative or association.
5. Plan the system	Select technologies (solar, wind, heat pumps, etc.) and where to install them.
6. Find funding	Raise money from members, grants, loans, crowdfunding.

10 Reasons to Start or Join a Community Energy Project

1. Help fight the climate crisis.
2. Keep money in your local community.
3. Reduce energy poverty in your area.
4. Strengthen your community and neighbourhood meet new people.
5. Produce your own clean renewable energy.
6. Educate others about energy, climate, and democracy.
7. It keeps the money locally in your community.
8. Inspire other communities to act.
9. Build a circular local economy.
10. Create the kind of sustainable world you want to live in.

Extra Inspiration

REScoop.eu – Federation of 2,000+ citizen energy cooperatives. https://rescoop.eu
Energy Cities – Network of 1,000+ municipalities leading energy transitions. https://energy-cities.eu
European Community Power Coalition – 40 organisations, local authorities, renewable energy industry, legal experts, environmental NGO's. https://communitypowercoalition.eu
Global Ecovillage Network-Europe Platform for sustainable communities. https://ecovillage.org
Advocacy Networks: INFORSE-Europe, inforse.org/europe/ FoE Europe. friendsoftheearth.eu

Publications

Community Energy: A Practical Guide to Reclaiming Power, Published by FoE Europe, REScoop, Energy Cities, 2014, 2021. Available in English and 12 European languages.156 pp., Download from: https://www.rescoop.eu/toolbox/community-energy-a-practical-guide-to-reclaiming-power

Renewable Energy Cooperatives: Cases from Denmark, Germany, Poland & Turkey, Published by INFORSE-Europe, WECF, SEI, Troya, 2022. 60 pp. ISBN 978-87-970130-2-1. PDF Download: http://inforse.org/europe/pdfs/Pub_Renewable_Energy_Cooperatives_Cases_from_Denmark_Germany_Poland_Turkey_2022.pdf

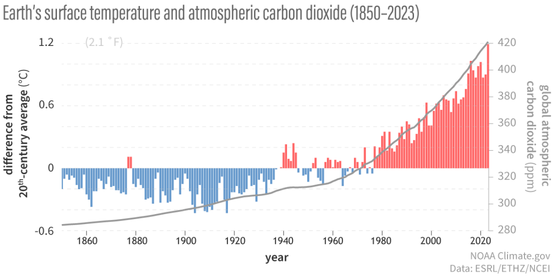
The Power of Community Energy: Analysis of Energy Cooperatives in Partner Countries. Published by WECF, SEI, Troya, INFORSE-Europe, 2011. PDF download: https://inforse.org/europe/pdfs/Pub_Power_of_Community_Energy_Analysis_ENG_10_2021_s.pdf

Monthly success stories, REScoop: https://rescoop.eu/news-and-events/stories

Ten Reasons to Start an Energy Community, REScoop: https://www.rescoop.eu/news-and-events/news/ten-reasons-to-start-or-join-a-community-energy-project

Dorset Energy Community Story *(Annex: for the instructor)* *https://www.dorsetcommunityenergy.org.uk/*

FACT SHEET: What is Climate Change?



About This Fact Sheet:

This fact sheet explains what climate change is, why it is happening, and how it affects people and nature. It gives simple explanations of key terms, global processes, and historical milestones. It also shows what can be done to reduce climate change and how the world works together to solve this problem.

Context:

Climate change is one of the biggest and most complex problems of today.

Scientists agree that **current climate change is caused mainly by human activities**, such as:

- burning fossil fuels,
- cutting down forests,
- agriculture,
- and industrial pollution.

These activities release gases that trap heat in the atmosphere (Oreskes, 2004; Znak, 2019).

The **IPCC** warns that we only have a short time — until around **2030** — to limit global warming to **1.5 °C,** which scientists find is a reasonable safe level of change.

To achieve this goal:

- global CO_2 emissions must drop by **45% from 2010 to 2030**,
- and other greenhouse gases (such as methane) must also be reduced.

This requires big changes in **energy, transport, and land use**.

International Work to Solve the Climate Crisis

The **United Nations (UN)** coordinates global action on climate change.

Key steps:

Year	Event	Why It Matters
1992	Earth Summit (UNCED) in Rio de Janeiro created the UN climate convention **(UNFCCC)**	Countries agreed to work together to reduce climate change.
COPs	Annual global climate Conferences of Parties / Governments (COP)	Governments negotiate rules and commitments to reduce climate change.
2015	**Paris Agreement (COP21)**	Countries agreed to keep global warming well below 2 °C, and aim for 1.5 °C.
2020, 2025	Countries submit **Nationally Determined Contributions (NDCs)**	National plans for reducing emissions and adapting to climate change.
EU	Joint EU climate plan	EU aims for **55% emission reduction by 2030**, compared to 1990.

Problem: When all countries' plans are added together, emissions will **not** fall fast enough to stay below 1.5-2 °C (UNFCCC).

Climate Change – Definition

Climate change means **long-term changes in temperature and weather patterns**.

Climate change includes:

- global warming (higher temperatures),
- changes in rainfall, storms, seasons, and extreme weather.

Causes of Climate Change

Today's climate change is caused mainly by **increased greenhouse gases** from human activity. The most important greenhouse gas is **CO_2 and it comes mainly from burning fossil fuels.**

Main Human Causes

- Burning coal, oil, and natural gas
- Cutting down forests
- Agriculture (methane from livestock, fertilizer use)
- Industry and waste
- Airplanes (both CO_2 from burning jet fuel and warming effects from vapour and particles, the vapour and particles are causing 2/3 of the warming from airplanes)

Main Greenhouse Gases - These gases trap heat and disturb Earth's energy balance:

Gas	Main Sources
CO_2 - Carbon dioxide	Fossil fuels, deforestation
CH_4 - Methane	Livestock, waste, fossil fuel extraction
N_2O - Nitrous oxide	Fertilizers, industry
F-gases	Refrigerants, manufacturing
Others	Particles from combustion incl. airplane jet motors, vapour in high altitudes from airplanes

Main Effects of Climate Change

Climate change leads to many serious impacts:

- Rising temperatures and more heatwaves
- Melting ice in the Arctic, Antarctic, and mountain glaciers
- Rising sea levels
- Stronger storms, droughts, and floods
- Changing rainfall patterns
- Plant and animal changes
- Crop failures and food insecurity
- Health risks (heat stress, disease spread)
- Loss of biodiversity
- Forced migration and climate refugees
- Increased inequality — vulnerable groups suffer the most

Feedback Mechanisms

Climate change does not happen in a simple straight line. some changes **increase** other changes:

- Melting ice exposes dark ground, which absorbs more heat → more warming.
- Meltwater changes ocean salinity → slows ocean currents.
- Smaller temperature differences between equator and poles → slower jet stream → unstable weather patterns.

These feedbacks make climate change faster and harder to predict.

What Can Be Done?

Mitigation: Reduce the causes of climate change

- Reduce fossil fuel use
    - Switch to renewable energy (solar, wind)
    - Improve energy efficiency and save energy
    - Live more sustainably (sufficiency)
    - Use trains, buses, bicycles instead of cars and planes
- Protect forests and oceans
- Change to sustainable agriculture and more plant-based diets

Adaptation: Prepare for Impacts

- Climate-resilient buildings and infrastructure
- Early warning systems for storms, floods, wildfires
- Protect water and food supplies
- Plan for health risks and displacement

Just Transition

Climate action must be **fair**.

- Workers losing fossil-fuel jobs must receive support and new opportunities.
- Local people must be included in decision-making (about larger renewable energy installations and other developments to reduce climate change).
- People in energy poverty should have access to affordable renewable energy.
- Communities without energy access should receive clean, reliable solutions (Giorgos, 2024).

A Short History of Climate Change Science and Actions

Year	Milestone
1827	Joseph Fourier: atmosphere traps heat ("greenhouse effect").
1856	Eunice Foote: CO_2 increases temperature (first experiment).
1859	John Tyndall: explained greenhouse mechanism.
1895	Svante Arrhenius: found higher CO_2 → global warming.
1958	Keeling Curve begins: first continuous CO_2 measurements.
1970s	Strong rise in climate science understanding. Climate movement starts. (Earth Day, Friends of the Earth)
1972	UN Stockholm global conference in environment
1987	Brundtland Report: "Sustainable Development".
1988	IPCC founded (regular climate reports every ~5 years).

Year	Milestone
1992 – today	UNFCCC was founded and started annual COP climate conferences. Civil society organisations get consultative status. (Climate Action Network)
1997	UNFCCC agreed the Kyoto Protocol to start emission reductions from 2008.
2009	International agency on renewable energy - IRENA founded.
2015	At UNFCCC COP21, the Paris Agreement is agreed.
2015	The UN Sustainable Development Goals were agreed for 2015-2030.
2018-19 - today	Youth Activism kickstarted by Greta Thunberg “School Strike for the Climate”. Fridays for the Future movement grows worldwide.6 million people on Earth Strike.
2020, 2025	National 10-year Climate Plans (NDCs) to the Paris Agreements made.

The Natural Greenhouse Effect

The natural greenhouse effect warms Earth to about **15 °C** (the global average temperature). Without it, the Earth would be **- 18 °C** - too cold for most life. Sunlight warms Earth’s surface and part of this heat is trapped by natural greenhouse gases in the atmosphere. This natural process makes life possible (Houghton, 1991).

Hot Facts and Records

Hottest Years

- **2024**: Warmest year ever recorded — **1.55 °C above pre-industrial level** (WMO).
- **2015–2024**: Ten warmest years on record.

Extreme weather examples

- Europe heatwaves 2024–2025 (record temperatures):
    - 37.2 °C Poland - 34 °C Denmark
    - 39.3 °C Germany - 45.8 °C Spain
    - 46.6 °C Portugal -

Melting Ice

- Antarctica: losing **136 billion tons of ice/year**
- Greenland: losing **267 billion tons/year**
- Full melt of Greenland = **+7.4 meters** sea level rise
- Full melt of Antarctica = **+60 meters** sea level rise

Floods

- Central Europe 2014: **2 million people affected**

Wildfires & Drought

- EU 2025: **1 million hectares burned** (worst year on record)
- 2022: Canada wheat – **34% drop**
- 2023 drought in Brazil and Vietnam → **coffee prices +40%**

Migration

- Over **20 million people per year** are displaced inside their countries due to climate impacts.
- Often cited estimate: **200 million climate migrants by 2050**.

UNFCCC Conferences (COPs) in ELY project partners countries:

Germany: 1995: COP1 in Berlin; 1999: COP6 in Bonn, 2017: COP23 in Bonn/Fiji,

Poland: 2008: COP14 in Poznan, 2013: COP 19 in Warsaw, 2018: COP 24 in Katowice.

Denmark: 2009: COP15 in Copenhagen.

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UNFCCC - United Nations Framework Convention for Climate Change https://unfccc.int/

UNFCCC - Paris Agreement: https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs/2024-ndc-synthesis-report#Projected-GHG-Emission-levels

NDCs - Nationally Determined Contributions to UNFCCC and National Climate Action Plans https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs

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Znak 2019 "Climate Change. Educational training for teachers" (2019) Znak Foundation. Book:

https://wydawnictwoznak.pl/ksiazka/Wsciekla-pogoda-Jak-mszcza-sie-zmiany-klimatu-kiedy-sa-ignorowane/8766 (a book for teachers, - not directly a training material)

ENGO: Environmental NGOs at UNFCCC Coordinated by Climate Action Network & Just Transition Now. https://climatenetwork.org/

YOUNGO: Youth representation at UNFCCC https://youngoclimate.org/

Earth Day: https://www.earthday.org/

Fridays for Future Movement: https://fridaysforfuture.org/

IRENA: https://www.irena.org/

EU Climate Actions: https://www.consilium.europa.eu/en/policies/climate-change/

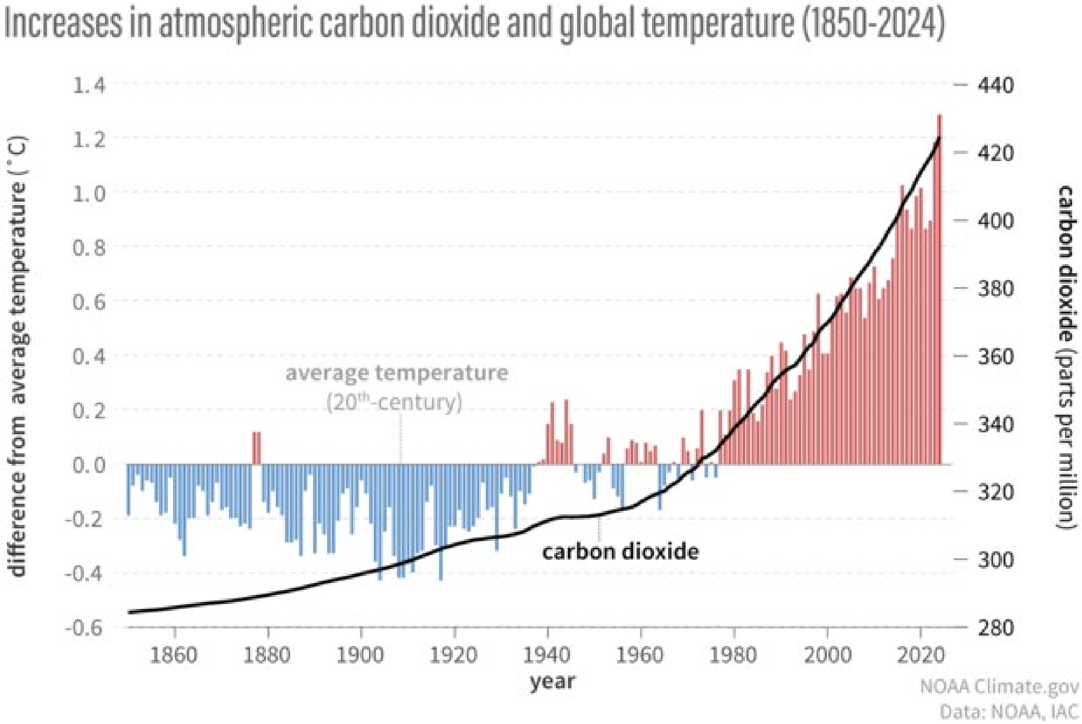
WMO: https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level

Copernicus: https://climate.copernicus.eu/new-record-daily-global-average-temperature-reached-july-2024

INFORSE, DIERET: Why do we need renewables? https://www.inforse.org/europe/dieret/WHY/why.html

Our World in Data: Maps, and graphs of CO2 emmissions per capita https://ourworldindata.org/.

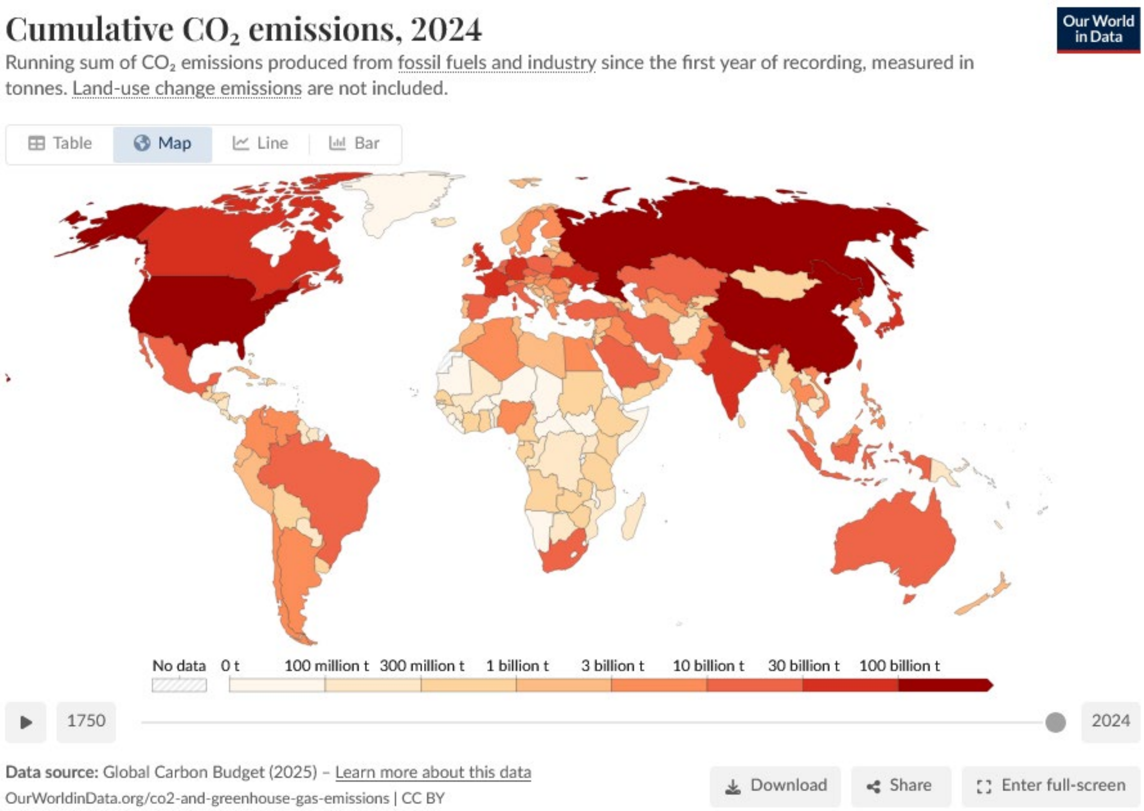
ANNEX 1: Timeline of increased CO_2 and global temperatures (1850-2024)



The bar chart shows: Yearly temperature compared to the twentieth-century average from 1850–2024. Red bars mean warmer-than-average years; blue bars mean colder-than-average years. The line graph shows: Atmospheric CO_2 amounts:

Source: NOAA Climate Gov. adapted based on Data from NOAA Global Monitoring Lab, and IAC.
Source: https://www.climate.gov/news-features/climate-qa/if-carbon-dioxide-hits-new-high-every-year-why-isn%E2%80%99t-every-year-hotter-last

ANNEX 2: Map of World's Cumulative CO_2 emission per capita. 2024



FACT SHEET – Social Aspects of Climate Change

Climate change is not only about the environment — it is also a social, economic and ethical issue. IPCC warns that without strong action to reduce emissions and adapt, climate change will increasingly threaten lives, economies, and ecosystems. Some people will be, and are already, more affected by climate change than others. Those who have less money or live in areas more exposed to floods, droughts, or heatwaves often suffer the most. Richer countries can protect themselves better. Climate change therefore makes existing inequalities worse.

UN Advice

The United Nations advises that social issues should always be part of climate action and green transitions. A fair transition to a climate-neutral society must include social protection, equal participation, and gender equality. These principles are included in the *UN Sustainable Development Goals (SDGs, 2015).* (See List of SDGs in Annex).

Inequality and Vulnerability

Poorer countries and communities often lack the money and infrastructure to deal with floods, droughts, and heatwaves. *Women, indigenous peoples, and minorities* face barriers to joining decision-making. Because of social inequality, women and girls are more affected by climate change. Vulnerable groups often live in more exposed places such as floodplains or informal settlements (IPCC, 2022; UNDP, 2023).

Livelihoods and Economic Impacts

Farmers and fishing communities are among the first to feel the effects of climate change. Heat, floods, and droughts reduce crop yields and destroy livelihoods. Ocean warming and acidification harm fish stocks. Informal and low-wage workers are most vulnerable to job losses and unsafe working conditions (FAO, 2021).

Health and Wellbeing

Climate change increases the risk of heatstroke, respiratory and infectious diseases, and malnutrition. Poor air quality and limited healthcare make these problems worse. Climate anxiety and trauma from disasters also harm mental health (WHO, 2021).

Migration and Displacement

Rising sea levels, droughts, and extreme weather events force millions of people to move every year. Climate migration often happens together with poverty and political instability. At present, people displaced by climate change do not have protection under international refugee law (IDMC, 2023).

Participation and Governance

Fair climate policies require that everyone can participate in decisions - also youth, women, and indigenous groups. Movements like Fridays for Future and feminist and indigenous activist movements push for justice and inclusion (UNFCCC, 2022).

Civil Society Voices at the UN

Since 1992, the UNFCCC (see Fact Sheet on ClimateChange) has included civil society voices as observers in the climate negotiations through different groups (called constituencies), The present groups are the ***environmental*** *organisations (ENGOs), indigenous organisations (IPO), youth (YOUNGO), and women and gender (WGC).* Other NGO groups represent trade unions, researchers, businesses, and farmers. The biggest group is the ENGOs with focal points by *Climate Action Network (CAN)* (since 1992) and Demand Climate Justice (DCJ) (since 2007).

Since 2009, the WGC has been working to ensure that women's rights and priorities are part of all climate policies. Their work led to the *Gender Action Plan* (GAP) adopted at COP23 (2017) with continued activities for 2025-2035 agreed at COP30 in 2025.

Just Transition

A ***just transition*** means moving to a sustainable climate-neutral society **without harming vulnerable people, and counties.** It includes *well planned changes with retraining workers, supporting poorer populations, gender-responsive changes* promoting women's equal participation, *respecting and using local knowledge, and involving youth, indigenous peoples, women, and local communities* in planning and decision-making. This also involves support for just transitions in developing countries. (UNDP, 2022, 2023)

Climate Justice

Climate justice means that **countries and corporations** which have **polluted the most should take responsibility and** pay for solving the problems they caused. Most CO_2 emissions have come from historical and current emissions of industrial countries in the Global North, but the poorest regions in the Global South suffer the worst impacts.

In the table below there is an overview summary of the main principles. (PPP, CJP, CJA, CJRT, UNDP, DCJ.)

Principles	Meaning
Equity	Support those most affected and least responsible for climate change. incl. poor countries and people, women, indigenous people, youth, local communities.
Recognition	Respect different knowledge systems, cultures, and experiences.
Participation	Include local and affected communities, youth, women in decisions.
Restorative Justice, Solidarity	Fix historical and systemic inequalities through fair reparation policies, including support for climate action in poorer countries.
Polluters Pays	Accelerate funding climate action in the poor countries financed by rich industrialized countries, which have benefited from freely burning fossil fuels for more than two centuries. (Example is the Green Climate Fund (GCF)).
Avoid False Solutions	Avoid expensive technological fixes, such as geoengineering, carbon storage, nuclear power, which are not reducing use of fossil fuels, and continue to harm the health of the people and the planet. They also take away funding from the just transition with sustainable renewables and saving energy.
No Undermining Tactics,	Stop countries and corporations using greenwashing, climate denying.
Avoid Un-Sustainability	Avoid unsustainable use of biomass, biofuels, avoid overuse of resources.

Just Transition Work Programme (JTWP)

As result of the UN climate negotiations, a global Just Transition Work Program (JTWP) was started in 2024. It includes knowledge sharing through stakeholder dialogues. In 2025 it was decided to develop support for just transition all over the world with a Just Transition Mechanism that will develop 2026-2027.

Sources and more information:

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IPCC AR6 WGII (2022), Chapters 8 & 18. https://www.ipcc.ch/report/ar6/wg2/
UNDP (2023) Climate change is a matter of justice – here's why, UNDP (2023)
https://climatepromise.undp.org/news-and-stories/climate-change-matter-justice-heres-why
FAO (2021) – The State of Food and Agriculture. https://www.fao.org/climate-change/en
Internal Displacement Monitoring Centre (IDMC, 2023). https://www.internal-displacement.org/
WHO (2021) – Climate Change and Health Factsheets. https://www.who.int/publications/m/item/fast-facts-on-climate-change-and-health
GGCA, UNDP (2016): Gender and Climate Change – Overview of Linkages between Gender and Climate Change.
https://www.undp.org/sites/g/files/zskgke326/files/publications/UNDP%20Linkages%20Gender%20and%20CC%20Policy%20Brief%201-WEB.pdf

GAP (2017) Gender Action Plan COP23 (2017), COP 30 decisions (2025).
https://unfccc.int/topics/gender/workstreams/the-gender-action-plan
UNFCCC: United Nations Convention for Climate Change – Civil Society Constituencies include:
- WGC - Gender and Women Constituency https://womengenderclimate.org/
- YOUNGO –Youth https://youngoclimate.org/
- ENGOs: Environmental organisations coordinated by Climate Action Network https://climatenetwork.org/ and Demand Climate Justice (DCJ) https://demandclimatejustice.org/
UNDP, 2022 Climate Promise. What is just transition? And why is it important? How it can help ?
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https://climatejusticetoolkit.org.au/resourcelibrary/understanding-false-climate-solutions
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GCF - Green Climate Fund https://www.greenclimate.fund/
JTWP, 2024 Just Transition Work Programme, of the UNFCCC.

ANNEX: List of the United Nations Sustainable Development Goals

1) No Poverty; 2) Zero Hunger; 3) Good Health and Well-Being; 4) Quality Education; 5) Gender Equality; 6) Clean Water and Sanitation; 7) Affordable and Clean Energy; 8) Decent Work and Economic Growth; 9) Industry, Innovation and Infrastructure; *10) Reduced Inequalities; 11) Sustainable Cities and Communities; 12) Responsible Consumption and Production*; **13) *Climate Action;*** *14)* Life Below Water; 15) Life on Land; 16) Peace, Justice and Strong Institutions; *17)* Partnerships for the Goals

Source: UN SDGs: https://sdgs.un.org/goals

FACT SHEET – Energy Poverty

Context

Energy poverty means not having enough access to safe, reliable, and affordable energy. This can be because there is no energy available or because people cannot pay for it. Energy is needed for basic needs as cooking, heating, and lighting.

Around 770 million people in the world still live without electricity, mostly in Sub-Saharan Africa and South Asia. This makes it harder to access education, health care, and jobs. Without more investment in clean energy, millions are left behind in the global development.

About 2.3 billion people continue to rely on solid biomass (wood, charcoal, dung), coal and kerozene for cooking and heating, particularly in rural areas of the Global South. Some of them have improved cookstoves with less smoke and in some cases with chimneys, but the majority still use traditional fires. These fuels cause smoke and air pollution inside homes, which kills around 3.2 million people globally each year (WHO, 2021). Women and children are most affected because they are near to fires during daily cooking.

In Europe, about 30–50 million people live in energy poverty, especially in Central, Eastern, and Southern Europe. High energy prices, poorly insulated buildings, and stagnant, low wages have created a widespread “heat or eat” dilemma, meaning some families must choose between heating and food. The 2022 energy price crisis made this even worse, especially for older people, single mothers, and renters. (See Annex, Figures. Price of electricity)

Why Energy Poverty?

Energy poverty is a multidimensional problem shaped by the following factors:

Income	Energy efficiency of buildings and appliances
Energy prices	Access to energy infrastructure

Energy poverty affects both poorer countries (because of lack of access and high cost) and richer ones (because of housing and price problems for poorer families).

Causes and Structural Drivers of Energy Poverty

Cause	Explanation
Low income and unemployment	People with low or unstable incomes spend a large share of their money on energy, sometimes over 20% compared to an average of 5-10 %. Unemployment and pensions increase this. (EPOV 2020; Bouzarovski et. al.., 2015).
High and changing energy prices	Energy price shocks, such as in 2022 in Europe with the war in Ukraine, make energy unaffordable for millions (IEA, 2023; UNDP, 2022).
Inefficient buildings and heating systems	Many homes in Eastern and Southern Europe have poor insulation, single glass windows and old heating systems, wasting energy (EC, 2020).
Disinvestment in marginalized communities	Rural and post-industrial regions often have outdated infrastructure, poor heating systems. (Bouzarovski et al., 2014; Walker & Day, 2012).
Weak regulation and lack of consumer protection	Weak rules and limited access to information allow landlords and energy companies to ignore efficiency or overcharge (UN Special Rapporteur, 2021).
Lack of supporting programs	There is lack of supporting programs for building renovation, and campaigns. (CHC, 2025)

Impacts on Health and Society

Impact	Description
Cold homes	Increase breathing and heart illnesses.
Overheated homes	Cause heat stress, dehydration, and poor sleep.
Energy stress	Leads for example to anxiety and depression.
Lower school education	Poor living conditions lower school attendance and focus.
Less digital access	Without electricity or internet people miss jobs and learning chances.

Solutions and Policy Tools

To reduce energy poverty, we need both short-term and long-term actions.

Type of Action	Examples
Short-term	Social support for vulnerable groups and social tariffs, where a low consumption of energy is charged a low price per energy unit (kWh) and the higher part of consumption is charged a higher price. Stop energy disconnections during winter or heatwaves. Give emergency help for heating or cooling.
Long-term	Renovate old buildings with insulation. Expand decentralized renewable energy and local energy communities to allow local use of cheap renewable energy. Increase consumer awareness and energy literacy. Energy poverty reduction plans. (EC 2020, CHC 2025)

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Annex:

Figure 1: Development of electricity prices for household consumers in the EU. ***Source:*** **Eurostat** [(nrg_pc_204)]

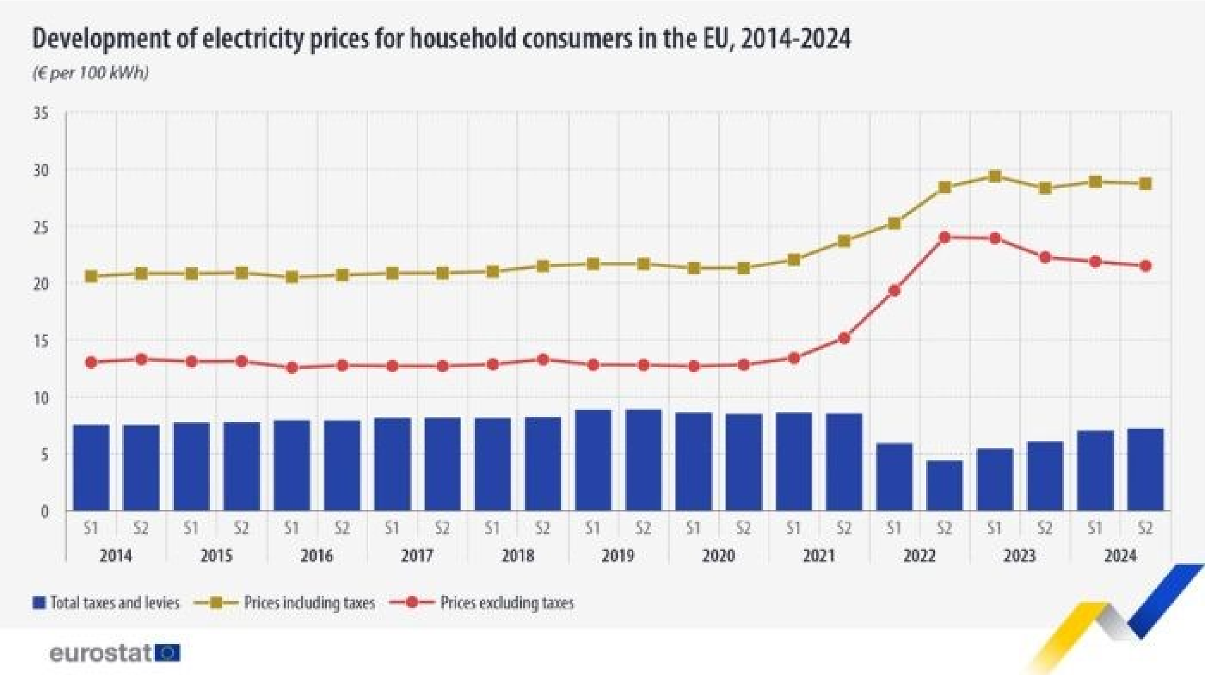


Figure 2: Electricity prices for household consumers, second half 2024.
Source: Eurostat [(nrg_pc_204)]

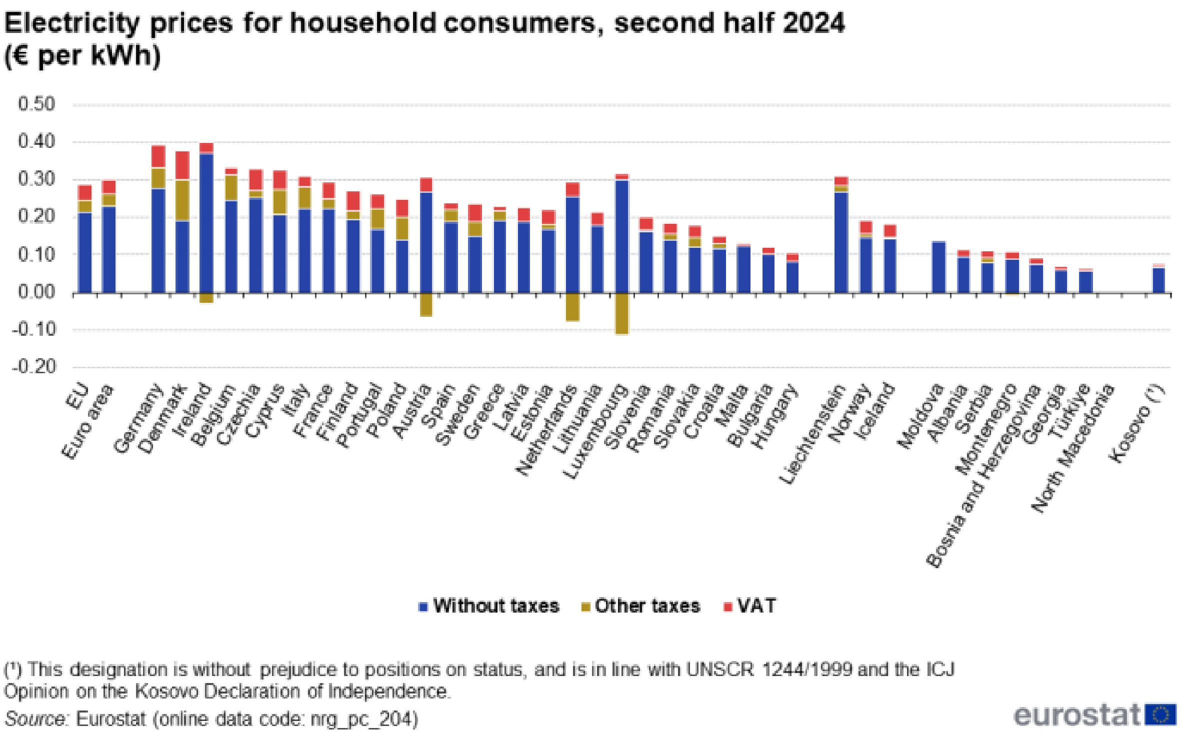
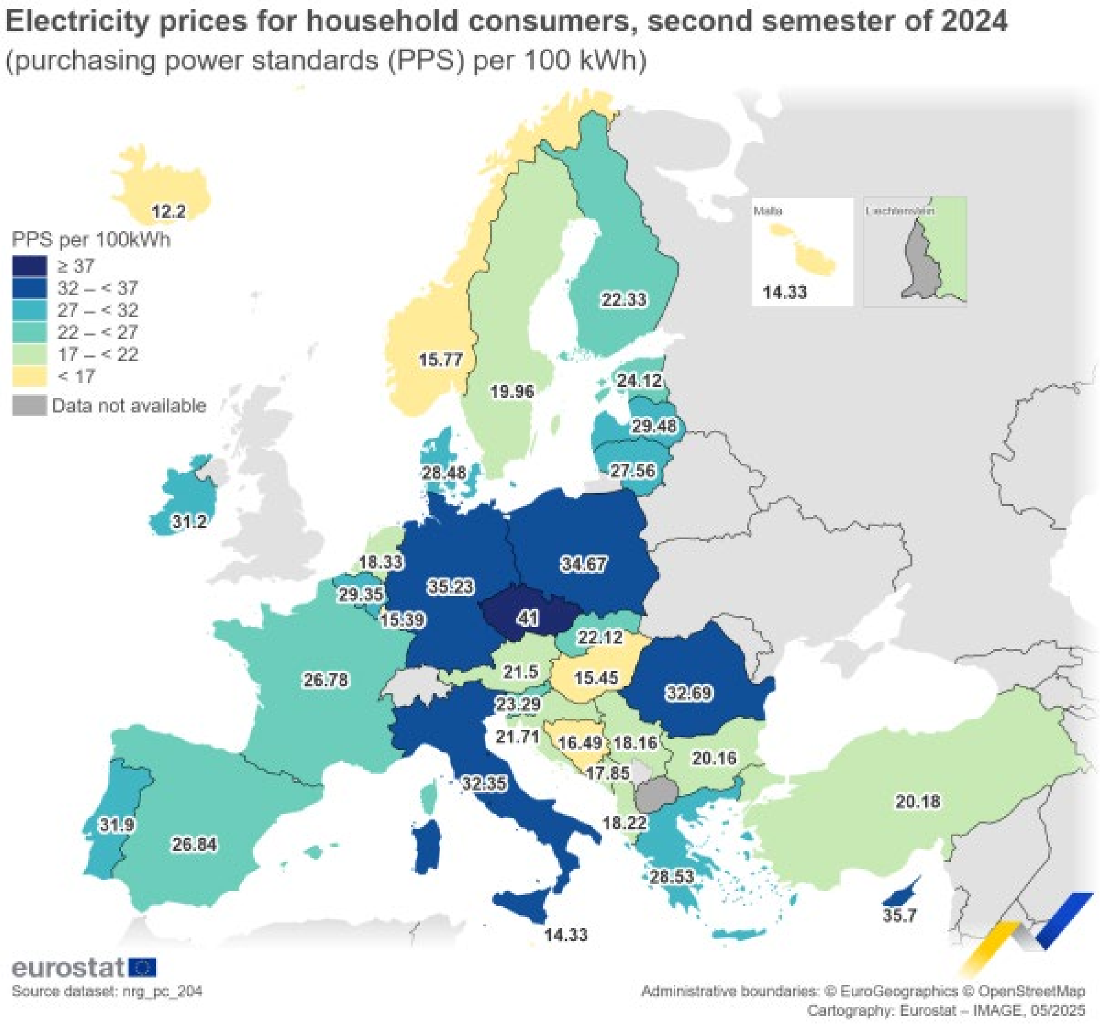


Figure 3: Electricity prices for household consumers, second semester of 2024, Map (PPS per 100 KWh), *Source:* Eurostat [(nrg_pc_204)]



FACT SHEET – Energy Wars

About this Fact Sheet

This fact sheet helps readers understand how energy resources can cause conflicts between countries. It explains the history, reasons, and risks of energy-related conflicts.

What Are Energy Wars?

Energy wars are conflicts caused by struggles over energy resources like oil, gas, coal, or minerals. They can include direct wars, sanctions, cyberattacks, infrastructure sabotage, and political pressure. These conflicts affect ordinary people through higher prices, displacement, and insecurity (UNDP, 2022; FRA, 2021).

Context

Energy is not only a product but also a source of power and control. Access to fossil fuels, renewable resources and critical minerals to produce batteries etc. determines global influence and economic strength (Klare, 2012; IRENA, 2022). Past examples like the 1973 and 1979 oil crisis and the Russian invasion in Ukraine show how energy can be used as a weapon. As fossil fuels decline in importance and the world shifts to renewables, new tensions arise over rare minerals, for instance lithium for batteries. These resources are mostly found in the Global South. This creates concerns about green colonialism by richer countries and industries in the Global North and China. ' (UNDP, 2022; IRENA, 2022).

Key Mechanisms of Energy Conflicts

Mechanism	Description
Resource Nationalism	Countries control oil or gas reserves to keep profits or gain power (e.g., Venezuela, Iran, Norway) (Klare, 2012).
Transit Conflicts	Fights over routes for oil, natural gas, and LNG pipelines or ships, (e.g. Baltic Sea, Strait of Hormuz in the Persian Gulf. (IEA, 2023, 2025).
Energy Embargoes	When countries stop exports to others as political pressure, like the 1973 Arab oil embargo (IEA, 2023). This boosted diversification and interest in renewables.
Supply Weaponization	Using energy exports as weapons, as Russia did with gas in 2022. (EC, 2022).
Infrastructure Attacks	Sabotage of pipelines, power plants, or dams, (e.g., explosions of the Nord Stream natural gas pipelines between Europe and Russia, destruction of dams of hydro power plants and attack and occupation of nuclear power plants in Ukraine. (BBC, 2023; UNDP, 2022; UWC, 2025).

Historical Examples

- 1973 Oil Crisis – Arab oil embargo to the U.S. and others supporting Israel during the Yom Kippur war, leading to oil price raising by 400%, causing recession, and increased diversification, renewables, and energy efficiency. (IEA, 2023).
- Gulf Wars (1990-2003) – Iraq's 1990 invasion of Kuwait, and the US-led invasion of Iraq were influenced by disputes over oil fields, securing oil transit, and reserves. (Klare, 2012).
- South China Sea Tensions – Conflicts over oil and gas reserves. (US EIA, 2013).
- Niger Delta Conflict – Communities protested pollution and lack of benefit from oil. (UNDP, 2022).

Contemporary Cases

Russia's war against Ukraine (2022-) shows how energy can become part of modern warfare. Russia cut gas exports to the EU and used energy as pressure. The EU responded with energy savings, the REPowerEU program to speed up renewable energy and diverting imports of coal, oil, and gas from other countries. (EC 2022).

Russia is strategically bombing the energy infrastructure causing power cuts in Ukraine. As an answer, more solar power and diesel generators are being installed in Ukraine. Russia's attacks on Ukrainian hydro power plant dams and nuclear plants caused major damage and safety risks. (UWC 2025; BBC 2023).

In 2025, the US bombed 3 nuclear sites in Iran to avoid the potential that a program for nuclear power is misused for nuclear weapon production. Around 450 people died, and global fear of escalation increased (UN NEWS, 2025). These show the danger when nuclear facilities are used in conflict situations.

In January 2026, the US attacked Venezuela, where among the reasons was to control the oil reserves.

Strategic Energy Regions

Region	Importance
Middle East	Has almost half of global proven oil reserves (OPEC, 2022).
Arctic	Melting ice opens untapped oil and gas areas in Russia, Canada and USA (IEA, 2023).
Central Asia	Important oil and gas production in Azerbaijan, Kazakhstan and other countries with pipelines to EU, Russia, and China.
Africa	Rising source of oil, gas, and minerals (UNDP, 2022).
South America	Holds lithium for batteries (IRENA, 2022).
China	Controls much of global solar cell and battery production (IEA, 2022; D.EARTH, 2023).

Conflicts on New Materials– A New Frontier

New conflicts are emerging around materials, which are rare or rapidly decreasing. Lithium, Cobalt are used for batteries, and rare earth elements are used for magnets in the generators of wind turbines. China dominates most of the deposits and production of these materials, which creates new global dependencies (IRENA, 2022).

In hunting for extraction rights, governments and corporations rush to stake their claim in poorer countries, indigenous areas and areas previously considered too dangerous and remote. This often happens against local wishes and bring more harm than benefits to the local people. These include pollution, destroyed land, worsened health, food insecurity, poor working conditions, and cultural loss. (Klare, 2012; UNDP, 2022,)

The need for new alternatives speeds up research. New batteries developed and widely used, which are using Lithium-Iron-Phosphate (LFP) and from 2025 Sodium-Iron-Phosphate instead of Lithium-Mangan-Cobalt (NMC). The iron-based batteries have lower cost, longer lifetime (more cycles), but are less fast to charge and have lower capacity (Highstar, 2025).

Uranium mining has exposed local native and indigenous populations to radioactivity for decades, causing severe health issues without adequate recognition or compensation in several countries e.g., in Australia, USA, and in Africa. In the last decade, protests managed to halt uranium mining in several indigenous territories in Canada and Australia. In 2021 Greenland banned uranium mining. (IPPNW, NIRS.). Since 2022, the Russian invasion of Ukraine, the EU wants to be independent from the Russian energy supply including uranium, which increases the hunt for new uranium mines. (EC 2022).

Consequences of Energy Wars

- Displacement, pollution and destruction of buildings and energy infrastructure from wars.
- Energy price shocks leading to inflation and crises.
- Slower climate action due to fossil fuel subsidies and military spending.
- Worsening energy injustice in poorer and import-dependent countries (UNDP, 2022).

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