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Renewable Energy Sources

FROM SCHOOL TO LIFE

Bağyurdu Anadolu Lisesi
2021
TURKEY

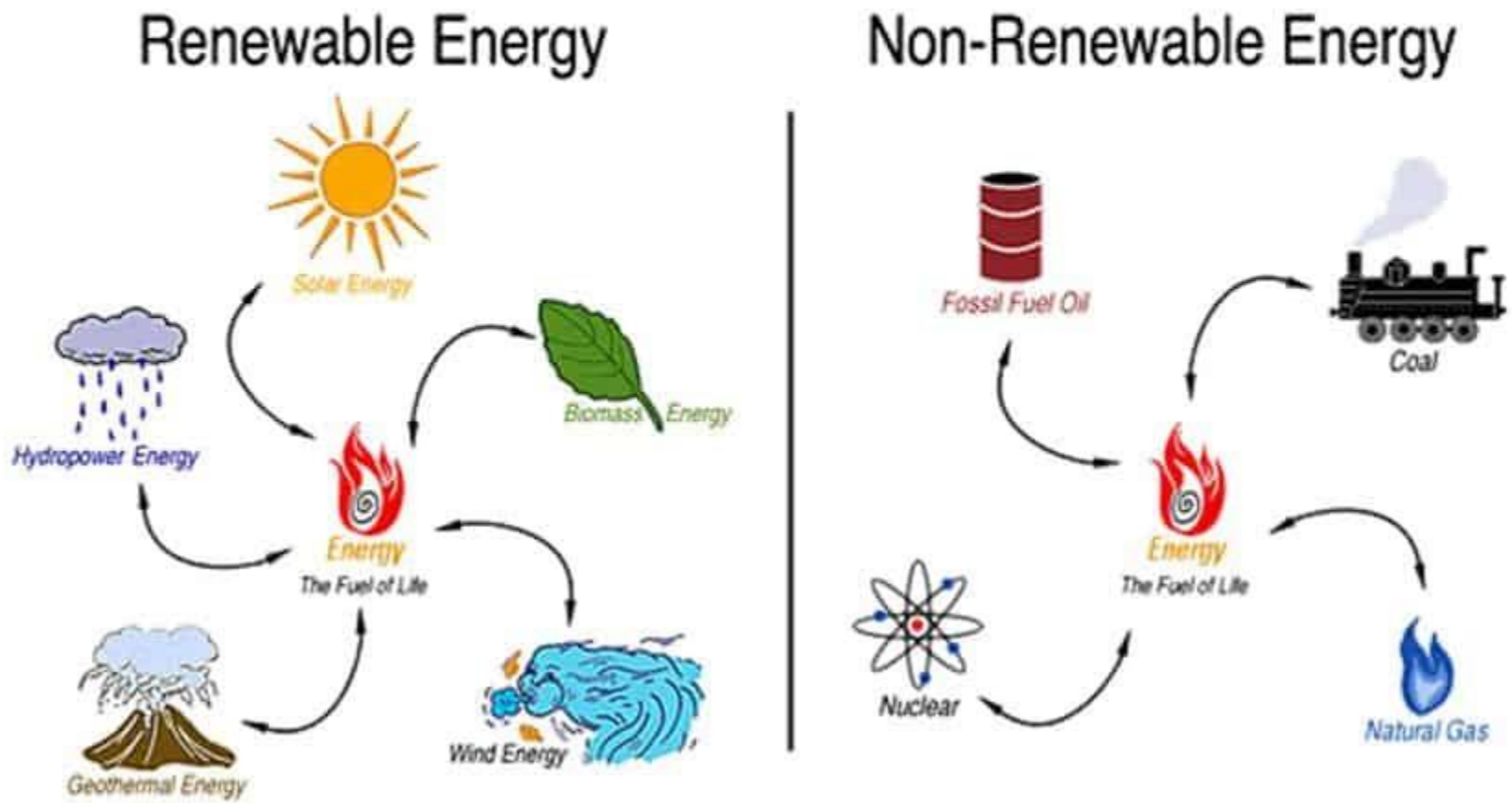
Bağyurdu Anatolian High School Project Team

What are Renewable Energy Sources?

When we talk about renewable energy sources, we must understand that all sources of energy are derived from nature. Both coal and petroleum are extracted from nature and can be used in the way that they are for creating energy. However, crude oil is usually refined and processed into gasoline, petroleum and other products before it is used. In the same way, coal has to be converted into other forms of energy to use it fully. In that sense, the renewable sources are those sources that can be used again and again as they are available in plenty and are not going to perish anytime soon. These sources can be used to convert their energy into electricity.

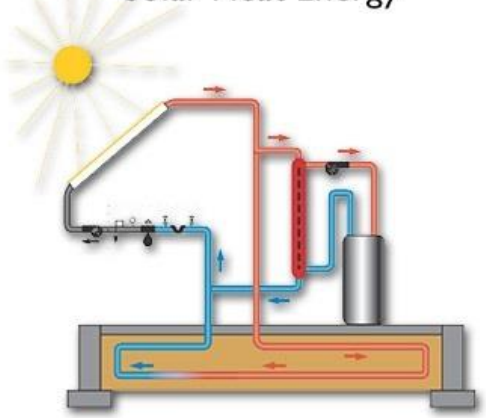
As of now, the consumption rates of coal and crude oil are such that they will soon be depleted. From then on, our dependence on renewable sources of energy will increase greatly. For this reason, scientific research is pouring in time, effort and financial resources to create infrastructure that can fully tap into the renewable sources of energy. This means having equipment that can convert any form of energy – solar, wind, water and others into viable means of electricity and power supply.

Renewable and non-renewable energy sources

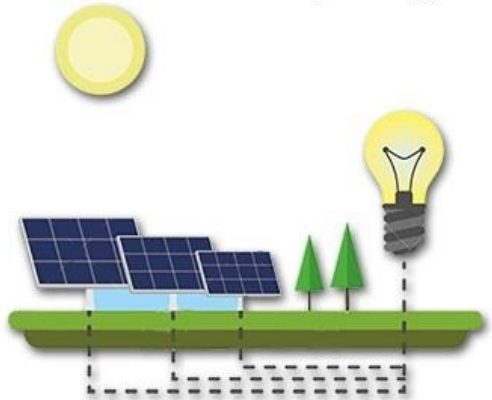


Sustainable Energy Examples

Solar Heat Energy



Solar Electricty Energy



Hydropower Energy

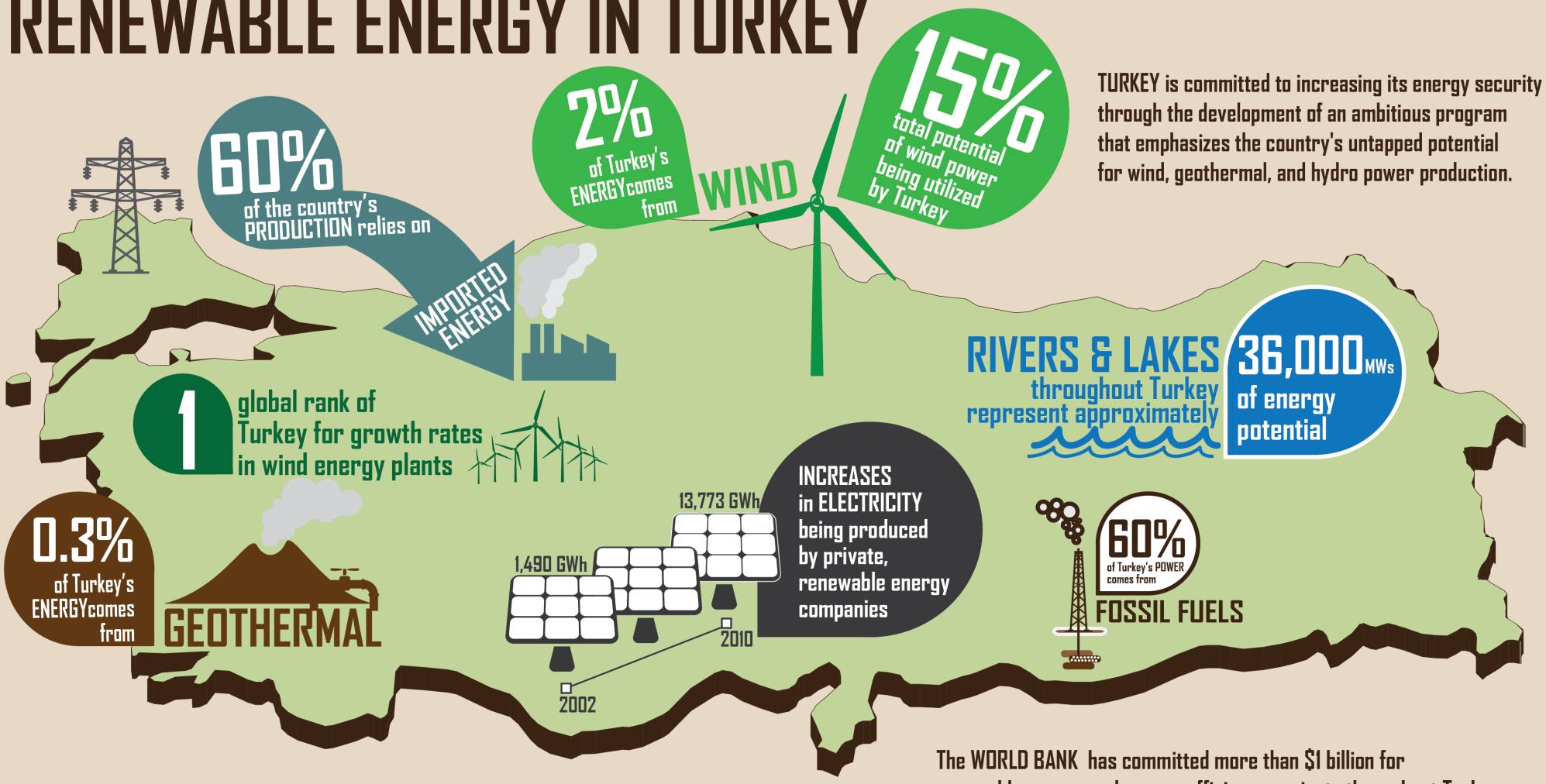
Geothermal Energy

Wind Energy

Ocean Energy

FROM SCHOOL TO LIFE

RENEWABLE ENERGY IN TURKEY



TURKEY is committed to increasing its energy security through the development of an ambitious program that emphasizes the country's untapped potential for wind, geothermal, and hydro power production.

The WORLD BANK has committed more than $1 billion for renewable energy and energy efficiency projects throughout Turkey

eca ENERGY EFFICIENCY

What is wind energy?

- Wind energy is generated by converting wind currents into other forms of energy using wind turbines.
- Winds are generated by complex mechanisms involving the rotation of the Earth, the heat capacity of the Sun, the cooling effect of the oceans and polar ice caps, temperature gradients between land and sea, and the physical effects of mountains and other obstacles.
- Wind turbines convert the force of the wind into a torque (rotational force), which is then used to propel an electric generator to create electricity.
- Wind energy power stations (known as wind farms) commonly aggregate the output of multiple wind turbines through a central connection point to the electricity grid. Across the world there are both on-shore (on land) and off-shore (out to sea) wind energy projects.
- Wind energy generation is the fastest growing energy source throughout the world, increasing at an average rate of nearly 30 per cent per year in the years between 2000 and 2008.

Wind Energy

Windmills have been used by many for a long time. The initial use was to move machines that would grind wheat into flour. Taking inspiration from this age-old technique, scientists were able to create windmills that would spin at higher speeds. Windmill farms have been erected in areas where the speeds are high enough to produce viable amounts of energy.

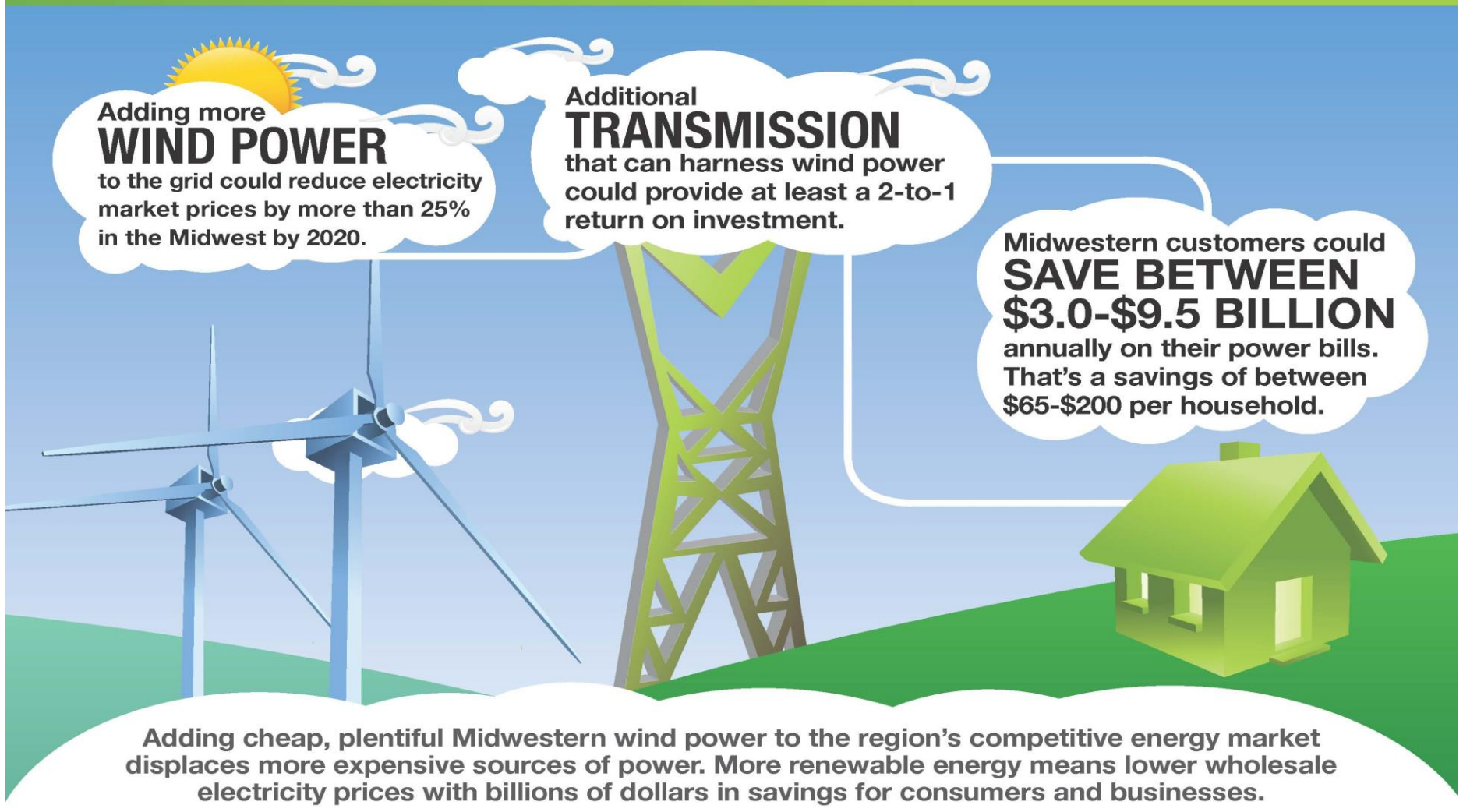
The blades of the windmill are attached to a turbine, that turns the kinetic energy (energy of movement) into electricity. Countries that have an abundance of empty land and high wind speeds have been able to utilize such renewable sources of energy to fill in the gap between demand and supply from traditional means of energy.

Most of the wind turbines are erected at high altitudes as the speed of wind is more than at low altitudes which helps to generate large amount of electricity. It does not cause any pollution, is completely renewable and reduces our alliance on foreign countries for supply of oil and gas.

The Answer is Blowing in the Wind:

Additional Wind Power Can Save Consumers Billions by 2020

Americans for a Clean Energy Grid



Adding cheap, plentiful Midwestern wind power to the region's competitive energy market displaces more expensive sources of power. More renewable energy means lower wholesale electricity prices with billions of dollars in savings for consumers and businesses.

LEARN MORE AT WWW.CLEANENERGYGRID.ORG

THE EUROPEAN OFFSHORE WIND INDUSTRY

Key trends and statistics 2016

JANUARY 2017

338 new grid-connected offshore wind turbines IN **6** wind farms

3,589 turbines are installed and grid-connected

4.8 MW average size offshore wind turbines

Work carried out in: **15** wind farms

NEW PROJECTS: **24.2** GW of consented wind farms

CABLE SUPPLIERS TO OFFSHORE WIND FARMS

European market

INTER ARRAY

44% NSW | 30% Nexans

EXPORT

52% Prysmian | 17% NSW

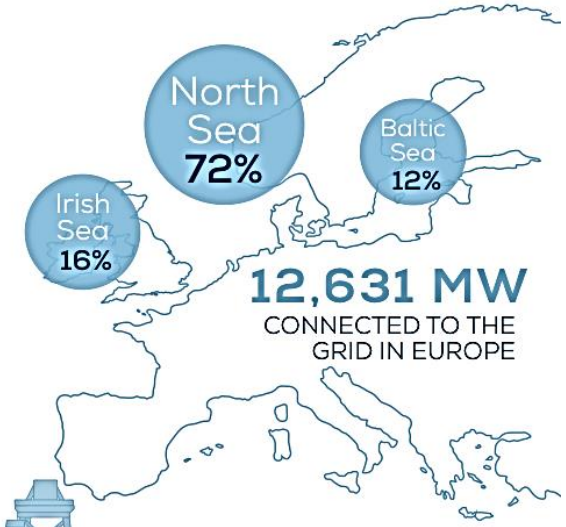
44 km AVERAGE DISTANCE TO SHORE

29 m AVERAGE WATER DEPTH

493 Monopiles

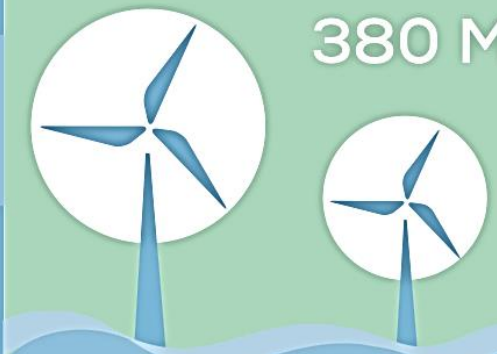
67 Jackets

SUBSTRUCTURES Installed in 2016



12,631 MW CONNECTED TO THE GRID IN EUROPE

AVERAGE SIZE OF CONNECTED WIND FARMS

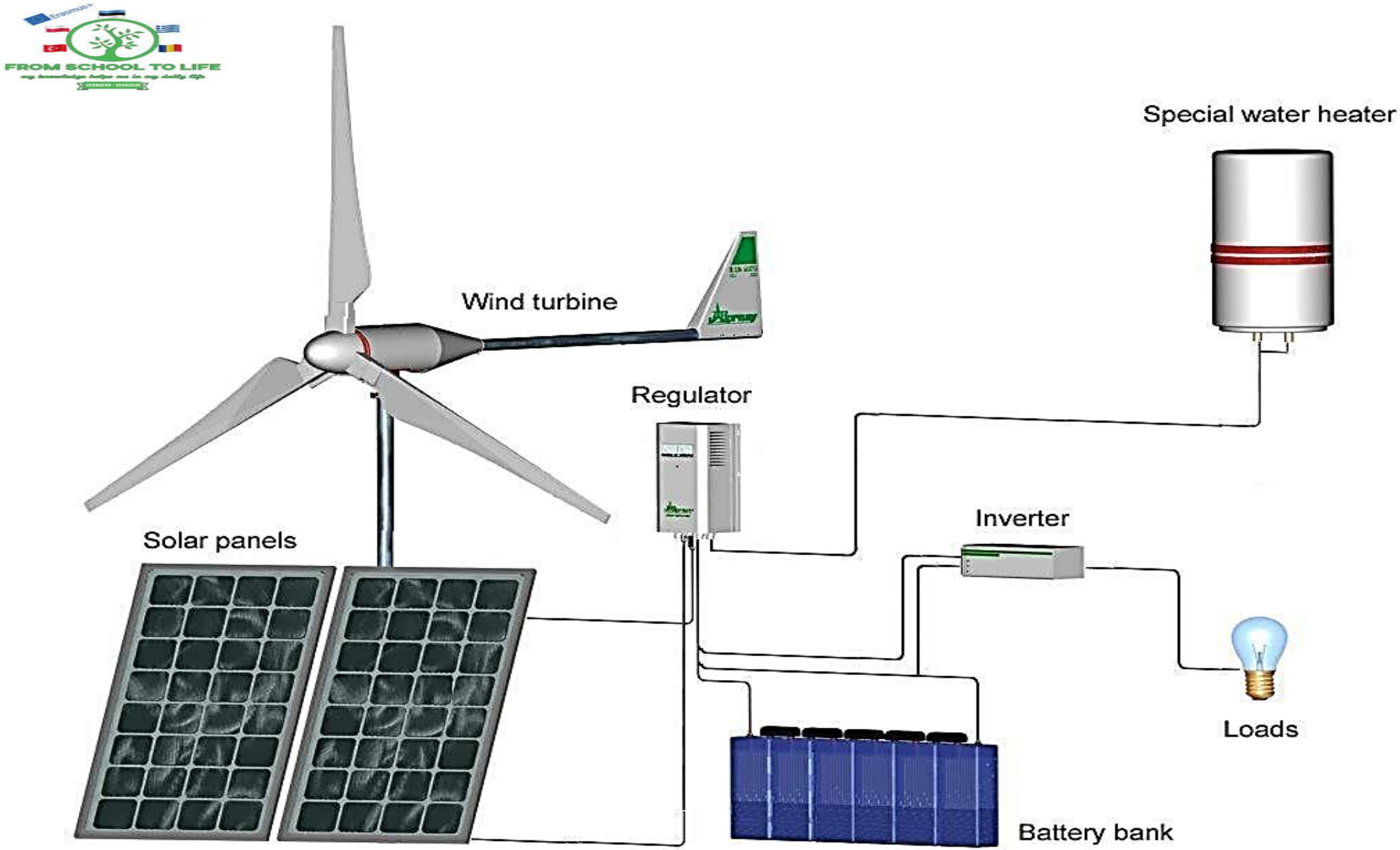


380 MW

TOP 3 DEVELOPERS IN 2016

Northland Power | DONG Energy | Global Infrastructure Partners

DOWNLOAD FULL REPORT PDF windeurope.org/stats/eu-offshore-2016


Special water heater
Wind turbine
Regulator
Inverter
Solar panels
Loads
Battery bank

Solar Energy

One of the first renewable sources of energy is sunlight. It is the reason why life on the planet Earth has flourished and is the one truly renewable source of energy. About 70% of sunlight gets reflected back into the space and we have only 30% of sunlight to meet up our energy demands.

Solar energy has become quite practical to use and many applications have created for it. First of these is solar heaters. Whether it is industrial grade water heating or simple heating to cook food, solar energy can be utilized quite easily. With the development of solar panels and photovoltaic cells, it can also be used to create and store energy as needed.

READ 41 Super Easy Ways to Stop Air Pollution From Today

Solar powered homes, cars and appliances are becoming common these days, as are solar farms that provide electricity to areas that are not on the grid. Solar energy can also be used for drying clothes, by plants in the process of photosynthesis and humans to keep their body warm during winter seasons.

Solar power is usable energy generated from the sun in the form of electric or thermal energy. Solar energy is captured in a variety of ways, the most common of which is with photovoltaic solar panels that convert the sun's rays into usable electricity. Aside from using photovoltaics to generate electricity, solar energy is commonly used in thermal applications to heat indoor spaces or fluids. Residential and commercial property owners can install solar hot water systems and design their buildings with passive solar heating in mind to fully take advantage of the sun's energy with solar technology.

Interested in benefiting from solar power? Solar panels are installed at three main scales: residential, commercial, and utility. Residential-scale solar is typically installed on rooftops of homes or in open land (ground-mounted) and is generally between 5 and 20 kilowatts (kW), depending on the size of a property. Commercial solar energy projects are generally installed at a greater scale than residential solar. Though individual installations can vary greatly in size, commercial-scale solar serves a consistent purpose: to provide on-site solar power to businesses and non-profits. Finally, utility-scale solar projects are typically large, several megawatt (MW) installations that provide solar energy to a large number of utility customers.

For some solar shoppers who may not be able to install solar on their property, community solar is a viable solar option that more directly connects utility-scale solar energy projects to residential consumers. As such, community solar farms are typically built in a central location as opposed to on any single customer's property. Residential consumers can subscribe to a community solar project to receive many of the benefits of solar power without installing solar panels on their property.

A solar panel (also known as a solar module) consists of a layer of silicon cells, a metal frame, a glass casing unit, and wiring to transfer electric current from the silicon. Silicon (atomic #14 on the periodic table) is a nonmetal with conductive properties that allow it to absorb and convert sunlight into usable electricity. When light hits a silicon cell, the light causes electrons in the silicon to be set in motion, initiating a flow of electric current. This is known as the “photovoltaic effect,” and it describes the general functionality of solar panel tech.

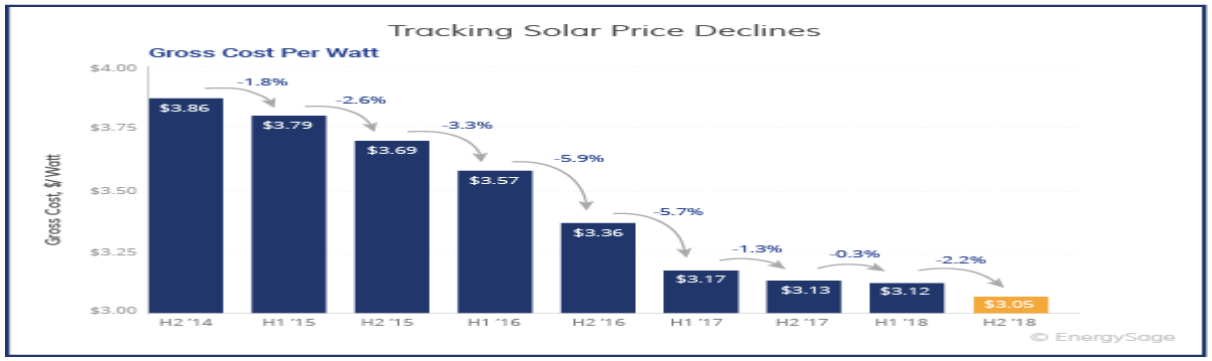
The science of generating electricity with solar panels boils down to this photovoltaic effect. It was first discovered in 1839 by Edmond Becquerel and can be thought of as a property of specific materials (known as semiconductors) that allows them to create an electric current when they are exposed to sunlight.

The photovoltaic process works through the following broad steps:

The silicon photovoltaic solar cell absorbs solar radiation
When the sun’s rays interact with the silicon cell, electrons begin to move, creating a flow of electric current
Wires capture and feed this direct current (DC) electricity to a solar inverter to be converted to alternating current (AC) electricity

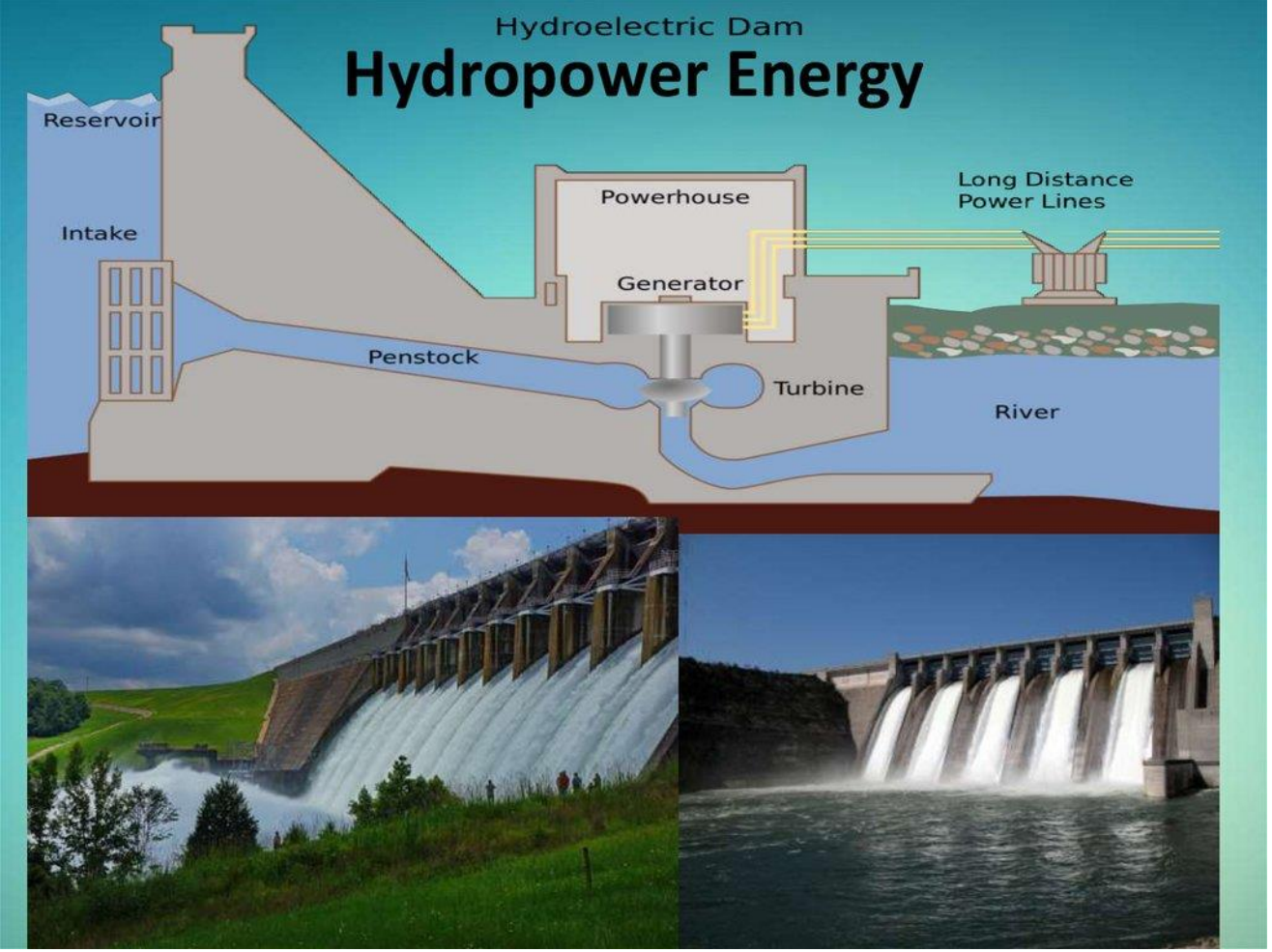
In 1954, Bell Labs developed the first silicon photovoltaic cell. Although solar energy had previously been captured and converted into usable energy through various methods,only after 1954 did solar power begin to become a viable source of electricity to power devices over extended periods of time. The first solar cells converted solar radiation to electricity at an efficiency of 4 percent - for reference, many widely available solar panels today can convert sunlight to solar power at above 20 percent efficiency, a number constantly on the rise.
Although adoption of solar energy was slow at first, a number of state and federal incentives and policies contributed to driving down the cost of solar panels far enough to become more widely adopted. At this point, solar power accounts for enough capacity to power 11 million of the 126 million households in the country.

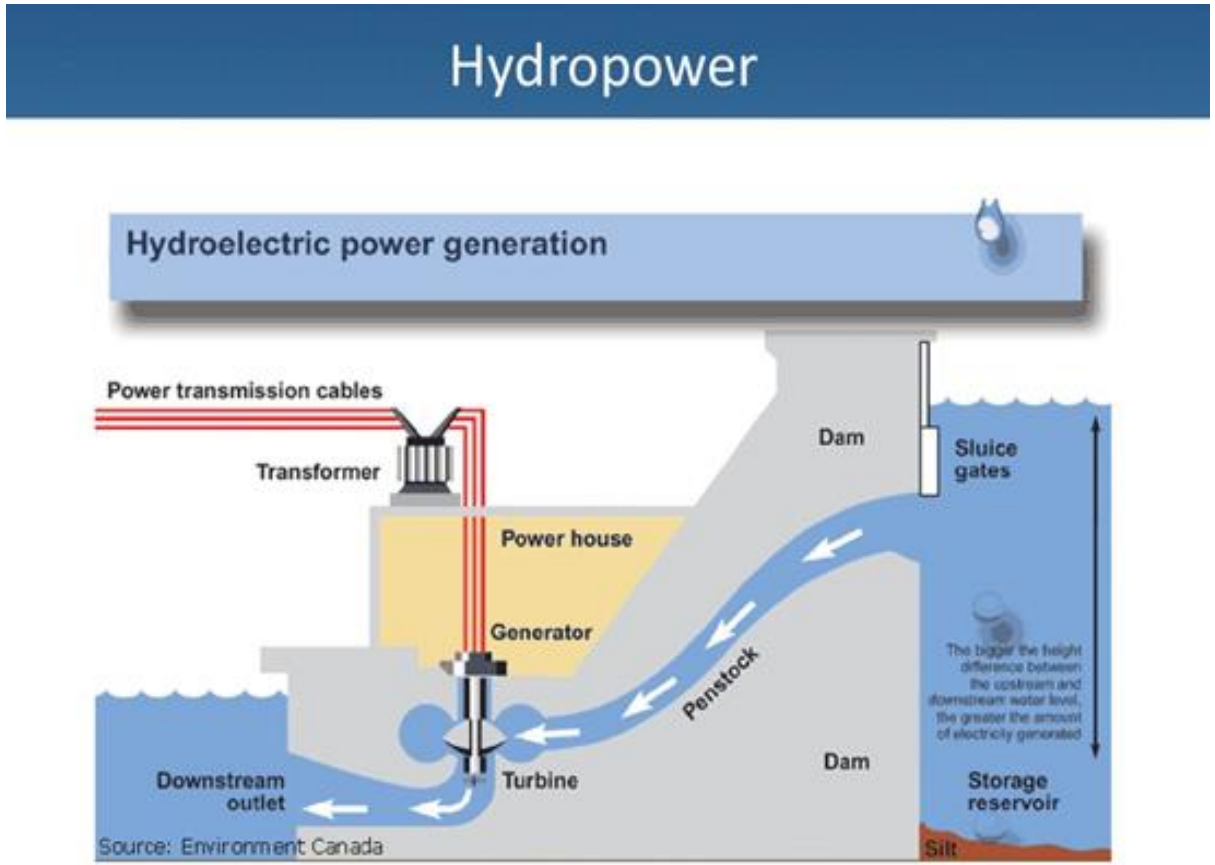
Concurrent with an increase in solar panel efficiency, the cost of solar energy has fallen substantially. In the last decade alone, the cost of a solar panel installation fell over 60 percent, and many industry experts predict that prices will continue to fall in the years to come:
Additionally, depending upon where you live, several rebates or incentives for solar power may contribute towards lowering the cost of solar energy even further. Nationwide, the federal Investment Tax Credit (ITC) is one of the primary incentives available to anyone interested in solar energy, as it allows you to deduct 26 percent of the cost of installing a solar system from your federal taxes. This incentive won't last forever - in 2023, the federal ITC steps down to 22%, and then goes away completely for residential solar installations in 2024.
Many states and utilities offer further incentives (such as net metering) in addition to the federal ITC, dropping the cost of solar power even further.



HydroElectric Energy

There is a large amount of kinetic energy stored in water. It is available for use when the rivers and streams flow towards the oceans, and the potential becomes greater when they turn into waterfalls. Hydroelectric energy is becoming a common source of electricity production in the 21st century.
Most dams that are being built have infrastructure that allows them to capture the energy from the water. The kinetic energy of moving water is then used by hydropower plants to give mechanical energy to turbines which in turn convert it to electrical energy through generators.
It is also seen as a simple and effective way to power regions that are not easily accessible by the regular power grid or simply face a lack of electricity far too often. Being a clean, cheap and renewable source of energy, a lot of research is being put into efficient utilization of the water resources we have available on the planet. Hydropower is renewable, environment friendly and produces no toxic gases.


Hydroelectric Dam
Hydropower Energy
Reservoir
Intake
Powerhouse
Long Distance
Power Lines
Generator
Penstock
Turbine
River


Hydropower
Hydroelectric power generation
Power transmission cables
Transformer
Dam
Sluice
gates
Power house
Generator
Penstock
Turbine
Dam
Downstream
outlet
Storage
reservoir
Silt
Source: Environment Canada

Geothermal Energy

Within the Earth, there is a great deal of energy trapped inside molten magma. All of this heat transfers itself to the deep stores of water and air that flow through the Earth. In order to release the heat and regulate the temperature of the core, the heated water and air are released through vents, which are seen as holes in the crust of the Earth. They form another of the renewable sources of energy, known as Geothermal energy. The vents of heated air and steam are used to generate power which is yet another renewable source of energy.

Geothermal energy is completely renewable, reduces dependence on fossil fuels, provides job benefits and significant cost saving. The downside is that it is suitable for particular region which are normally prone to earthquakes and volcanoes, and may release some harmful gases.

Uses & Applications

Geothermal energy has many uses across the world.

Some of the geothermal energy examples include the lava that ejects steam and hot occasionally, hot springs, and geysers. They bear witness that indeed geothermal energy is effective. This energy can be used in many applications that require heat.

These include heating homes, heating swimming pools, cooking, bathing, and other industrial processes. In a nutshell, the geothermal energy is used to generate electricity or provide heat.

1). Electricity Production

Modern technologies have given us the opportunity to generate electricity out of hot water and steam extracted from beneath the earth's surface.

Power plants are used to produce electricity by activating the turbines by steam.

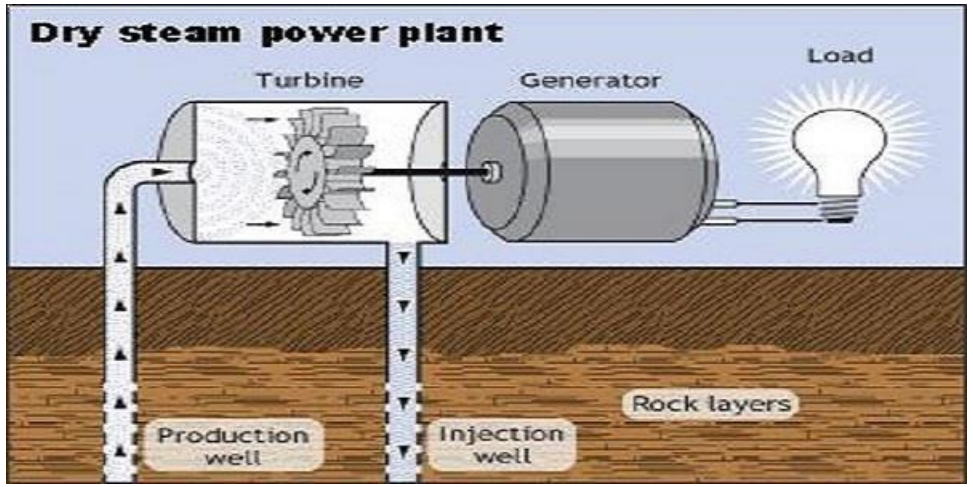
There are basically three ways, viz. dry steam plants, flash plants, and binary plants, which are used to generate this power. These three methods are explained subsequently.

Dry steam method

In dry steam plants, the hot steam is pumped directly into the power plant to turn the turbine which will then produce electricity.

This steam is taken from the hot water from geothermal reservoirs.

Check the photo illustration which shows how this steam produces electricity by turning the turbine which will turn the generator and ultimately produce electricity. The dry steam plant basically uses hydrothermal fluids from the ground.

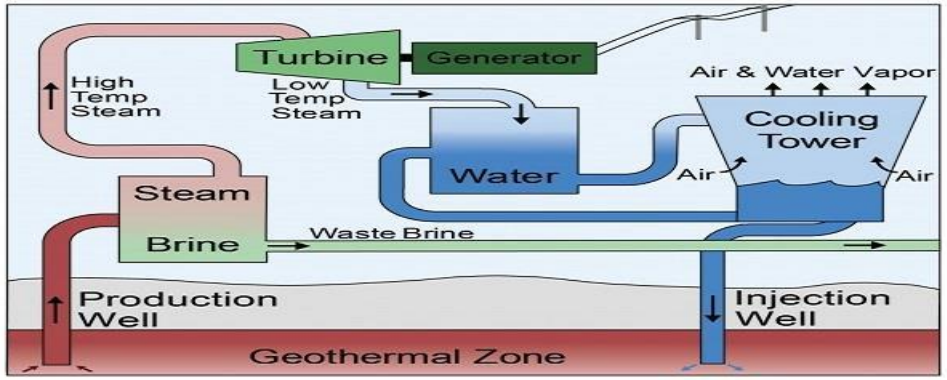


Flash method

Flash steam plants are the most common in the industry.

Basically, hot water (usually ranging from 300 to 700 degrees Fahrenheit) is pumped through wells installed underground. When this water turns into steam, the steam is used to turn the turbine to generate electricity.

Some of the steam will cool and condense into the well to return to the ground. The process is continuous hence the energy is considered to be renewable and sustainable.

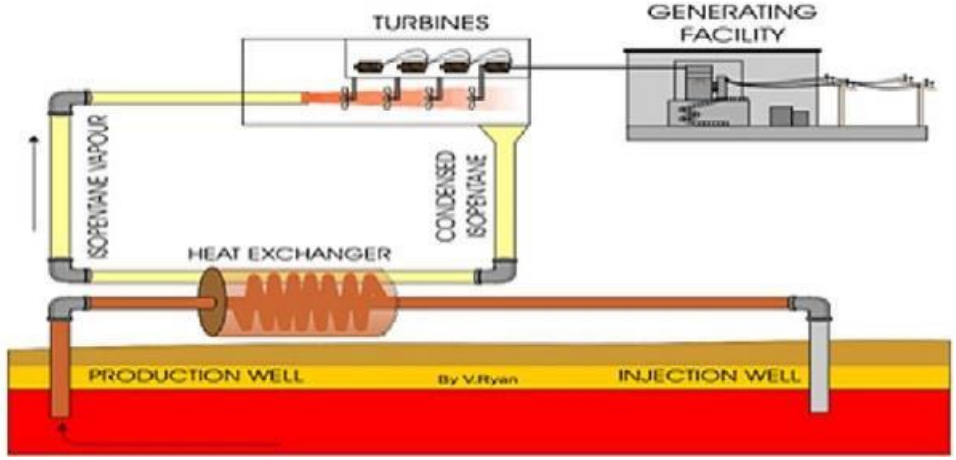


Binary cycle

These plants use a different liquid with a lower boiling point than water.

The liquid is often isobutene which is used to extract heat and then evaporates to form steam that will turn the turbines and then generate power.

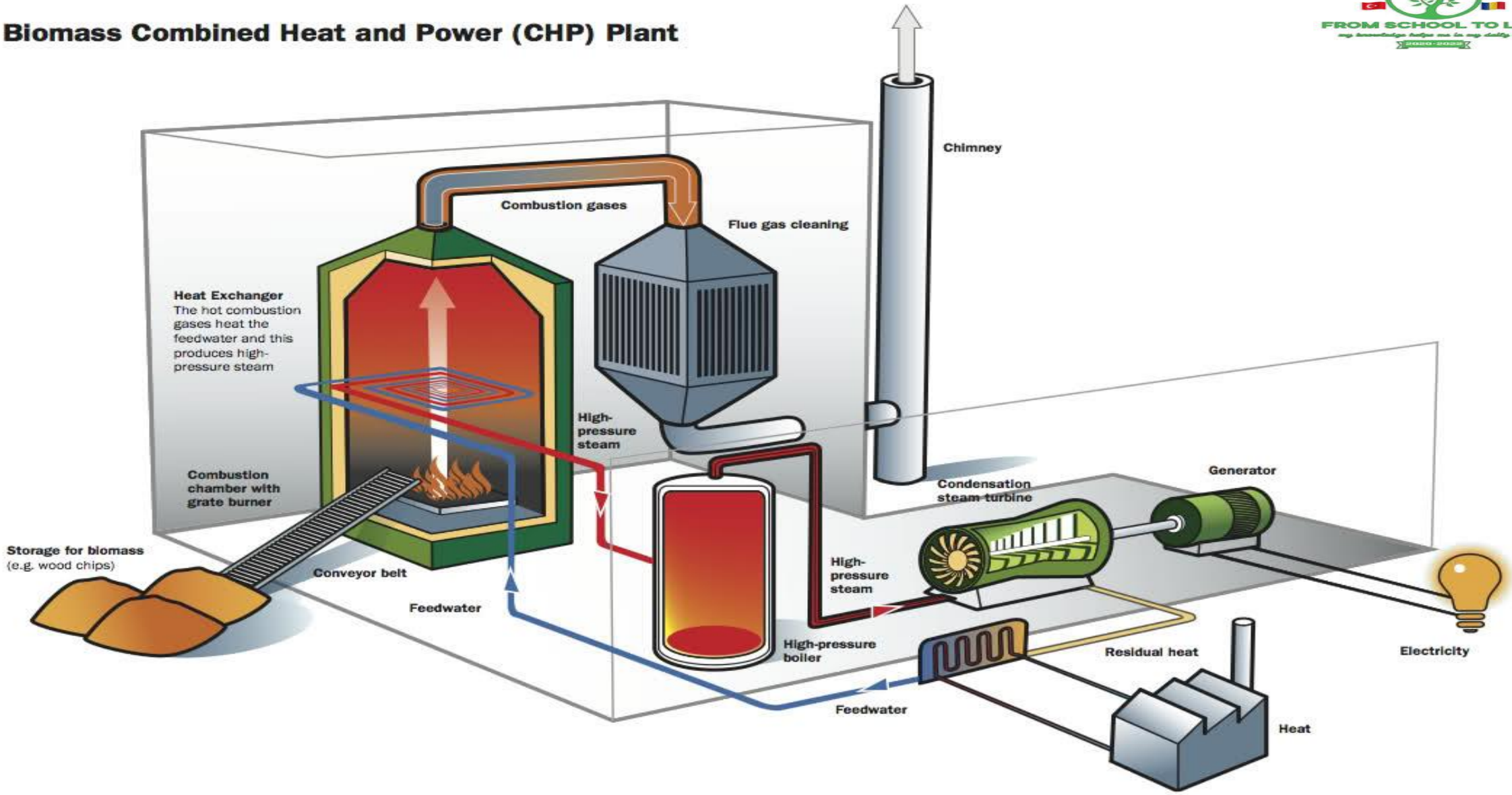
The geothermal water at low temperature is pumped through the heat exchanger which will transfer heat to isobutene. This liquid will then boil. See the picture below that illustrates the process.



Biomass Energy

Finally, we have biofuels and biogas as renewable source of energy. These are obtained from plants, plant waste and crops,landfills, municipal and industrial waste, trees and agricultural waste making them 'biological' in nature. Biogas has been produced in natural circumstances for thousands of years. It is now that we have been able to produce it in controlled conditions and compress it to make Compressed Natural Gas (CNG).
It can be used for transportation, power generation and heating homes. Biomass energy does not produce any greenhouse gases, helps to reduce landfills, renewable as long as plants, crops and waste exist. In the same way, biofuels are basically Ethanol, which are made when sugar is fermented. It is an alcohol substance and like CNG, it has found application in the transportation sector by way of being cleaner fuels. It is normally blended with gasoline as a form of car fuel.

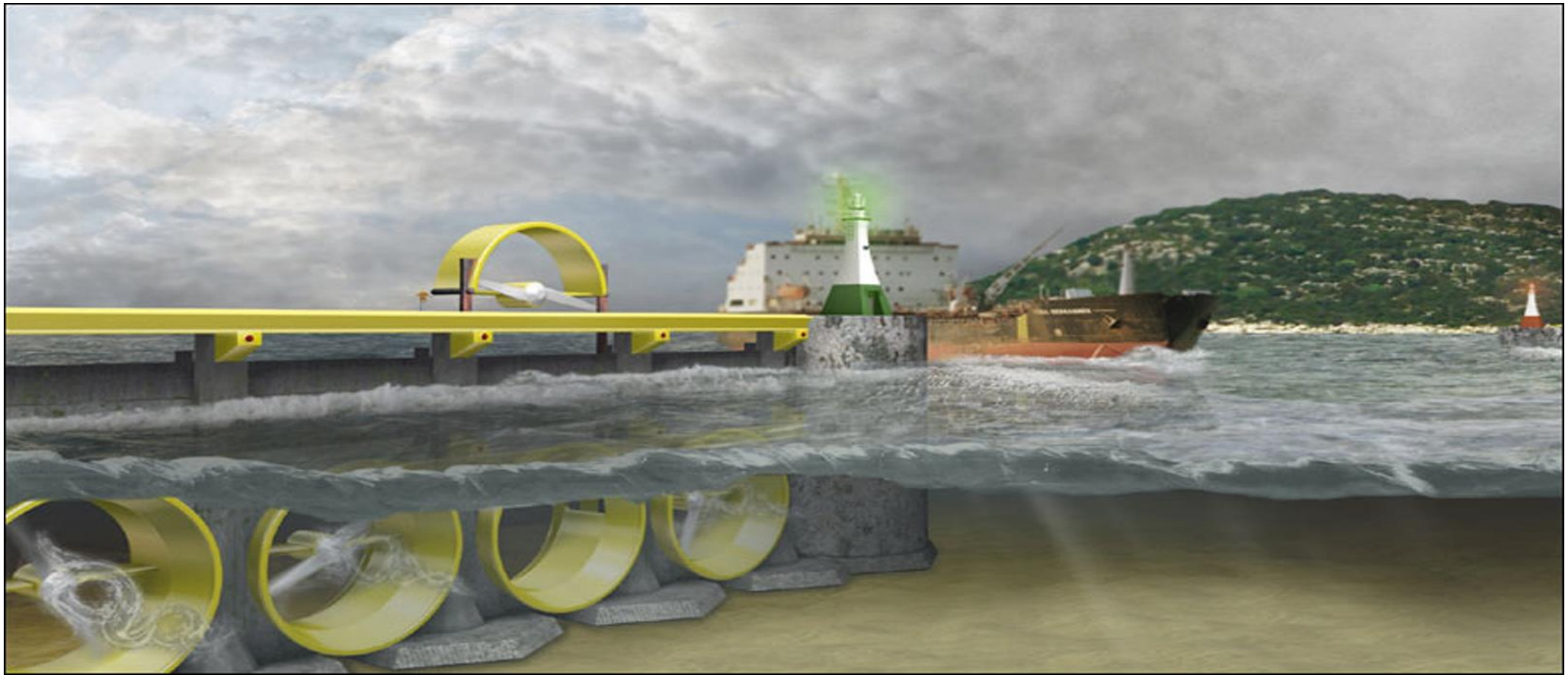
Biomass Combined Heat and Power (CHP) Plant



Ocean Energy

Ocean energy has vast potential as 70% of the earth is covered with water. The tides that hit sea shore have enormous potential in them and can be used to convert to electrical energy. Ocean energy can be captured via 3 ways (a) Wave Energy, (b) Tidal Energy, (c) OTEC (Ocean Thermal Energy Conversion).

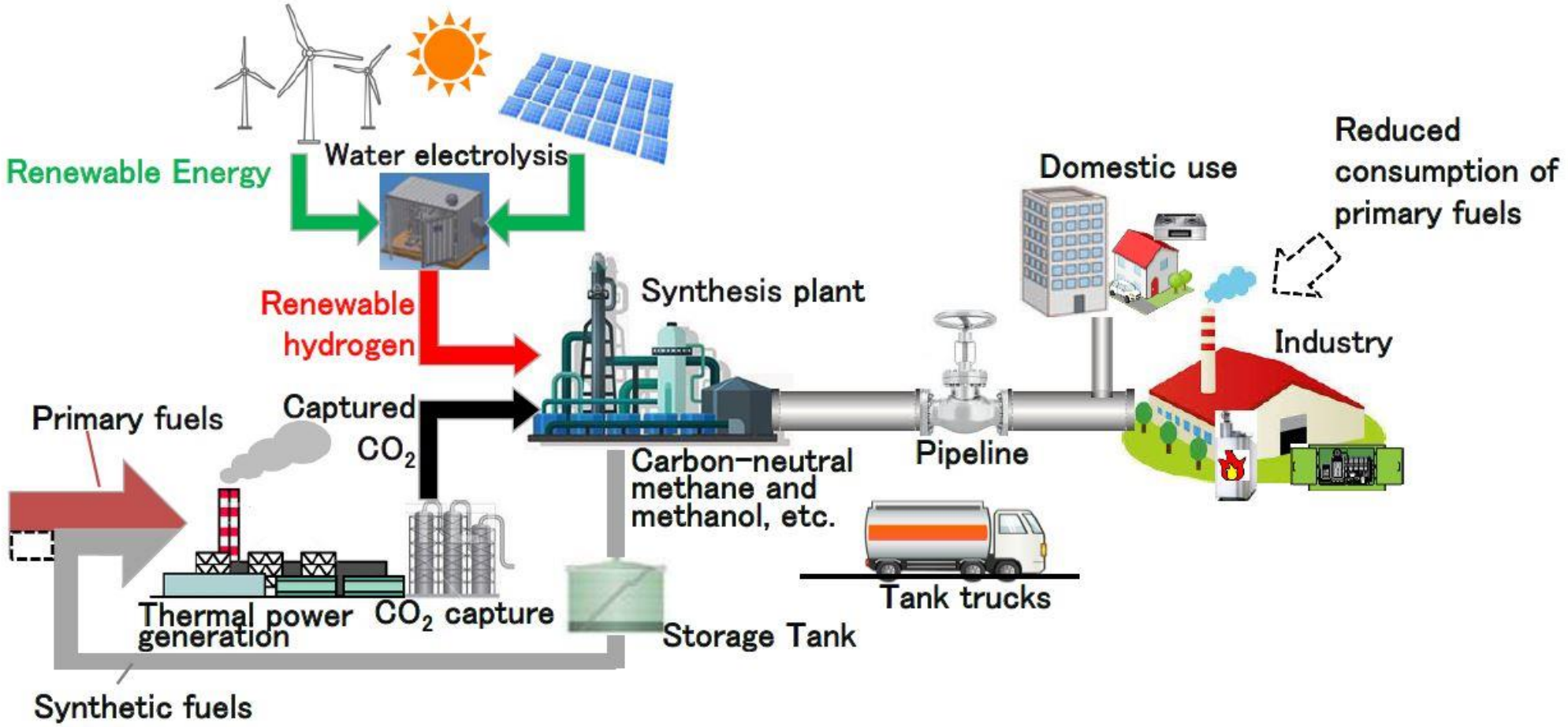
Wave energy is captured directly from the surface of the waves which are nothing but regular disturbances produced on the surface of water. Tidal energy captures kinetic energy from incoming and outgoing tides and tidal energy generator uses that kinetic energy and convert it to electrical energy. OTEC uses the heat stored in sea water to convert to electricity. Both these energy sources are completely renewable and can go a long way in reducing our dependence on non-renewable sources.



Hydrogen Energy

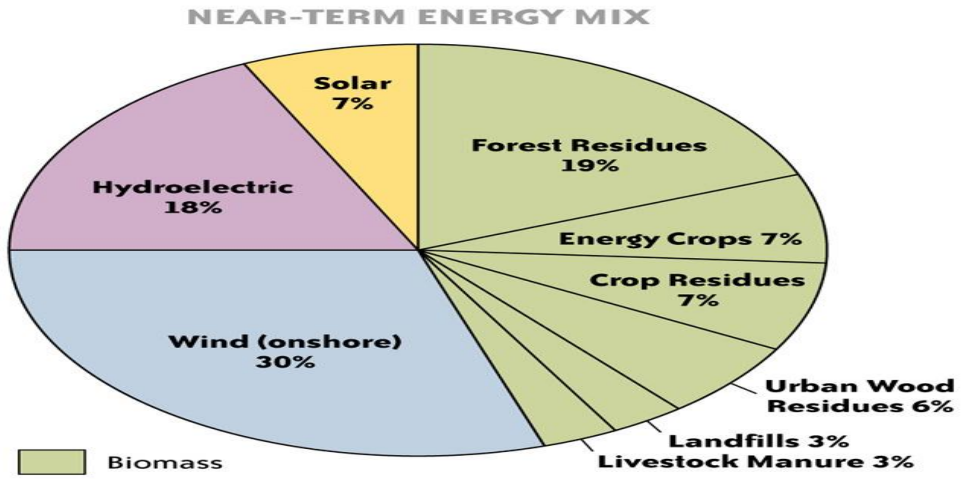
Hydrogen is the most common element available on earth as it is available with water and can be a tremendous renewable source of energy to power ships, rockets, marines, vehicles, homes and industries. Water(H2O) contains two thirds of hydrogen but is usually found in combination with other elements.

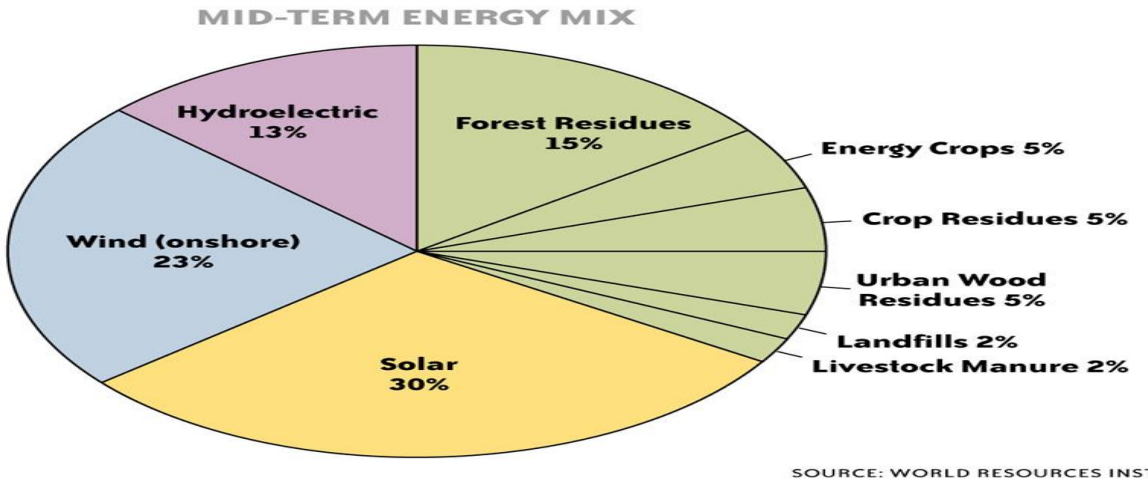
Once it is separated from water, it can be used as a fuel or could be used for generating electricity. Hydrogen energy is completely renewable, environment friendly, do not leave any toxic emissions and can be produced on demand. It takes lot of energy to extract hydrogen from other elements and therefore proves to be bit expensive to extract.



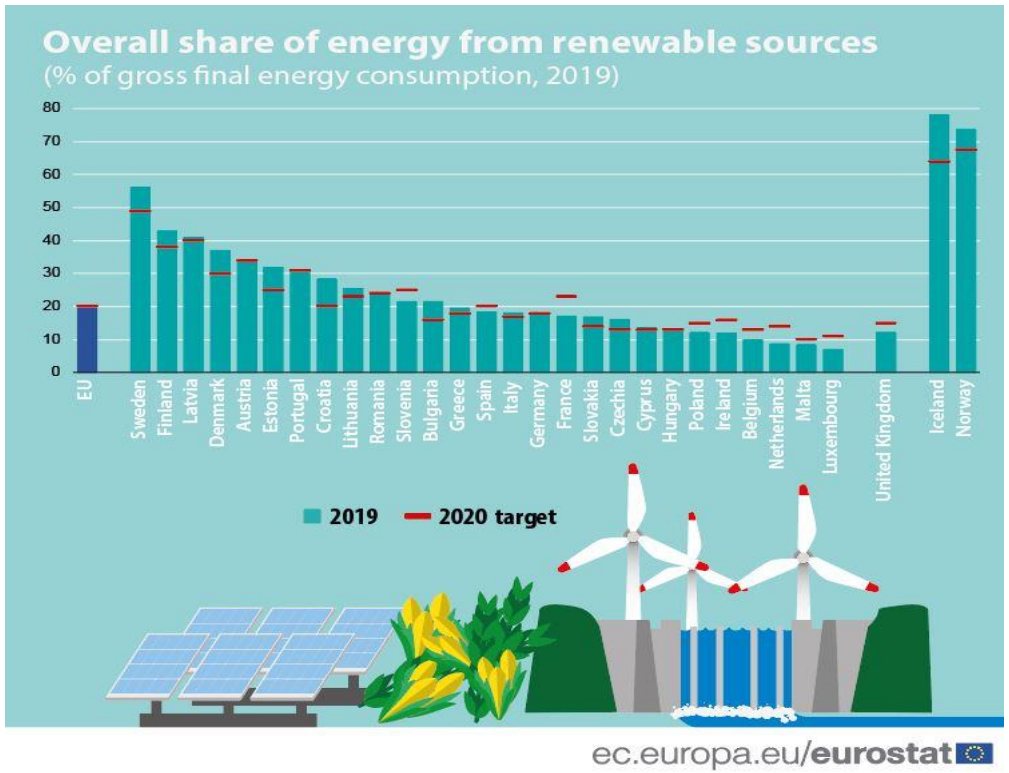
New renewable electricity generation

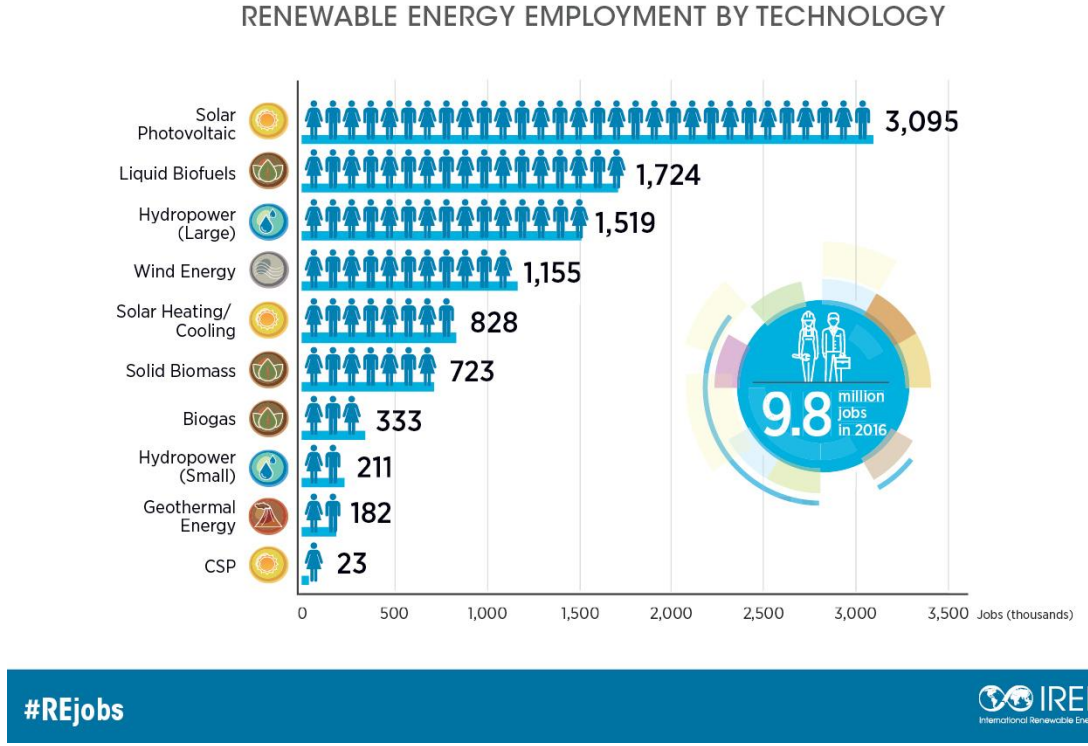
A World Resources Institute study reported that in the next five years, biofuels, including wood and grass crops, could account for half of the state's renewable-power generation. After 2015, solar power, which will fall in price, should become the fastest-growing renewable energy source.



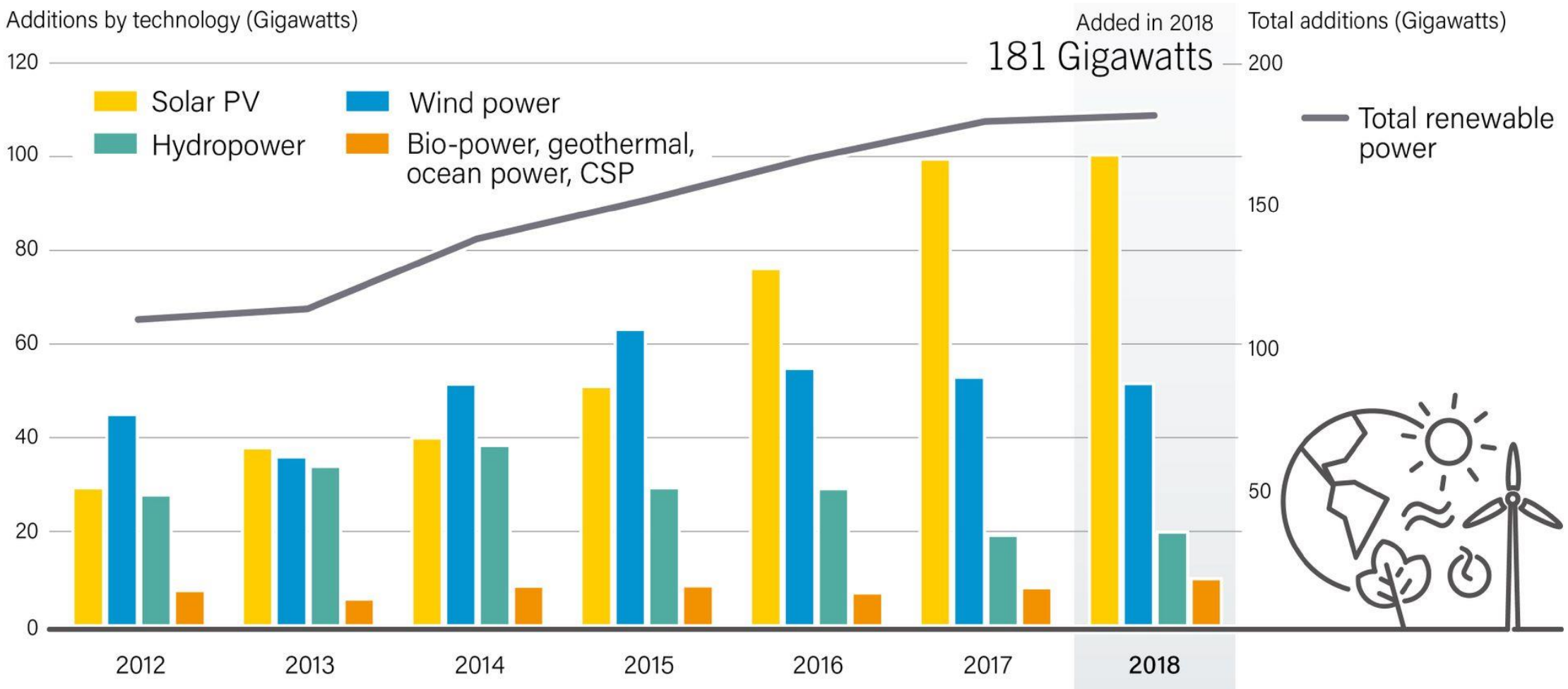


SOURCE: WORLD RESOURCES INSTITUTE





Annual Additions of Renewable Power Capacity, by Technology and Total, 2012-2018



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