The Renewable Energy In the KRG - Garmayan area

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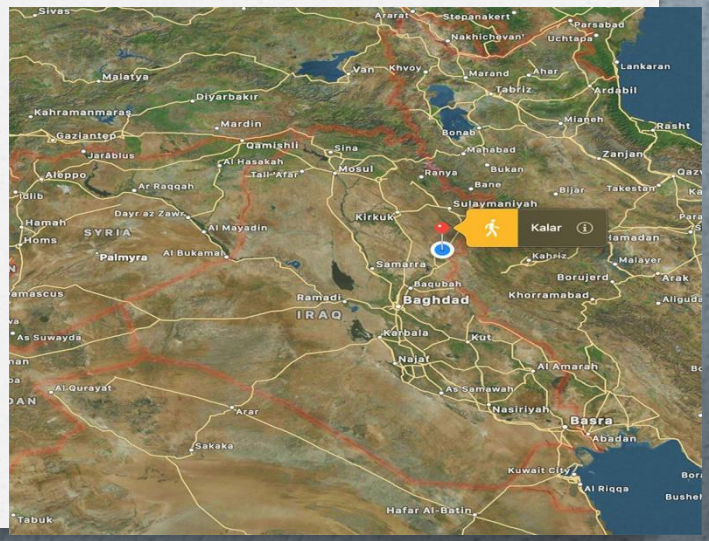
keywords

- The energy that reaches the earth in one hour is sufficient for the people of the earth for a whole year. If they are well exploited.

Definition of Kurdistan

- Iraq is **one of the easternmost countries of the Arab world**, located at about the same latitude as the southern United States. It is bordered to the north by Turkey, to the east by Iran, to the west by Syria and Jordan, and to the south by Saudi Arabia and Kuwait
- Its distribute in to 18 governmental. Baghdad is the capital of Iraq
- And in the local governmental in the North of Iraq (Kurdistan(KRG)) Irbil city is its capital
- Bagdad is the most densely populated city with about (6 million) and Irbil with about 3 million .
- Iraq land area is about 438,317 km2 and Kurdistan 40,643 km2



1-Energy supply sources in KRG

1-1-Energy produced by thermoelectric plants and dams is in the foreground.

1-2- Local generators in residential areas, which have become a part of society in Iraq and in their organized form that is not hidden from anyone.

1-3-The energy produced by solar cells, which is installed by individuals in the private sector and without government support, and whose capacity ranges from 1 kilowatt to 30 kilowatts, which has become popular in recent years after raising the price of electricity and reducing the hours of electricity processing

1-4-Hydroelectricity Source

As for the regional government, which depends on energy produced through dams and gas-operated stations

Where there are

1-4-1- Dukan dams with a production capacity of 415 megawatts .

1-4-2- Darbandikhan dams with a production capacity of 240 megawatts .

1-5-thermoelectric energy Source

Each of Thermal power stations in Sulaymaniyah and Erbil consisting of eight units of the type (Frame-9E) to produce 1000 MW, a contract was made with the American GE and ABB German companies to implement the simple cycle.The combined cycle was also built with an addition of 500 MW using steam units that reuse the heat emitted from the exhausts of gas turbines through specialized boilers (Heat Recovery Generators (HRSG) without consuming additional fuel and this leads to increased production efficiency and rid the environment of combustion residues Reducing the amount of carbon emitted to the atmosphere, and after completing the combined cycle, the plant's capacity became 1500 MW.

As for the Dohuk plant, it has a capacity of 1000 MW and can be increased to 1500 MW,

With stations smaller than 300 megawatts located in Khurmala, Kalar, Sulaymaniyah and Dohuk

2-Total power product in KGR

The total energy produced in the KGR through Dams and thermal power stations is about (6000 MW).

The percentage of losses in the network is about 40%.

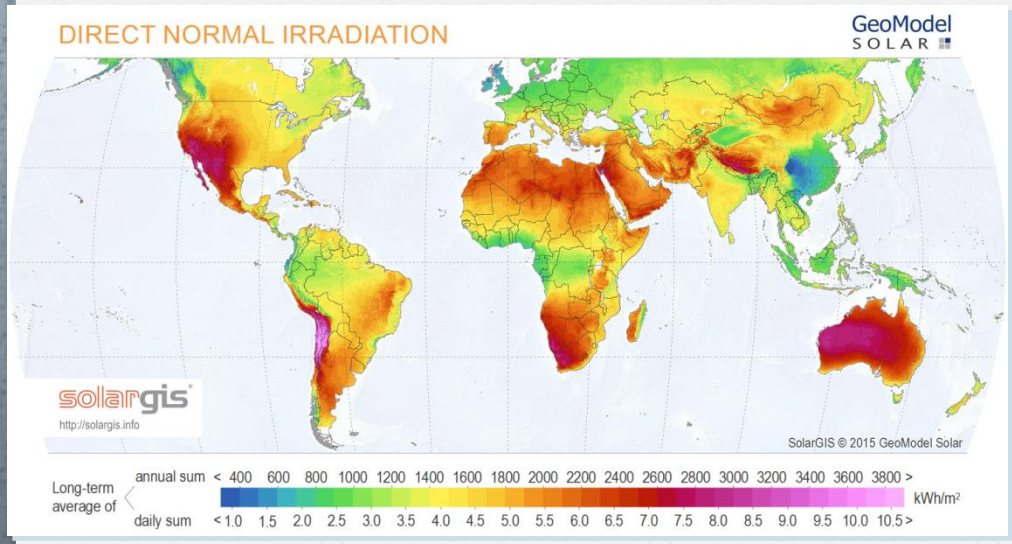
The losses are caused by the presence of old networks that have not been replaced, with the problem of insulators in the electrical networks .

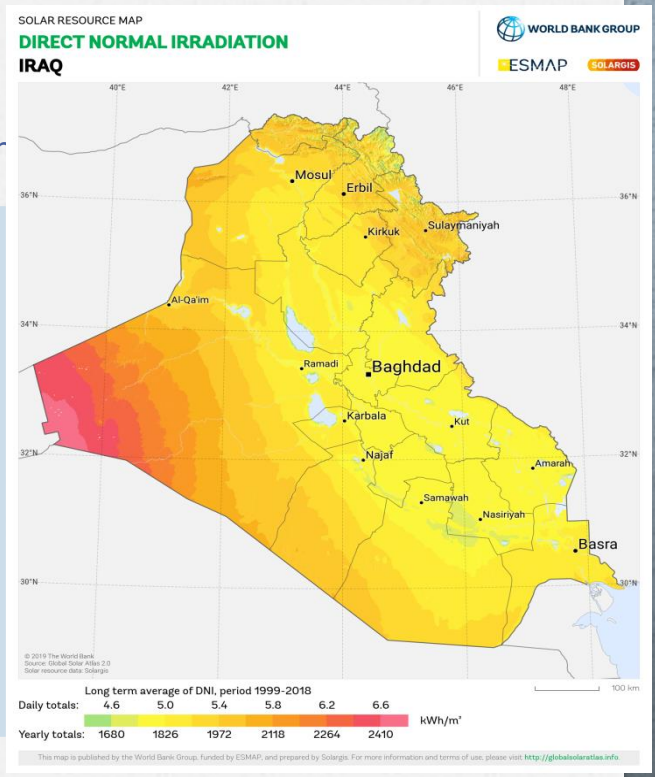
With the absence of an electricity bill collection system, which was initiated by the regional government by installing smart watches.

3-The limitations of the current energy resources in the region

- All major sources of energy generation in the KRG are limited either by running out or due to climate changes so must Therefore, we must go towards alternative energy, which is renewable energies.

Because of the location of the KRG which makes it a good location for generating energy from solar radiation





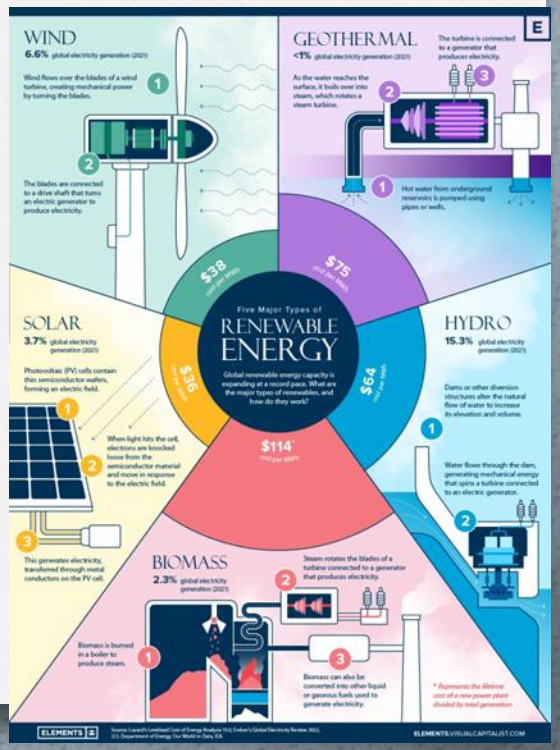
4-What is renewable energy?

- Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed. Sunlight and wind, for example, are such sources that are constantly being replenished. Renewable energy sources are plentiful and all around us.
- Fossil fuels - coal, oil and gas - on the other hand, are non-renewable resources that take hundreds of millions of years to form. Fossil fuels, when burned to produce energy, cause harmful greenhouse gas emissions, such as carbon dioxide.
- Generating renewable energy creates far lower emissions than burning fossil fuels. Transitioning from fossil fuels, which currently account for the lion's share of emissions, to renewable energy is key to addressing the climate crisis.
- Renewables are now cheaper in most countries, and generate three times more jobs than fossil fuels.

5-Why Use Renewable Energy Resources?

- Today we mainly utilize fossil fuels to heat and power our homes and fuel our cars. These energy sources are conventional and easily available to use coal, oil, and natural gas for meeting our energy needs, but we have a limited supply of these fuels on the Earth.

- World using this energy much more rapidly than they are being created. Subsequently, their source will run out in the future. And considering state safety concerns and waste disposal problems, the United States will retire much of its nuclear capacity by 2020



6-Here are a few common sources of renewable energy:

6-1-SOLAR ENERGY

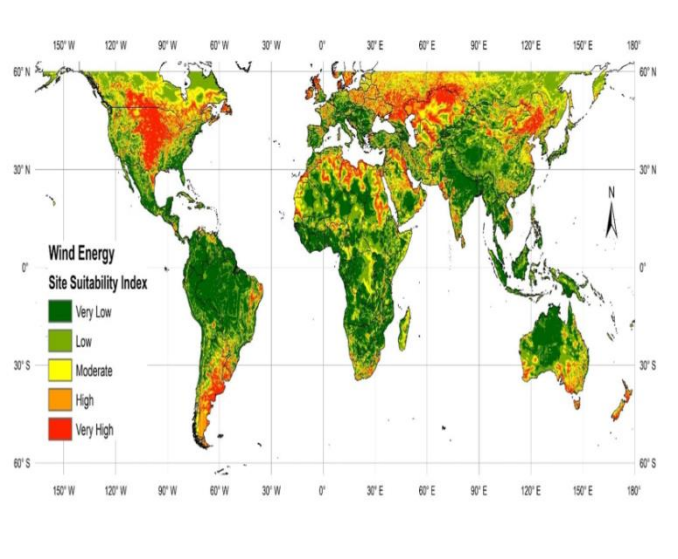
- Solar energy is the most abundant of all energy resources and can even be harnessed in cloudy weather. The rate at which solar energy is intercepted by the Earth is about 10,000 times greater than the rate at which humankind consumes energy.
- Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation.
- Although not all countries are equally endowed with solar energy, a significant contribution to the energy mix from direct solar energy is possible for every country.
- The cost of manufacturing solar panels has plummeted dramatically in the last decade, making them not only affordable but often the cheapest form of electricity. Solar panels have a lifespan of roughly 30 years, and come in variety of shades depending on the type of material used in manufacturing.

6-2-WIND Energy

- Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Wind energy has been used for millennia, but onshore and offshore wind energy technologies have evolved over the last few years to maximize the electricity produced - with taller turbines and larger rotor diameters.

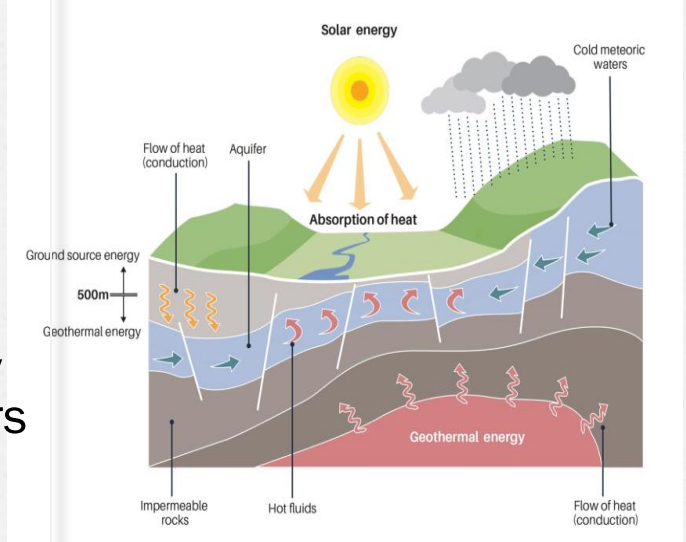
- Though average wind speeds vary considerably by location, the world's technical potential for wind energy exceeds global electricity production, and ample potential exists in most regions of the world to enable significant wind energy deployment.

- Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Offshore wind power offers tremendous potential.



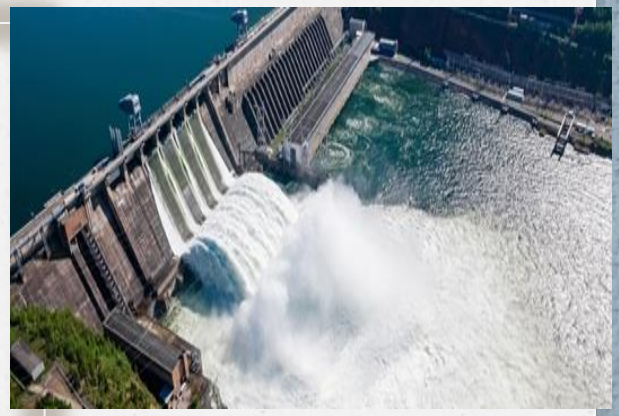
6-3-GEOTHERMAL ENERGY

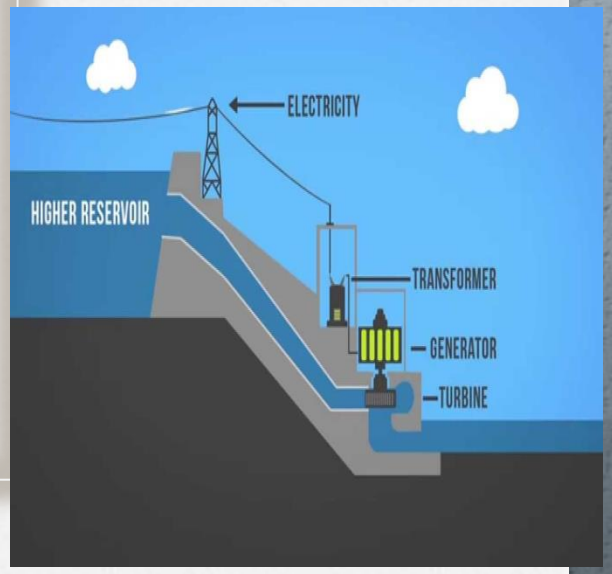
- Geothermal energy utilizes the accessible thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.
- Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.
- Once at the surface, fluids of various temperatures can be used to generate electricity. The technology for electricity generation from hydrothermal reservoirs is mature and reliable, and has been operating for more than 100 years.



6-4-HYDROPOWE

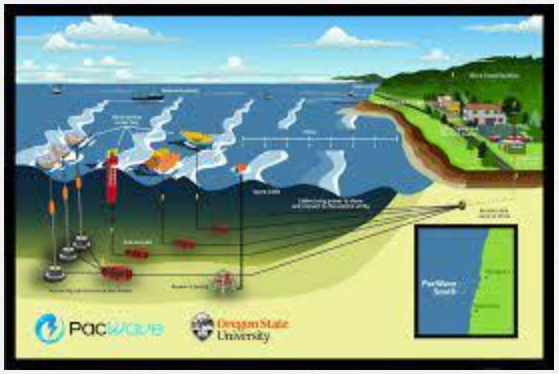
- Hydropower harnesses the energy of water moving from higher to lower elevations. It can be generated from reservoirs and rivers. Reservoir hydropower plants rely on stored water in a reservoir, while run-of-river hydropower plants harness energy from the available flow of the river.
- Hydropower reservoirs often have multiple uses - providing drinking water, water for irrigation, flood and drought control, navigation services, as well as energy supply.
- Hydropower currently is the largest source of renewable energy in the electricity sector. It relies on generally stable rainfall patterns, and can be negatively impacted by climate-induced droughts or changes to ecosystems which impact rainfall patterns.
- The infrastructure needed to create hydropower can also impact on ecosystems in adverse ways. For this reason, many consider small-scale hydro a more environmentally-friendly option, and especially suitable for communities in remote locations.





6-5-OCEAN ENERGY

- Ocean energy derives from technologies that use the kinetic and thermal energy of seawater - waves or currents for instance - to produce electricity or heat.
- Ocean energy systems are still at an early stage of development, with a number of prototype wave and tidal current devices being explored. The theoretical potential for ocean energy easily exceeds present human energy requirements.



6-6-Bioenergy

- Bioenergy is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung and other manures for heat and power production, and agricultural crops for liquid biofuels. Most biomass is used in rural areas for cooking, lighting and space heating, generally by poorer populations in developing countries.

- Modern biomass systems include dedicated crops or trees, residues from agriculture and forestry, and various organic waste streams.
- Energy created by burning biomass creates greenhouse gas emissions, but at lower levels than burning fossil fuels like coal, oil or gas. However, bioenergy should only be used in limited applications, given potential negative environmental impacts related to large-scale increases in forest and bioenergy plantations, and resulting deforestation and land-use change.

9-A comparison of the methods used in the region to generate electric power?

There are two methods of thermal power plants and dams used in the region to generate energy, and each of them has its disadvantages.

9-1-HYDROPOWE

1- Dukan dams with a production capacity of 415 megawatts .

2- Darbandikhan dams with a production capacity of 240 megawatts .

This layer has become unsecured for power generation due to climate fluctuations, lack of rainfall, regional problems, high costs in the construction phase, and limited geographical topography.

9-2-Thermal power stations using Fossil fuels .

- 9-2-1-The environmental impact of electricity generation is the impact resulting from the generation of electric power. Power plants contribute to causing severe damage to the environment due to the burning of raw materials such as coal, fuel, and oil. These materials are extracted from the ground in general, and this happens when the materials are burned, producing gas containing toxic substances such as carbon dioxide.
- 9-2-2-Some of these gases resulting from the combustion of raw materials cause a rise in the Earth's temperature, which directly contributes to the increase in global warming. This combustion also causes significant pollution of the air that humans and other organisms inhale, which endangers their health. We are not the only ones who breathe this air in the atmosphere, as there are plants and animals, as they are all directly affected.

10-What kind of renewable energies is best for generating electricity in this country?

- When noting the geographical location and the cost of generating electricity from renewable energies we see Wind and Solar They are the cheapest

Energy Source	% of 2021 Global Electricity Generation	Avg. levelized cost of energy per MWh
Hydro	15.3%	$64
Wind	6.6%	$38
Solar	3.7%	$36
Biomass	2.3%	$114
Geothermal	<1%	$75

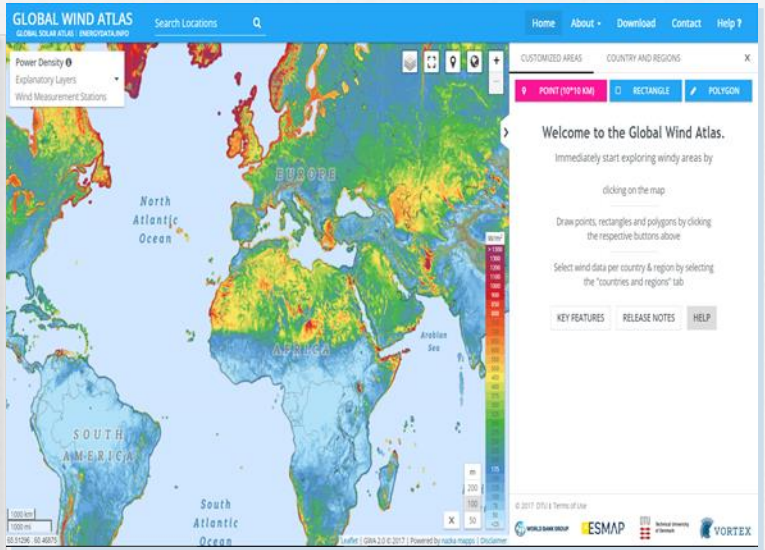
Kurdistan It has three stations with a capacity of more than 1000 megawatts With several small stations with a capacity of 150-300 MW

- The 165 MW project is being implemented by the UK-based company Aggreko.
- It will use currently unused gas from the oil fields around Haseera Village and completed 2021. Due to its high importance, the Minister of Electricity is personally following up and supervising work on this project. The project was implemented at a cost of 2.03 Billion IQD
- This station was established in the year 2021, which feeds the national electricity grid, but the problem is that the efficiency of this station decreases and reaches 100 megawatts in the summer.
- Knowing that when taking into consideration and studying this region, it turns out that For the good in terms of location for the establishment of solar energy stations

11-1-WIND POWER

When we see globalwindatlas .inf

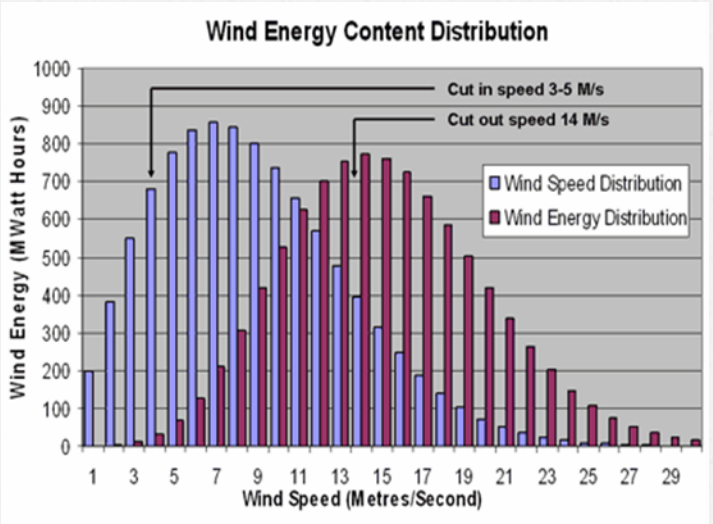
- ☐ Generally, average annual wind speeds of at least 4.0-4.5 m/s (14.4- 16.2 km/h; 9.0- 10.2 mph) are needed for a small wind turbine to produce enough electricity to be cost-effective. A very useful resource for evaluating a site for its wind energy potential is a wind resource potential map.



- And so we see that the wind speed in or country is about 4.5-5 m/s

Did wind turbin as we see in https://www.mpoweruk.com/wind_power.htm

- Small wind turbines generally operate between force 3 and force 7 on the Beaufort scale with the rated capacity commonly being defined at force 6 with a wind speed of 12 m/s.
- Below force 3 the wind turbine will not generate significant power.
- At force 3, wind speeds range from 3.6 to 5.8 m/s (8 to 13 mph). Wind conditions are described as "light" and leaves are in movement and flags begin to extend.
- At force 7, wind speeds range from 14 to 17 m/s (32 to 39 mph). Wind conditions are described as "strong" and whole trees are in motion.
- With winds above force 7 small, domestic wind turbines should be shut down to prevent damage.
- Large turbines used in the electricity grid are designed to work with wind speeds of up to 25 m/s (90 km/h, 56 mph) which corresponds to between force 9 (severe gale, 23 m/s) and force 10 (storm, 27 m/s) on the Beaufort Scale.
- So wind speed Not enough to generate electricity in our region



11-2-solar power

which is divided into:

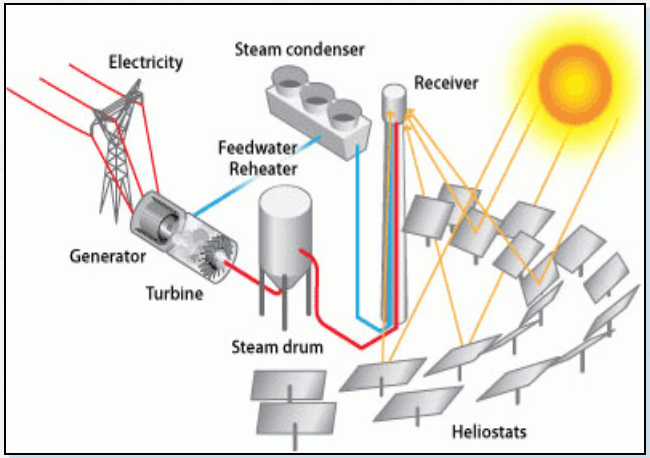
- 1-Solar Photovoltaic
- 2-Power Tower System Concentrating Solar-Thermal
- 3-Linear Concentrator System Concentrating Solar-Thermal
- 4-Dish/Engine System Concentrating Solar-Thermal

11-2-1-Solar Photovoltaic

- What is photovoltaic (PV) technology and how does it work? PV materials and devices convert sunlight into electrical energy. A single PV device is known as a cell. An individual PV cell is usually small, typically producing about 1 or 2 watts of power. These cells are made of different semiconductor materials and are often less than the thickness of four human hairs. In order to withstand the outdoors for many years, cells are sandwiched between protective materials in a combination of glass and/or plastics
- To boost the power output of PV cells, they are connected together in chains to form larger units known as modules or panels. Modules can be used individually, or several can be connected to form arrays. One or more arrays is then connected to the electrical grid as part of a complete PV system. Because of this modular structure, PV systems can be built to meet almost any electric power need, small or large
- The largest PV systems in the country are located in California and produce power for utilities to distribute to their customers. The Solar Star PV power station produces 579 megawatts of electricity, while the Topaz Solar Farm and Desert Sunlight Solar Farm each produce 550 megawatts..

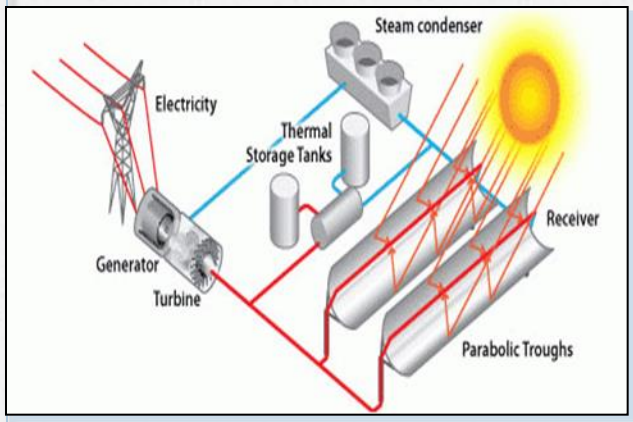
11-2-2-Power Tower System Concentrating Solar-Thermal Power

- In power tower concentrating solar power systems, a large number of flat, sun-tracking mirrors, known as heliostats, focus sunlight onto a receiver at the top of a tall tower. A heat-transfer fluid heated in the receiver is used to heat a working fluid, which, in turn, is used in a conventional turbine generator to produce electricity. Some power towers use water/steam as the heat-transfer fluid. Other advanced designs are experimenting with high temperature molten salts or sand-like particles to maximize the power cycle temperature.
- The Ivanpah Solar Electric Generating System is the largest concentrated solar thermal plant in the U.S. Located in California's Mojave Desert, the plant is capable of producing 392 megawatts of electricity using 173,500 heliostats, each with two mirrors that focus sunlight onto three solar power towers.
- Aside from the U.S., Spain has several power tower systems. Planta Solar 10 and Planta Solar 20 are water/steam systems with capacities of 11 and 20 megawatts, respectively. Gemasolar, previously known as Solar Tres, produces nearly 20 megawatts of electricity and utilizes molten-salt thermal storage.



11-2-3-Linear Concentrator System Concentrating Solar-Thermal Power

- Linear concentrating solar power (CSP) collectors capture the sun's energy with large mirrors that reflect and focus the sunlight onto a linear receiver tube. The receiver contains a fluid that is heated by the sunlight and then used to heat a traditional power cycle that spins a turbine that drives a generator to produce electricity. Alternatively, steam can be generated directly in the solar field, which eliminates the need for costly heat exchangers.
- Linear concentrating collector fields consist of a large number of collectors in parallel rows that are typically aligned in a north-south orientation to maximize annual and summer energy collection. With a single-axis sun-tracking system, this configuration enables the mirrors to track the sun from east to west during the day, which ensures that the sun reflects continuously onto the receiver tubes.
- Linear systems may incorporate thermal storage. In these systems, the collector field is oversized to heat a storage system during the day so the additional steam it generates can be used to produce electricity in the evening or during cloudy weather. These plants can also be designed as hybrids, meaning that they use fossil fuel to supplement the solar output during periods of low solar radiation. In such a design, a natural gas-fired heater or gas-steam boiler/reheater is used. In the future, linear systems may be integrated with existing or new combined-cycle natural-gas- and coal-fired plants.



11-2-4-Dish/Engine System Concentrating Solar-Thermal Power

- Dish/engine systems use a parabolic dish of mirrors to direct and concentrate sunlight onto a central engine that produces electricity. The dish/engine system is a concentrating solar power (CSP) technology that produces smaller amounts of electricity than other CSP technologies—typically in the range of 3 to 25 kilowatts—but is beneficial for modular use. The two major parts of the system are the solar concentrator and the power conversion unit

12-installatian and cost

12-1-Solar photovoltaics installatian and cost and problems.

- Solar photovoltaics is one of the most cost-effective technologies for electricity generation and therefore its use is growing across the globe. Global solar photovoltaic capacity has grown from around five gigawatts in 2005 to approximately 940 gigawatts in 2021. In that same year, cumulative solar PV installations reached some 307 gigawatts in China alone. Investment in solar energy has grown during the last years and the technology remains one of the most heavily funded renewable sources

- Between 2010 and 2021, the average installed cost of photovoltaics worldwide declined steadily due to the widespread availability of materials, which reduced production expenses. In 2021, the average installed cost of solar PV systems stood at 857 U.S. dollars per kilowatt. Likewise, the levelized cost of electricity (LCOE) for solar photovoltaics has seen a similar trend over the past decade.

-

Problems with panels can result in a production loss of up to 20%, since a poorly-performing panel will affect the production of a whole string of panels

- 1-**Hot spots on the panels:** Hot spots are places on the panels which are overloaded and therefore become warm. Hotspots on panels are mainly caused by badly-soldered connections, or are a result of a structural defect in the solar cells.
- Badly-soldered connections cause low resistance in the part of the panel that receives the power generated by the cell. As a result, the voltage can rise, which leads to a hotspot in the soldered points and/or a cell. This phenomenon can ultimately lead to a short-circuit, and reduces the performance and lifespan of the PV panel. We have identified hot spots in several solar parks, leading to solar panels being replaced, adding significant Opex costs to those projects.

- 2-**Micro-cracks:** One phenomenon we regularly encounter are 'micro-cracks' in crystalline PV panels. These are virtually imperceptible microscopic tears in the solar cells. Micro-cracks can occur during PV modules production, but also during shipping or due to careless handling practice during installation. Micro-cracks do not necessarily result in immediate production loss, incidentally, but can grow over time, for example due to thermal tension, or under the influence of seasonal and weather conditions. Larger micro-cracks will damage the solar cells, and this will lead to production loss.
- Damage at the solar cell's contact points will have a particularly significant influence on the cell's energy production. Because the cells in the panel are wired in series, this will also impact on the power output in the entire panel. As a result, the panel's performance decreases in direct correlation to the number of broken cells. Multiple busbars are often installed in the more expensive panels in order to mitigate this problem. We have recently tested several module brands at different solar parks and found out that, on average, micro-cracks affect a high percentage of the modules, resulting in significant production loss (we have seen 2-3% performance shortfall related to micro-cracks).

- 3-**Snail trail contamination:** Snail trail is a discolouration of the panel which usually only manifests itself after a couple of years of production. Snail trails have multiple causes, but one cause can be attributed to the use of defective front metallization silver paste, in the solar cell manufacturing process. Defective silver paste can lead to moisture in the panel, and as a result of this moisture, an oxydation can occur between the silver paste and the encapsulation material called EVA (ethylene vinyl acetate).
- This unwanted process releases silver oxide, acetic acid (vinegar) and hydrogen. The effect of this reaction is fed from the back of the panel to the front of the panel, and causes a chemical breakdown on the front of the panel. This becomes visible as 'snail trails', resulting in a reduction in the panel's performance. The snail trails can also arise as a result of microscopic cracks in the panel.
- 4-**PID Effect:** PID stands for 'Potential Induced Degradation'. This problem can arise when a voltage difference occurs between the panel and the earthing. For safety reasons, the solar panel is earthed, which can cause a harmful potential difference between the earthing and the voltage generated by the panel. In some cases, this generates a voltage which is partly discharged in the primary power circuit. The consequences of this effect are an ongoing reduction in performance and accelerated ageing of the PV panel. We have seen PID affecting solar plants and leading to performance loss of up to 10%. We are currently investigating several ways of reducing – or even reverting – PID effect.
- 5-**Internal corrosion, delamination:** Internal corrosion (rusting) occurs when moisture penetrates into the panel. Panels must be air- and water-tight. In order to achieve this, the components of panels (the glass layer, the solar cells and the back sheet) are laminated under vacuum. However, if the lamination process has been not done properly or was too short, this can lead to delamination during operation. Delamination is the detachment of the laminated components. Delamination – but also incorrectly fitted module trim, for example – can cause moisture to penetrate or bubbles to occur. Moisture leads to corrosion, which becomes visible as darker spots on the panel.
- This often starts at the edge of the panel and can – depending on the severity – spread across the rest of the panel. Corrosion on the metal conducting part of the panel – in particular – will lead to significant reduction in the panel's production. The panel's production will decrease in direct correlation to the size of these darker (corroded) areas. Frameless/thin-film PV panels and panels manufactured based on glass substrates in particular can also suffer from moisture and corrosion problems.

12-2-CSP installatian and cost and problems

- Between 2010 and 2021, the average installation cost for concentrated solar power (CSP) worldwide reached a record low at 4,746 U.S. dollars per kilowatt in 2020. In 2021, however, CSP installation costs increased again, amounting to 9,091 U.S. dollars per kilowatt installed

- The costs and electricity production of concentrating solar power (CSP) parabolic trough (PT) and solar tower (ST) plants are presented and compared with photovoltaics (PV) plants in the United States. Production and costs of alternative CSP technologies are strongly non-uniform. Without thermal energy storage (TES), actualized construction costs are 5213–6672 $/kW for CSP PT and 6084 $/kW for CSP ST. With TES, the actualized costs of PT and ST increase to 8258 $/kW and 9227 $/kW respectively. The annual capacity factors of the more reliable PT plants are 28–29% without TES, and 29–33% with TES. ST plants presently deliver much smaller annual capacity factors even when boosted by natural gas (NG) combustion, or fitted with TES. ST appears to be less mature and more troublesome technology than PT. TES is still not delivering the expected improvements suffering efficiency and reliability issues. PV are less expensive than CSP, with actualized construction costs 4739 $/kW. However, as the capacity factors of PV plants are only 26.3–28.5%, CSP already deliver a 1–2% better capacity factors even without TES. In a decadal perspective, PV may certainly suffer soon of the competition by CSP, more likely PT, with the addition of TES, once this energy storage technology will mature, if a simple but reliable mass production product could be defined.

Challenges Faced by Solar Thermal Power

- **1-Dependency on local partnerships :** Unlike PV panels which only require grid connectivity and availability of panels, CSP requires establishing a proper thermal power plant. This involves land, water, manpower, resources, and infrastructure among other things. For most raw materials solar companies will be dependent on the local supplies which may not meet the expected quality or service standards. Government approvals are required for land use and establishment of power plants.

- **2-Lack of experts in CSP :** CSP is known as the underdog of the alternative energy market. Since solar panels dominate the industry little attention has been paid to solar thermal power. Most of the technological advances that have taken place have happened in the sector of photovoltaics. Hence, there is lack of experts in the field of CSP. Even if a company wants to grow and expand its operations, it will have a hard time finding skilled individuals and professionals

- **3-Requirement of high startup capital :** As mentioned above CSP requires a lot more infrastructure, raw materials and manpower than installing solar panels. This means that the overheads involved in CSP are much higher. Added to this is the fact that CSP cannot be deployed on an individual level like PV panels.

- **4-Problems with natural gas :** One of the major directions in which CSP can head is hybridization. However the falling prices of natural gas poses a constant threat to the popularity of CSP and solar power in general. According to experts, solar power cannot compete with the prices of natural gas in general. Most of the consumers are worried about their wallets. Natural gas provides a cheaper and environmentally friendly option. The only way for CSP is to go is hybridization.

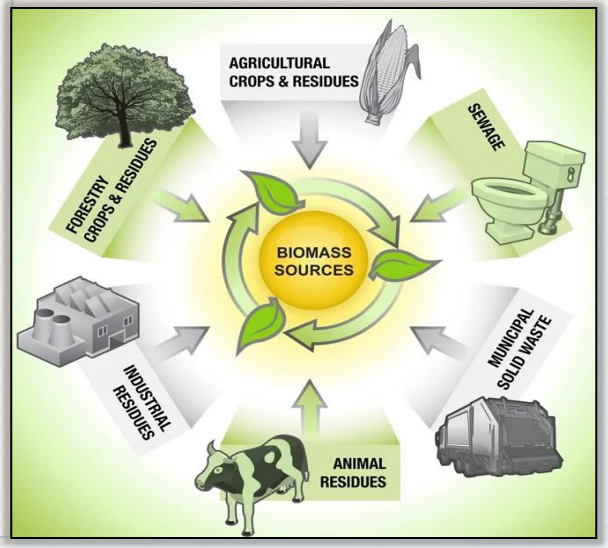
- **5-Still in early stage :** In spite of the latest developments in CSP energy storage like molten salt storage, the technology is still in its early stages and not fully ready for full-scale commercial application. CSP will still take about 10 years to reach where PV panels are today in terms of use and popularity.

13-Biomass :

Produce energy from lignocellulosic residues, biomass obtained from plant residues such as rice husks, coffee souks, palm oil, and sugar cane by implementing value-chains that include biorefineries that transform certified bio-products, resulting in an array of alternative fuels such as biodiesel and ethanol.

Some of the advantages of biomass energy

- 1-Biomass is always and widely available as a renewable source of energy
- 2-It is carbon neutral
- 3-It reduces the overreliance of fossil fuels.
- 4- Is less expensive than fossil fuels
- 5- Biomass production adds a revenue source for manufacturers.
- 6- Less garbage in landfills.



13-1-While the advantages of biomass energy are plenty, there are also some shortcomings, including

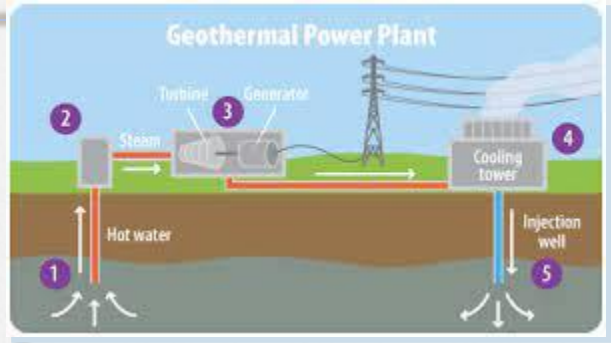
- 1-Biomass energy is not as efficient as fossil fuels
- 2-It is not entirely clean
- 3-Can lead to deforestation.
- 4-Biomass plants require a lot of space

14-GEOTHERMAL ENERGY

Geothermal energy utilizes the accessible thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.
Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.
Once at the surface, fluids of various temperatures can be used to generate electricity. The technology for electricity generation from hydrothermal reservoirs is mature and reliable, and has been operating for more than 100 years.

What are the Advantages of Using Geothermal?

- 1-Environmentally Friendly
- Geothermal energy is more environmentally friendly than conventional fuel sources such as coal and other fossil fuels. In addition, the carbon footprint of a geothermal power plant is low. While there is some pollution associated with geothermal energy, this is relatively minimal when compared to fossil fuels.
- 2. Renewable
- Geothermal energy is a source of renewable energy that will last until the Earth is destroyed by the sun in around 5 billion years. The hot reservoirs within the Earth are naturally replenished, making it both renewable and sustainable.



- 3. Huge Potential
- Worldwide energy consumption is currently around 15 terawatts, which is far from the total potential energy available from geothermal sources. While we can't currently use most reservoirs there is a hope that the number of exploitable geothermal resources will increase with ongoing research and development in the industry. It is currently estimated that geothermal power plants could provide between 0.0035 and 2 terawatts of power.
- 4. Sustainable / Stable
- Geothermal provides a reliable source of energy as compared to other renewable resources such as wind and solar power. This is because the resource is always available to be tapped into, unlike with wind or solar energy.
- 5. Heating and Cooling
- Effective use of geothermal for electricity generation requires water temperatures of over 150°C to drive turbines. Alternatively, the temperature difference between the surface and a ground source can be used. Due to the ground being more resistant to seasonal heat changes than the air, it can act as a heat sink/ source with a geothermal heat pump just two metres below the surface.
- 6. Reliable
- Energy generated from this resource is easy to calculate since it does not fluctuate in the same way as other energy sources, such as solar and wind. This means we can predict the power output from a geothermal plant with a high degree of accuracy.

- 7. No Fuel Required
- Since geothermal energy is a naturally occurring resource there is no fuel required, such as with fossil fuels that are a finite resource which needs mining or otherwise extracting from the earth.

- 8. Rapid Evolution
- There is a great deal of exploration into geothermal energy at the moment, meaning that new technologies are being created to improve the energy process. There are an increasing number of projects to improve and grow this area of industry. With this rapid evolution many of the current cons of geothermal energy will be mitigated against.

What are the Disadvantages of Geothermal Energy?

- 1. Location Restricted
- The largest single disadvantage of geothermal energy is that it is location specific. Geothermal plants need to be built in places where the energy is accessible, which means that some areas are not able to exploit this resource. Of course, this is not a problem if you live in a place where geothermal energy is readily accessible, such as Iceland.
- 2. Environmental Side Effects
- Although geothermal energy does not typically release greenhouse gases, there are many of these gases stored under the Earth's surface which are released into the atmosphere during digging. While these gases are also released into the atmosphere naturally, the rate increases near geothermal plants. However, these gas emissions are still far lower than those associated with fossil fuels.
- 3. Earthquakes
- Geothermal energy also runs the risk of triggering earthquakes. This is due to alterations in the Earth's structure as a result of digging. This problem is more prevalent with enhanced geothermal power plants, which force water into the Earth's crust to open up fissures to greater exploitation of the resource. However, since most geothermal plants are away from population centres, the implications of these earthquakes are relatively minor.
- 4. High Costs
- Geothermal energy is an expensive resource to tap into, with price tags ranging from around $2-$7 million for a plant with a 1 megawatt capacity. However, where the upfront costs are high, the outlay can be recouped as part of a long-term investment.
- 5. Sustainability
- In order to maintain the sustainability of geothermal energy fluid needs to be pumped back into the underground reservoirs faster than it is depleted. This means that geothermal energy needs to be properly managed to maintain its sustainability.

Summary:

- Through this research paper, we presented the sources of energy generation in the region and their capacity with alternatives and the most important renewable energies used to generate electricity, and we presented the ones used in the region with the problems, costs and disadvantages of each. We concluded that it is the best of the two methods.
- **1-Solar Photovoltaic**
- **2- Tower System Concentrating**