-> Get updated from all solar energy initiatives (bz they are imp. for mains) and their amendments.

Environment Class 17

29th March, 2024 at 9:00 AM

NATIONAL SOLAR MISSION (09:07 AM)

- The target was to achieve **100 GW** of installed solar energy capacity by 2022. (We could have achieved only approx. 57GW of energy.)
- It has been revised to **300 GW by 2030.**

PM SURYODAYA YOJANA

- The centre will subsidize the cost of setting up a rooftop solar system for households that consume less than **300 units** of electricity per month.
- The target is to install rooftop solar panels on **1 crore houses.**
- The household can become a supplier of electricity to the power grid if solar energy supply is more than demand.
- **Net metering** is required to record energy flow in both directions and at the end of the billing period net energy use is calculated (We targeted 40GW or 40% energy but we have achieved 25GW only.)

PM KUSUM YOJANA

- **It has three components:**
- a) Installation of stand-alone solar-powered agricultural pumps.
- b) Solarization of grid-connected agricultural pumps. (i.e. we install solar panels at power grid itself)
- c) 10 GW of solar capacity through the installation of small solar power plants with individual capacity up to 2 MW. (i.e. asking farmers to give permission for installation of Solar panels which can generate 2MW of energy and will be connected with power grid.)

SURYA MITRA

- It is a **skill development program** considering the opportunities for employment in growing solar energy power.

INTERNATIONAL SOLAR ALLIANCE

- On the sidelines of the **Paris Agreement 2015,** COP 21, India and France conceptualized the International Solar Alliance.
- It is headquartered in **Gurugram Haryana.**
- All UN members can become part of this alliance.
- It is guided by the Towards 1000s strategy: which aims to mobilise 1000 billion dollars of investment in Solar Energy by 2030 in developing nations.

ONE WORLD ONE SUN ONE GRID (09:33 AM) (OWOSOG)

- At the first assembly of ISA in 2018, the PM announced this initiative.
- It aims to connect different regional grids with common grids, that will be used to transfer renewable energy power, particularly solar energy.
- It was officially launched at COP26 of UNFCCC.
- **It aims to be implemented in three phases:**
- 1. Interconnection of Middle East, South Asia, and South East Asia.
- 2. This grid is getting interconnected with the African Power grid.
- 3. Global Interconnection

-> Do visit website of Niti Ayog to get information of potential energy developer states.

-> Wind turbines produce AC.
-> India has the 4th largest wind power capacity in the world.

WIND ENERGY (09:40 AM)

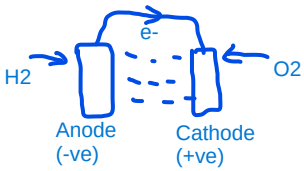
- There are two types of Wind Turbines:
- **1. Horizontal Axis Wind Turbine:** The design and installation are complex, they require larger space and depend upon wind direction but they have a higher power coefficient.
- **2. Vertical Axis Wind Turbines:** They are simpler and movement is not dependent upon wind direction but has a lower power coefficient.
- **Challenges:**
- **Intermittency:** Only efficient/functional when strong winds are blowing.
- High initial cost. -> Land use, Environmental impact (potential impact on birds and marine life).
- Offshore wind turbines can adversely affect aquatic ecosystem
- **Govt Schemes:**
- **National Wind-Solar Hybrid Policy 2018:**
- For efficient use of land, and transmission infrastructure, to reduce variability in renewable power generation, and to achieve better grid stability.

Govt. announced

- **National Offshore-Wind Energy Policy 2015:**
- To promote spatial planning and management of Maritime Renewable Energy Resources in India's EEZ by boosting indigenization.

HYDROGEN AS FUEL (10:04 AM) or Hydrogen as a source of energy.

- Hydrogen is a great energy source with very high energy density, clean burning, water vapour as the end product, ~~and~~ along with energy. $H_2 + O_2 \text{ ------> } 2H_2O$ (It is an Exothermic reaction)
- It is also a reliable source of energy, unlike solar or wind.
- Even though hydrogen is the most abundant element in the universe, on Earth and in the atmosphere, it is not available in free form, which allows industrial extraction.
- Different methods of production are used for hydrogen and all these production methods are assigned a color.
- 1. Green Hydrogen:
- It is produced through the electrolysis of water using renewable energy sources like solar, wind, tidal, etc. $2H_2O \text{ (Water)} \xrightarrow{\text{Energy}} 2H_2 + O_2$ (This Energy can be solar, wind, tidal, geothermal etc.)
- Green hydrogen does not produce greenhouse gases during production.
- If we use nuclear energy for electrolysis, we can call it pink or purple hydrogen.
- 2. Grey Hydrogen
- This uses a process called Steam-Methane Reforming.
- $CH_4 + H_2O \text{ (steam)} = CO + 3H_2$
- $CO + H_2O = CO_2 + H_2$ This is followed by water gas shift reaction where CO reacts with more steam and further produces Hydrogen.
- 3. Brown Hydrogen: This method releases significant amount of CO_2 in atmosphere.
- This uses a method called coal gasification.
- It involves the oxidation of coal to produce syngas. $C(coal) + H_2O \text{ -------> } CO + H_2$
- This follows the water gas shift reaction $CO + H_2O \text{ ---------> } CO_2 + H_2$
- This process generates a large amount of CO_2 and ~~coal tar~~ other gas which include coal tar, SO_2, NH_3 etc.
- It has certain benefits: even low-quality coal can be made into syngas and some of the byproducts have utility in industrial processes.
- 4. Turquoise Hydrogen
- It uses a process called methane pyrolysis. $CH_4 \xrightarrow{\text{Energy}} C(solid) + 2H_2$
- Environment friendliness depends upon the energy source.
- 5. Blue hydrogen:
- This is similar to grey and brown hydrogen but includes the capture of carbon dioxide.



H2 ----------> 2H+ + 2e-

2H+ + 2e- + 1/2O2 ----------> H2O

HOW TO USE HYDROGEN (10:58 AM)

- There are two methods:
- **i. Hydrogen Combustion Engine:** (efficiency is 40 to 50 percent)
- It works by burning hydrogen in a combustion chamber similar to how petrol or diesel engine operates.
- It requires air for combustion.
- Hydrogen is ignited in the presence of oxygen which leads to high temperature and high-pressure explosion
- This explosion forces a piston in the engine to move, converting the energy of the explosion into mechanical work moving vehicles or powering a generator.
- **ii. Fuel Cell**
- Fuel cells generate electricity through an electrochemical process similar to batteries but with a continuous supply of fuels.
- The most common type is a proton exchange membrane fuel cell.
- In a fuel cell, there is an anode, where hydrogen molecules are split into electrons and protons through a catalyst.
- A polymer electrolyte membrane allows protons to pass through but electrons are forced through an external circuit to the cathode (oxygen side).
- Where ~~electron~~ hydrogen ions, electrons and oxygen combines and form H_20 in the process, an electrical current is produced which can be used to do work.
- Fuel cells have very high efficiency (more than 80 percent).

CHALLENGES IN HYDROGEN AS A SOURCE OF ENERGY

- About 95 percent of hydrogen produced is through steam methane reforming and coal gasification. which have high carbon footprint.
- Green hydrogen production is a cleaner method but is very expensive and accounts for less than 5 percent of hydrogen production on a global scale.
- Hydrogen ~~is used~~ needs to be stored at high pressure in transportation which requires energy-expensive infrastructure and materials which can handle such Hydrogen storage.
- Another storage can be cryogenic (minus 250 degrees Celsius), this is very costly and energy-intensive.
- Moving hydrogen whether by pipeline road or other methods is challenging and expensive.
- Fuel cells are very expensive due to the use of catalysts like platinum.
- Hydrogen combustion engines are less efficient and contribute to NOx emissions.
- Hydrogen is highly flammable it's also the smallest and lightest molecule making it prone to leaks.

- **The government of India has announced the National Green Hydrogen Mission with the following Objectives:**
- 5 million metric tons of Green Hydrogen Production Capacity by 2030.
- 125 GW of electricity using green hydrogen.
- Reduction in fossil fuel import over 1 lakh crore rupees.
- 50 million metric tons of reduction of greenhouse gases.
- The mission has a financial incentive mechanism called Strategic Intervention for Green Hydrogen Transition Program. (SIGHT)

BIOFUELS

- Biomass is converted to energy through various processes including direct burning, ~~and chemical~~ or biological conversion ~~to a liquid or gaseous fuel.~~ thermo-chemical conversion to produce fuel
- Biomass-based energy is considered renewable as inherent energy comes from the sun and it can regrow in a relatively short time.

TYPES OF BIOFUELS

a. **Bioethanol:** It is made from the **fermenting and distillation** of crops that are high in carbohydrates such as corn wheat, and sugar cane among others.
- It is often used as an additive to Petrol which reduces CO2 emission.

b. **Biodiesel:**
- It is made from vegetable oil and animal fats.
- It can be used as an additive to diesel fuel in vehicles.

c. **Biogas:** (It is methane)
- It is produced by anaerobic digestion of organic matter such as agricultural waste or manure.

- ~~**Bioethanol:**~~ d. Biomethanol: (It is also called methyl alcohol or wood alcohol)
- Made from wood, organic waste, etc.

GENERATIONS OF BIOFUEL

- **Ist Gen Biofuels:** Made from feedstock such as Corn, Wheat, and Sugarcane, among others.
- **2nd Gen Biofuels:** These are made from nonfood feedstock such as agricultural waste, and rotting crops. and from non-food crop such as Jathropa. forestry residue
- **3rd Gen Biofuels:** Made from seaweed, algae, and others.
- 4th Gen: This includes genetic engineering to enhance the growth of algae and regeneration which can help further in biofuel production.

NATIONAL POLICY ON BIOFUEL 2018

- It divides biofuel into two categories **basic and advanced.**
- The viability gap funding scheme for ethanol refineries.
- **MSP for nonedible oil.** to incentivize farmers.
- the target of 20 percent blending of ethanol in petrol and 5 percent biodiesel in diesel by 2025.-26.
- It is implemented by the **National Biofuels Coordination Committee** under the Ministry of Petroleum and Natural Gas. (chaired by minister is the overall coordinator of policy)
- ~~Expoer~~ Export of biofuel will generally not be permitted except with the approval of NBCC.

Topic for the Next Class: Biofuel Continued

Policy aims at