

50 IMPORTANT TOPICS

REVISION SERIES FOR PRELIMS 2022



- GEOGRAPHY
- POLITY

- ENVIRONMENT
- HISTORY

- INDIAN ECONOMY
- IR
- SCI & TECH

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REVISION SERIES

PART 3

RENEWABLE ENERGY

RENEWABLE ENERGY

- Renewable energy is energy that is collected from **renewable resources** that are **naturally replenished on a human timescale**.
- It includes sources such as **sunlight, wind, rain, tides, waves, and geothermal heat**.
- Renewable energy often provides energy for: **electricity generation to a grid, air and water heating/cooling, and stand-alone power systems**.
- **Cogeneration or combined heat and power (CHP)** is the use of a **heat engine or power station to generate electricity and useful heat at the same time**.



RENEWABLE ENERGY CAPACITY

- The country's installed Renewable Energy (RE) capacity stands at 150.54 GW.
 - Solar: 48.55 GW
 - Wind: 40.03 GW
 - Small hydro Power: 4.83
 - Bio-power: 10.62
 - Large Hydro: 46.51 GW
 - Nuclear energy: 6.78 GW



4th largest installed capacity of renewable energy in the world



4th largest installed capacity of wind power in the world



Fifth-largest solar installed capacity in the world



RENEWABLE ENERGY CAPACITY

- At **COP 21**, as part of its Nationally Determined Contributions (NDCs), **India had committed to achieving 40% of its installed electricity capacity** from non-fossil energy sources by 2030.
- India has achieved its target of achieving **40% of its installed electricity capacity from non-fossil energy sources by 2030** in November 2021.
- The **total non-fossil based installed energy capacity** is 157.32 GW which is **40.1% of the total installed electricity capacity** of 392.01 GW.
- According to the Central Electricity Authority, by 2030, **India's power requirement will touch 817 GW**, more than half of which would be clean energy, and **280GW would be from solar energy alone.**



PM KUSUM

- Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan.
- Launched by the **Ministry of New and Renewable Energy (MNRE)**.
- To provide **energy and water security, de-dieselise the farm sector and also generate additional income for farmers by producing solar power**, Government launched PM-KUSUM Scheme for farmers.
- The Scheme consists of **three components**:
 - Component A: Installation of 10,000 MW of Decentralized Grid Connected Solar Power Plants each of capacity up to 2 MW
 - Component B: Setting up of 20 lakh standalone Solar Powered Agriculture Pumps
 - Component C: Solarisation of 15 Lakh existing Grid-connected Agriculture Pumps
- It is one of the biggest initiatives in the world **to provide clean energy to more than 3.5 million farmers across India.**



Solar Photo Voltaic (PV) Technology

- **Solar photovoltaic energy** or PV solar energy directly converts sunlight into electricity, using a technology based on the **photovoltaic effect**.
- When radiation from the sun hits one of the faces of a **photoelectric cell** (many of which make up a solar panel), it produces an **electric voltage differential** between both faces that makes the electrons flow between one to the other, **generating an electric current**.
- PV installations may be **ground-mounted, rooftop-mounted, wall-mounted** or floating.
- The mount may be **fixed** or use a **solar tracker** to follow the sun across the sky.

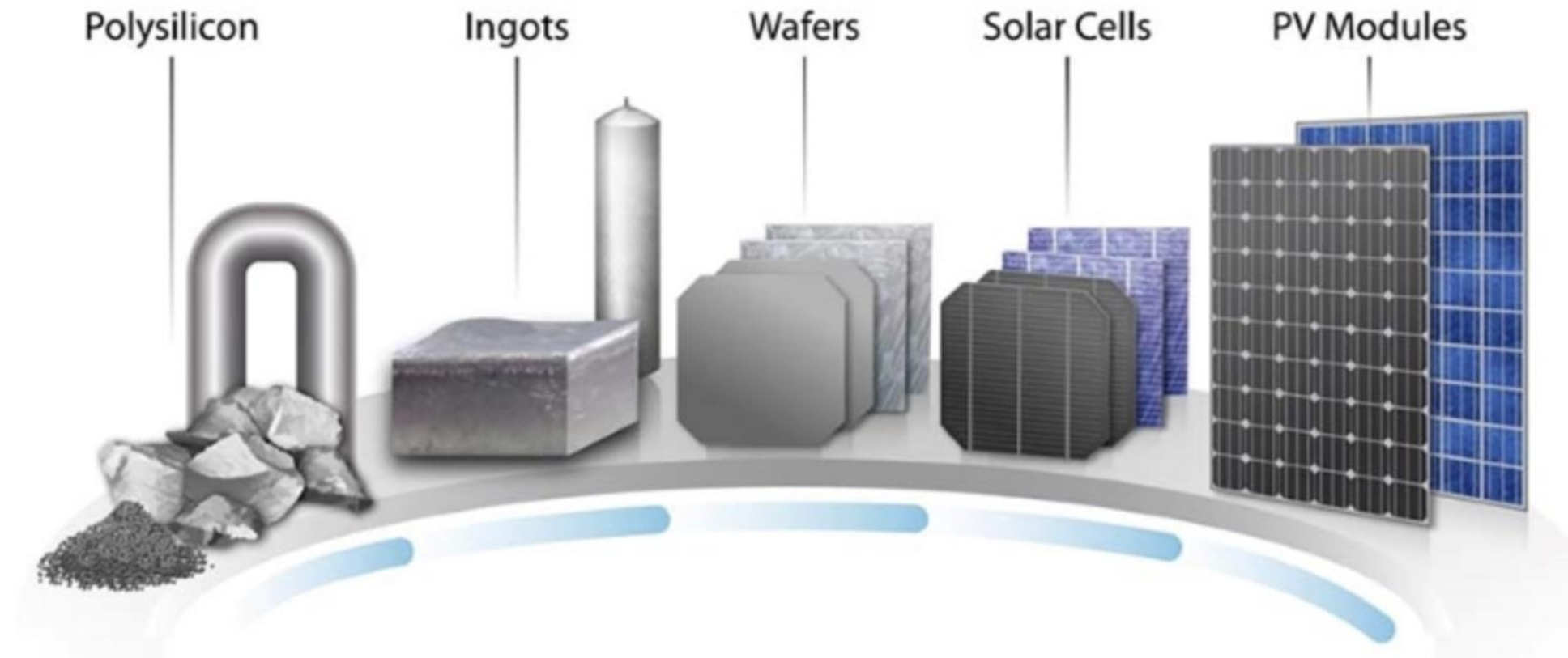


Production Linked Incentive (PLI) Scheme

- On 28.04.2021, the Government introduced, Production Linked Incentive Scheme “**National Programme on High Efficiency Solar PV Modules**” with an outlay of Rs. 4500 crores to **support and promote manufacturing of high efficiency solar PV modules**, including the **upstage vertical components** like cells, wafers, ingots and polysilicon in India and thus **reduce the import dependence** in Solar Photo Voltaic (PV) sector.
- The idea is **increased investment prospects in domestic manufacturing. (13 sectors with a total outlay of around Rs 2 lakh crore)**
- The plan to augment local manufacturing follows an **additional allocation of Rs19,500 crore** for the production-linked incentive (PLI) scheme for high-efficiency solar modules in the FY23 Union budget.
- India currently has a manufacturing capacity of **3GW for solar cells and 15GW for module.**
- The government plans to create an additional domestic solar equipment manufacturing capacity of **25 gigawatts (GW) each of solar cells and modules, and 10GW of wafers by April 2023**
- The **manufacturing push** comes ahead of India’s plan to impose a **basic customs duty of 40% on modules and 25% on solar cell imports** from 1 April 2022



Polysilicon, a high-purity form of silicon, is a key raw material in the solar photovoltaic (PV) supply chain. To produce solar modules, polysilicon is melted at high temperatures to form ingots, which are then sliced into wafers and processed into solar cells and solar modules.



Grid Connected Rooftop Solar Programme

- Government of India has set the target of achieving **100 GW of solar power capacity** in the country by the year **2022** of which **40 GW to be achieved from rooftop solar (RTS)**.
- Hence, it **aims** to achieve a cumulative capacity of **40,000 MW from Rooftop Solar Projects by the year 2022**.
- The Government, on 19th February 2019 approved **Phase-II of “Grid Connected Rooftop and Small Solar Power Plants Programme”** for achieving cumulative capacity of **40 GW RTS plants by 2022**.
- In Phase-II, it has been decided to implement the programme by making the **DISCOMs and its local offices** as the nodal points for implementation of the RTS programme.
- DISCOMs will play a key role in expansion of RTS as DISCOMs are having a direct contact with end user and they provide approval for installation, manage the distribution network and also have billing interface with rooftop owner.
- In a **grid-connected rooftop or small Solar Photovoltaic (SPV) system** wherein the **DC power generated from the SPV panel is converted to AC power** using the power conditioning unit and is fed to the grid.

Solar Parks Scheme

- To facilitate **large scale grid connected solar power projects**, a scheme for “**Development of Solar Parks and Ultra Mega Solar Power Projects**” is under implementation with a target capacity of **40 GW capacity by March 2022**.
- Solar parks provide solar power developers with a **plug and play model**, by facilitating necessary infrastructure like land, power evacuation facilities, road connectivity, water facility etc. along with all statutory clearances. (*'Plug and play' concept normally refers to ready facilities in terms of building, power-water-sewage connectivity, road connectivity, beside other basic things including clearances in hand required to start the industry*)
- As on 30.11.2021, **52 solar parks** have been sanctioned with a cumulative capacity of **37.92 GW in 14 states**.
- Solar power projects of an aggregate capacity of around **9.2 GW** have already been commissioned in these parks.



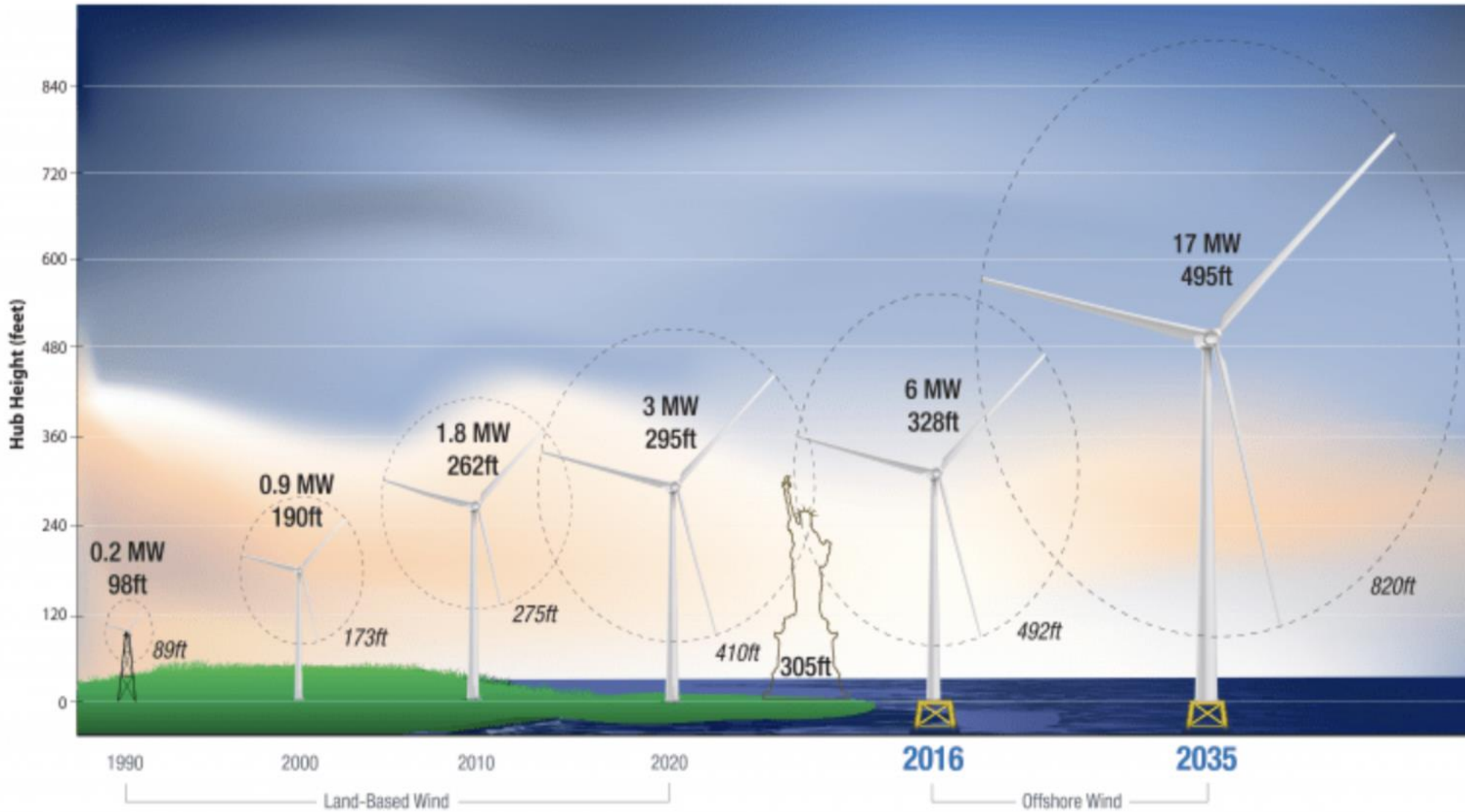
Offshore Wind Energy

- **Offshore wind energy** is obtained by harnessing the **power of the wind at sea**, where the wind **reaches a higher speed** and is **more constant** because there are **no barriers**.
- In order to make the most of this resource, **mega-structures are installed** that are seated on the seabed and equipped with the latest technical innovate
- Offshore wind farms must be at **least 200 nautical miles from the shore** and **50 feet deep** in the oceans.



Offshore Wind Energy

- The wind resources assessment carried out by the National Institute of Wind Energy (NIWE) gives **total wind energy potential at 302 GW at 100 meter and 695.50 GW at 120 meter hub height.**
- Out of the total estimated potential more than **95% of commercially exploitable wind resources** are concentrated in **seven states** (Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu).
- The precious land resources required for **onshore wind projects** are gradually becoming a **major constraint.**
- With exhaustion of best windy sites, we expect upward movements of market determined tariffs for onshore wind energy in future.
- Offshore wind turbines are **much larger in size** (in range of 5 to 10 MW per turbine) as against 2-3 MW of an onshore wind turbine.
- While, the **cost per MW** for offshore turbines are **higher** because of stronger structures and **foundations needed in marine environment, the desirable tariffs can be achieved on account of higher efficiencies** of these turbines after development of the eco system.



Wind Turbine Capacity (Megawatt) | Hub Height (feet)
Rotor Diameter (feet)

Illustration of increasing turbine heights and blades lengths over time

National Offshore Wind Energy Policy

- The **National Offshore wind energy policy** was notified in October 2015 with an **objective** to develop the **offshore wind energy** in the **Indian Exclusive Economic Zone (EEZ)** along the Indian coastline of 7600 km.
- **National Institute of Wind Energy (NIWE)** has been authorised as the Nodal Agency for development of offshore wind energy.
- **Eight zones** are identified each in **Gujarat and Tamil Nadu** having cumulative offshore wind energy potential of 70 GW.
- Ministry set a **target of 5.0 GW of offshore wind installations by 2022 and 30 GW by 2030** which has been issued to give confidence to the project developers in India market.



National Wind-Solar Hybrid Policy

- Solar and wind power **being variable** in nature pose certain **challenges** on grid security and stability.
- Studies revealed that in India, **solar and wind resources are complementary to each other** and **hybridization** of these two technologies would help in **minimizing the variability** apart from optimally utilizing the infrastructure including land and transmission system.
- Superimposition of wind and solar resource maps shows that there are **large areas** where **both wind and solar** have **high to moderate potential**.



National Wind-Solar Hybrid Policy

- The main objective of the **National Wind-Solar Hybrid Policy, 2018** is to provide a framework for promotion of **large grid connected wind-solar PV hybrid system** for **optimal and efficient utilization of wind and solar resources**, transmission infrastructure and land.
- The wind - solar PV hybrid systems will help in **reducing the variability** in renewable power generation and achieving better grid stability.
- The policy also aims to **encourage new technologies, methods and way-outs** involving combined operation of wind and solar PV plants.



National Wind-Solar Hybrid Policy

- The existing wind farms have scope of adding solar PV capacity and similarly there may be wind potential in the vicinity of existing solar PV plant.
- On technology front, the Policy provides for **integration of both the energy sources** i.e. wind and solar at AC as well as DC level.
- The Policy also provides for **flexibility in share of** wind and solar components in hybrid project, subject to the condition that, rated power capacity of one resource be **at least 25 per cent** of the rated power capacity of other resource for it to be recognised hybrid project.
- The Policy provides for procurement of power from a hybrid project on **tariff based transparent bidding process** for which Government entities may invite bids.
- Policy also permits use of **battery storage** in the hybrid project for optimising the output and further reduce the variability.
- It mandates the regulatory authorities to formulate necessary standards and regulations for wind-solar hybrid systems.



Wind-Solar Hybrid Parks

- The Union Ministry of New and Renewable Energy (MNRE) is planning on setting up new solar hybrid parks in the country.
- The solar power project is commissioned on contiguous land, while the wind power project requires scattered land on footprint basis.
- It not only increases the transmission cost but also increases the possibility of land-related issues.
- In order to overcome these challenges and to speed up the installation of wind power projects, the scheme – **Development of Wind Parks/Wind-Solar Hybrid Park** – with proper infrastructure including evacuation facilities in place has been proposed.
- The competitive bidding process has resulted in competitive tariffs which are much lower than traditional Feed-in Tariffs.
- A number of projects have been **delayed** due to land, NoCs and transmission related issues.
- These challenges and uncertainties have raised the concerns of investors in the sector.
- Wind Energy Park will **provide a plug and play solution** (availability of land, transmission, necessary infrastructure and necessary approvals) to the investors for installing wind/wind-solar power projects.



Wind-Solar Hybrid Parks

- The probable sites for the parks have been identified with the help of **National Institute of Wind Energy (NIWE)** on the basis of availability of mainly wind resource and suitability of land for such projects.
- The identified sites would be circulated to **concerned state governments for their approval.**
- The State government would designate park developer who would undertake the development of park including DPR preparation, land, transmission infrastructure, etc.
- Sites have been identified across **seven states** – Tamil Nadu, Andhra Pradesh, Karnataka, Telangana, Gujarat, Rajasthan and Madhya Pradesh – and the Concept Note has identified potential to install projects for a capacity of 53,495 MW (5 MW per sq. km).
- The capacity of each park should be **500 MW and more.**
- The parks of lower capacity may also be developed depending upon the availability of land and resource.
- The capacity of each park shall not be less than 50 MW.
- MNRE will provide financial assistance of ₹25 lakh per park to the developer for DPR preparation and ₹30 lakh per MW or 30 per cent of the park development cost to park developer, whichever is lower



International Solar Alliance

- It is an **Indian initiative** that was launched by the **Prime Minister of India and the President of France** on 30th November 2015 in Paris, France on the side-lines of the Conference of the Parties (**COP21**), with **124 solar resource-rich countries** lying fully or partially between the tropic of Cancer and tropic of Capricorn as prospective members. (Sunshine countries -Suryaputra ("Sons of the Sun"))
- The **primary objective** of the alliance is to work for **efficient consumption of solar energy** to reduce dependence on fossil fuels and its mission is “working towards making solar energy **available 24×7 at affordable cost to all**.”
- The objective is to collectively **address key common challenges** to the scaling up of solar energy in ISA member countries.
- The International Solar Alliance (ISA) became **first international intergovernmental organization** headquartered in India (Gurugram) on 6th December, 2017.
- ISA is part of **India's vision** to provide clean and affordable energy to all.

International Solar Alliance

- The alliance is a **treaty-based inter-governmental organization**.
- Countries that **do not fall within the Tropics can join** the alliance and enjoy all benefits as other members, with the exception of voting rights.
- After the United Nations, it is the largest grouping of states world-wide.
- The alliance is also called International Agency for Solar Policy and Application (IASPA).
- The organisation aims to **deploy over 1,000 gigawatt of solar energy and mobilise more than USD 1,000 billion into solar power by 2030**, according to the United Nations Framework Convention on Climate Change (UNFCCC).



International Solar Alliance

- The International Solar Alliance (ISA) and the Ministry of External Affairs (MEA), signed **the Host Country Agreement**.
- The Agreement will give ISA a **juridical personality** and gives it power to contract, to acquire and dispose of movable and immovable properties, to institute and defend legal proceedings.
- Under this agreement, ISA shall enjoy such **privileges, applicable tax concessions and immunities** as are necessary for ISA's Headquarter to independently discharge its function and programmes.
- ISA shall be deriving its status, privileges and immunities as per Article 10 of Framework Agreement.



OSOWOG

- **India had first proposed connecting** solar energy supply across borders at the International Solar Alliance in 2018 to allow parts of the world with excess renewable power to send power to other countries.
- The vision behind the OSOWOG is “**The Sun Never Sets**” and is a constant at some geographical location, globally, at any given point of time.
- Hence solar energy can be utilized through **interconnected transmission**.
- The proposal is aimed at addressing the **issue of reliability** of supply from solar power plants, which do not generate electricity after the sun has set.
- A **transnational grid** would allow countries to source solar power from regions where it is daytime to meet their green energy needs even when their own installed solar capacity is not generating energy.
- OSOWOG is also aimed at addressing the issue of **high cost of energy storage**.
- **High cost of energy storage** is a key challenge to boosting the use of renewable energy and that the OSOWOG initiative is a possible solution for driving down the need for storage, which in effect will reduce the costs of the energy transition.



OSOWOG

- OSOWOG is planned to be completed in **three phases**.
 - The first phase will entail interconnectivity within the **Asian continent**;
 - The second phase will add **Africa** and
 - the third phase will **globalise the whole project**.

Green Grids Initiative

- In May 2021 a partnership was revealed with the **UK's Green Grids Initiative**, a coalition to accelerate the deployment of solar infrastructure around the world.
- The project was formally launched at COP26 on 2 November.
- The 'Green Grids Initiative' is backed by **more than 80 countries**.
- It will allow areas with **excess renewable power to send it to areas with deficits**.
- Aiming to synergize its efforts and actions with other similar initiatives globally, **OSOWOG has joined hands with GGI to form a unified GGI-OSOWOG initiative**, which aims to contribute to the collaborative, rapid development of resilient grids globally – building on continental, regional and national grid infrastructure programs.

Global Solar Council

- The Global Solar Council (GSC) was launched on December 6, 2015, following the **historic United Nations Climate Change Conference (UN COP 21)**.
- The GSC came into being as **International Coalition of more than 30 nations**, utilising maximum solar energy, decided to harness the renewable energy for the greater good.
- The GSC has its headquarters in Washington D.C., USA.
- Global Solar Council is an **international non-profit association** of the **national, regional and international associations** in solar energy and the world.

Renewable Energy Certificates

- Renewable Energy Certificates (RECs) are a **market-based instrument** that certifies the bearer owns **one megawatt-hour (MWh)** of electricity generated from a renewable energy resource.
- Once the power provider has fed the energy into the grid, the REC received can then be sold on the open market as an energy commodity.
- RECs earned may be sold, for example, to other entities that are polluting as a carbon credit to offset their emissions.
- In India, RECs are traded on two power exchanges – **Indian Energy Exchange (IEX)** and **Power Exchange of India (PXIL)**.
- The price of RECs is determined by **market demand**, and contained between the 'floor price' (minimum price) and 'forbearance price' (maximum price) specified by the **Central Electricity Regulatory Commission (CERC)**.



Renewable Energy Certificates

- There are **two categories of RECs**
 - **Solar RECs** –They are issued to eligible entities for generation of electricity based on solar as renewable energy source
 - **Non-solar RECs** –They are issued to eligible entities for generation of electricity based on renewable energy sources other than solar.
- **National Load Despatch Centre (NLDC)** is responsible for registration of Renewable Energy Generation Facilities, issuance of Renewable Energy Certificates etc.
- Under the renewable purchase obligation (RPO), bulk purchasers like **discoms, open access consumers and capacitive users** are required to buy certain proportion of RECs.

REC - Amendments

The Salient features of changes proposed in revamped REC mechanism are -

- **Validity of REC** would be **perpetual** i.e., till it is sold.
- Floor and forbearance prices are **not required to be specified.**
- CERC to have **monitoring and the surveillance mechanism** to ensure that there is no hoarding of RECs.
- The RE generator who are eligible for REC, will be eligible for issuance of RECs for the period of PPA as per the prevailing guidelines. The existing RE projects that are eligible for REC would continue to get RECs for 25 years.

REC - Amendments

- A **technology multiplier** can be introduced for promotion of new and high priced RE technologies, which can be allocated in various baskets specific to technologies depending on maturity.
- RECs can be issued to **obligated entities** (including DISCOMs and open access consumers) which purchase RE Power beyond their RPO compliance notified by the Central Government.
- **No REC** to be issued to the beneficiary of subsidies/concessions or waiver of any other charges. The FOR to define concessional charges uniformly for denying the RECs.
- Allowing **traders and bilateral transactions** in REC mechanism.
- The changes proposed in revamped REC mechanism will be **implemented by CERC** through regulatory process.

CERC

- Central Electricity Regulatory Commission, a **key regulator** of power sector in India, is a **statutory body** functioning with quasi-judicial status under sec - 76 of the **Electricity Act 2003**.
- Under **Ministry of Power**.
- **Purpose** - Rationalization of electricity tariffs, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies and for matters connected Electricity Tariff regulation.



RPO

- To provide a **fillip to the ambitious renewable energy targets**, obligations have been imposed on **certain entities to purchase energy from renewable sources** by various state electricity regulatory commissions (SERCs) based on each state's varying renewable energy potentials.
- Known as renewable purchase obligations (RPOs), **power distribution companies, captive power plants and other large electricity consumers** are bound to meet them by **purchasing a certain percentage of their requirements from renewable energy sources.**



RPO

- **RPO, instituted in 2011**, is a mandate that requires **large power procurers** to source a **pre-determined fraction** of their electricity from renewable sources.
- The **Ministry of New and Renewable Energy (MNRE)** introduced **incremental annual RPO targets** amounting to 21 per cent in 2022.
- To address **mismatch** between availability of RE sources and the requirement of the obligated entities to meet their renewable purchase obligation (RPO), **Pan-India market-based Renewable Energy Certificate (REC) Mechanism** was introduced in the year 2010.
- Renewable energy producers sell electricity to distribution licensees at the rate of conventional energy and recover the balance cost by selling RECs to other obligated entities, enabling them to meet their RPOs.
- RECs serve as a **substitute to physical procurement** of renewable energy and help obligated entities to plan and tap on favourable market conditions.



Indian Energy Exchange

- It is India's premier energy marketplace, providing a nationwide **automated trading platform** for the **physical delivery of electricity, renewables, and certificates**.
- It is India's first and largest power and electricity exchange.
- It commands a market share of over **98 percent of the traded volume in power**, as well as a broad participant base of over 6300. (Other - Power Exchange of India Ltd - PXIL)
- More recently, IEX has pioneered **cross border electricity trade** expanding its power market beyond India in an endeavour to create an **integrated South Asian Power Market**.
- IEX is powered by state-of-the-art, intuitive and customer centric technology, enabling **efficient price discovery** and **facilitating the ease of power procurement**.

Indian Energy Exchange

- It is the **first and largest energy exchange** in India providing a nationwide, automated trading platform for physical delivery of electricity, Renewable Energy Certificates and Energy Saving Certificates.
- The exchange platform **enables efficient price discovery** and increases the **accessibility and transparency** of the power market in India while **also enhancing the speed and efficiency of trade execution.**
- It is a publicly listed company with National Stock Exchange (NSE) and Bombay Stock Exchange (BSE).
- It is approved and regulated by **Central Electricity Regulatory Commission (CERC)** and has been **operating since 2008.**

Markets

IEX offers various compelling choices to trade in – Electricity Market, Green Market and Certificates.

Electricity Market

- Day Ahead Market
- Term Ahead Market
- Real Time Market
- Cross Border Electricity Trade

Green Market

- Green Term Ahead Market

Certificate Market

- Renewable Energy Certificates
- Energy Saving Certificates

GDAM

- It is a marketplace for **trading renewable power** on a **day-ahead basis**.
- The day-ahead market allows **buyers and sellers to hedge against price volatility in the Real Time Energy Market** by locking in energy prices before the operating day.
- **National Load Despatch Center (NLDC)**, Power System Operation Corporation Limited (POSOCO) as the **nodal agency** has set up the requisite technologies and infrastructure for the launch of the GDAM.
- With GDAM, any **renewable energy generating company** can set up and sell renewable energy on the exchange.
- The Green Day-ahead market will **operate in an integrated way** with the conventional day-ahead market.
- The Exchanges will offer the market participants to submit bids together for both conventional and renewable energy through the **separate bidding windows**.
- The clearance will take place in a **sequential manner** - renewable energy bids will be cleared first in accordance with the must run status of the renewables, followed by conventional segment.
- This mechanism will allow renewable energy sellers to **subsequently bid** in the conventional segment should their bids remain uncleared in the green market.
- There will be **separate price discoveries** for the both the conventional and renewables.

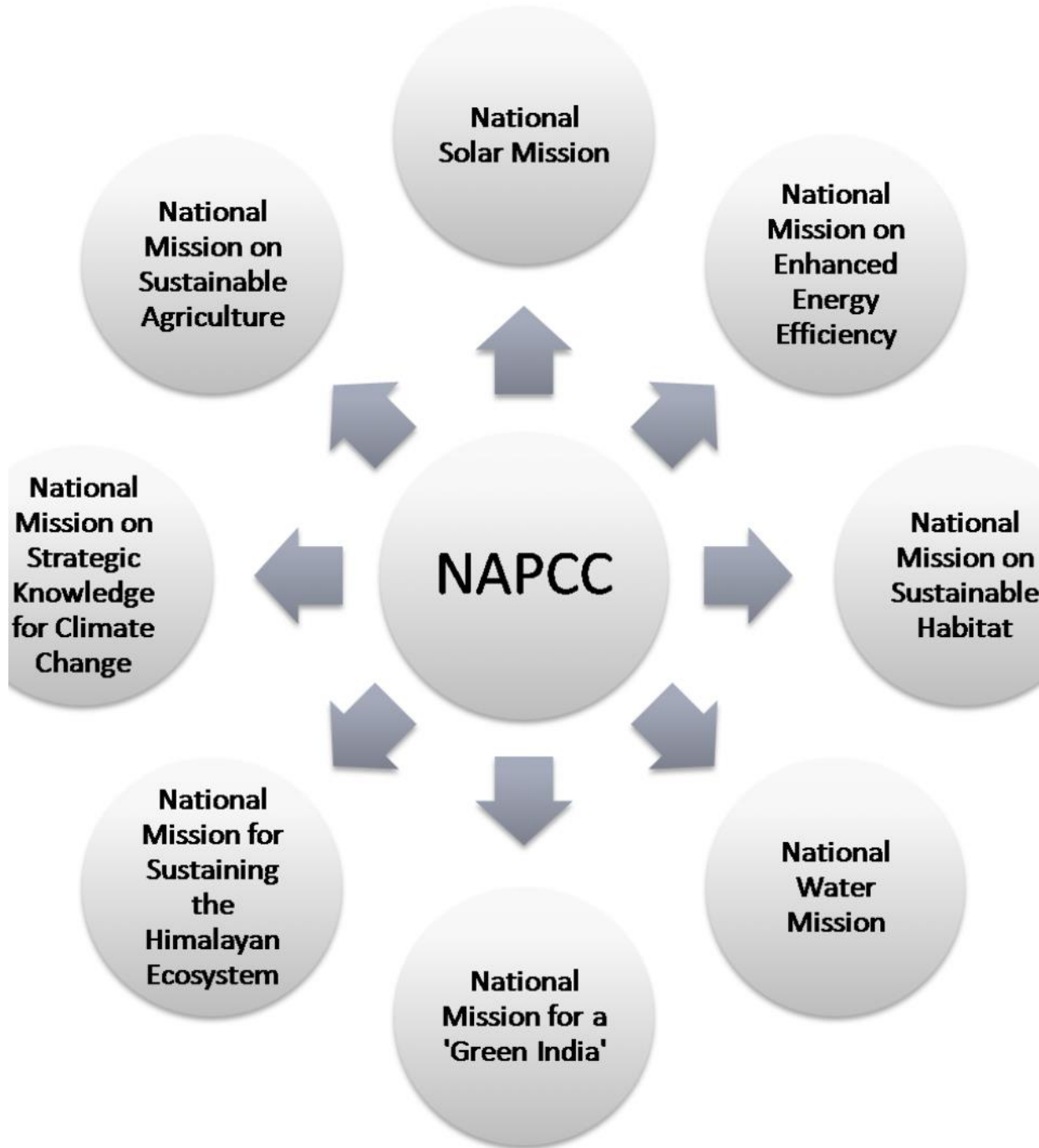


GTAM

- On 21 August 2020, the green term-ahead market (GTAM), a **power trading platform**, was launched to **enable bulk electricity buyers** (discoms; corporates with a contracted load of 1 MW or above) to procure renewable energy (RE) on a **short-term basis** from sellers (merchant RE projects or discoms having surplus RE beyond their renewable purchase obligations or RPOs).
- Typically, **discoms and open-access consumers procure electricity** by signing **long-term power purchase agreements (PPAs)** for seven years or above.
- But, with GTAM's launch, a new platform has emerged through from which these buyers can procure RE.

GTAM

- It is an **alternative new model introduced** for selling off the power by the renewable developers in the open market without getting into **long term PPAs**.
- Transactions through GTAM will be **bilateral** in nature with clear identification of corresponding buyers and sellers, there will not be any difficulty in accounting for Renewable Purchase Obligations (RPO).
- GTAM contracts will be segregated into **Solar RPO & Non-Solar RPO** as RPO targets are also segregated.
- **Daily & Weekly Contracts** – Bidding will take place on MWh basis.
- **Price discovery** will take place on a **continuous basis, price time priority basis**.
- Subsequently, looking at the market conditions **open auction** can be introduced for **daily & weekly contracts**.
- Energy scheduled through **GTAM contract** shall be considered as **deemed RPO compliance of the buyer**.



Perform Achieve and Trade (PAT)

- **Perform Achieve and Trade (PAT) scheme** is a market-based compliance mechanism to accelerate improvements in **energy efficiency in energy intensive industries**.
- The Union Ministry of Power and Bureau of Energy Efficiency were entrusted with the task of preparing the implementation plan for the NMEEE.
- ‘Perform, Achieve and Trade’ (PAT) is a competitive mechanism under NMEEE for **reducing energy use in large industries**.
- The government shortlists industries and restricts the amount of energy they can consume and defines a time limit of three years by when this restriction should be met as part of PAT scheme.
- These **three years of time** are called one **PAT cycle**.
- The industries are chosen after in-depth, sectorwise analysis by the government.



Perform Achieve and Trade (PAT)

- Industries that participate in this scheme are called **designated consumers (DC)**.
- Those that overachieve their targets are issued **energy savings certificates (ESCerts)** that can be traded with industries that have not achieved their targets.
- Non-achievers have to buy the ESCerts after the three years for compliance.
- Announcements for **six cycles** since 2012 have been made so far.
- The energy savings achieved by notified industries is converted into tradable instruments called Energy Saving Certificates (ESCerts).
- The ESCerts after issuance by Bureau of Energy Efficiency are traded at **Power Exchanges**.
- **BEE has developed online PATNet portal** for issuance/entitlement to purchase of ESCerts in electronic forms defined in the PAT Rules, 2012.
- **CERC is the market regulator** for trading of ESCerts and POSOCO is Registry for ESCerts.
- **Trading off ESCerts at Power Exchange** had commenced from 26th September, 2017.



Perform Achieve and Trade (PAT)

- PAT scheme covered about **13 energy-intensive sectors**.
- Sectors included are thermal power plants (TPP), cement, aluminium, iron and steel, pulp and paper, fertiliser, chlor-alkali, petroleum refineries, petrochemicals, distribution companies, railways, textile and commercial buildings (hotels and airports).
- BEE has rolled out **six PAT cycles** till 31st March, 2020, with a total of 1073 DCs covering 13 sectors.
- It is projected that **total energy savings** of about 26 MTOE translating into avoiding of about 70 million tonnes of CO₂ will be achieved by March 2023.



Bureau of Energy Efficiency

- The Bureau of Energy Efficiency is an agency of the Government of India, under the **Ministry of Power** created in March 2002 under the provisions of the **nation's 2001 Energy Conservation Act**.
- The agency's function is to **develop programs** which will increase the **conservation and efficient use of energy** in India.

Energy Accounting

- The **government has** mandated electricity distribution companies to undertake **energy accounting** on periodic basis.
- A regulation in this regard was issued by Bureau of Energy Efficiency (BEE) with the approval of Ministry of Power, under the provisions of **Energy Conservation (EC) Act, 2001**.
- **Energy accounting reports** will provide **detailed information about electricity consumption by different categories** of consumers and the **transmission and distribution losses** in various areas.
- It will identify areas of **high losses and theft and enable corrective action**.
- This measure will also enable **fixation of responsibility** on officers for losses and theft.
- The data will enable the discoms to take **appropriate measure** for reducing their electricity losses.
- The discoms will be able to plan for **suitable infrastructure up-gradation as well as demand side management (DSM) efforts** in an effective manner.
- This initiative will **further contribute** towards India's climate actions in meeting our Paris Agreement Goals



Hydrogen

- Hydrogen is emerging as an important source of energy since it has **zero carbon content** and is a **nonpolluting** source of energy in contrast to hydrocarbons that have net carbon content in the range of 75– 85 per cent.
- As per International Renewable Energy Agency (IRENA), Hydrogen shall make up **6 per cent of total energy consumption by 2050**.
- It is also the **most abundant element** in the universe.
- But on Earth it is found in **complex molecules** such as water or hydrocarbons.
- It takes **more energy to produce hydrogen** (by separating it from other elements in molecules) than hydrogen provides when it is converted to useful energy.



Hydrogen

- The **by-product** the burning of hydrogen produces is **water**.
- Combusting one kilo of hydrogen releases three times more energy than a kilo of gasoline and produces only water.
- It has the **highest energy content by weight and lowest energy content by volume**.
- **Hydrogen fuel cell** is an **electrochemical cell** that converts the chemical energy of hydrogen and oxygen into electricity, whose waste product, again, is water.
- Fuel cells can produce **electricity continuously** for as long as hydrogen and oxygen are supplied



Hydrogen - Color Coding

- **Green hydrogen** is produced through **water electrolysis** process by employing renewable electricity. The reason it is called green is that there is **no CO₂ emission** during the production process. Water electrolysis is a process which uses electricity to decompose water into hydrogen gas and oxygen.
- **Blue hydrogen** is sourced from **fossil fuel**. However, the CO₂ is captured and stored underground (carbon sequestration). As no CO₂ is emitted, so the blue hydrogen production process is categorised as carbon neutral.
- **Gray hydrogen** is produced from **fossil fuel** and commonly uses steam methane reforming (SMR) method. During this process, CO₂ is produced and eventually released to the atmosphere.
- **Black or brown hydrogen** is produced from **coal**. The black and brown colours refer to the type bituminous (black) and lignite (brown) coal. The gasification of coal is a method used to produce hydrogen. However, it is a very polluting process, and CO₂ and carbon monoxide are produced as byproducts and released to the atmosphere.



Hydrogen - Color Coding

- **Turquoise hydrogen** can be extracted by using the thermal splitting of methane via methane pyrolysis. The process, though at the experimental stage, remove the carbon in a solid form instead of CO₂ gas.
- **Purple hydrogen** is made though using nuclear power and heat through combined chemo thermal electrolysis splitting of water.
- **Pink hydrogen** is generated through electrolysis of water by using electricity from a nuclear power plant.
- **Red hydrogen** is produced through the high-temperature catalytic splitting of water using nuclear power thermal as an energy source.
- **White hydrogen** refers to naturally occurring hydrogen.



National Hydrogen Energy Mission

- There will be **five key areas** the government will focus on.
- These include R&D, demand creation, how it can be used in industry, how to create an eco-system including policies for this and how to bring industry on board along with international partnerships.
- In these five areas, **demand creation will focus on what kind of niche products** can be taken up and how effectively the fuel can be used in trucks and buses.
- In the industrial sector, the government is looking at hydrogen as a **replacement for coke** in the steel industry and also making use of the fuel in the fertiliser sector.
- MNRE has indicated that by 2025-26, the **industrial sector** will be one of the major recipients of hydrogen.



National Hydrogen Energy Mission

- The government plans to implement the **Green Hydrogen Consumption Obligation (GHCO)** in **fertilizer production and petroleum refining**, similar to what was done with renewable purchase obligations (RPO).
- With the current cost of green hydrogen produced by electrolysis estimated at around **₹350 per kg**, the plan is to more than halve it to **₹160 per kg by 2029-30**.
- The government also aims to extend the **production-linked incentive (PLI)** scheme for **manufacturing electrolyzers** to produce green hydrogen.

Hydrogen CNG (H-CNG)

- An ideal blend of **18% hydrogen in CNG** can be used as automotive fuel after compression.
- It is cleaner and more economical.
- HCNG will ensure **70% more reduction** in carbon monoxide emissions compared to CNG.
- The **thermal efficiency and fuel economy** is also increased by HCNG.
- In a step towards promoting alternative clean fuel for transportation, the Union road transport and highways ministry has notified hydrogen-enriched compressed natural gas (CNG) as an automobile fuel.
- It is an intermediate but important step in our transition towards a hydrogen economy.
- It can also be used as an **industrial input** to refineries.
- 50 buses have been rolled out as part of a pilot project in Delhi that use blended hydrogen in compressed natural gas (CNG) with plans to scale it up in the coming months across the country.



Flexible/Flex Fuel Vehicles

- Also known as **dual-fuel vehicle**.
- It is a well-accepted concept in **Brazil**, representing over 80% of the total number of new vehicles sold in the country (2019).
- It is a modified version of vehicles that which comprises of **the internal combustion engine** which could run both on gasoline and blended petrol with either ethanol or methanol fuel.
- Both of the fuels are stored in **same common tank**.
- The **fuel injection and spark timing** are automatically adjusted in accordance with the actual blend detected by the fuel composition sensor.
- Though technology exists to allow ethanol FFVs to run on any mixture of gasoline and ethanol, from pure gasoline up to 100% ethanol (E100), North American and European flex-fuel vehicles are optimized to run on **E85**, a blend of 85% anhydrous ethanol fuel with 15% gasoline.
- The government has also advised carmakers to start making **Flex Fuel Strong Hybrid Electric Vehicles (FFSHEV)**. Such a vehicle, though yet to be made widely available in world markets, essentially houses an electric motor which powers the vehicle alongside the traditional petrol engine
- FFV is different from the **bi-fuel vehicles** as in the bi-fuel vehicle, **two fuels are stored in the separate tanks** and engine runs on one fuel at a time.



Global Fuel Economy Initiative

- The Global Fuel Economy Initiative (GFEI) is collaboration between the **UNEP, IEA, the University of California, International Council on Clean Transportation, International Transport Forum and the FIA Foundation.**
- GFEI promotes **fuel efficiency in cars** and light duty vans, through the adoption of the **cost effective fuel efficiency technologies.**
- The objective of the GFEI is to **help stabilize greenhouse gas emissions** from the global light duty vehicle fleet through a **50% improvement of vehicle fuel efficiency worldwide by 2050.**
- GFEI promotes the introduction of cleaner, more energy efficient vehicles in **developing and transitional countries.**
- It offers **support to governments** to develop fuel economy policies.



National Policy on Biofuels 2018 - Amendments

- Recently, the Union Cabinet approved amendments to the National Policy on Biofuels, 2018.
 - To allow **more feedstocks** for production of biofuels
 - To promote the **production of biofuels in the country**, under the Make in India program, by units located in Special Economic Zones (SEZ)/ Export Oriented Units (EoUs),
 - Addition of **new members** to the **National Biofuel Coordination Committee (NBCC)** which is chaired by the union minister of petroleum and natural gas and has members from 14 other ministries. *(As per National Policy on Biofuels-2018, this Ministry has constituted a National Biofuel Coordination Committee (NBCC), under the Chairmanship of Minister, Petroleum & Natural Gas (P&NG) to provide overall coordination, effective end-to-end implementation and monitoring of biofuel programme)*



National Policy on Biofuels 2018 - Amendments

- Permission will be granted for the **export of biofuels in specific cases.**
- Instead of 2030, the Centre plans to move ahead with its **ethanol blending target of 20% of petrol containing ethanol by 2025-26.**
- To **delete/amend certain phrases** in the Policy in line with decisions taken during the meetings of National Biofuel Coordination Committee.



National Policy on Biofuels 2018

- **1st Generation Biofuels:** Also called conventional biofuels. It is derived from starch, sugar and vegetable oil. It creates pressure on food security as it deviates the food resources towards fuel production.
- **2nd Generation Biofuels:** It is derived from woods, organic wastes, paddy straw, etc. This does not create pressure on food security.
- **3rd Generation Biofuels:** It is extracted from marine algae.
- **4th Generation Biofuels:** It is extracted from marine algae but at the same time it is emission negative. It absorbs more emissions than it produces.



Thank you