

ESI-2021-22 AND OTHER CA 2021-22 INDUSTRY (ESI – CHAPTER-8) – PART-3

Table of Contents

1. Renewable Energy: Wind Energy	2
1) Wind ENergy.....	2
2) Offshore Wind Energy	2
3) National Wind Mission	3
4) Scheme for procurement of blended wind power from 2500 MW ISTS connected projects.....	3
5) Report: Global Wind Report 2022	3
2. Renewable: Hydroelectricity	3
3. Renewable: Biofuels	4
1) Generations of Biofuel.....	4
2) Ethanol Blending	5
3) National Policy on Biofuels, 2018.....	7
4) Pradhan Mantri Ji-Van (Jaiv Indhan Vatavaran Anukool Fasal Awashesh Nivaran) Yojana.....	7
5) ICAR-Central Tuber Crops Research institute (CTCRI) finds Cassava (Tapioca) as promising raw material for bioethanol (June 2021)	8
4. Methanol (CH₃oh) Economy	8
6) Methanol Production from High Ash Coal	9
5. Coal Gasification.....	10
7) National Coal Gasification Mission	10
8) Budget 2022-23 announced: “Four Pilot Projects for Coal gasification and Conversion of Coal into chemicals required for the industry to be set up to evolve technical and financial viability”	10
6. Used Cooking Oil (UCO) Based Biodiesel	10
7. Other Recent initiatives	11
1) National Mission on Use of Biomass in Coal Based Thermal Power Plants (May 2021: PIB)	11
2) E-100 Pilot Projects (June 2021).....	11

• Biogas production of Fat Rich Sludge (Sep 2021).....	11
3) Steps Taken to Promote Bio-Gas.....	12
8. Hydrogen Energy.....	13
1) Hydrogen Fuel Cell.....	13
a) Fuel-Cell Electric Vehicles (FCEVs).....	14
b) Types of electric vehicles: EV/BEV, HEV, PHEV, FCEV	14
2) Hydrogen Energy	14
a) National Hydrogen Mission.....	14
b) Advantages of Hydrogen Fuel	15
c) Limitation of Hydrogen Fuel.....	15
d) Various Types of Hydrogen	15
e) Current Usage of Hydrogen in India.....	15
f) Hydrogen Enriched CNG (H-CNG)	16
3) Large Scale Reactor Developed for Cost-Effective Production of Hydrogen using Sunlight and Water (Sep 2021: PIB)	16
9. Energy Efficiency:	16
1) National LED Program:	16
2) Street Lightening National Program (SLNP)	17
3) The Bureau of Energy Efficiency.....	17
4) Perform Achieve and Trade (PAT) Scheme of BEE	17
5) Star Labelling Program by BEE	18
6) Municipal Demand Side Management (Municipal DSM)	18
7) Building Energy Efficiency Program (BEEP).....	18
8) RAISE (Retrofit of Air-conditioning to improve Indoor Air Quality for Safety and Efficiency) Program	18
9) Other popular steps.....	18
10) Ministry of Power manadates energy accounting of DISCOMS with a view to reduce electricity losses (Oct 2021).....	19
11) Global Fuel Economy Initiative (GEFI)	19

1. RENEWABLE ENERGY: WIND ENERGY

1) WIND ENERGY

- **Potential of Wind Energy in the country**
 - As per National Institute of Wind Energy (NIWE) in Chennai, India's wind power potential at a hub height of 100 meters is 302 GW (695 GW at hub height of 120 meters). A very remarkable fact is that half of this potential is located on wastelands.
 - » As of 31st March 2021, India's capacity to generate from wind reached 39.2 GW a year. In addition, another 20GW over the next five years was in offing.
 - The wind energy sector is led by the **indigenous wind power** industry with a strong project ecosystem, operational capabilities and a manufacturing base of 10 GW per annum.
- **India target of wind energy:** 60GW by 2022

2) OFFSHORE WIND ENERGY

- **What is offshore wind energy?**
 - It refers to deployment of wind farms inside the water bodies. They utilize the sea wind to generate electricity. These wind farms either use **fixed foundation turbines** or **floating wind turbines**.
 - **A fixed foundation turbine** is built on shallow water, whereas a floating wind turbine is built in deeper waters where its foundation is anchored in sea-bed. Floating wind farms are still in infancy.
- **Target:** MNRE has set a target of installing 5GW of offshore capacity by 2022 and 30GW by 2030.
- **India's offshore wind energy potential:**
 - **IYB: Offshore wind in India** has a potential of approx. 70 GW mainly off-Tamil Nadu and Gujarat Coasts. Eight Zones each in Gujarat and Tamil Nadu have been identified as potential off-shore zones.
 - The National Institute of Wind Energy (NIWE) estimates 36 GW of offshore potential off the Gujarat coast and 35 GW off the TN coast using mesoscale satellite data.
 - **MNRE:** India can generate 127 GW of offshore wind energy with its 7,600 km of coastline. Other sources mention it to be (World Bank Report - 195 GW (112 fixed and 83 floating);
- **Advantages of offshore wind energy parks:**
 - Renewable Energy
 - No land acquisition and land scarcity issues
 - Offshore wind turbines are more efficient compared to onshore ones (wind speed over water bodies is high and is consistent in direction)
- **Steps Taken**
 1. **National Offshore Wind Energy Policy, 2015**
 - Nodal Ministry MNRE has been authorized for use of offshore areas within EEZ of the country
 - National Institute of Wind Energy (NIWE) has been authorized as Nodal agency for development of offshore wind energy in the country and to carry out allocation of offshore wind energy blocks, coordination and allied functions with related ministries and agencies.
 - Significance of the Policy
 - Paves the way for offshore wind energy development activities, in waters, in or adjacent to the country, up to the seaward distance of 200 Nautical Miles (EEZ of the country) from the base line.

- National Targets for offshore wind energy capacity has been set at 5 GW by 2022 and 30 GW by 2030.
2. Other steps include:
- The Draft offshore wind energy lease rules, 2019
 - Gujarat invited expression of interest (EOI) for India's first offshore wind project of 1 GW in 2018, which attracted many companies. But these EOI's haven't moved forward due to high capital expenditure and lack of government support. **To date, India has not begun any offshore wind projects.**

3) NATIONAL WIND MISSION

- Launched in 2015 under NAPCC
- **Aims and Objective**
 - » To achieve the target of 60 GW by 2022 with an investment of 10 lakh crore.
 - » Make India a global leader in wind power, by creating conditions conducive for its diffusion across the country in a time bound manner.

4) SCHEME FOR PROCUREMENT OF BLENDED WIND POWER FROM 2500 MW ISTS CONNECTED PROJECTS

- The objective of the Scheme is to provide a **framework for procurement of electricity from 2500 MW ISTS Grid Connected Wind Power Projects** with up to **20% blending with Solar PV Power** through a transparent process of bidding.
- **Solar Energy Corporation of India Ltd. (SECI)** is the nodal agency for implementation of the Scheme.
- It has provisions for payment security mechanism, commission schedule, power offtake constraints, power purchase agreement, etc. SECI has awarded 970 MW of projects under this scheme at discovered tariff of Rs. 2.99-3.00 per unit

5) REPORT: GLOBAL WIND REPORT 2022

- Published by the Global Wind Energy Council (GWEC).
- New installations 93.6 GW in 2021. Total wind energy capacity (global): 837GW.
 - » **Global Offshore wind market** enjoyed its best year in 2021, with 21.1 GW commissioned.
 - » **Global onshore wind market** added 72.5 GW in 2021.
- **In India,** more than 1.4 GW of wind was installed in 2021.
- As per the report, the new offshore installations in 2022 are likely to decline 2019/20 levels, primarily due to reduction in China. However, market growth is expected to regain momentum from 2023, eventually passing the 30 GW mark in 2026.

2. RENEWABLE: HYDROELECTRICITY

- **Intro**
 - » India has hydropower potential of around 1,45,000 MW and at 60% load factor, it can meet the demand of around 85,000 MW.
 - » In 2022, hydropower capacity of 46.5 GW accounted for roughly 11.7% of total capacity.
 - Roughly, 12% of power generation in 2020-21 was from hydropower.
 - » **Reducing role since independence:**
 - In 1947, 37% of the total power generation capacity and over 53% of power generation came from hydropower.
- **Classification in small and large hydro**
 - » In India, hydro power plants of 25 MW or below capacity are classified as small hydro, which have further been classified into micro (100 kw or below), mini (101kw-2MW) and small hydro (2-25 mW) segments.

- » Large Hydro power plants in India come under Ministry of Power, whereas the plants with capacity upto 25 MW and below was entrusted with the MNRE in Nov 1999.

- Steps taken recently to Promote Hydro Power Sector

1. March 2019 Guidelines

- **Approved by Union Cabinet in March 2019**
- **Details**
 - Declaring Large Hydropower Projects (>25 MW) as Renewable Energy**
 - Hydropower Purchase Obligation (HPO)
 - Tariff rationalisation measures
 - Budgetary support for flood moderation component &
 - Budgetary support for enabling infrastructure like bridges, roads etc.

3. RENEWABLE: BIOFUELS

- Biofuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion, rather than fuel produced by geological processes such as those involved in the formation of fossil fuels.
- They are made from **recently grown biomass** (plant or animal matter). They are **renewable** because the source is continuously replenished.
 - E.g., Biogas, bioethanol, biodiesel etc.
- **Biogas** is the biofuel produced through anaerobic digestion of organic waste.
- **Bioethanol** is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn, sugarcane, or sweet sorghum.
 - **Cellulosic biomass**, derived from non-food sources, such as trees and grasses, is also being developed as a feedstock for ethanol production.
 - **Ethanol** can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emission

1) GENERATIONS OF BIOFUEL

- 1G Biofuel:** They are produced directly from food crops such as wheat, sugar, vegetable oil and **even animal fat** etc.
 - Advantages includes known simple tech, cost competitiveness with fossil fuels etc.
 - Criticisms include food vs fuel debate etc.
 - **They are also known as conventional biofuels. Most common first generation bio fuels include:**
 - Biodiesel:** Extraction of vegetable oils (both edible and non-edible), with or without esterification, from seeds of plants like soybean, rape (canola) and sunflower.
 - Bio-Ethanol:** Fermentation of simple sugar from sugar crops (sugarcane) or starch crops (corn, wheat etc).
 - Bio-Gas:** Anaerobic fermentation of organic waste and crop residue as energy crops.
- 2G Biofuels:** Produced from **non-food organic crops** such as wood, organic waste, food crop waste and specific biomass crops. It includes use of non-food-crops technologies like **jatropha**-based fuels.
 - The advantages include use of wasteland, less impact on food security.
 - There are some limitations including high capital cost, advanced conversion technologies etc.
 - One well known second-generation technology is Lignocellulosic processing which uses forest material.
- 3G Biofuels:** The source is based on improvements in the production of biomass.

- It takes the advantage of biotechnology to engineer special crops such as algae (sometimes called oilgae) for biomass production.
- Algae act as low cost, high-energy and entirely renewable feedstock. It has impressive diversity and higher yield. Advantages include the ease of generating the biomass anywhere where sunlight and carbon is present.
- Some limitations include still developing tech, high technology cost, some poisonous algae etc.

- Advantages of Biofuels

i. Renewable

- **Reduce dependency on imports and our vulnerability due to fluctuation in crude oil prices.**

ii. Cleaner

- Less polluting as addition of bioethanol in petrol reduces its pollutant output. Similarly, biogas plants are a much cleaner alternative than the wood/ cow dung cake being used.
- Further, bio fuels helps in moving towards newer vehicle emission targets (BS-IV and BS-VI).

iii. Lesser impact on climate change

- Biogas also reduces the emission of GHGs such as methane and Carbondioxide.

iv. Can Promote sustainable agriculture:

- Government is promoting farmers to move from water intensive crops like wheat and rice to **Maize** which is suitable for biofuel production.

v. Increase farmer's income

- By providing them another way to use their surplus crops.

vi. Sanitation

- Some biofuels like biogas can play an important role in dealing with the problems of open defecation and sanitation in rural and semi-urban areas.

vii. Social impacts

- Biofuels like biogas can reduce the drudgery of women involved in collecting fuel wood and thus plays a role in women empowerment.

viii. Reduces Import Dependency and saving foreign exchange

- Steps taken by government to support biofuels

- National Policy on Biofuels, 2018**
- Pradhan Mantri Ji-Van Yojana (PMJY)**
- EBP**
- Biogas programs**

2) ETHANOL BLENDING

- Process of mixing ethanol with Petrol is called Ethanol blending. The mixture is called as Ethanol Fuel/ Gasohol which is considered as a quasi-renewable energy.
- In India, the practice of blending ethanol was started in 2001. Ethanol blending was first time mentioned in the Auto Fuel Policy of 2003.
- **Benefits of Ethanol Blending**
 - Reduces vehicular emissions especially CO (Carbon Monoxides) emissions.
 - It is cheaper than petrol as it is easier to manufacture.
 - It reduces our import dependency.
 - Trade balance, foreign exchange etc.
 - Ethanol has higher octane rating than ethanol-free petrol
 - In case of India Ethanol production can generate higher sugarcane prices for farmers.
- **Ethanol Blended Petrol (EBP) Program** was launched by the Government in **2003**, and was aimed at **promoting 5% blending of molasses-based ethanol** with petrol, to promote the use of alternative and environment friendly

fuels, to reduce import dependency for energy requirements and to increase value addition to Sugar industry enabling them to clear cane price arrears of farmers.

- In 2008, use of sugarcane juice was allowed for developing ethanol for EBP.
- In 2012, it was decided that 5% mandatory ethanol blending with petrol should be implemented across the country.

- **Current Status**

- The Government has set **10% blending target for mixing ethanol with petrol by 2022 and 20% blending target by 2030.**
- **Total Production and Target Production:**
 - From 38 crore litre in 2013-14, the ethanol supply under Ethanol Blended Petrol (EBP) Program was **173 litre in Ethanol Supply Year 2019-20.**
 - In ESY 2021-22, the target is to produce 400 crore litre of ethanol to achieve the target of 10% blending.

- **The roadmap for ethanol Blending in India 2020-25: Released by PM Modi on 5th June 2021** i.e., on World Environment Day.

- Gradual rollout of ethanol blended fuel to achieve E10 fuel supply by 2023 and E20 by 2023-25.
- Introduce vehicles which are compatible by rolling out the E20 material compliant and E10 engine tuned vehicles from April 2023 and production of E-20 tuned engines from April 2025.

- **Pilot Project** of E100 dispensing from 3 locations at Pune was also launched by the PM.

- **Secretary, Department of Food and Public Distribution (DFPD)** said that as a result of various measures taken to address demand and supply side issues, it is likely that ethanol distillation capacities in the country would be more than doubled by **2025 and we would be able to achieve 20% blending target.**

- **BIS specifications** for E12 and E15 blending have also been notified on 2nd June 2021.

- **MoRT&H by Central Motor Vehicles** (twenty fifth amendment) Rules, 2021 have notified the mass emission standards for E12 and E15 fuels.

- Now, Vehicle manufacturers will be able to manufacture vehicles compliant with E12 and E15. Vehicles will also display this detail with visible stickers

- **Government has issued advisory to carmakers to introduce flexible fuel engines in Vehicles:**

- Flex fuel engines are engines that can run on more than 1 fuel.
- Carmakers have been given six months to introduce flex fuels. These are being used successfully in countries like Brazil where customers have an option of switching fuel (gasoline or blended petrol with different levels of ethanol blend)
- **TVS Motors and Bajaj Auto** are already producing flex-fuel engines for their two and three wheelers.

- **Other Steps being taken**

- Government has also **allowed conversion of surplus stock of rice with FCI and Maize to ethanol** so that these targets of blending can be achieved smoothly
 - For e.g., in June 2021, Centre allocated **78,000 tonnes of rice from FCI for ethanol production.**
 - It has been allocated at subsidized rate of Rs 20 per kg
- Government is encouraging sugar mills and molasses based standalone distilleries to enhance their ethanol distillation capacity.
 - Soft loans with interest subvention is being provided for enhancement and augmentation of ethanol production capacity

- **In Sep 2019**, the CCEA took the following decisions to increase the supply of ethanol for OMCs
 - Increase in the price of ethanol to be procured by public sector oil marketing companies (OMCs) from sugar mills for blending with petrol for the 2019-20 supply year from 1st Dec 2019.
 - The Government has allowed production of ethanol from B-Heavy Molasses, sugarcane juice, sugar syrup and sugar. This will help mills deal with overproduction and make timely payments for farmers for the cane deliveries by them.
- **In Aug 2020**, in a meeting where ways and means to increase the supply of ethanol to OMCs, it was agreed that producers of ethanol (sugar mills), buyers of ethanol (OMCs) and the lenders (banks) are willing to enter into a tri-partite agreement (TPA) about producing, buying and paying for the ethanol through an escrow account etc., the banks can consider giving loans to sugar mills even with weak balance sheets.

3) NATIONAL POLICY ON BIOFUELS, 2018

- **Aims**
 - Reduce India's oil import dependency.
 - Provide better income opportunities to farmers by helping them dispose of their surplus stock in economic manner.
- **Key Highlights**
 - **Categorization of Biofuels to enable extension of appropriate financial and fiscal incentives under each category.**
 1. **Basic Biofuels** viz. First Generation (1G) bioethanol and biodiesel
 2. **Advanced Biofuels** - Second Generation (2G) Ethanol, Municipal Solid Waste to drop-in fuels, Third Generation (3G biofuels), bio-CNG etc.
 - **Expands the scope of raw material for ethanol production**
 - Allowing use of sugarcane juice, sugar containing materials like Sugar Beet, Sweet Sorghum, starch containing materials like Corn, Cassava, Damaged Food grains like wheat, broken rice, Rotten Potatoes unfit for human consumption for ethanol production.
 - **Allows use of surplus food grains for production of ethanol** for blending with petrol
 - With the approval of National Biofuel Coordination Committee.
 - Reduce risk to farmers not getting appropriate price for their produce during the surplus production phase.
 - **A VGF for 2G Ethanol bio-refineries** of Rs 5,000 crore in 6 years in addition to additional tax incentives, higher purchase price as compared to 1G biofuels.
 - The new policy encourages setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, used cooking oil, short gestation crops.
 - **Specifies the role of all the concerned ministries/ Departments** with respect to biofuels

4) PRADHAN MANTRI JI-VAN (JAIV INDHAN VATAVARAN ANUKOOL FASAL AWASHESH NIVARAN) YOJANA

- **Why in news?**
 - Cabinet approves "Pradhan Mantri JI-VAN Yojana (Feb 2019)
- **Ministry** of Petroleum and Natural Gas
- **Key Highlights**
 - The Yojana provides **financial support (VGF)** to Integrated Bioethanol Plant using **Lignocellulosic biomass** and other renewable feedstock.

- Under the yojana, **12 commercial scale** and **10 demonstration scale Second Generation (2G)** ethanol projects will be provided with VGF support in two phases:
 - **Phase-I (2018-19 to 2022-23)**: wherein six commercial projects and five demonstration projects will be supported.
 - **Phase-II (2020-21 to 2023-24)**: wherein remaining six commercial projects and five demonstration projects will be supported.
 - The ethanol produced by the scheme will be **mandatorily supplied to OMCs** to further enhance the blending percentage under EBP program.
 - **Centre for High Technology (CHT)**, a technical body under the aegis of MoP&NG, will be the **implementation Agency** for the scheme
- **Significance**
 - **Incentivize 2G Ethanol Sector** by setting up commercial and demonstration projects
 - **Increased R&D** in the sector.
- **Other Advantages** – Reducing GHG emission; reducing import dependence; fighting air pollution due to stubble burning; increasing farmers' income; Employment opportunities; helping in Swatch Bharat; Indigenization of 2G biomass to ethanol tech.

5) ICAR-CENTRAL TUBER CROPS RESEARCH INSTITUTE (CTCRI) FINDS CASSAVA (TAPIOCA) AS PROMISING RAW MATERIAL FOR BIOETHANOL (JUNE 2021)

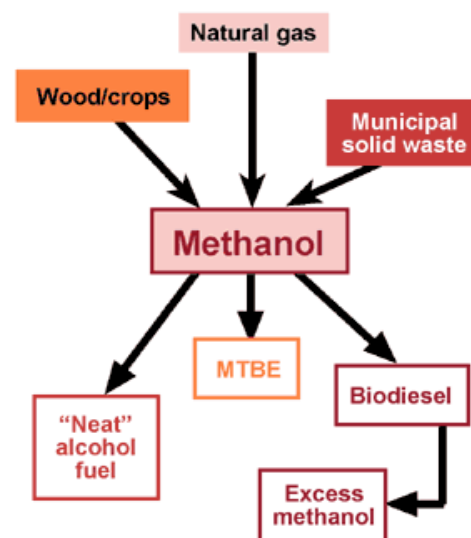
- Cassava with its high starch content and the ability to grow under low management conditions has been globally recognized as a potential candidate for bioethanol production.
- **Economic viability** for scale up of the production must be evaluated as there was this reported failure of an alcohol plant set up in Palakkad in the late 1990s.
- **Advantages of Cassava over sugarcane**:
 - Its starch with its unique physio chemical properties finds extensive applications in the food and industrial sectors.
 - The Agricultural residue of Cassava such as peels, stems, and leaves are potential feedstock for **2G bioethanol** production.
- **Tapioca production in India**: Currently, around 4.98 million tonnes is produced in India with major production coming from **TN and Kerala**. Expansion of cultivation is also taking place in non-traditional areas like Maharashtra.

4. METHANOL (CH₃OH) ECONOMY

- **Introduction:**
 - Methanol fuel is an alternative biofuel for internal combustion and other engines, either in combination with gasoline or independently. It is produced from high ash coal, agricultural residue, CO₂ from thermal power plants, and natural gas.
 - **How is Methanol produced from Coal:**
 - **Gasification of Coal**: To produce Synthesis gas (carbon monoxide and hydrogen).
 - **Catalytic conversion** of Synthesis gas to produce methanol.
 - It is less expensive to produce sustainably than ethanol fuel, and is generally more toxic and has lower energy density.

- Although slightly lower in energy content than petrol and diesel, methanol can replace both these fuels in transport sector (road, rail and marine), energy sector and retail cooking (replacing LPG, Kerosene etc.)

Methanol: A Life Cycle



- Methanol Blending:**

- Methanol is utilized a motor fuel, to power ship engines, and to generate clean power all over the world. Methanol is also used to generate di-methyl ether (DME), a liquid fuel that is very similar to diesel - existing diesel engines simply need to be minimally changed to use DME instead of diesel.

- Various initiatives to promote use of Methanol:**

- NITI Aayog's Methanol Economy Program** is aimed at reducing India's oil import bill, GHG emissions and converting coal reserves and municipal solid waste into methanol.
- The **Bureau of Indian Standards** has notified 20% DME blending with LPG.
- The MoRT&H have notified M-15, M-85, M-100 blends.
 - Test standards and plans for the M-15 blend are being evolved in consultation with the Indian Oil Corporation Limited (IOCL), Automotive Research Association of India and Society of Indian Automobile Manufacturers.

- Advantages:**

- Reduces Import Dependency:** Blending 15% methanol in Gasoline can result in at least 15% reduction in import of gasoline/crude oil.
- Lesser Pollution:** In addition, it would bring down GHG emissions by 20% in terms of particulate matter, Nox, and Sox, thereby improving the urban air quality.
- Very less alternation in CNG engine required** for use of methanol fuel

6) METHANOL PRODUCTION FROM HIGH ASH COAL

- How is methanol produced:**

- Majority of the worldwide methane is derived from natural gas, which is relatively easy to process.
 - Limitation for India:** India is import dependent on natural gas. This leads to CAD issues, exchange range fluctuation challenges etc.
- Other option is to **use Coal**. However, Indian coal is ash-rich and most of the global technologies will not be adequate in this kind of coal.

- India's first indigenously designed High Ash Coal Gasification Based Methanol Production Plant at BHEL R&D Centre, Hyderabad (Sep 2021)**

- BHEL R&D at Hyderabad began working on Indian High Ash coal gasification in 2016 with support from NITI Aayog to produce 0.25 ton per day methanol. The project was supported by DST with a grant of 10 Cr.

- In 2021, BHEL has demonstrated a facility to create 0.25 TPD Methanol from high ash Indian Coal using a 1.2 TPD Fluidized bed gasifier. The methanol purity is between 98 and 99.5 %.

5. COAL GASIFICATION

- It is the process of producing syngas (a mixture consisting primarily of CO, H₂, CO₂, Natural Gas and Water Vapors) – from coal and water, air and/or oxygen.
- **Uses:**
 - **Historically**, coal/lignite (**especially the deep, unreachable ones**) was gasified to produce coal gas also known as “town gas”. It was used for heating and municipal lighting.
 - **Currently**, they are used for electricity generation, or for production of chemical feedstocks. The hydrogen obtained from coal gasification can be used for various purposes such as making ammonia, powering a hydrogen economy, or upgrading fossil fuels.
 - Syngas may also be converted by additional treatment into **methanol** which itself can be used as transportation fuel or fuel additive, or which can be converted into gasoline.
- **Coal Gas/ Syn Gas** is a cleaner fuel than coal.

7) NATIONAL COAL GASIFICATION MISSION

- **Why in news?**
 - **Ministry of Coal** has prepared a blueprint for the ‘National Coal Gasification Mission’ (Nov 2021)
- **Key Proposals**
 - 100 MT coal gasification by the year 2030.
 - 15% methanol blending target with petrol to encourage investments in the sector.
 - Massive Tax Waivers to incentivize coal gasification
 - Rebate in revenue share in coal block auction and also linkage for the same.
- **Past Announcements:**
 - PM Modi, in June 2020, had said that Rs 20,000 crore will be invested in coal gasification projects by 2030 to utilize 100 million tonnes of coal.
- **Significance**
 - Promotion of coal gasification leads to eco-friendly alternate utility of the fuel abundantly available in the country (coal).
 - A lot of India’s coal deposits are non-recoverable → Promoting coal gasification could help extract those plentiful reserves that are deep, scattered and covered by forests.
-

8) BUDGET 2022-23 ANNOUNCED: “FOUR PILOT PROJECTS FOR COAL GASIFICATION AND CONVERSION OF COAL INTO CHEMICALS REQUIRED FOR THE INDUSTRY TO BE SET UP TO EVOLVE TECHNICAL AND FINANCIAL VIABILITY”

6. USED COOKING OIL (UCO) BASED BIODIESEL

- **Why in news?**
 - Petroleum Minister flags off 1st supply of Used Cooking Oil-Based Biodiesel from Indian Oil’s Tikrikalan Terminal (May 2021)
- **Details**
 - This is a landmark in India’s presence of Biofuels and will have a positive impact on the environment. This initiative will garner substantial economic benefits for the nation by shoring up the indigenous Biodiesel supply, reducing import dependence, and generating rural employment.

- **Advantages of using UCO based biofuel:**
 - Used cooking oil if used again can lead to various health issues. During frying, several properties of cooking oil is changed. Total Polar Compounds are formed on repeated frying. These compounds are associated with several health issues like hypertension, atherosclerosis, Alzheimer's disease, liver disease etc.
 - **Other renewable energy-based advantages**
- **Various Initiative to promote use of UCO in India:**
 - 2018 Biofuel Policy calls for setting up of supply chain for production of biodiesel using non-edible oil seeds, Used Cooking oil etc.
 - **FSSAI** in association with the **Biodiesel Association of India (BDAI)** has launched Repurposed Used Cooking Oil Project. Under this project, UCO will be purchased from hotels, traders, manufacturers etc. at reasonable price.

7. OTHER RECENT INITIATIVES

1) NATIONAL MISSION ON USE OF BIOMASS IN COAL BASED THERMAL POWER PLANTS (MAY 2021: PIB)

- In order to address the issue of air pollution due to farm stubble burning and to reduce carbon footprints of thermal generation, **Ministry of Power** has decided to set up a **National Mission on use of Biomass in coal based thermal power plants**.
- The mission will have **following objectives**:
 - (a) To increase the level of co-firing from present 5% to higher levels to have a larger share of carbon neutral power generation from the thermal power plants.
 - (b) To take up R&D activity in boiler design to handle the higher amount of silica, alkalis in the biomass pellets.
 - (c) To facilitate overcoming the constraints in supply chain of biomass pellets and agro- residue and its transport upto to the power plants.
 - (d) To consider regulatory issues in biomass co-firing

2) E-100 PILOT PROJECTS (JUNE 2021)

- Launched at Pune City by Public Sector OMCs on 5th June 2021
- To facilitate sale of E-100 fuel.
 - MoP&NG vide its order dated March 22, 2021 has amended the Motor Spirit and High Speed Diesel (Regulation of Supply, Distribution and Prevention of Malpractices) Order, 2005 by **permitting the direct sale of Bio-Ethanol** (E100) by an oil company for use as standalone fuel or blending with motor spirit, for compatible automobiles to all consumers, in accordance with the standards specified by the Bureau of India Standards (BIS).

3) BIOGAS PRODUCTION OF FAT RICH SLUDGE (SEP 2021)

- Researchers at **CSIR-CFTRI Mysore** have developed a novel high performance bioreactor system integrated with sustainable pre-treatment process for enabling anaerobic digestion of complex fat-rich sludge from dairy industry. It has further been integrated with membrane bioreactor based-wastewater treatment to enable zero liquid discharge in the dairy industry.
- It can also be applied for anaerobic digestion of complex solid waste containing Fats and oils and can be coupled with wastewater treatment to enable Zero liquid discharge.

- **Dairy and food industry** are likely industries that can take up the technology. The technology will also be applicable for any biodegradable waste sludge and food waste from any food industry as well as food industry wastewaters

4) STEPS TAKEN TO PROMOTE BIO-GAS

1. National Biogas and Manure Management Program (NBMMP)

- By MNRE.
- It is a central sector scheme with an aim to setting up family type biogas plants for providing biogas as clean cooking fuel and a source of lighting primarily set up for rural and semi-urban households.
 - The slurry produced from biogas plants as a by-product is an organic bio-manure for enhancing crop yield and maintaining soil health.
- It is being implemented in all the state and UTs by MNRE through state nodal departments, Khadi and Village Industries Commission (KVIC) and Biogas Development and Training Centres (BDTCs).

2. Promotion of off-grid biogas power project for captive power generation

3. Gobar Dhan Yojana

- The scheme was first announced in Budget 2018-19.
- Galvanizing Organic Bio Agro Resources - Dhan (GOBAR-Dhan) focuses on managing and converting cattle dung and solid waste in farms to compost, bio gas and bio CNG.
- The scheme aims to collect cattle waste and solid waste from farmers for sale to entrepreneurs, who thereafter, will produce manure, biogas and bio-CNG from the waste. Thus the schemes connect farmers to buyers so that farmers can get right prize for dung and agri-waste.
- Government has also announced an online trading platform to connect to buyers of agri-waste facilitating the GOBAR-dhan scheme.
- **Ministry**
 - Ministry of Drinking Water and Sanitation (now Jal Shakti)
 - It will be implemented under SLWM funding pattern of SBM-G guideline

4. SATAT Initiative – To Promote Compressed Biogas as an alternative, green transparent fuel

- **Introduction**
 - » The potential for **Compressed Bio-Gas production** from various sources in India is estimated at about 62 million tonnes per annum.
- **About SATAT - Sustainable Alternative Towards Affordable Transport (SATAT)**
 - » This is an innovative initiative to set up Compressed Biogas (CBG) production plants and make available CBG in the market for use in automotive fuels.
 - » The national policy on biofuels, 2018 emphasize active promotion of advanced bio-fuels, including CBG.
- **Ministry**
 - » Union **Ministry of Petroleum and Natural Gas & Skill Development and Entrepreneurship**, with PSU OMCs inviting Expression of Interests (EoI) from potential entrepreneurs.
- **Advantages**
 - » Potential to boost availability of more affordable transport fuels.
 - » Better use of agri-residue and MSW.
 - » Additional revenue source to farmers
 - » Direct and indirect job opportunities.
 - » Reduce import dependency and volatility to price fluctuation

8. HYDROGEN ENERGY

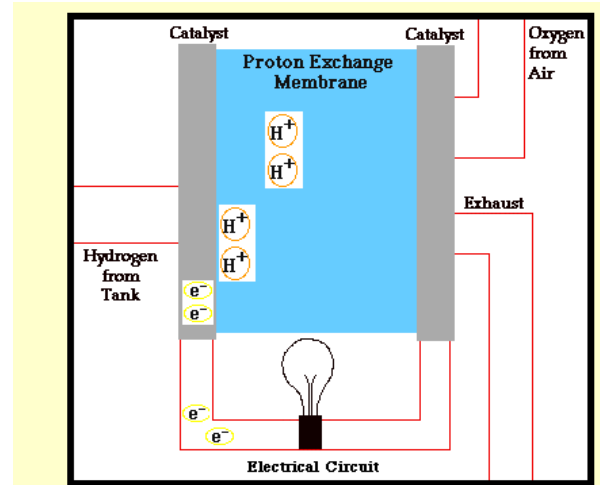
1) HYDROGEN FUEL CELL

- Introduction

- » Hydrogen is the simplest fuel. A fuel cell combines hydrogen and oxygen to produce electricity, heat, and water.

- Fuel Cell

- » A fuel cell is a device that **converts chemical potential energy (energy stored in the molecular bonds) into electrical energy**.
 - A Proton Exchange Membrane (PEM) cell uses hydrogen (H_2), and Oxygen (O_2) as fuel.
 - The products of the reaction are water, electricity and heat.
- » **Key Elements of a fuel cell**
 - **The anode**, the negative electrode of the fuel cell, conducts the electrons that are fed from the hydrogen molecule so that they can be used in the external circuit.
 - **The Cathode**, the positive post of the fuel cell, has channels etched into that distribute the oxygen to all surface of the catalyst. It also conducts electrons back from the external circuit to the catalyst, where they can recombine with hydrogen ion and oxygen to form water.
 - The **electrolyte** is a **proton exchange membrane**. This specially treated material, which looks something like ordinary kitchen plastic wrap, only conducts positively charged ions. The **membrane blocks electrons**.
 - **The catalyst** is a special material that facilitates the reaction of oxygen & hydrogen. It is usually made up of platinum nano particles very thinly coated onto carbon paper or clothe.
- » **How does a fuel cell work?**
 - Hydrogen from a tank onboard the vehicle, enters into anode side of the fuel cell.
 - Oxygen pulled from air enters from cathode side
- » **As the hydrogen molecule encounters the membrane, a catalyst forces it to split into electron and proton**
 - The proton moves through fuel cell stack and the electron follows an external circuit, delivering current to the electric motor and other vehicle components.
 - At cathode side, the proton and electron join again, and they combine with oxygen to form the vehicle's only tailpipe emission, water.



- Advantages of Hydrogen Fuel Cell

- Fuel cell **avoids the "thermal bottleneck"** (a consequence of 2nd law of thermodynamics) and are thus inherently **more efficient than combustion engines**, which must first convert chemical potential energy into heat, and then mechanical energy.
- Hydrogen is high in energy (high energy density).
- Fuel cells **don't have any moving part** and thus are more reliable than traditional engines.
- **No pollution** (Only steam (H_2O) emitted as by product)
- **No Greenhouse gas and Climate Change** (since no GHG are produced as biproducts)

- **Limitation**
 - Complex and difficult to build
 - Still mostly in research phase
 - Extracting hydrogen is difficult and expensive - **catalyst used is Platinum**- which is very expensive.

A) FUEL-CELL ELECTRIC VEHICLES (FCEVS)

- **Why in news?**
 - Union Transport Minister Nitin Gadkari travelled to Parliament in a hydrogen-based Fuel Cell Electric Vehicle (FCEV) (March 2022)
 - » He used a Toyota Mirai, which sports three hydrogen tanks, and can be refuelled in an estimated five minutes. It also has a 1.24 Kwh lithium ion battery pack. The car is powered by a 182 hp electric motor.
 - » **Why?**
 - Demonstration; Spreading awareness about hydrogen, FCEV technology and its benefits to support hydrogen based society for India
- **Details**
 - FCEV combine hydrogen and oxygen to produce electricity which runs the motor.
 - » E.g.s of cars using FCEV: Toyota's Mirai, Honda's Clarity, and Hyundai's Nexo.
 - Since they are powered entirely by electricity, FCEVs are considered EVs, but unlike BEVs, their range and refueling processes are comparable to conventional cars and trucks.
 - » The **major difference** between a BEV and a refueling time of just five minutes, compared to 30-45 mins charging for a BEV.
 - » Also, consumers get five times better energy storage per unit volume and weight, which frees up a lot of space for other things, while allowing the rider to go farther.

B) TYPES OF ELECTRIC VEHICLES: EV/BEV, HEV, PHEV, FCEV

- **Electric Vehicles:** The standard EV is also known as **Battery powered EV (BEV)**:
 - They don't have an internal combustion engine and instead of an petrol/diesel, these vehicles run solely on battery power. These can be charged at home or commercial charging stations.
- **Hybrid Electric Vehicles (HEVs):** They run on both Internal Combustion Engines and electric motor that uses energy stored in a battery. However, unlike other Evs, HEV cars battery is charged by regenerative braking.
 - **Micro (or mild) Hybrid** uses both battery and electric motor to make the car run. Though they can't run solely on electric power, they maximize fuel economy by shutting off the internal combustion engine during complete stops.
- **Plug-in Hybrid Electric Vehicles (PHEV):** They expand the concept of HEVs. They have both an internal combustion engine and a battery powered electric motor. This allows the battery to store enough power to feed the electric motor and in turn decrease the gas usage by as much as 60%. They can travel around 60 kms on electric power, rather than 2-3 kms with a standard HEVs.
- **FCEV:** discussion above

2) HYDROGEN ENERGY

A) NATIONAL HYDROGEN MISSION

- **National Hydrogen Mission**

- The mission was announced in Union Budget 2021-22 and provides a roadmap for using hydrogen as an energy source, with **specific focus on green hydrogen**.
 - » **Why Green Hydrogen?**
 - It is a clean burning fuel which can decarbonize a number of sectors including iron and steel, chemicals, and transportation.
 - Renewable energy that can't be stored or used by the grid can be channeled to produce hydrogen.
 - » Budget has earmarked **Rs 15,00 crore** for the mission and the Indian Renewable Energy Development Agency.

B) ADVANTAGES OF HYDROGEN FUEL

- **Abundance:** It is the most abundant element in the Universe.
- **Energy Density** -> High
- **Can contribute to achieving Net Zero by 2050**
- **No Pollution** (only releases water)
- **Leading options for storing energy from renewables**
- **Advantages of Hydrogen Vehicles (Fuel cell Stack) over other Electric Vehicles (Lithium-ion batteries)**
 - A fuel cell electric vehicle can be **refueled in just 5 minutes**. EV takes 30-45 minutes for charging.
 - **Energy storage per unit volume and weight** is higher in fuel cells than other types of electric vehicles.
 - **EV battery materials** are controlled by a few larger players. Scaled up hydrogen fuel cell will bring countries on equal footing.
 - **EV batteries** (like Lithium ion batteries) have still not been found viable for heavy vehicles like trucks.

C) LIMITATION OF HYDROGEN FUEL

- **Hydrogen** molecule is not available in abundance on earth and is found in combination with other elements.
 - Thus, external energy source is required to isolate hydrogen. If coal or other fossil fuel is used for this extraction, it is called grey hydrogen and has carbon footprint.
- Hydrogen technology is "**yet to be scaled up**". Tesla CEO Elon Musk has called fuel cell technology "mind-bogglingly stupid".
- **Lack of fueling station infrastructure**
- **Safety is a concern**
 - Hydrogen is pressurized and stored in a cryogenic engine. Some companies like Toyota and Hyundai have said that safety and reliability of hydrogen fuel tanks is similar to that of standard CNG engines

D) VARIOUS TYPES OF HYDROGEN

- The most common element in nature is not found freely. It exists only combined with other elements and has to be extracted from naturally occurring compounds like water (which is a combination of two hydrogen atoms and one oxygen atom). This process is energy intensive.
 - **Grey Hydrogen**
 - » Hydrogen produced from fossil fuels. This constitutes a bulk of hydrogen produced today.
 - **Blue Hydrogen**
 - » Hydrogen generated from fossil fuels with carbon capture and storage options
 - **Green Hydrogen**
 - » Hydrogen generated entirely from renewable power sources. Here electricity generated from renewable energy is used to split water into hydrogen and oxygen

E) CURRENT USAGE OF HYDROGEN IN INDIA

Currently, India consumes around 5.5 million tonnes of hydrogen, primarily produced from imported fossil fuels.

F) HYDROGEN ENRICHED CNG (H-CNG)

- In Sep 2020, MoRT&H has notified hydrogen-enriched compressed natural gas (CNG) as an automobile fuel.
- In Oct 2020, **Delhi became the first city in India to operate buses running on hydrogen spiked compressed natural gas (H-CNG)** in a six-month pilot project.
 - » The buses are running on a new technology patented by Indian Oil Cooperation for producing **H-CNG - 18% hydrogen in CNG - directly from natural gas** without resorting to conventional blending.
- **What is H-CNG?**
 - » It is a hydrogen enriched compressed natural gas. The ideal hydrogen concentration is 18%.
 - In **Delhi**, instead of physically blending hydrogen with CNG, hydrogen spiked CNG will be produced using a compact reforming process patented by IOC.
- **Advantages of H-CNG over CNG**
 - » **Less Air Pollution**
 - Emits 70% less CO₂.
 - Reduces total hydrocarbons emissions by around 15% and increases fuel efficiency by 3-4%.
 - » **Increases fuel efficiency**
 - » **Higher power output**
- **Updates in Sep 2021**
 - » **CNG to HCNG model 'Capital intensive'**; Delhi government unlikely to scale up pilot project.

3) LARGE SCALE REACTOR DEVELOPED FOR COST-EFFECTIVE PRODUCTION OF HYDROGEN USING SUNLIGHT AND WATER (SEP 2021: PIB)

- A team of scientists from the Institute of Nano Science and Technology (INST), Mohali, an autonomous institute of Department of Science & Technology (DST), GoI, have developed a **prototype reactor which operates under natural sunlight to produce hydrogen at a larger scale (around 6.1 L in 8 hours)**. They have used an earth-abundant chemical called carbon nitrides as a catalyst for the purpose.
- The INST team employed a low-cost organic semiconductor in carbon nitrides which can be prepared using cheaper precursors like urea and melamine at ease in a kilogram scale.
 - When the sunlight falls on this semi-conductor, electrons and holes are generated. The electrons reduce the protons to produce hydrogen, and holes are consumed by some chemical agents called sacrificial agents.
- This work is supported by the DST Nano Mission NATDP project, and the related article has been published in the 'Journal of Cleaner Production' recently, and the team is in the process of obtaining patent for the technology.

9. ENERGY EFFICIENCY:

1) NATIONAL LED PROGRAM:

- It is a program for promoting use of most efficient lighting technology at affordable rates. It was launched in **Jan 2015**. The Program includes **two components**:

- **UNNAT Jyoti by Affordable LED for All (UJALA)** - launched in 2015 to replace incandescent lamps with LEDs in home and street lightening.
 - **Key Achievements:**
 - **Completed 7 years in 2022**
 - **Distributed 36.78 crore LEDs across the country**
 - **Advantages:**
 - **Energy Saving:** LED bulbs consume around 1/4th of the electricity consumed by CFLs and around 1/10th consumed by ordinary bulbs.
 - UJALA program has led to saving of 47 GWh energy per annum, and reduced 3.8 crore tonnes of CO2 emissions.
 - **Long Life:** LEDs tend to have 8-10 times the life of that of CFLs.
 - **Cost Saving:**
 - UJALA ensured mass procurement and overall reduction in prices of LED bulbs.
 - **Environmentally Safe:** They are completely safe and don't present any hazard to human eye. They don't contain mercury and thus have no negative impact on environment.
 - **Industrial growth:** The scheme has given impetus to domestic lighting industry.
 - **EESL (Energy Efficiency Services Limited),** which is the implementing agency, has also enrolled SHGs for distribution of LEDs to ensure inclusive growth.

- **Other Details for Prelims**

- 1) **Ministry:** Ministry of Power

2) STREET LIGHTENING NATIONAL PROGRAM (SLNP)

- The program was launched in Jan 2015 to replace 3.5 crore conventional street lights with smart and energy efficient LED lights by March 2019.
- **Energy Efficiency Services limited (EESL)** is the implementing agency for both UJALA and SLNP.

3) THE BUREAU OF ENERGY EFFICIENCY

- The Government of India has set up Bureau of Energy Efficiency (BEE) on 1st March 2002 under the provision of the Energy Conservation Act, 2001. It is a statutory body under Ministry of Power.
- The mission of Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles with the primary objective of reducing energy intensity of the Indian economy within the overall framework of the Energy Conservation Act, 2001. This will be achieved with active participation of all stakeholders, resulting into accelerated and sustained adoption of energy efficiency in all sectors.

4) PERFORM ACHIEVE AND TRADE (PAT) SCHEME OF BEE

- It is a flagship scheme of BEE under the National Mission for Enhanced Energy Efficiency (NMEEE).
- The scheme aims to reduce energy consumption in **energy-intensive industries** through **certification of excess energy savings** which can be traded.
 - The energy intensive sectors include - Chlor-Alkali, Pulp & Paper, Textile, Aluminium, and Thermal Power Plants, Fertilizer, Iron & Steel and Cement.

5) STAR LABELLING PROGRAM BY BEE

- The Star Labelling Programme has been formulated by Bureau of Energy Efficiency, as part of its mandate, under the Energy Conservation Act, 2001. it was launched in 2006.
- The star rating is the **measure of energy efficiency** of an appliance. It has a five point scale where higher the rating lower is the energy consumption and hence more savings.
- Under this Programme, BEE has covered **26 appliances** (AC, Fans, Color TV, computer, direct cool refrigerators, industrial motor, water heater, submersible pumps, diesel generators, LED lamps, chillers, agri-pumps etc) till date wherein 10 appliances are under mandatory regime.
- **In Jan 2021**, Air compressors and Ultra High Definition (UHD) TV were brought under standards and labelling program on voluntary basis.

6) MUNICIPAL DEMAND SIDE MANAGEMENT (MUNICIPAL DSM)

- The Municipality Demand Side Management (Mu-DSM) **scheme of BEE**, aimed at improving the overall energy efficiency of ULBs was launched under 11th five-year plan.
- Bureau of Energy Efficiency has initiated a programme to cover 175 municipalities in the country by conducting **energy audits** and preparation of Detailed Project Reports (DPRs) and implementation.

7) BUILDING ENERGY EFFICIENCY PROGRAM (BEEP)

- BEEP was launched in 2017.
 - It is implemented by EESL.
 - Under this EESL planned to invest 1,000 crore rupees to cover **10,000 larger government/private buildings** in 2-3 years.
 - It would install LED lights, efficient ceiling fans, energy efficient Acs etc.
- **Progress in 2020:** Building Energy Efficiency Projects have been completed in 10,411 buildings including Railway Stations and Airports.

8) RAISE (RETROFIT OF AIR-CONDITIONING TO IMPROVE INDOOR AIR QUALITY FOR SAFETY AND EFFICIENCY) PROGRAM

- RAISE programme was launched by Union Power Minister on 20th July 2020.
- The programme focuses on **improving indoor air quality (IAQ), thermal comfort, and energy efficiency (EE)** in office's air conditioning system. Considering employee's occupational health and safety is paramount in any workplace amidst the COVID-19 scenario, EESL is providing such solutions across the country with standardization and demand aggregation approach.
- EESL has undertaken a retrofit of its office air-conditioning and ventilation system. EESL's corporate office in Scope Complex has been taken up as a pilot for this initiative.

9) OTHER POPULAR STEPS

Appliance exchange program is one of the schemes initiated by Tata Power - DDL, under which customers are offered 40-50% subsidy on replacing old inefficient appliances with new BEE five-star rated ones.

10) MINISTRY OF POWER MANADATES ENERGY ACCOUNTING OF DISCOMS WITH A VIEW TO REDUCE ELECTRICITY LOSSES (OCT 2021)

- **The 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.
 - » It stipulates quarterly energy accounting by DISCOMS, through a certified energy manager, within 60 days.
 - » There will also be an annual energy audit by an independent Accredited Energy Auditor.
 - » **Both** these reports will be published in public domain.
- **Energy accounting reports** will provide detailed information about electricity consumption by different categories of consumers & the transmission and distribution losses in various areas.
 - » It will identify areas of high loses and theft and enable corrective actions.
 - » It will also enable fixation of responsibility on officers for losses and thefts.
- Through this information, discoms will be able to take appropriate measures for reducing their electricity losses. It will also be able to make suitable infrastructure-upgradation as well as demand side management (DSM) efforts in an effective manner

11) GLOBAL FUEL ECONOMY INITIATIVE (GEFI)

- GFEI was established to ensure that the world's vehicle fleet is as clean and efficient as possible in response to global concerns about clean air and climate change.
- It is a partnership between 6 organizations (IEA, UNEP, the International Transport Forum of the OECD (ITF), the International Council on Clean Transportation (ICCT), the University of California-Davis and the FIA foundation) that promote research, discussion, and action to improve fuel economy worldwide and transition to low carbon, zero emission (at tailpipe) 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.
- **Key activities:**
 - Data development and analysis of fuel economy potential by country and region
 - Support for national and regional policy-making efforts