



HYPERLOOP 2018

ENERGY

CONSOLIDATED PRELIMS CURRENT AFFAIRS

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1. SOLAR ENERGY

1.1 Basic Technology in Solar Cells

1.1.1 Solar Photovoltaic

Solar photovoltaic (SPV) cells convert solar radiation (sunlight) into electricity. A solar cell is a semi-conducting device made of silicon and/or other materials, which, when exposed to sunlight, generates electricity. Solar cells are connected in series and parallel combinations to form modules that provide the required power.

- Crystalline Silicon solar cells (C-Si): Monocrystalline and Polycrystalline
- Thin-film solar cells: Amorphous Silicon Solar cells (A-Si), CIGS, CdTe

PV modules are manufactured by assembling the solar cells after stringing, tabbing and providing other interconnections.

Solar Thermal

Solar Thermal Power systems, also known as Concentrating Solar Power systems, use concentrated solar radiation as a high temperature energy source to produce electricity using thermal route. High temperature solar energy collectors are basically of three types:

- **Parabolic trough system:** at the receiver can reach 400° C and produce steam for generating electricity.
- **Power tower system:** The reflected rays of the sun are always aimed at the receiver, where temperatures well above 1000° C can be reached.
- **Parabolic dish systems:** Parabolic dish systems can reach 1000° C at the receiver, and achieve the highest efficiencies for converting solar energy to electricity.

Status of Indian solar manufacturing

There are more than 110 Indian solar cell and module makers registered with the government, out of which Consultancy Bridge to India expects only a handful to survive. This is because of Chinese modules which are 10-20% cheaper than those made in India. That is squeezing out Indian cell and module makers, many of which have inferior technology, depend on imports of raw materials, have limited access to cheap loans and operate below capacity.

Lack of significant domestic solar manufacturing capacity is a concern, as this is a major gap as like India's huge mobile phone market but negligible local production.

1.1.2 Cheaper Solar Cells

Researchers at Australia's University of New South Wales recently set a new world record for solar cell efficiency by developing the largest single **perovskite photovoltaics** cell, which is 10 times bigger than the current certified high-efficiency perovskite solar cells.

Two technologies are

1. The hydrogenation

- Hydrogenated amorphous silicon (a-Si:H) is used for doping and as intrinsic absorber layers in thin-film silicon solar cells.
- a-Si:H is a very versatile material with properties that are of high interest for application in other devices such as heterojunction solar cells, detectors, or optoelectronic devices.

2. Perovskite cells technology

- Solar cell which includes a perovskite structured compound, as the light-harvesting active layer
- Solar cell efficiencies of devices using these materials have increased from 3.8% in 2009 to 22.1% in early 2016, making this the fastest-advancing solar technology to date

What is Passive solar technology?

In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This technology has been used by humans since long time

1.1.3. Rooftop solar power

The government has set itself a target of 100 GW of solar power by 2022, of which 60 GW is to come from utilities and 40 GW from rooftop solar installations.

What is rooftop solar?

- Rooftop solar installations can be installed on the roofs of buildings
- They fall under two brackets: commercial and residential.

What are the benefits?

- Provides an alternative source of electricity to the grid
- Environment Friendly and very useful in remote locations

Hurdles

- Variability in supply.
 - Efficiency depends on sunlight
 - No power generation during night
- Storage technology for electricity, however, is still underdeveloped and storage solutions are expensive.

Way forward

- Imports of cheap solar panels are continuously placing a downward pressure on prices and so this scenario could change in the future.

1.1.4 India's largest floating solar power plant

At the Banasura Sagar reservoir in Wayanad. The 500 kWp (kilowatt peak) solar plant floats on 6,000 square metres of water surface of the reservoir.

Background:

- So far a 100 KW plant was the largest in the floating solar executed by the NTPC in Kerala.
- First floating solar project was executed in West Bengal in 2014 at Rajarhat.
- Two floating solar projects with the capacity of 10 MW each are coming up in Andhra Pradesh and Kerala.

Advantages

- No lands acquisition problem
- More efficient than land based solar panels because of more temperature difference
- Reduces water evaporation

1.1.5 Indian Railway's first set of solar plants

Part of the government's National Solar Mission in which Indian Railways plans to commission 1000 MWp solar plants across its network

- Aim is a 100 per cent de-carbonised, most energy efficient and highest electrified rail network in the world.

1.1.6 Clean Cooking movement

Prime Minister gave a call to start-ups to initiate a clean cooking movement by tapping the huge market potential of solar energy

- By 2030, India aimed to address 40 per cent of its power needs by means of renewable energy.
- The solar energy led clean cooking to rural women which made a positive difference in their lives

- It will also contributed to a cleaner environment

1.2 Government Initiations

1.2.1 International Solar Alliance

International Solar Alliance

Fiji, Niger and Tuvalu have deposited instrument of ratification of the Framework Agreement of the International Solar Alliance (ISA) in the recently held 5th meeting of International Steering Committee (ISC) of the ISA.

- Till date 40 countries have signed and 11 countries have ratified the Framework Agreement of the ISA.
- With ratifications by 15 countries, the ISA will become a treaty based intergovernmental international organization

About International Solar Alliance (ISA):

The initiative was launched at the UN climate Change conference in paris at the end of 2015 by the President of france and the Prime minister of India

Joint efforts

- Innovative policies, projects, programmes, capacity building measures and financial instruments to mobilise more than USD 1 trillion dollars of investments that are needed by 2030.
- The reduced cost of finance would enable the undertaking of more ambitious solar energy programmes.

Aim

- The aim is for countries to work together towards the deployment of appropriate benchmarks, facilitating resource assessments, supporting research and development and demonstration facilities, with a view to encourage innovative and affordable applications of solar technologies.

Five Key Focus Areas

Key focus areas to achieve these objectives are to:

- promote solar technologies, new business models and investment in the solar sector to enhance prosperity
- formulate projects and programmes to promote solar applications

- develop innovative financial mechanisms to reduce cost of capital
- build a common knowledge e-Portal
- facilitate capacity building for promotion and absorption of solar technologies and R&D among member countries

India's Contribution

- India has offered a contribution of Rs 175 crore for creating ISA corpus fund and for meeting the cost of ISA secretariat for initial five years.
- International Steering Committee was establishment under the mandate of the Paris Declaration of ISA to provide the guidance and direction to establish the ISA.
- India has suggested that Multilateral Development Banks and other financial institutions support solar projects through low-cost finance, and research & technology institutions worldwide try their utmost to bring the cost of solar power and storage within reach of all.

1.2.2 Solar Briefcase

Uttarakhand Govt. launches 'Solar Briefcase' to provide electricity in remote areas. 47 villages and 1, 40,000 families do not have access to electricity.



How will it work?

This system is perfect for the budget conscious buyer who needs reliable portable power. It has a built-in 50w high efficiency portable solar panel for recharging built-in 50Ah battery directly with sunlight. This system can easily power small to medium-sized electronic devices such as cell phones, game systems, laptops, iPads.

1.2.3 Green Airports and Light houses

- The Government of India encourages development of green airports.

- AAI has commenced installation of 1MWp solar power plant at Tirupathi and Vijaywada Airports.
- Earlier, the Cochin International Airport Limited (CIAL) became the first airport in the world, to be completely powered by solar energy.

Why needed?

- The aviation industry has a reputation for being particularly carbon intensive
- Eco-savvy airports hope to change that by reducing the sector's carbon emissions

2. RENEWABLE AND CLEAN ENERGY**2.1 Tamil Nadu's success story in Wind energy**

Tamil Nadu has reaped the benefits of better planning and forecasting in integrating wind energy into its energy mix

- Tamil Nadu is also expected to fully realize its renewable energy potential once the Raigarh-Pugalur green power transmission corridor, with a capacity of 6,000 MW, is completed by May 2019
- And it has the largest wind capacities in the country and significant developer and manufacturer interest.
- It is also investing in its fourth wind power sub-station at Thennampatti, in addition to the ones in Ramanathapuram, Thoothukudi and Tirunelveli.
- And most importantly, it must continue to build on its planning process for the sector to truly integrate clean energy into its grids.

2.2 World Renewable Energy Technology Congress

The Energy and Environment Foundation is organizing 8th World Renewable Energy Technology Congress & Expo-2017 in, Delhi.

The theme of the conference is "Renewable Energy: What Works".

3Ds, which today's global engagements need to focus their energy upon. These are -

- a common shared goal of De-carbonization of the energy space;
- to look at more Decentralization of energy space; and
- More and more Digitalization of the energy space.

2.3 First large-scale battery storage project for wind and solar

Denmark's Vestas will help to build the world's first utility-scale project that uses battery technology to store power from both wind and solar sources.

Project in Australia

- The project in Australia aims to bring down the cost of renewable energy production and help secure a steady supply of renewable power to the grid regardless of weather condition.
- It will use batteries supplied by U.S. electric carmaker Tesla Inc

How will help India?

- So many remote places will benefit, which are still out of reach from electricity
- Can bolster government electric mobility plan

2.4 Fuel from oxygen in air

Researchers from Cardiff University in the U.K. have discovered:

- Methanol can be produced from methane through a simple catalysis that allows methanol production at low temperatures
- Using oxygen and hydrogen peroxide.

Current methanol synthesis

- Breaking down natural gas at high temperatures into hydrogen gas and carbon monoxide
- Reassembling them expensive and energy-intensive processes known as 'steam reforming' and 'methanol synthesis.'

Uses:

- Natural gas could use this method for "waste" gas saving
- Reducing carbon dioxide emissions

2.5 World's First Hydrogen Tram Begins Operation in China

The world's first hybrid electric tram powered by hydrogen fuel cells has started running in China, marking a big step in the application of green energy in public transport.

- Water being its only emission, the tram emits no pollutants.
- No nitrogen oxides will be produced as the temperature of the reaction inside hydrogen fuel cells is controlled under 100 degrees Celsius.
- The distance between carriage floor of the tram and the rail is only 35cm thanks to the latest low-floor technology, which can remove station platforms

2.6 Indian Renewable Energy Development Agency Limited (IREDA)

- IREDA is a Mini Ratna (Category – I) Government of India Enterprise.

- It is under the administrative control of Ministry of New and Renewable Energy (MNRE).
- IREDA is a Public Limited Government Company established as a Non-Banking Financial Institution in 1987.
- motto: “ENERGY FOR EVER”.

Objectives:

- To give financial support to specific projects and schemes for generating electricity and / or energy through new and renewable sources and conserving energy through energy efficiency.
- To strive to be competitive institution through customer satisfaction.
- To maintain its position as a leading organization to provide efficient and effective financing in renewable energy and energy efficiency / conservation projects.
- Improvement in the efficiency of services provided to customers through continual improvement of systems, processes and resources.

2.7 Tracing India's nuclear journey

Experimental reactors:

- **Apsara**, India's first nuclear reactor. This reactor was with the help from United Kingdom under a lease agreement.
- Our second reactor for research purposes, CIRUS, was built with cooperation with Canada and went into operation in the early 1960's.

Commercial reactors:

- The Tarapur Atomic Power Station (TAPS) which was built by General Electric of USA.
- Special materials like nuclear fuel, zirconium components and heavy water production required extensive work in the laboratories of the Bhabha Atomic Research Centre (BARC).

India now has twenty-one reactor units in service.

Agreements with other countries:

- India signed cooperation agreements with the Westinghouse of USA and AREVA of France in 2008.

2.8 India's three-stage nuclear power programme

Indian Nuclear Power Generation : Envisages A Three Stage Programme

- **STAGE 1** » Pressurised Heavy Water Reactor using
- **STAGE 2** » Fast Breeder Reactor

- **STAGE 3 » Breeder Reactor**

STAGE 1 » Pressurised Heavy Water Reactor using

- Natural UO_2 as fuel matrix
- Heavy water as moderator and coolant

In the reactor

- India achieved complete self- reliance in this technology and this stage of the programme is in the industrial domain.

The future plan includes

- Setting up of VVER type plants based on Russian Technology is under progress to augment power generation .
- MOX fuel (Mixed oxide) is developed and introduced at Tarapur To conserve fuel and to develop new fuel technology.

STAGE 2 » Fast Breeder Reactor

India's second stage of nuclear power generation envisages the use of Pu-239 obtained from the first stage reactor operation, as the fuel core in fast breeder reactors (FBR). The main features of FBTR are

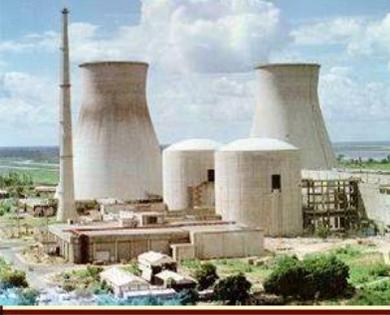
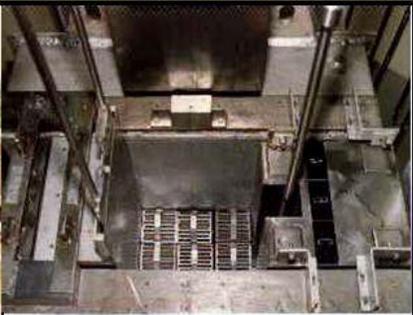
- Pu-239 serves as the main fissile element in the FBR
- A blanket of U-238 surrounding the fuel core will undergo nuclear transmutation to produce fresh Pu-239 as more and more Pu-239 is consumed during the operation.
- Besides a blanket of Th-232 around the FBR core also undergoes neutron capture reactions leading to the formation of U-233.
- U-233 is the nuclear reactor fuel for the third stage of India's Nuclear Power Programme.

STAGE 3 » Breeder Reactor

The third phase of India's Nuclear Power Generation programme is, breeder reactors using U-233 fuel. India's vast thorium deposits permit design and operation of U-233 fuelled breeder reactors.

- U-233 is obtained from the nuclear transmutation of Th-232 used as a blanket in the second phase Pu-239 fuelled FBR.
- Besides, U-233 fuelled breeder reactors will have a Th-232 blanket around the U-233 reactor core which will generate more U-233.
- These U-233/Th-232 based breeder reactors are under development and would serve as the mainstay of the final thorium utilization stage of the Indian nuclear programme.

Three Stage Nuclear Power Programme of India : Status

		
<p>Stage – I PHWRs</p> <ul style="list-style-type: none"> • 17- operating • 2 - under construction • Scaling to 700 MWe • Construction period reduced • POWER POTENTIAL ≅ 10,000 MWe 	<p>Stage - II Fast Breeder Reactors</p> <ul style="list-style-type: none"> • 40 MWth FBTR - Operating • Technology Objectives realised • 500 MWe PFBR- under construction • POWER POTENTIAL ≅ 500,000 MWe for 100 y 	<p>Stage - III Thorium Based Reactors</p> <ul style="list-style-type: none"> • 30 kWth KAMINI- operating • 300 MWe AHWR- under regulatory examination • POWER POTENTIAL ≅ Very large. • Availability of accelerator driven neutron sources can covert Thorium • Participation in ITER for fusion technology development
<p>LWRs</p> <ul style="list-style-type: none"> • 2 BWRs operating • 2 PWRs construction 		

2.9 Fast Breeder Reactors (FBRs) in India

- Fast reactors generally have an excess of neutrons that can breed more fuel from otherwise non-fissionable isotopes.
- The most common breeding reaction is that on uranium-238 to produce plutonium-239 .
- Breeder reactors could, in principle, extract almost all of the energy contained in uranium or thorium, decreasing fuel requirements.

India’s three stage nuclear programme envisages, construction of Fast Breeder Reactors (FBRs) in Stage-II, fuelled by Plutonium produced in stage-I.

KAMINI (Kalpakkam Mini reactor) was the first reactor in the world designed specifically to use uranium-233 fuel.

What is the progress now?

- India has designed an Advanced Heavy Water Reactor (AHWR) which would breed U-233 from Thorium.

- Construction of the pilot AHWR was envisaged in the 12th plan period. 2018 is now the target dates.

2.10 Nuclear Power Corporation of India Limited (NPCIL)

- It is a Public Sector Enterprise under the administrative control of the **Department of Atomic Energy (DAE)**, Government of India.
- NPCIL also has equity participation in BHAVINI, another PSU of Department of Atomic Energy (DAE) which implements Fast Breeder Reactors programme in the country.

Functions

- NPCIL is responsible for design, construction, commissioning and operation of nuclear power reactors.

3. FOSSIL FUELS

3.1 Oil & Gas

3.1.1. Methanol - A clean fuel

Advantages of Methanol

- It is clean, cheaper than fossil fuels and a good substitute for heavy fuels.
- Will help India use its vast reserves of coal, Can reduce the petroleum imports.
- Methanol can be produced from municipal waste as well
- It can be made from natural gas

How Methanol is produced?

Methanol can be produced from natural gas, coal and renewable sources such as municipal waste, biomass and recycled carbon dioxide.

Role of NITI Aayog

NITI Aayog is working on a roadmap for conversion from coal to by studying Chinese model

Property	Methanol	Ethanol
appearance	colorless	colorless
physical effect	very poisonous and fatal when ingested	feel intoxicated when ingested

uses	used in solvents and fuels, it is primarily used to make other chemicals.	for alcohol, cleaning, solvents, and fuels
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3.1.2 LPG (Cooking gas)

- The central government has asked oil companies to raise domestic LPG prices by Rs.4 per cylinder every month until the entire subsidy is wiped out.
- The government had earlier asked the LPG retailers to revise prices by Rs2 per month, to gradually remove the subsidy involved. The move now is to fast-track the price revision, so as to better allocate scarce resources.

Need for reducing the subsidy?

- The upfront subsidy (subsidy payment in advance) distorts the market, breeds corruption and comes in the way of efficiency improvement.
- Following the implementation of direct benefits transfer for LPG to below poverty line (BPL) households, it makes no sense to provide such consumption subsidies for the non-poor.
- Subsidised kerosene needs to be promptly replaced with aids like solar lanterns. It should hugely improve public health.
- Piped supply of gas in towns would be cheaper than distribution via cylinders.
- Composite cylinders would lower costs, as compared to steel ones.

Properties	Compressed Gas(CNG)	Natural	Liquified Petroleum Gas(Auto gas)
Constituents	Consists mostly of methane	of	Consists mainly of Propane and Butane
Source	Obtained from natural gas-and-condensate wells, oil wells, coal bed methane wells.		Automatically generated from gas fields when natural gas is extracted from the reservoir. By-product of cracking process during crude-oil refining.

Properties	It is lighter than air and hence disperses quickly in the event of spillage.	Highly inflammable. It is heavier than air and on leakage will settle to ground and accumulate in low lying areas.
Uses	Substitute for gasoline in automobiles.	Heating and cooking in homes, refrigeration, industrial, agricultural, catering and automobile fuel.
Environmental effects	Releases less greenhouse gas.	Releases CO ₂ which is a greenhouse gas but is cleaner when compared to gasoline.

3.1.3 Coalbed Methane

Coalbed methane (CBM or coal-bed methane), coalbed gas, coal seam gas (CSG), or coal-mine methane (CMM) is an unconventional source of natural gas is now considered as an alternative source for augmenting India's energy resource. Riding upon Make-in-India, SMEs (Small and Medium Enterprises) can play a pivotal role in the national agenda by increasingly using natural gas in meeting domestic manufacturing goals in a clean and productive manner.

What is Coalbed Methane?

- It is a natural gas found in coal seams
- It mainly consists of **Methane (CH₄)** with minor amounts of nitrogen, carbon dioxide and heavier hydrocarbons like ethane
- Earlier the CBM was wasted and vented out into the atmosphere during mining but now CBM is considered as a precious energy resource
- Extraction requires drilling wells into the coal seams and removing water contained in the seam and release absorbed (and free) gas out of the coal

Why CBM is Referred as an Unconventional Gas?

Conventional gas is found pooling within spaces of the rock formation. Because of this, extraction of conventional gas is simple but that is not the case with unconventional gases like CBM.

Renewed interest

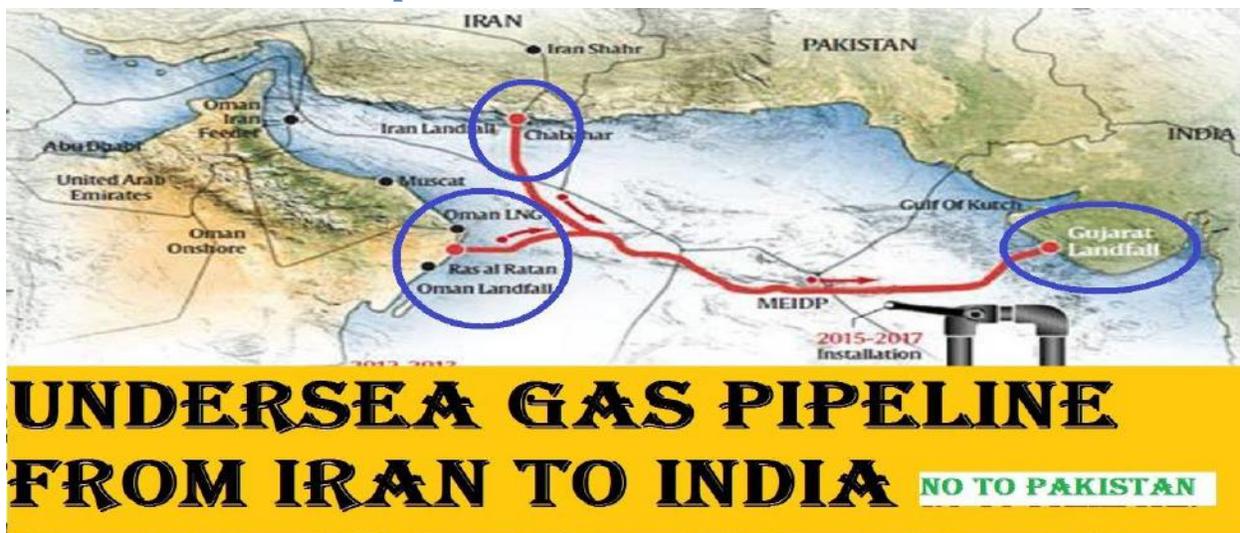
- India has the third largest reserves in the world. So there is scope for CBM

- The problem so far has been a lack of investor interest, which should now recover due to the new Open Acreage Licensing Policy (OALP) and HELP (Hydrocarbon Exploration and Licensing Policy) introduced by the government.

HELP

- uniform license for exploration and production of all forms of hydrocarbon
- an open acreage policy
- easy to administer revenue sharing model and
- marketing and pricing freedom for the crude oil and natural gas produced.

3.1.4. India-Iran Gas Pipeline



A 1,300-km undersea pipeline from Iran, avoiding Pakistani waters, can bring natural gas from the Persian Gulf to India.

Study on gas pipeline:

- Natural gas imported through the pipeline is cheaper than the rate at which some of the domestic fields supply gas.

3.1.5 India's Farzad-B gas field deal with Iran

As India and Iran engage in a blame game, the fate of the multi-billion dollar Farzad-B gas field contract that New Delhi has been pursuing with Tehran since 2009, seems doomed.

- Iran accuses India of inflexibility
- India charges Iran with “changing goal posts” and adopting “delay tactics”.

Background

- The Indian consortium of oil companies discovered gas reserves in the field under an exploration contract signed in 2002.

- The field in the Persian Gulf holds about 19 trillion cubic feet of gas, according to Indian estimates. The contract expired in 2009.
- But the contract for development of the field first delayed by the sanctions against Iran imposed by the U.S. between 1995 and 2016.

Significance of the deal

- Geopolitically Iran is gaining importance over Saudi Arabia.
- Geographically, Iran is the closest to India of all the countries in that region.
- On the energy front, we really need gas. We are really running short on gas
- While India bought oil from Iran even during the years of U.S. sanctions, relations recently have seen a bit of a downturn.
- The impasse over the deal has affected the oil trade, with India recently reducing its crude oil purchases from Iran (down 30-40% from a year ago).

3.1.6 Hydrocarbon cooperation with Kazakhstan

- India is considering to expanding hydrocarbon cooperation with resource-rich Kazakhstan including exploration and production of hydrocarbons
- Participation of Indian companies in the oil and gas sector of Central Asia's biggest country.
- Kazakhstan is one the suppliers of uranium to India.

3.1.7 India to build natural gas trading platform

India will soon build a natural gas trading platform, which will help in transparent pricing and encourage investment in the sector.

Presently, most of the gas produced in India today is governed by a government-set price formula

Pact with Japan for setting up flexible LNG market

- Contribute to the diversification of gas supplies for India.
- Establishing reliable LNG spot price indices reflecting true LNG demand and supply.
- Cooperate in facilitating flexibility in LNG contracts, abolition of Destination Restriction Clause.

3.1.8 India to renegotiate LNG rate with US, Russia

After getting Qatar and Australia to lower gas price, India is seeking to renegotiate rate of LNG (liquefied natural gas) it has contracted from the US and Russia to reflect current market realities.

LNG:

- Liquefied natural gas (LNG) is natural gas (predominantly methane, CH₄, with some mixture of ethane C₂H₆) that has been converted to liquid form
- It is odorless, colorless, non-toxic and non-corrosive.
- The liquefaction process involves removal of certain components, such as dust, acid gases, helium, water, and heavy hydrocarbons,

Benefits of LNG:

- Safe storage, safe transportation and safe usage
- Well-to-Wheel greenhouse gas reduction of between 11% and 20%
- NOx emissions reduced by 80%
- Particulate emissions reduced by 75%
- Least expensive transportable fuels.

LNG Terminals in India:

- RGPPL LNG Terminal, Maharashtra,
- Dahej Terminal, Petronet LNG Ltd, Gujarat
- Hazira Terminal, Shell Ltd, Gujarat
- Kochi Terminal, Petronet LNG Ltd.

3.1.9 Mega oil and gas auctions

OALP programme

- The Government has launched the Open Acreage Licensing (OALP) Programme in June 2017
- It is as per the new Hydrocarbon Exploration and Licensing Policy (HELP).
- OALP bidding mechanism allows investors to bid for oil and gas fields throughout the year.

Hydrocarbon Exploration and Licensing Policy

- Uniform license for exploration and production of all forms of hydrocarbon.
- Easy to administer revenue sharing model and
- Marketing and pricing freedom for the crude oil and natural gas produced.

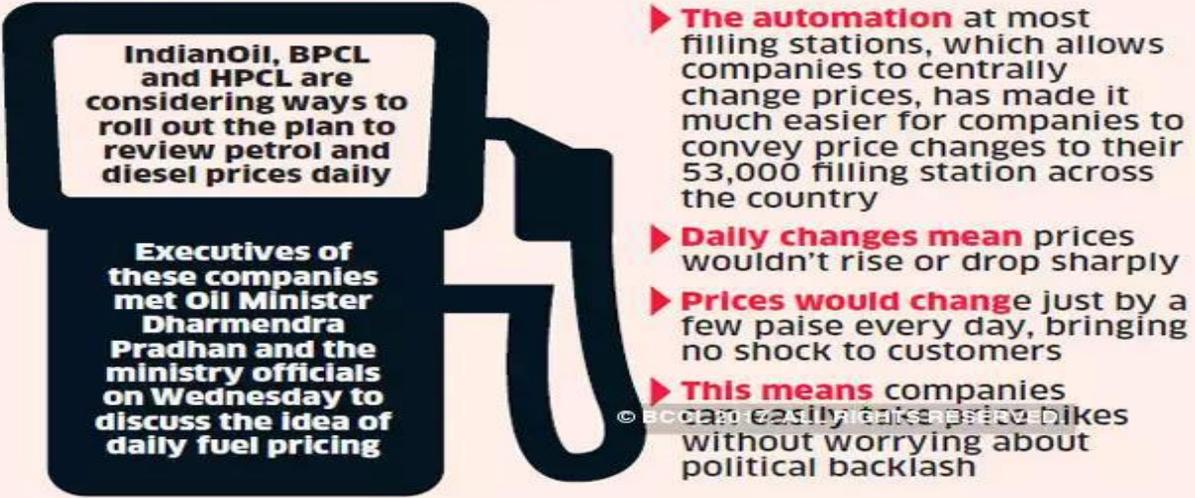
3.1.10 Dynamic Fuel Pricing

- In Administered Pricing, under the cost plus formula, prices of all petroleum products are fixed on the basis cost of procuring and refining crude oil.
- Cross subsidization among petroleum products was in existence under the administered pricing mechanism.
- The prices of petrol and diesel subsidized the prices of liquefied petroleum gas (LPG) and kerosene.

- The APM ensured a 12 per cent post-tax return to the oil companies.
- This is lower than those prices determined by the free market.

The dismantling of the administered pricing mechanism means that oil companies are free to take independent decisions based on import parity and market forces in pricing of petroleum products rather than being governed by the dictates of the Government.

Dynamic Fuel Pricing



IndianOil, BPCL and HPCL are considering ways to roll out the plan to review petrol and diesel prices daily

Executives of these companies met Oil Minister Dharmendra Pradhan and the ministry officials on Wednesday to discuss the idea of daily fuel pricing

- ▶ **The automation** at most filling stations, which allows companies to centrally change prices, has made it much easier for companies to convey price changes to their 53,000 filling station across the country
- ▶ **Daily changes mean** prices wouldn't rise or drop sharply
- ▶ **Prices would change** just by a few paise every day, bringing no shock to customers
- ▶ **This means** companies can easily raise prices without worrying about political backlash

3.1.11 World's largest combustion research facility

The National Centre for Combustion Research and Development (NCCRD), was opened at the Indian Institute of Technology-Madras (IIT-M).

Benefits

- The intention is to make it a knowledge base in areas like gasification, combustion, propulsion and automotive sectors.
- Provide an impetus to research in alternative energy and environmental protection by focusing on effective utilisation of combustion

The research interests are in three major application sectors -- automotive, thermal power and aerospace propulsion, besides fire research and microgravity combustion.

3.1.12 Pradhan Mantri Urja Ganga - First Piped Natural Gas (PNG) project

Oil Minister launched supply of Piped Natural Gas (PNG) project under 'Pradhan Mantri Urja Ganga' (PMUG) in Odisha.



- Gas (India) Limited (**GAIL**) started supply of environment-friendly PNG to 255 houses in Nalco Nagar.
- PMUG will pass through five states like Uttar Pradesh, Bihar, Jharkhand, Odisha and West Bengal.
- The longest stretch of the project, which is about 769 km, will be built in Odisha

Pradhan Mantri Urja Ganga:

- The gas pipeline project aims to provide piped cooking (PNG) gas to residents of the eastern region of the country and CNG gas for the vehicles.
- The project is being implemented by state-run gas utility GAIL.

3.1.13 Clean Cooking Forum

Clean Cooking Forum was held in New Delhi earlier this month to discuss on fuel alternatives

Alcohol as fuel

- Use of alcohol for cooking is gaining traction in African and Latin American countries as it provides clean burning, drastically reducing household pollution.
- It can be produced from renewable sources

- Its flash point (the lower the flash point the more dangerous a fuel is for kitchen use) is 170 C whereas for diesel and kerosene it is more than 500C

Indian scenario

- Since India has a good supply of natural gas, Niti Aayog is pushing for a national programme of methanol as a substitute for diesel or gasoline for transportation.
- There is no programme at present for its use as cooking fuel in rural households.
- Most of the alcohol produced in India is from molasses, which is a byproduct of the sugar industry

Pyrolysis oil

- Pyrolysis oil is a medium calorific value (CV) fuel with CV of 17 MJ/kg
- can be produced from any biomass and agricultural residues via fast pyrolysis route (hence the name pyrolysis oil).
- It can be an efficient alternative for cooking fuel in India

3.2 Other Fossil Fuels**3.2.1. Coal as a Fuel**

Coal is a “dirty fuel”, so to tackle the problem of climate change, the government must exponentially increase the generation of renewables. But

Benefits of Coal:

- Coal offers the cheapest source of energy
- Electricity infrastructure in India is built around this fuel
- Alternatives are not competitive

Importance of coal in Power Generation

Presently 81% of power generation from the coal.

- Renewable energy sources and coal will coexist, as the availability of coal is abundant in India
- Coal-based generation is the cheapest mode and most affordable source of power in the country
- Absence of cost-effective storage of renewable energy
- Variable cost is far lower than that for solar power.

Problems:

- Global warming and Climate Change

- The US-based research group, Health Effects Institute, has reported that India will soon overtake China with the most number of deaths caused by respiratory illness
- The bulk of our population lives in villages where 40 per cent still use firewood and dung for cooking and lighting which affects health and environment

The government should augment coal production but also support renewables. It should conserve demand, improve efficiency of usage but also develop green coal technologies like coal gasification.

3.2.2 Opening up coal mines to commercial auction

Coal mines are opened to commercial auctions. It will improve supply of the fuel, and its quality.

Coal production in India :

- India is the third largest coal producer in the world. But it is also its third largest importer.
- Indian coal, on average, has about 45 per cent ash, much higher than the 25-30 per cent ideally required for the efficient burning of the fuel in thermal power stations.
- CIL(Coal India Limited)'s overwhelming dominance of commercial mining has contributed to less private investing in technology

3.2.3 Coal India to take up clean coal technologies

Coal India would be taking up clean coal technologies like coal to liquid, coal to poly-chemicals and coal to methanol, etc in a big way.

- **Coal washing** will remove unwanted minerals by mixing crushed coal with a liquid and allowing the impurities to separate and settle.
- **Wet scrubbers, or flue gas desulfurization systems**, remove sulfur dioxide, a major cause of acid rain, by spraying flue gas with limestone and water. The mixture reacts with the sulfur dioxide to form synthetic gypsum, a component of drywall.
- **Low-NO_x (nitrogen oxide) burners** reduce the creation of nitrogen oxides, a cause of ground-level ozone, by restricting oxygen and manipulating the combustion process.
- Electrostatic precipitators remove particulates by charging particles with an electrical field and then capturing them on collection plates.

- **Gasification** avoids burning coal altogether. This process produces syngas—a mixture consisting primarily of carbon monoxide (CO), hydrogen (H₂), carbon dioxide (CO₂), methane (CH₄), and water vapor (H₂O)—from coal and water, air and/or oxygen.

4. SAFETY OF POWER PLANTS

4.1 Disaster management drill to take place at Kudankulam power plant

The drill to keep people and officials from all departments equipped will be conducted at a radius of up to 1.6 km, 5 km and 16 km from the nuclear power plant.

Earlier, the Supreme Court

- asked the government to submit a disaster management plan
- directed the Tamil Nadu Government to carry out mock drills covering all the 40 villages situated within a 16-kilometer radius of the nuclear plant.
- these drills must be repeated after every two years

Disaster management at nuclear plants

Risks associated with nuclear plants

- High-level waste, Other waste, Radioactive gases and effluents
- Accidents leading to a large scale release of radioactivity in the environment
- Critical accidents where an uncontrolled nuclear chain reaction takes place inadvertently leading to bursts of neutrons and gamma radiations

Emergency preparedness at nuclear facilities

- Strict compliance with the regulatory framework of AERB (Atomic energy regulatory board) is ensured
- Based on the severity of the emergencies, detailed emergency response plans are in place at all the nuclear facilities and are functional during entire lifetime of the facility.
- Detailed response plans are put in place by the Collector of the concerned district in association with the plant authorities.
- Periodic mock drills/exercises involving the community are to be held to ensure the quality of the preparedness.
- During an actual emergency at any of the DAE(Department of Atomic Energy) facility, the Crisis Management Group (CMG) of DAE activates the emergency response and coordinates with other agencies.

- Monitoring and response support coverage is being enhanced through 18 numbers of Emergency Response Centers (ERCs) established by BARC.

Role of the National Disaster Management Authority (NDMA)

- NDMA will coordinate at the national level
- Has prepared guidelines on management of nuclear and radiological emergencies
- Assistance in establishment of emergency response centres

4.2 Safety issues in thermal power plants

Cautions:

- Stored coal must be watered and monitored frequently because coal dust is so combustible.
- Explosions at coal-fired power plants are a real danger. Safety precautions are critically important to prevent fires and other accidents.
- Coal dust, hydrogen, and other gases pose the highest explosion risk in coal power plants.
- There are several causes of power boiler accidents. While low water condition was the number one cause, operator error or poor maintenance was a close second

5 ELECTRIFICATION

5.1 Draft National Electricity Plan

- For the period 2022-27, priority has been given to development of hydro and nuclear-based projects for power generation.
- Coal based capacity addition will not be required in this period, as a capacity of 50 GW is already under construction against a requirement of 44 GW.
- It has also suggested some measures to improve energy efficiency:

5.2 Apps in Electricity

The user-friendly apps of power ministry

- **GARV** - to know the village electrification status
- **GARV-II** -to know habitation-wise data down to the households
- **MERIT**
 - to know the price being paid by your power utility for electricity

- to know whether states are actually giving priority to cheaper sources of power
- provides data on individual state portfolios - power generation, demand met etc on a daily basis
- **URJA Mitra** - notifications about power distribution such as power cuts
 - also gives information on release of connections and complaints
- **TAMRA** - track the status of projects and clearances
- **TARANG** - track the status of projects and clearances of transmission projects
- The **UJALA app** - ensuring the fastest rollout of LED bulbs
- **Mining Surveillance System (MSS) app** - allows reporting illegal mining
- **Coal Mitra** - identifies the most efficient thermal power plants
- **ARUN** - provides a DIY (Do It Yourself) guide for solar rooftop installations, and critical knowhow about government incentives, costs and methods of installation
- **Vidyut Pravah**
 - spot market prices of electricity updated on real time basis
 - to check the power availability status with the utilities

5.3 Grahak Sadak Koyla Vitaran App

The customer friendly app, launched recently to help achieve transparency in despatch operations, as a tool to monitor, whether the despatches are made on the fair principle of 'First in First Out' and keeps track of all the activities from issuance of Sale Order to physical delivery of coal by road.

Benefits:

- The main benefits of the App for the customers, against the Sale Orders issued, include easy accessibility of the information at the click of the button, apart from transparency in the system of loading programme and despatch.
- The main features of the app are that it provides date-wise, truck-wise quantity of coal delivered against the Sale Orders and information related to Scheme-wise, Colliery-wise, Grade-wise, customer-wise details of Sale Orders issued during a period.

5.4 PPPs for mini power grid projects

The Rockefeller Foundation has facilitated setting up of 106 mini power grids in many villages and the larger aim is to have 1,000 such projects in less than three years.

About mini power grids:

- A mini grid is defined as a system that uses a renewable energy-based generator having a capacity of 10 kilowatt or more to supply electricity through a public distribution network
- Smart Power India is helping these companies on various fronts, including setting up their plants and put in place an effective business model.

5.5 Open access charges in electricity distribution

High open access charges is likely to continue given the lack of progress in tariff rationalisation.

Open access charges

- Open access charges primarily comprise Cross Subsidy Surcharge (CSS), additional surcharge, wheeling & transmission charges and transmission & distribution losses in kind.
- The National Tariff Policy prescribes that the amount of CSS and the additional surcharge to be levied on large consumers procuring electricity under open access should not be so burdensome that it eliminates competition.

Tariff rationalisation could bring consistency in the levels of open access charges across the states.

5.6 Ease of Doing Business – Getting Electricity

Background

World Bank “Ease of doing business” initiative ranks countries on the basis of ten parameters. ‘Getting Electricity’ is the one of these parameters. For ‘Getting Electricity’, World Bank measures the performance on 4 parameters:

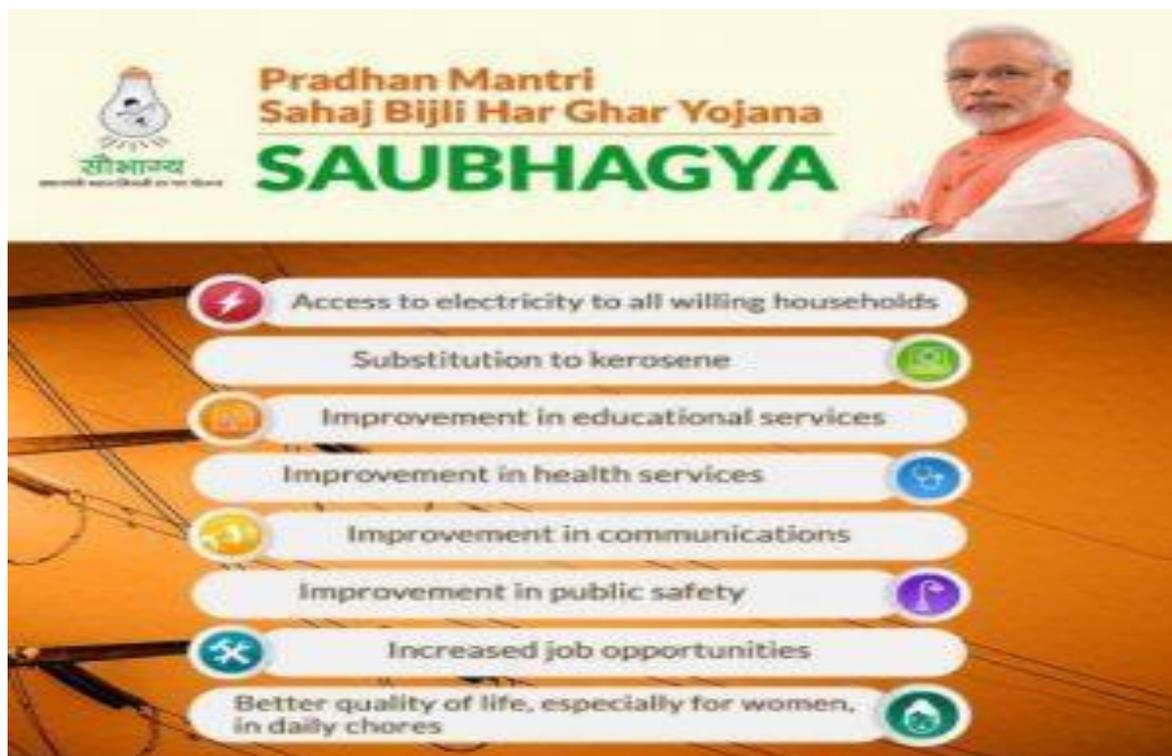
- (i) Number of procedures
- (ii) Time for obtaining a commercial electricity connection;
- (iii) Cost for obtaining a commercial electricity connection upto 140 KVA, and
- (iv) Reliability of power supply.

India has made several reform initiatives because of which India’s ranking has improved from 99 in the Report 2015 to 26 in the Report 2017. These reforms include regulatory easing as well as administrative easing measures

- Regulatory Reforms are made by Central Electricity authority and Regulators
- Administrative easing measures
 - Online application with no requirement of physical documents to be accepted.
 - Utility does external connection and installs meter
- Electrical connections (up to 150 KVA) are required be provided within 7 days
- Mumbai and Delhi have SCADA systems in place for automatic restoration of power supply

5.7 Saubhagya Web-portal

- Saubhagya Web-portal is a Platform for Monitoring Universal Household Electrification
- It has wider scope for ensuring transparency and accelerating household electrification in rural as well as urban areas in the country



The portal can be accessed at <http://saubhagya.gov.in>.

- The Saubhagya Dashboard is a platform for monitoring household electrification progress, which would disseminate information on
 - Household Electrification Status (State, District, village-wise)
 - Household Progress on live basis
 - State-wise Target vs Achievement
 - Monthly Electrification Progress, etc.
- The Saubhagya web-portal has a feature on village electrification camps and in line with that, DISCOMs will organize camps in villages/cluster of villages.
- All States have been asked to announce the schedules of the village camps to be held to create awareness among the people.

SAUBHAGYA Scheme Features

- All willing households in rural areas and poor families in urban areas are given free electricity connections.
- There are around 4 Crore un-electrified households in the country and they are targeted for providing electricity connections by December 2018.

Why need for new scheme?

- Despite the government's aggressive village electrification programme, under the Deen Dayal Upadhyay Gram Jyoti Yojana, it was realised that the problem of electricity 'access' wasn't resolved.
- With a large number of household still remaining without access to electricity, the scheme aims at ensuring the coverage of households as opposed to only villages.

6 ELECTRIC VEHICLES

6.1 E- Vehicles

Energy minister, GoI announced that only electric vehicles (EVs) will be sold in India from 2030.

- The current National Electric Mobility Mission Plan (NEMMP) has set a sales target of 5-7 million EVs and hybrid electric vehicles annually by 2020. But actual demand is 23 million.
- The transition would require a battery capacity of about 400 GWh (gigawatt hours) each year

Bottlenecks

- Indian battery manufacturing chain is not aligned to the global value chain
- Currently, the domestic battery market is largely dominated by lead-acid battery technologies.
- There is an increasing import bill for electronics products

Resources Shortage

- Different variants of lithium-ion batteries are predominantly used in electric vehicles.
- Manufacturing lithium-ion batteries would require critical minerals such as cobalt, graphite, lithium and phosphate. Among them, lithium is of particular importance.
- The resource endowment is limited to only nine countries and 95% of global lithium production comes from Argentina, Australia, Chile and China.

Way forward

- A recent extension of the PTA with Chile provides India some tariff concessions for lithium carbonate imports, need PTAs with more countries
- Joint acquisition of mines in foreign lands can also be pursued
- Recycling of Lithium

Lithium

- Could become as precious as gold in this century, so can be called as new 'White Gold'
- With atomic number 3, is a soft, silvery-white alkali metal
- Like all alkali metals, lithium is highly reactive and flammable, and is stored in mineral oil
- It never occurs freely in nature, but only in (usually ionic) compounds, such as pegmatite minerals
- It is present in ocean water and is commonly obtained from brines
- Lithium metal is isolated electrolytically from a mixture of lithium chloride and potassium chloride
- Recycling is easy because of the low melting point (180 °C) of lithium metal and the very low water solubility of its fluoride, carbonate and phosphate salts

6.2 Infrastructure for the electric vehicles

NITI Aayog Vice Chairman, Dr. Rajiv Kumar, released a proposal to develop electric vehicle charging infrastructure in Delhi.

Salient features of the proposal

- The proposal for the quick pilot could be used to provide a structure for EV infrastructure rollout in the Gurgaon-IGI-South Delhi-Noida corridor.
- This planning will make the actual rollout easier and faster and also save cost on the deployment.

The planning process is based on a five-step process;

1. project kickoff
 2. formation of "long list" of locations
 3. streamlining and timing
 4. documentation and
 5. wrap-up
- This proposal for developing the pilot includes 55 locations with 135 charging stations of which 46 are DC quick charging stations and 89 are slower AC charging stations.
 - This deployment would require cooperation with state governments; selected government authorities and companies as well as some private enterprises (e.g. DIAL at IGI, DLF Mall).

Further expansion of this in Delhi NCR and other cities in India is something to be considered based on the experience from this "Quick pilot".

6.3 National Electric Mobility Mission Plan

This is a comprehensive collaborative planning for promotion of hybrid and electric mobility in India through a combination of policies aimed at gradually ensuring a vehicle population of about 6-7 million electric/hybrid vehicles in India by the year 2020 along with a certain level of indigenisation of technology ensuring India's global leadership in some vehicle segments.

It is a composite scheme using different policy-levers such as:

1. Demand side incentives to facilitate acquisition of hybrid/electric vehicles
2. Promoting R&D in technology including battery technology, power electronics, motors, systems integration, battery management system, testing infrastructure, and ensuring industry participation in the same
3. Promoting charging infrastructure
4. Supply side incentives
5. Encouraging retro-fitment of on-road vehicles with hybrid kit

7 ENERGY CONSERVATION

7.1 The Energy Conservation Building Code (ECBC) 2017

- The 2017 ECBC is an update of the Code first introduced in 2007
- Compares very favourably with international best practices
- If implemented correctly, could make new buildings producers of electricity rather than simply consuming energy, according to the Green Business Certification Institute, USA
- **The ECBC 2017 has three levels of adoption**
 - Basic
 - ECBC Plus, and
 - Super ECBC
- While the Code is primarily designed for new commercial buildings, there are measures that existing buildings can adopt to reduce energy consumption
- The 2017 Codes have already been adopted by 12 states

7.2 All Central Government offices to retrofit energy efficient appliances

The Ministry of Finance has issued guidelines for mandatory installation of energy efficient appliances in all Central Government buildings across India.

- Energy Efficiency Services Limited, a joint venture of PSUs under the Ministry of Power, to execute work
- Currently, EESL is the implementation agency for the Buildings Energy Efficiency Programme, which was launched in May 2017 by Minister of State (IC) FOR Power , Coal , Mines & New & Renewable Energy

Buildings Energy Efficiency Programme

- Apart from retrofitting, EESL also aims to widen its services in areas like centralized AC system, Energy Audits, and New Generation Energy Management System in buildings.

The National LED Programme

- To facilitate rapid adoption of LED based home and street lighting across the country.
- The government plans to replace 77 crore incandescent bulbs and 3.5 crore street with energy efficient LED bulbs and lights under DELP and SLNP by March 2019.
- For this, the Energy Efficiency Services Ltd (EESL) along with Discoms, will be distributing LED bulbs to consumers at Rs 10 per unit.

- The programme components, **Unnat Jeevan** by Affordable LEDs and Appliances for All (UJALA) and Street Lighting National Programme (SNLP) of EESL are currently under implementation in 29 States and 7 Union Territories.

Advantages of LED Bulbs

LED stands for light-emitting diode (LED). This specialized electronic component is assembled into a lamp or bulb for use in light fixtures. LED bulbs have the following advantages:

- LED bulbs are energy efficient. As compared to the incandescent bulbs, LEDs consume up to 90% less power.
- Lesser consumption of power also means lesser emission of CO₂, and thus reduced carbon footprints.
- Use of LED bulbs naturally is indicative of a dramatic decrease in power costs.
- LED bulbs are long lasting. A single bulb may last as long as 20 years. Thus usage of the same also results in time-efficiency.
- Money and energy is saved in maintenance and replacement costs due to the long LED lifespan.

7.3 Enhanced oil recovery projects

In a bid to boost oil production from mature fields ONGC is planning to increase focus on EOR(Enhanced Oil Recovery)

EOR

- It is the implementation of various techniques for increasing the amount of crude oil that can be extracted from an oil field.
- Is also called tertiary recovery
- Contacts to be for 15 years or longer

7.4 India is fourth largest in LEED projects

Background

- The 'green building' movement began in the U.S. about 25 years ago, has gained momentum in India in the last 10 years.
- The Green Business Certification Institute (GBCI), a part of the U.S.-based Green Business Certification Inc., commenced India operations in 2014
- India is now the fourth-largest country in the number of LEED projects after the U.S., Canada and China.

- The GBC, which has been organising its sustainability conference Greenbuild in the U.S. for the last 15 years, decided to hold the event in India this year for the first time.

Green building scenario in India

- India has shown that green buildings are not just for offices; it is into every industry segment — manufacturing, hotels, hospitals, schools, colleges, temples, data centres, metro stations, airports and shipping terminals.
- the metro cities have now gone for Green Buildings in a big way, and even tier 1 cities are adopting them, the action will now shift to tier-2 and tier-3 cities.
- Maharashtra is number one because Mumbai is one of the early adopters. It is closely followed by Delhi and Bengaluru.

LEED rating

- Leadership in Energy and Environmental Design, is the most widely used green building rating system in the world.
- there are five pillars to it: energy, water, human experience, waste and carbon footprint

Green Building

- we will be able to save energy and water in green buildings
- Today, possibly a green building would be 5% costlier than a normal building but because of savings from energy and water, your payback period very low
- health and well-being are big factors that prompts people to go for green buildings

7.5 Energy Savings Certificates

- These are introduced in 2013 by the Bureau of Energy Efficiency (BEE), have received the regulator's nod for being traded on a separate market platform.
- BEE in 2013 launched tradable certificates for industries which achieved energy efficiency standards.
- Titled 'Perform, **achieve and trade**', the scheme aimed at major sectors such as thermal power generation, cement, fertiliser, aluminium, iron and steel, pulp and paper.
- These cover 65 per cent of the electricity consumed by industries.

How they work?

- These industries were given targets for reducing energy consumption.
- Over-achievement by a certain commercial unit is converted into tradable 'Energy Savings Certificate' at the end of the targeted year, which it can sell to the ones that couldn't achieve the targets.

Value of the certificates

- The pricing of the certificates would be as per the Energy Conservation Rules.
- The rules prescribe that one certificate shall be equal to the energy consumed in terms of one metric tonne of oil equivalent (mtoe).

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