Energy Efficiency Is The Key For Sustainable Development

- The growing population, enormous increase in energy intensive economic activities are reasons for massive demand for energy in India.
- As the conventional source of energy are reducing and the renewable sources are under developing phase, **improving energy efficiency** at all levels of the *energy spectrum is the cost-effective and quick solution to address this problems*.
- Also, increased energy efficiency can be helpful in *overcoming some of the concerns regarding the limitations imposed on sustainable development by environmental emissions*.
- The government, through **Nationally Determined Contributions** has aimed to *reduce emission intensity of GDP to 33-35 per cent* below what is was in 2005 by 2030.
- However, to achieve this target, there is a need for a concerted move to ensure increased energy efficiency especially in these 3 sectors:

A. Industrial sector

B. Real estate

C. Consumer appliance

A. Industrial Sector:

- With an aim of energy efficiency improvement, Bureau of Energy Efficiency (BEE) is implementing **Perform, Achieve and Trade (PAT) scheme** under the **National Mission for Enhancement Energy Efficiency (MNEEE)**.

About PAT:

- It is a regulatory instrument to *reduce specific energy consumption in energy intensive industries*, with an associated **market based mechanism** to enhance the cost effectiveness through certification of excess energy saving which can be traded.
- PAT cycle-I covered total 6 sectors including Aluminium, Cement, Chlor-Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power Plant, Textile, which were mandated to reduce their specific energy consumption (SEC) i.e., *energy used per unit of production*.
- The implementation of PAT in designated industries has led to **energy saving of 8.67 MTOE** in **year 2015**, which is about 1.25 per cent of total primary energy supply to the country in the "first cycle". This energy saving also translates into mitigating about 31 million tonne of CO_2 emission.
- The "second cycle" of PAT was notified in March, 2016 covering 11 sectors which include eight existing sectors and three new sectors, viz. Railways, Refineries and DISCOMs.
- Since PAT scheme is currently based on a rolling cycle i.e. inclusion of new sectors/designated consumers every year, the "third cycle" of PAT was notified in March 2017.
- Targets for the "**fourth cycle" of PAT** have been notified in March 2018 under which two new sectors i.e. Petrochemical and Commercial Buildings (Hotels) have been added.
- At present total 956 designated consumers belonging to 13 energy intensive sectors are under PAT cycles-II, III, IV and V undergoing implementation of energy efficiency projects to achieve the assigned targets.

B. Real Estate Sector:

- The Bureau of Energy Efficiency (BEE) envisages a phased approach for developing an energy conservation code for the residential sector.

- The real estate sector **consumes over 30 percent** of the total electricity consumption in India annually and is **second only to the industrial sector** *as the largest emitter of greenhouse* gases; of which around 75 per cent is used in residential spaces.
- The building envelope thus will impact both the **thermal comfort** as well as **electricity used for space conditioning**.
- In this context, BEE has two programs (1) **Eco Samhita. Energy Conservation Building Code for Residential Buildings**, and (2) **Labelling for Energy Efficient Homes**.

1. Eco Samhita (Energy Conservation Building Code for Residential Buildings):

- The Eco-Niwas Samhita (Part 1 : Building Envelope) aims to *set minimum building envelope performance standards to limit heat gains* (for cooling dominated climates) and to *limit heat loss* (for heating dominated climate) as well as for ensuring adequate natural ventilation and daylighting. The code is applicable to **all residential use building projects built on plot area > 500** m^2.
- It was aimed to significantly **curtail the anticipated energy demand for comfort cooling** in times to come.
- This critical investment in envelope construction and design made today will reap the benefits of reduced GHG emissions for the entire lifetime of the buildings.

2. Labelling Programme for Energy Efficient Homes:

- The objective of proposed labeling programme is mentioned below:
  - To provide consumers the information for EE Homes
  - Energy sustainability for India
  - To achieve Indian NDC targets
  - Market transformation for Energy Efficiency in housing sector
- The estimated energy saving potential through proposed labeling program is around 388 BU by the year 2030.
- The programme also brings up various ancillary benefits:
  - It will stimulate the **larger energy-efficient materials and technologies market**.
  - The housing value chain would encourage an additional set of professionals to expedite the complete process of residential label granting. This way, the labeling regime shall also be a **stimulant for the Indian job market**.
  - It will also motivate material manufactures to invest in **energy-efficient material manufacturing** in India.
  - Labelling mechanism shall cause a **reduction in energy bills**.
  - It helps the nation in working towards the **fulfilment of Global Sustainable Developing Goals 7** of the United Nations: Affordable and Clean Energy.

C. Consumer Appliances:

- Bureau of Energy Efficiency (BEE) has been promoting energy conservation through optimum temperature settings for Air Conditioners.
- According to the study of BEE, **one degree increase** in the AC temperature setting results in **saving of 6 per cent of electricity consumed**.
- **24-26 degree Celsius default setting** has been recommended by BEE for energy savings and also to reduce greenhouse gas emissions.

- Savings of over 3.0 Billion units of electricity are estimated at consumer-end through adoption of **Star Rated Microwave Ovens** and **Washing Machines** by 2030.
- This would be equivalent to Green House Gases (GHG) reduction of 2.4 Million-ton of CO_2 by the year 2030 through these recent initiatives.

Tapping Sustainable Energy Alternatives

- Sustainable development is "development that meets the needs of the present without compromising the ability of future generations".

Impact of Climate Change:

- According to World Health Organisation, climate change affects the social and environmental determinants of health-clean air, safe drinking water, food security and shelter.
- Between 2030 and 2050, climate change is expected to cause approximately 2,50,000 additional deaths every year from malnutrition, diseases like malaria, diarrhoea and heat stress.
- Its cost to health is estimated to be between 2-4 billion US dollars a year by 2030.

Need to tap sustainable energy source:

- Emissions in India were estimated to have **grown by 6.3 per cent in 2018**, pushed by strong annual economic growth of around 8 per cent, according to recent projections by the Global Carbon Project.
- India was among the **four major emitters** in 2017 (7 per cent) along with China (27 per cent), the US (15 per cent) and the European Union (10 per cent). The rest of the world contributed 41 per cent.
- Nearly **65 percent of India's electricity** is generated from **thermal power**, for which the feedstock is invariably **coal mined in India**.
- Power generation through the Boiler-Turbine route results in atmosphere pollution due to the release of particulate matter, carbon dioxide, sulphur and nitrous oxides.
- The other major energy source is oil. Oil pollution is an inescapable fact of life.
- The process of extraction of oil transportation and storage of oil cause enormous loss to the natural and human environment.
- **Road transport sector** accounts for 6.7 per cent of India's Gross Domestic Product (GDP).
- Currently, **diesel** alone meets an estimated 72 per cent of transportation fuel demand **followed by petrol** at 23 per cent and balance by other fuels such as CNG, LPG etc. for which the demand has been steadily rising.
- Another major source of environment pollution is **nuclear power generation**. Nuclear plants create 50 per cent more thermal pollution than fossil fuel plants.

Steps Taken:

- India is a signatory to the landmark **Pairs Agreement on Climate Change**, which has brought all nations to a common cause to undertake efforts to combat climate change through **Nationally Determined Contributions (NDCs).**
- India being the **founding nation of International Solar Alliance**, has the leverage to switch over to cleaner energies and clean-up its smog-choked cities.
- The **National Solar Mission** promotes ecologically sustainable growth, while addressing the country's energy security challenge and contribute to global effort to meet climate change.

- India has set an ambitious renewable capacity expansion programme, with a projected growth of **achieving 40 per cent** of its total power generation from **non-fossil fuel** sources by 2030, to meet NDC target.
- Another technology that has been unveiled by Indian scientists is for **conversion of sewage into biofuels**. A sewage treatment plant (STP) **launched in Delhi** would convert 10 lakh litres of sewage into three tones of biofuel per day.
- Beside biofuels, India has the *potential to generate green energy from Solar, Wind, Geothermal, Ocean Thermal Energy,* which are all-non-carbon options and can help reduce carbon imports by demand substitution.
- India has set a target to **phase out petrol and diesel driven vehicle by 2030**.
- Indian automotive sector is among the fastest growing industries in the world.
- As per International Energy Agency (IEA) estimates, globally transportation sector accounts for **30 per cent of worldwide energy consumption** and is the second largest source of carbon dioxide emission contributing to 20 per cent of greenhouse gas.
- India's **National Mission for Electric Mobility** seeks to mitigate the adverse impact of economic development, by completely switching over to electric vehicles by 2030.

Conclusion:

The challenge India faces now is to improve energy access to modern energy at affordable price in sustainable manner without sacrificing economic growth and social development.

Financing Renewables in India

- For India, the success of the renewable energy sector will be crucial to meet its Nationally Determined Contribution (NDC) under the Paris Agreement and its transition towards a sustainable future.

Targets set by India:

- India has set an ambitious domestic target of **175 GW of renewable energy by 2022**. This includes **100 GW from solar**, **60 GW from wind**, **10 GW from bio-power** and **5 GW from small hydro power**.
- The **National Electricity plan 2018** reaffirms further **expansion to 275 GW 2027**.

Achievement:

- As part of national efforts, India has embarked on an intensive renewable energy programme with 77GW renewable energy capacity on ground and 54 GW at different stages of fruition, India is well on the way to realize the ambitious target of 175 GW by 2022.
- By the year 2022, the renewable power share in the overall electric installed capacity is **expected to reach 37per cent**. If large hydro is included, the share of non-fossil fuel electric installed capacity in the electricity mix would be around 48 per cent.

The steps taken by the government to support the renewable energy sector:

- **Fiscal and promotional** incentives, such as capital subsidy, guidelines for transparent competitive bidding process, **waiver of Inter State Transmission System** (ISTS) **charges** and losses, viability gap funding (VGF), standards for deployment of renewable systems and devices and devices and permitting foreign direct Investment up to 100 per cent under the automatic route.

Source of Finance:

- India renewable energy sector received approximately US 3.2 billion in the form of **foreign Direct Investment (FDI)** in recent years.
- There exist other provisions such as **priority sector lending status** for loans up to a limit of Rs 150 million to *borrowers for solar, biomass, wind and micro-hydel power generation and also form renewable energy based public utilities like street lighting systems and remote village electrification*.
- Generally, **grants and concessional finance** both play a role in stimulating renewable energy investment, although their share is miniscule in total finance space in India.
- At present, concessional finance is manly for strengthening transmission and distribution networks and solar roof top sectors.
- KfW, Germany's concessional line of credit for Green Energy Corridor Project; World Bank, Asian Development Bank and New Development Bank for the solar roof top projects; and European Investment Bank (EIB) for financing renewable are non-going examples.

Challenges in Finance landscape:

- The finance landscape for the energy sector is undergoing significant changes. With renewable, in many situations out competing other energy technologies, the financial markets have started repositioning themselves for a fundamental shift towards renewable energy finance.
- Financial assistance in the form of low-interest rate, long-term loans and loan guarantees are globally accepted means to address the high up-front capital costs of renewable.
- In this context, arranging institutional finance for increased renewable deployment would require concerted efforts.
- Gearing up the banking sector, exploring international funding, and developing a suitable mechanism for risk mitigation or sharing by addressing both technical and financial bottlenecks in a challenge.

Way forward:

- **Pension or sovereign funds** are potent sources for patient capital for renewables. Top 400 Global funds manage assets of around US $ 75 trillion. Green bond issuance has surpassed US $ 120 billion.
- In 2014, the Securities and Exchange Board of India (SEBI) introduced **Infrastructure Investments Trusts (InvITs)**. Due to the current limitation of 49 per cent cap on leverage, **InvITs are unable to offer adequate returns** in comparison to alternative investment avenues with similar assets.
- **Reducing cost of the foreign debt** by **reducing the currency hedging cost** has potential to mobilize foreign capital and spur investment by reducing the cost of the capital. This would reduce the delivered cost of renewables and make them more competitive.
- The timelines and reliability of payments for power purchase by state distribution companies remains a persistent risk for investments. **Robust Payment Security Mechanism** (PSM) will contribute to de-risking the investment.
- Need for a **dedicated ecosystem** that looks at the financing needs of the renewable in most of the bilateral and multilateral financing institutions.

Conclusion:

- India has rightly **been-exploring a combination of short and long-term policy solutions**.
- New ways of financing renewable, including through credit and risk guarantees, innovative currency hedging facilities, government bonds etc. would help in attracting additional capital, lowering the cost of debt, and also ensuring that India achieves its renewable energy targets.

E-waste Management

- Electronic waste (e-waste) comprises waste electronics/electrical goods that are not fit for their originally intended use or have reached their end of life.
- These gadgets and equipment **contain hazardous constituents**, although e-waste itself is not harmful.
- E-waste **contains valuable materials** such as copper, silver, gold and platinum which could be processed for their recovery when such wastes are dismantled and processed, *since it is only at this stage that they pose hazards to health and environment*.
- India is among the world's largest consumers of mobile phones. With more than **1.5 million tonnes of e-waste generated annually**, most consumers are still unaware of how to dispose of their e-waste.
- Recycling of e-waste was **almost entirely left to the informal sector**, which does not have adequate means to handle either the increasing quantities or certain processes, leading to intolerable risk for human health and the environment.

Legislative framework:

- The law on **e-waste management** was first **passed in 2011**. It was based on **Extended Producer Responsibility (EPR)**, which put the onus on the producer for the **management of the final stages of the life of its product** in an eco-friendly way, by creating certain norms in tandem with State Pollution Control Boards.
- It has been made mandatory for leading multinational companies to set up electronics manufacturing facilities and R & D centres for hardware and software.
- The present rule has strengthened the EPR, which is the global best practice to ensure the **take-back of the end-of-life products**.
- A new arrangement entitled, '**Producer Responsibility Organisation' (PRO)** has been introduced to strengthen EPR further.
- PRO, a professional organisation, would be authorised or financed collectively or individually by producers, *to share the responsibility for collection and channelization of e-waste*.
- Further, Central Pollution Control Board (CPCB) shall conduct random sampling of electrical and electronic equipment placed on the market to monitor and verify the **compliance of law on Restriction of Hazardous Substances (RoHS)** and the cost for sample and testing shall be borne by the producer.
- If the product does not comply with RoHS provisions, the producers shall take corrective measures to bring the product into compliance, and withdraw or recall the product from the market, within a reasonable period as per the guidelines of CPCB.

Steps To Achieve India's Solar Potential

- Country's **per capita consumption of electricity** stands at a meager **1,100 kWh/year** which is much lower compared to other large economies like the US and China. Demand for power is set to rise further with increasing rates of urbanization and industrial growth.
- Unfortunately, our traditional sources of energy generation are already nearing their saturation levels.

- Clearly, we need to look at alternate solution so we can address our energy security in a sustainable fashion, with a progressive reduction in carbon level.

Steps Taken:

- The Indian Government has set the renewable capacity target at 175 GW, to be achieved by the year 2022, with the **highest percentage, 100 GW, to be contributed by solar power**.
- In the past years, we have already added **28 GW solar capacity** while the compound annual growth rate has reached as high as 55 percent.
- Launch of the **International Solar Alliance**, was also a significant step.
- By setting up solar parks, providing viability gap funding support and introducing schemes like **KUSUM** (*aiming to harness solar power for agriculture*) and **SRISTI** (*catalyzing adoption of rooftop solar solution*), the Government has shown its keenness to fast track growth of solar industry.
- However, there is room for more strategic interventions to fully realize India's solar potential.

Five areas that need attention:

I. ***Technology:*** Newer advancements in the field like **floating solar** (solar panels mounted on structures that float on water bodies), and **BIPV** (wherein the conventional materials used for facades and roofs of buildings are replaced by photovoltaics systems) can play a vital role in increasing capacity.

II. ***Policy Push:*** Considering that tariffs are now significantly lower than other sources of energy, we need to move towards healthier tariffs to help private players work with sustainable business models, and attract a higher capital inflow.

III. ***Discom Health:*** These distribution companies form a crucial link in the cycle of energy generation and have an impact on the overall process. Hence, maintaining discounts in good shape forms an extremely important link on the road to 2022. The healthier the distribution companies, the more power they can purchase and supply.

IV. ***Financial Reforms:*** As of now, sectoral categorisation of banks sees renewable as part of the power sector, due to which, for most banks, the loan limit is majorly consumed by thermal plants and only a small fraction of the fund remains available for the renewable sector. Considering the above, renewable should be categorized as a separate sector. The government can also consider according priority sector status to renewable, given its strategic importance.

V. ***Enabling Ease of Doing Business:*** The government's pursuit of reforms has created a more conducive environment for investments in India, reflected in our steady rise in Ease of Doing Business rankings over the past couple of years.

Geo-Thermal and Ocean Energy Technologies

- The possibility of venturing into new emerging renewable energy technologies, such as Floating Solar, Offshore wind, solar wind hybrid, energy storage, etc is being explored.
- However, renewable energy technology such as **geo-thermal and ocean energy** still remains at a **nascent stage in India**.

A. Ocean Energy:

- Ocean energy is the energy harnessed from **ocean waves, tidal range** (rise and fall) & **tidal streams, temperature gradients and salinity gradients**.

- Around 536 MW of installed ocean energy capacity is in operation at the end of 2016, with major share of two large scale tidal barrage plants i.e. the 254 MW sihwa plant in the South Korea (completed in 2011) and the 240 MW La Range tidal power station in France (completed in 1966).
- Leading countries in Ocean Energy technology are UK, USA, Sweden, Canada, France, South Korea.
- As per study conducted by IIT Madras, **Theoretical Potential for tidal Energy in India** is **12500 MW**.
- Promising locations are **Gulf of Khambhat & Gulf of Kutch (GJ), Sunderbans (WB), Western Ghats (MH)**, etc.
- **Theoretical Potential for Wave Energy** in India is **41,000 MW**, Promising locations are *Western Coast of Maharashtra, Goa, Karnataka, Kerala, Kanyakumari, Southern tip of India* etc.
- These technologies are **more suitable for off grid electricity** generation in remote coastal areas/mangroves/islands.
- Major bottlenecks for deployment are **high upfront cost** (e.g. Rs. 60 Crore for 1.125 MW wave energy plant at A & N islands).

Technology:

a) Tidal Energy: The Tidal cycle occurs energy 12 hours due to the gravitational pull of the moon. The difference in water level from low tide and high tide is potential energy that can be harnessed. Tidal water is captured in a barrage across an estuary during high tide and forced through a turbine during low tide. In order to harness power from the tidal energy, the height of *high tide must be at least five meters* (16 feet) greater than low tide.

b) Wave Energy: Wave energy is generated by the movement of a device either floating on the surface of the ocean or moored to the ocean floor by the forces generated by the ocean waves. Wave conversion devices floats on the surface have joints hinged together that moves with the waves. The kinetic energy pumps fluid through turbines and generates electric power. This wave motion drives a turbine.

c) Current Energy: Ocean current is ocean water moving in one direction. Kinetic energy can be captured from tidal currents with submerged turbines that are very similar in appearance to miniature wind turbines.

d) Ocean Thermal Energy Conversion (OTEC): Ocean thermal energy conversion or OTEC, uses ocean temperature differences from the surface to depths lower than 1,000 metres, to harness energy. A temperature difference of even 20ºC can yield energy efficiently. There are two types **closed cycle and open cycle**. In the closed cycle method, a working fluid, such as ammonia, is pumped through a heat exchanger and vaporized. This vaporized steam runs a turbine.

- In the **open cycle system**, the warm surface water is pressurized in a vacuum chamber and converted to steam to run the turbine. The steam is then condensed using cold ocean water from lower depths.

B. Geothermal Energy:

- Geothermal Energy is a mature renewable energy technology that has a potential to provide **clean and reliable energy for power generation and direct heating/cooling**.
- Geothermal Energy can be utilized for both **electric power production** and **direct heat applications** including Ground Source Heat Pump (GSHP) for space or district heating generating hot water for domestic/industrial use, running cold storage and greenhouse, horticulture, etc.

World Scenario:

- Total Installed Capacity for Geothermal Power is around 13.5 G.W. Leading countries in geothermal power generation capacity are USA, Phillippines, Indonesia, New Zealand, etc.

Indian Scenario:

- India is still at nascent stage of geothermal energy utilization with no geothermal power plant set up in the country so far due to high upfront cost of Rs. 30 Cr/MW & indicative Tariff in range of Rs. 10 per KWh, site specific deployment, lack of load center and power evacuation facility nearby, high risk involved in exploration, etc.
- As per preliminary investigations undertaken by the GSI in 1970 to 1980 there are around **300 geothermal hot springs in India**.
- Most of these geothermal hot springs are in medium potential (100 C to 200 C) and low potential (< 100 C) zones.
- The promising geothermal **sites for electric power generation** are *Puga Valley & Chummathang in Jammu & Kashmir, Cambay in Gujarat, Tattapani in Chattisgarh, Khammam in Telangana & Ratnagiri in Maharashtra*.
- The promising geothermal **sites for direct heal use applications** are *Rajgir in Bihar. Manikaran in Himachal Pradesh, Surajkund in Jharkhand, Tapoban in Uttarakhand & Sohana region in Haryana*.

Technology:

There are three types of geothermal power plants:

i) **Dry Steam Plants:** Which use geothermal steam directly. Dry steam power plants use very hot (235ºC) steam from the geothermal reservoir. The steam goes directly through a pipe to a turbine to spin a generator that produces electricity.

ii) **Flash Steam Plants:** Which use high pressure hot water to produce steam. Flash steam power plants use hot water (>182º C) from the geothermal reservoir. When the water is pumped to the generator, it is released from the pressure of the deep reservoir. The sudden drop in pressure causes some of the water to vaporize to steam, which spins a turbine to generate electricity.

iii) **Binary Cycle Plants:** Which used moderate-temperature water (107 to 182 ºC) from the geothermal reservoir. In binary system, hot geothermal fluids are passed through one side of a heat exchanger to heat a working fluid in a separate adjacent pipe. The working fluid, usually an organic compound with a low boiling point such as Iso-butane or Iso-pentane, is vaporized and passed through a turbine to generate electricity.

Biogas-A Story Untold

- India generates about 1,45,128 tonne of waste daily (or around 53 million tonne annually) and on an average 46 per cent of it is processed daily, according to the Ministry of New and Renewable Energy (MNRE).
- Hence Waste to Energy programme would be used to recover energy in the form of Biogas/BioCNG/Power from urban, industrial and agricultural wastes gains importance. Besides, it also promotes off-grid connectivity.

Challenges:

- While a programme of this kind requires government support, the challenge is to ensure that various Ministries work in Synergy.

- Another challenges for Waste to Energy management is, how various schemes can become revenue generator for small players.
- "Maintaining cattle is becoming difficult for an individual. Therefore, individual biogas plants are seeing a decline.
- Marketing of the concept is another uphill task.

Indian Scenario:

- About 184 Waste to Energy plants based on urban, industrial and agricultural wastes have been set up in private sector with an aggregate capacity of 315.24 MWeq.

Biogas: as transport fuel

- Compressed Biogas (CBG) has the potential to boost availability of more affordable transport fuels, better use of agricultural residue, and cattle dung, as well as to provide an addition revenue source to farmers.

Initiatives:

- Called **Sustainable Alternative Towards Affordable Transportation (SATAT),** it is expected to benefit vehicle-users as well as farmers and entrepreneurs.
- The Working Group on Biofuels is in the process of finalizing a pan-India pricing model for CBG.
- The potential for CBG production from various sources in India is estimated at about 62 million toones annually.
- Given the abundance of biomass in the country, CBG has the potential to replace CNG in automotive, industrial and commercial uses in the coming years. Industry experts say that if the country exploits this, no surprises then that gas imports will come down to zero one day.

Benefits:

- There are multiple benefits of converting agricultural residue and cattle dung into CBG on a commercial scale:
  - Responsible waste management reduction in carbon emissions and pollution.
  - Additional revenue source for farmers
  - Boost to entrepreneurship, rural economy and employment.
  - Support to national commitments in achieving climate change goals
  - Reduction in import of natural gas and crude oil
  - Buffer against crude oil/gas price fluctuations.

Conclusion:

Biogas cannot succeed without governmental support as it is still at a very nascent stage here. But once it takes off, the government can play the role of a facilitator and allow private sector to run the business.

Driving a Green Transition for the Environment

Electric mobility is the definitive game-changer for the transport sector the world over. India has its own vision for electric mobility: *as a member of the eight-country Clean Energy Ministerial*, a high-level forum to promote clean energy policies and programs, India aims to **achieve a 30 per cent electric vehicle penetration by 2030**.

Going Electric For The Environment

- Internal combustion engines (ICEs) are among the leading sources of air pollution across the world, and India regularly features in the list of countries which have the world's highest rates of vehicular emissions.
- According to the National Green Tribunal (NGT), vehicular emission is one of the major sources of India's urban pollution. By 2030, India is anticipated to have an estimated 400 million customers in need of mobility.
- Electric vehicles have **zero tail-pipe emissions**, simply because they do not use an internal combustion engine (ICE).
- According to a **NITI Aayog report**, India can reduce 64 per cent of the energy demand for road transport and 37 per cent of carbon emissions by 2030, by pursuing a shared, electric and connected mobility future.

What About Emission From An Electric Mobility Future

- It may be argue that EVs are simply transferring the burden of fossil fuel, if instead of petrol and diesel, the source of electric power generation is coal. Coal-based thermal power generation today meets 70 per cent of India's power need.
- *Could more electric mobility-linked demand simply trigger more coal-based energy demand?*
- Research in Europe has shown that even powered by the most carbon-intensive electricity, **EVs still have lower GHG emission** that a conventional, internal combustion engine powered vehicle.
- Further when calculating emissions from a purely energy generation point of view – renewable vs. conventional – calculation do not include the considerable energy required to extract, refine and manufacture petrol of diesel.

Steps Taken

- India is fast shaping its transition to a renewable-led energy future.
- The recent **National Mission on Transformative Mobility and Battery Storage**, which encourages setting up large-scale, export-competitive integrated batteries and cell-integrated batteries and cell-manufacturing giga-plants in India through a **Phased Manufacturing Programme (PMP)**.
- The mission's focus on **production localization** can bring down the battery storage costs.
- Considering that battery costs are a significant cost to overall EV costs, this step can make EVs affordable, making them attractive.
- Solar-powered public charging stations are also being rolled out by discoms like BHEL and across India, delivering 100 per cent zero-emissions based electricity to electric vehicles.

How Is India Enabling The Electric Transition

- While the Indian EV story has been in making for almost two decades, now it seems to be acquiring significant momentum in both its mobility and overall sustainable energy transition.
- The increasing public consciousness on the adverse health effect of air pollution combined with robust policy framework for EVs has translated to the emergence of a fast-growing private sector ecosystem.
- Considering both its environmental and economic benefits, the goal of 30 per cent fleet electrification will necessitate even more collaboration among OEMs and related service providers across automobile, technology, energy, and allied fields.

India's Conundram: Aligning Emission Mitigation with Development

Socio-economic parameters which necessitates growth:

- With a per capita GDP of $1965 (vis-à-vis a world average of $10363), India's HDI is 0.64, placing it at a rank of 130 among 189 countries.
- Nearly 12 per cent of the households still do not have access to basic services like clean water and 55 per cent of the households live in mud or semi-concrete houses.
- India's **per capita electricity consumption** was about a fourth of the global average while its **per capita energy consumption** was around one-fifth of the global average in 2015/16, reflecting a combination of the prevailing energy access and affordability issues.

Need For Emission Mitigation:

- In recent years, as economic growth picked up in the non-OECD countries, the share of OECD and non OECD emissions has reversed.
- **India and China accounted for 55 per cent** of non- OECD emissions, with China contributing to 44 per cent and India accounting for 11 per cent in 2017.
- India's GHG emissions (excluding land use change and forestry) increased by nearly 115 per cent between 1994 and 2014 the energy sector contributing to the majority of GHG emissions.
- The recent **IPCC Special Report on impacts and emissions pathways of 1.5ºC** clearly states that the speed and scale with which transitions will need to occur are not the same as would be required for 2ºC world.

What makes India's current energy transitions unique?

- The key elements of India's current transition story need to relate with enhancing efficiency in the energy system to dampen the growth in future energy requirements and to simultaneously transitions towards cleaner energy forms, wherever feasible, to reduce the ensuing emissions.
- Accordingly, we are now witnessing the era of the transition to new renewable like solar and wind energy.

Initiatives for Emission reduction:

- India had set out its Nationality Determined Contribution (NDC) targets for 2030, which broadly have three main targets:

1. Reducing the emissions intensity of its GDP 33 percent – 35 percent from 2005 levels.
2. Achieving40 percent cumulative electric power installed capacity based on non-fossil energy sources, contingent on international transfer of technology and low cost finance.
3. Creating an additional carbon sink of 2.5 – 3.0 billion tones of CO_2 equivalent through additional forest and tree cover.

- Despite its low historic emissions, India is today at a juncture where it is faced with tremendous pressure to increase its economic growth and provide for improved access to energy and services whilst attempting to simultaneously minimize GHG emissions.

India's energy sector choices for low carbon development:

- Energy efficiency improvements,
- Power sector decarbonisation through renewable like solar and wind, and
- Increased electrification offend-uses as the power sector gets increasingly decarbonised.

Role of Energy efficiency:

- A recent assessment indicates that an energy reduction of at least 12 percent could be achieved by 2041 by efficiency improvements alone across energy demand sectors.

Challenges:

- With regards to economically viable technological choices, several options do exist and are gainfully being exploited already in the country.
- However, they often entail **high upfront capital costs** for setting up the associated infrastructure.
- Therefore, the financial requirements of these alternatives need to be carefully considered especially if they need to be adopted at larger scales.
- A recent estimate suggested that the country would need around $4.5 trillion by 2040 to meet its developmental aspirations alone. In light of this, it is important that the country does not compromise on development related spending while proceeding towards a low carbon pathway.
- **Accelerating the pace of electrification** of vehicles could prove to be detrimental **unless the power generation sector is already highly decarbonised**.
- Adoption of some efficiency measures **may require behavioural changes** apart from purely technological solutions, and therefore necessitate ways to motivate consumers to shift to such options through innovative business models and strategies.
- The biggest challenges to adoption of energy efficient technologies in the industry sector **comes from the Micro, Small and Medium Enterprises (MSMEs)**.
- They also lack capital and motivation to shift to better processes and technologies because unlike the big industries, they lack the advantage of scale.
- In other cases, such as in the transport sector there may still be technological gaps in terms of availability of economically viable alternative.

Innovation:

- There are several examples of innovative ways through which India has adopted switchovers to efficient alternatives.
- The aggregation of demands to drive down prices of the technological solution is one such example that has been adopted in case of **procurement of LED lights** and efficient power-looms equipment to small and medium units in the Textile Industry. However, India needs several such strategies.

Linking climate mitigation with sustainable development:

- There are several other concerns that need to be handled simultaneously with emission mitigation.
- The three biggest challenges as put forth by the World Economic Forum in a recent article are skill development and employment for the future workforce, socio-economic inclusion of rural India, and a healthy and sustainable future.
- Employment consideration are critical considering the changes choices that India may witness in technologies, like renewable, may promise employment generation, there might be job losses in other sectors, like the coal sector.

Conclusion:

- In sum, on the one hand, India's energy transition story needs to address the technology development perspective.

- At the same time, India needs to address the social development perspective wherein it needs to enable a higher standard of living for all her citizens.
- Connects across linked sectors also require careful investigation of trade-offs to ensure the success of mitigation strategies. India must therefore undertake an integrated and holistic approach to use innovative business models ad dynamic decision making to address the multiple challenges.

Climate Change: Challenges and Opportunities

- On April 1, the Indian Meteorological Department put out its forecast for the April to June season: the average temperature in most parts of the country are likely to be 0.5 degree Celsius higher than normal with some areas registering temperature increases of more than 1 degree Celsius.
- Annual mean temperature in India between 1901 and 2017 has shown a significant increasing trend (0.66ºC per hundred years). Global average temperature is now 1ºC above pre-industrial levels.
- India has already been experiencing the impacts of 1ºC warming. It was evident in Uttarakhand, Chennai, Srinagar, Malin, and north-east India, the heat waves of the past summer and the uneven rainfall across the country with floods affecting some regions and very severe drought conditions facing many parts of the country.
- Scientists working on the IPCC special report, Global Warming at 1.5º, concluded that without a rapid and appreciable reduction in greenhouse gas emissions, the world was on a path to temperature increase of 1.5 degrees Celsius in twelve years that is by 2040.
- The IPCC special report had a clear message for resource poor and vulnerable contries such as India that it would be among those most adversely affected if warming exceeds 1.5ºC.

India In A Warming World

- South Asia, particularly India is a hotspot, and will exposed to multiple and overlapping hazards as the planet warms. The impacts even at 1.5ºC warming is considerable-intensified droughts and water stress, heatwaves, habitat degradation, and reduced crop yields.
- It will impact water supplies.
- India's heavily populated 7,500 km long coastline will be affected by sea-level rise and resulting coastal flooding. Experts say that it could directly affect 50 million people, many of whom are directly dependent on the sea for their livelihood.

Acting On Climate Change:

- In 2008, India launched the National Action Plan on Climate Change.
- **Eight missions** – solar energy, energy efficiency, forestry, sustainable habitat, water, agriculture, Himalayan ecosystem, and developing strategic knowledge for climate change – form the core of the multi-pronged, long-term, and integrated strategies for addressing climate change. Besides a national level plan, 32 states and union territories have prepared state level climate action plans.
- The progress however has been uneven. Most of the efforts have been focused on the energy-related missions.
- Financial and technological constraints have hampered the effective implementation of the state plans.

Current Status:

- As of February 2019, non-fossil fuel sources-based installed capacity accounted for 36.3 per cent of the country's total power generation capacity of 350.16GW.

- India has also committed to reducing the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level.
- Between 2005 and 2014, India has reduced the emission intensity of the economy by 21 per cent.
- At this average annual rate of 2 percent, India will meet its Paris goal nearly a decade ahead of 2030.
- Another commitment made is to create an additional carbon sink of 2.5 to 3 billion tones of CO_2 equivalent through additional forest and tree cover by 2030. However, as regards the forestry goal, India's achievements are not as robust.

Highlighes of India's Climate Actions

- Total annual GHG emissions have increased from 2,136.8 million tones (Mt) of CO_2 in 2010 to 2,607.5 Mt of CO2e in 2014.
- Emission intensity of India's GDP has reduced by 21 per cent over the period of 2005-2015.
- Solar installed capacity has increased by about 9 times from 2.63 GW to 23.28 GW between March 2014 and August 2018.
- Supercritical thermal power units have risen from 40 to 66 with avoided emissions amounting to 7 MtCO2 in 2016-17.
- Forest and tree cover increased from 24.0 per cent of the total geographical area as reported in India State of Forest Report (ISFR) 2013 to 24.39 percent as reported in ISFR 2017.
- India in partnership with France launched the International Solar Alliance at the UN Climate Summit in Paris 2015.
- India is partnering 22 member countries and the European Union in the Mission Innovation' on clean energy, and is a co-lead in smart grid off-grid and sustainable biofuels innovation challenges.

Forest and Water-Conservation and Sustainable Development

Though nearly 70 per cent of the world is covered by water, only about 2.5 per cent of it is freshwater and less than 1 per cent of the freshwater is actually accessible in lakes and rivers.

Water Crisis:

- The increasing world population, improving living standards, changing consumption patterns and expansion of irrigated agriculture are the main driving forces for the rising global demand for water.
- Extensive degradation because of urbanization has threatened the forests that nurture the water regime in the ground.
- Consequently about two billion of world's population is going through water stress which is expected to increase with time.
- Issues pertaining to water accessibility, quantity and quality are major global concerns.
- India is no exception as it is *home to one-sixth of the world's total population but has only 4 per cent of the water resources* sustaining the economy in terms of agriculture, power and biological productivity.
- Values of per capita surface water availability have continuously declined and in the near future the country is expected to become 'water stressed'.

Forests, Water and People-Interconnections

- The health of forests and its composition has direct impact on water availability as well as quality which shows the importance of the relationship between forests and water.
- Forests absorb rainfall and snow melt and also slow runoff, reduce soil erosion, improve water infiltration rates, recharge aquires, thus exhibiting 'sponge effect'.
- At the same time forests growing along the streams filter pollutants from entering the water.
- Since, forests are storehouses of biodiversity, these play on equally important role in global cycling of carbon, oxygen and other gases influencing the earth's atmosphere.

Tapping Forest Catchment Potential:

- A few of the country's pioneer efforts to tap forest catchment potential to augment water supplies to major cities and drier regions are highlighted as below:
  - Construction of Mullaperiyar dam on Periyar River in Kerala.
  - Forests surrounding the lake and the entire lake area now constitute the Periyar Tiger Reserve.
  - Protection to high altitude oligotrophic lake, Marsar and diverse forests in the mid slopes constituting the catchment of Dagwan River so as to ensure clean water supply for the city of Srinagar and J & K.

Forest Management and Water Conservations:

- **Policy and Legal Framework:** Management of Indian forests **commenced way back in 1860s** with the establishment of forest reserves, law enforcement and initiation of silviculture-based forest workline.
- The Constitution of India-**Article 48A** provides a clear mandate of the State to protect the environment.
- **Forest and the protection of wildlife** fall within the **Concurrent List**.
- The Environment (Protection) Act, 1986 is the umbrella legislation for the protection of all aspects of the environment.
- The issue of pollution and water quality falls primarily under the Water (Prevention and Control of Pollution) Act, 1974.
- The Indian Forest (conservation) Act, 1980 are the primary legislation governing forests; while the Wild Life (Protection) Act, 1972 and the Biological Diversity Act, 2002 are significant from the perspective of biodiversity, intellectual property right, and access and benefit sharing.

Paradigm Shift:

- Newer approaches aims to achieve target of 33 per cent forest cover in the country.
- Presently, about 25 per cent of country's geographical area is covered under diverse forests including 'Trees Outside Forests'. India has established an impressive network of protected area and presently Pas (Protected Areas) represent nearly 5 per cent area of the country.

Conservation of Water Resources:

- In the federal scheme of the Indian Constitution, **regulation and development** of **inter-state rivers** falls within the legislative competence of the **Union Government**.
- **States** have the legislative competence over **water supplies, irrigation and canals, drainage and water storage**. States also have the power over issues relating to land and land use.
- A large number of irrigation projects were implemented.

- Country has gained considerable experience in execution of integrated watershed management programmes (IWMP).

Contribution to the Sustainable Development:

- In recent past, India has directed its development pathway to meet its priorities of food water and energy security; economic growth; disaster resilience and poverty alleviation while maintaining the natural capital and adopt transparent and robust governance along democratic lines.
- SDGs related to water (**SDG 6**) and land (**SDG 15**) explicitly acknowledges the linkages between forests and water.
- Further, SDG 6 and SDG 15 have strong interconnections with targets to other SDGs.
- Hence, approaches adopted towards ecosystem management, biodiversity conservation, effective and efficient use of water resources would not only contribute to other SDGs but would ensure sustainable overall development and fulfilment of global commitments.