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VISIONIAS
INSPIRING INNOVATION

TRANSITIONING TO A SUSTAINABLE ENERGY ECOSYSTEM

INTRODUCTION

Energy is the "golden thread" connecting economic, social and environmental realms. With a direct influence on the progress of a number of non-energy Sustainable Development Goals (SDGs) focused on areas such as health, gender equality, climate and sustainable production, consumption and cities, energy is one of the keys to facilitate or restrict progress across the development agenda.

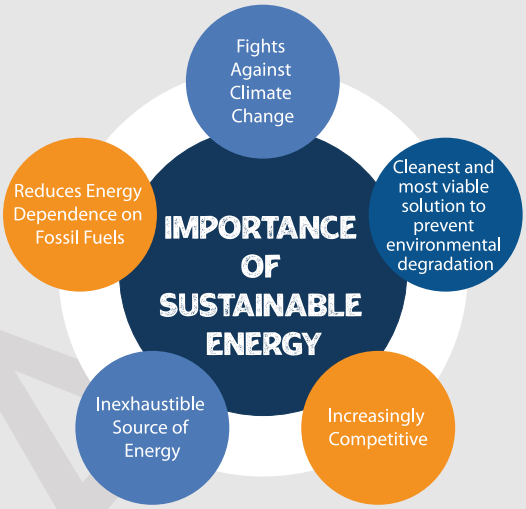
While the COVID-19 pandemic has presented multiple challenges for furthering socio-economic development, transitioning to a sustainable energy future remains a critical aspect of recovering better together. Many economies are now turning to domestic conventional and renewable energy resources in order to reduce import reliance. At the same time, they are also looking at renewables and energy efficiency as part of broader economic recovery. It is therefore an opportune time for India to re-evaluate its energy strategy and examine the choices, opportunities and risks across the energy sector.

In this backdrop, it becomes crucial to understand What is sustainable energy, How investing in sustainable energy can generate co-benefits for the overall development, What efforts has India made towards achievement of the SDG 7, What challenges does India face in progressing towards sustainable energy and What can be done to create a better energy system for India's future. In this edition, we will answer these questions.

WHAT IS SUSTAINABLE ENERGY?

Sustainable energy is the **energy produced and used so that it meets the needs of the present without compromising the needs of future generations.**

- The concept of sustainable energy has multiple facets including environmental aspects such as reducing **greenhouse gas emissions, social aspects such as enhancing** access to energy, and economic aspects such as affordable and reliable supply.
- **All renewable energy sources** like solar, wind, geothermal, hydropower and ocean energy are sustainable as they are stable and available in plenty.
- As of today, **around 20% of the world's energy needs come from renewable energy sources** and hydropower is the most common form of alternative energy used around the world.
- International frameworks like the **Paris Agreement** and the **United Nation's Sustainable Development Goals for 2030** aim for a rapid transition to sustainable energy.



- Sustainable Development Goal 7 (SDG 7) offers a framework for realizing not only a sustainable energy future, but also underpins the achievement of myriad socio-economic developmental objectives in areas including poverty, education, sustainable cities and communities, and the fight against climate change.

Gole 7: Ensure access to affordable , reliable sustainable and modern enery fo all by 2030

- Universal access to affordable, reliable and modern energy services.
- Enhance international cooperation to facilitate access to clean energy research and technology.
- Substantially increase the share of renewable energy in the energy mix.
- Double the global rate of improvement in energy efficiency.
- Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries.

HOW INVESTING IN SDG 7 CAN GENERATE CO-BENEFITS FOR OVERALL DEVELOPMENT ?

The close interplay between the energy sector and the economy alters the socio-economic footprint and generates a number of benefits in terms of GDP, employment and human welfare.

Economic Impacts: Economic effect of SDG 7 can be observed by understanding the direct impact through optimization of energy usage and indirect impact by the opportunities that it creates.

- **Employment generation:** Jobs in renewable energy can be created directly and indirectly along the entire value chain, including in the manufacturing and distribution of equipment; the production of inputs such as chemicals; or even in services like project management, installation, operation, and maintenance.
  - ILO has estimated that by 2022 more than 300,000 workers will be employed in India's solar and wind energy sectors to meet the country's target of generating 175 gigawatts of electricity from renewable sources. Also, more than 3.2 million people can be employed in the entire renewable energy sector by 2050 (five times more people than what the entire Indian fossil-fuel sector employs today).
- **Increases Self- sufficiency:** Energy demand in India is expected to double between 2020 and 2050. India's abundant renewables potential and transition to lower-carbon fuels, such as green hydrogen and biofuels can help the country reduce dependence on fossil fuel imports to meet this demand. This will in turn decrease the risk of macroeconomic instability caused due to fluctuation in prices of fossil fuels.
- **Business opportunities:** As the world shifts towards lower-carbon energy, there are new growth industries in lower-carbon fuels, technologies, products and solutions (such as energy storage and demand-side response solutions to address intermittency issues).
- **Regional development:** The decline in fossil fuels in the energy mix will require resources and economic activity to be reallocated at the state and regional level. For instance, the energy transition will create **new regional opportunities** for other lower-carbon energy sources and technologies, such as in the renewables-rich regions of the south and west.
- **Energy savings:** Transitioning to the best available technologies, employing energy management services and applying nature- based energy efficiency solutions can offer large energy savings. For energy importers, efficient energy use can boost currency reserves, while for exporters, domestic energy efficiency increases resources available for export.

Social Impacts: These can be understood by analysing the positive and reinforcing interlinkages between the SDG 7 and the rest of the SDGs.

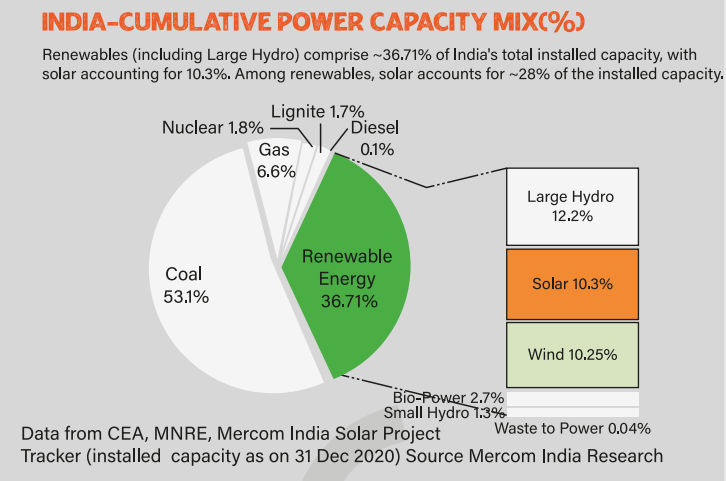
- **Access to basic services:** Universal access to affordable, reliable and modern energy services (target 7.1) is crucial for vulnerable people to meet diverse basic services, such as access to drinking water and sanitation (target 6.1), access to health care (targets 3.7 and 3.8), access to education (target 4.1), access to information (target 9.c) and access to adequate and safe housing (target 11.1) with important contribution to reducing poverty in all its dimensions (target 1.2).
- **Gender Equality:** Access to energy implies an increase in safety and security, contributing to reducing the incidence of violence (target 16.1) against women and inequalities (target 10.2) between sexes.
- **Better Health:** The increase in the use of renewable energy (target 7.2) is critical in strengthening resilience and adaptive capacity to climate-related hazards (target 13.1) and contributes to reducing contamination of hazardous chemicals in air, water and land (target 12.4), with significant impact on reducing the number of deaths and illnesses due to pollution (target 3.9).
- **Other benefits:** Investments in technological innovation towards SDG 7 would stimulate innovations for water efficiency in water-pumping and irrigation systems (target 6.4), and would stimulate creation of new jobs (target 8.5), decarbonize the transport sector allowing better air quality in cities (target 11.2), ensure sustainable production and consumption patterns (target 12.a) and reduce fuel consumption with environmental benefits (targets 12.c and 13.2).

WHAT EFFORTS HAS INDIA MADE FOR ACHIEVEMENT OF SDG 7?

Energy efficiency, electrification and a switch towards decarbonised fuels are the three main pillars of India's energy strategy, with the need for a transformative move towards renewable electricity, hydrogen and bioenergy as key fuels. In this direction, various measures have been taken by the government such as:

Universal access to affordable, reliable and modern energy services

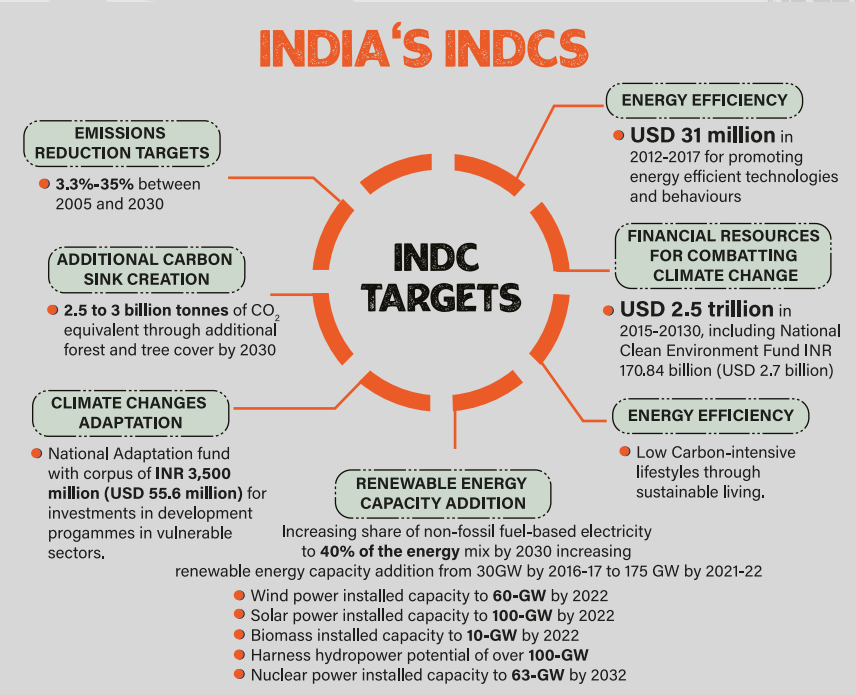
- **State Rooftop Solar Attractiveness Index (SARAL):** designed collaboratively by the Ministry of New and Renewable Energy (MNRE), Shakti Sustainable Energy Foundation (SSEF), Associated Chambers of Commerce and Industry of India (ASSOCHAM) and Ernst & Young (EY) will make power sector sustainable and viable (as the cost of solar energy is reducing) and will help to ensure 24/7 power supply to all consumers. It has a target to extract 40 GW solar energy from rooftop systems.



- **Saubhagya scheme:** It seeks to ensure universal household electrification (in both rural and urban areas) by providing last mile connectivity.
- **One Nation, One Grid Scheme:** The plan contemplates interlinking five regional Indian grids to operate on the same frequency to enable the transfer of power from resource-centric to load-centric regions, ensuring power connectivity to all states at an affordable rate.
- **Smart Cities Mission:** launched in 2015, carrying the objective of promoting cities that provide core infrastructure and decent quality of life to its citizens, a clean and sustainable environment, and application of 'smart' solutions. Such programs seek urban 'smart energy' solutions characterised by low carbon emissions and energy resilience. Diu became the first city in India to run on 100% renewable energy during daytime.
- **Reforms in solar energy procurement processes:** In 2019, the Ministry of Power (MoP) issued the Amendment to the Guidelines for Tariff Based Competitive Bidding Process for Procurement of Power from Grid Connected Solar PV Power Projects to reduce risk, enhance transparency and increase the affordability of solar power.

International cooperation to facilitate access to clean energy research and technology

- **International Solar Alliance (ISA)** was established in 2015 by India and France and is a global organisation which provides an exclusive platform for cooperation and interaction amongst the various stakeholders in the global community, especially the solar resource-rich countries.
- **Contributing to the Paris Climate Goal:** India is the one of the few major countries which are on course to achieve their pledged Intended Nationally Determined Contributions (INDCs).
- **One Sun, One World, One Grid (OSOWOG):** The vision behind the OSOWOG is "The Sun Never Sets" i.e., solar energy is always available in some area at a given time. This energy can be shared through an interconnected transmission.
  - The interconnected grid is envisioned with India at the fulcrum and two broad zones viz. far East which would include countries like Myanmar, and far West which would cover the Middle East and the African Region.



Energy efficiency

- **Energy Conservation Building Code:** To promote the objectives of the National Electricity Plan (NEP 2018), GOI launched the ECO Niwas Samhita, i.e. the Energy Conservation Building Code for Residential Buildings (ECBC-R). The implementation of this code is likely to further boost energy efficiency in the ever-growing residential sector and create more demand for renewable energy-generation sources, while aligning with the goal of environment conservation.

- NEP takes into consideration the need to address the issue of climate change, and accordingly envisages the usage of coal for electricity generation, only to the extent India in unable to procure power from its many zero-emission alternatives.

Promoting investment in energy infrastructure and clean energy technology

- **National Wind Hybrid Policy:** MNRE adopted the Policy in May, 2018 which provides a framework for the promotion of large-grid-connected wind- solar PV hybrid systems for the optimal and efficient utilisation of land and transmission infrastructure. A scheme for new hybrid projects under the policy is also expected shortly.
- **Flue Gas Desulphurization (FGD) norm:** MoEFCC directed the installation of FGD systems for meeting the emission limits for Sulphur Dioxide, and Selective Catalytic Reduction/Selective Non-Catalytic Reduction Technology in order to meet the revised limits for Nitrogen Oxide.
- **Dispute Resolution:** The Union Minister of State for Power and New & Renewable Energy (IC) and Skill Development & Entrepreneurship, endorsed a proposition to set up a Dispute Resolution Committee to consider unforeseen conflicts between solar/wind power developers and the Solar Energy Corporation of India (SECI) and National Thermal Power Corporation of India (NTPC) beyond contractual matters.
- **Incentives in E-mobility sector:**
  - To create an ecosystem for e-mobility in India and to achieve 30 per cent electric vehicle penetration target by 2030, following measures were announced in the Union Budget 2019-20:
    - income tax deduction on interest paid on loans for purchase of EV;
    - exemption of customs duty on certain parts of EVs;
    - and reduction of GST rate on purchase of EVs (12% to 5%) and on EV chargers (18% to 5%).
  - **National Electric Mobility Mission Plan 2020** (NEMMP 2020) was established for manufacturing policies aimed at encouraging investments in the E-mobility sector.

- **Proposals for changes in laws or regulations**
  - **Draft Amendments to Electricity Act, 2003:** The Draft Amendments to the Electricity Act, 2003 were issued in 2018 which sought to increase competition in the sector by segregating the distribution segment into distribution and supply, rationalising tariff determination and promoting renewable energy. The salient features were as follows:
    - Definition of Renewable Energy Sources to include hydro, wind, solar, bio-mass, bio-fuel, waste including municipal and solid waste, geo-thermal, tidal, co- generation from these sources, and other sources as notified by the central government.
    - Renewable Purchase Obligations (RPO) to include Hydro energy sources.
    - **National Renewable Energy Policy (NREP):** to be prepared and notified by the Central Government in consultation with states. Under it a minimum percentage of purchase of electricity from renewable and hydro sources of energy will be prescribed.
  - **Dam Safety Bill, 2019:** Large hydropower projects were given a 'renewable energy source' status in India. Previously, only hydropower projects less than 25 MWs were considered as renewable energy projects.

WHAT ARE THE CHALLENGES FACED BY INDIA IN THE DEVELOPMENT OF SUSTAINABLE ENERGY?

Institutional and Governance challenges

- **Lack of coordination in policy implementation:** Electricity, being a subject of the Concurrent List within the Constitution of India, Parliament as well as the state legislatures have concurrent powers to enact laws on this subject. In the context of renewable energy, there have been various instances where developers have faced sustainability and operational issues due to a tug-of-war between the Central and state governments.
- **Land acquisition challenges:** Issues such as lack of a proper Land Utilization Policy, poorly maintained land records, land ceiling limits, and the task of obtaining permissions from local bodies act as roadblocks to the implementation of large-sale renewable energy projects.
- **Inadequacy of trained manpower:** Currently, the Indian RE power sector is facing severe shortage of trained personnel, which in turn causes cost overruns.

Technological challenges

- **Integration of distributed energy systems:** Many RE generation sites, such as solar PV and wind farms, are distributed across a wide geographical scope. Therefore, it becomes very difficult to control and monitor the flow of energy without sophisticated tools in the system.
- **Locational dependency:** Most of the RE power generation is location specific. Sometimes, generation sites and load centres are far away from each other causing huge cost overrun in transmission of power.
  - For example, the major load centre of the northern part of India lies in Delhi. But the onshore wind power plants are far away from this region.
- **Necessity of energy storage system (ESS) and associated challenges:** Due to the intermittency of various REs, it is very important to create an ESS to get an uninterrupted power supply to the consumers. Advanced battery technologies could enable rapid deployment of rooftop solar installations, which is currently restricted by the high cost of energy storage solutions.

Economic challenges

- **Falling tariffs:** Over the last five years, solar tariffs in auctions have dipped about 50%. The low tariffs distort future tariff expectations of discoms and raise risk of project cancellation or contract renegotiation on other projects.
- **Poor investor sentiment:** due to delayed or non-payment by discoms to clean energy developers. As of July 2019, distribution companies across India owed renewable power producers Rs 9,736 crore, according to CEA data. Around three-quarters of the amount was owed by four southern states — Andhra Pradesh, Tamil Nadu, Telangana and Karnataka.
  - Ambiguity over goods and services tax (GST) on solar equipment is also hampering the growth of the solar energy sector.
- **Financing issues:** Large investments are needed for transitioning to sustainable energy, and current investment levels are falling short as the initial unit capital costs of renewable projects are very high compared to fossil fuels.

Other challenges

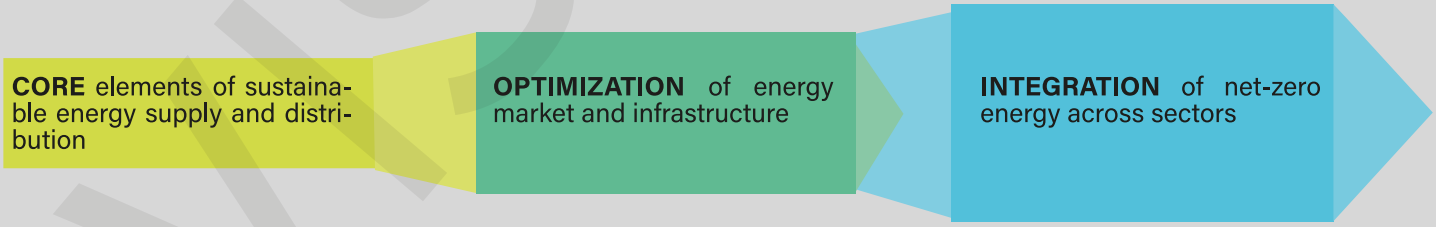
- **Cyberattacks:** The increasing reliance on digital systems creates systematic vulnerabilities to cyberattack, while critical energy infrastructure, from generation, transmission, distribution to metering, is vulnerable to cyberattacks as, in many cases, they rely on outdated computer systems.
- **Fragility in supply of Critical Raw Materials (CRMs):** The sustained supply of CRMs at a stable price is a core component of the concept of clean energy supply security. However, today, some 50 per cent of CRMs are located in fragile States or politically unstable regions.
  - CRMs are elements such as **rare earth metals, lithium, cobalt** and others that are used in clean energy systems such as wind turbine generators, solar panels, energy storage systems and for electric motors in EVs and high efficiency lights.
- **Problem of waste generation:** The ballooning solar PV industry is giving rise to a growing waste problem, predicted to reach as much as a cumulative 78 million tonnes globally by 2050 (IRENA and IEA 2016), with Asia-Pacific economies contributing more than half of that amount. Nations are yet to develop policies and plans on how to properly dispose of, or recycle, panels at end of their lives.
- **Social acceptance of renewable-based energy system:** Social acceptance is still not very encouraging in urban India. For example, human manure-based biogas is highly unacceptable in the current modern Indian era and is treated as a dirty fuel.

WHAT CAN BE DONE TO CREATE A BETTER ENERGY SYSTEM FOR INDIA'S FUTURE?

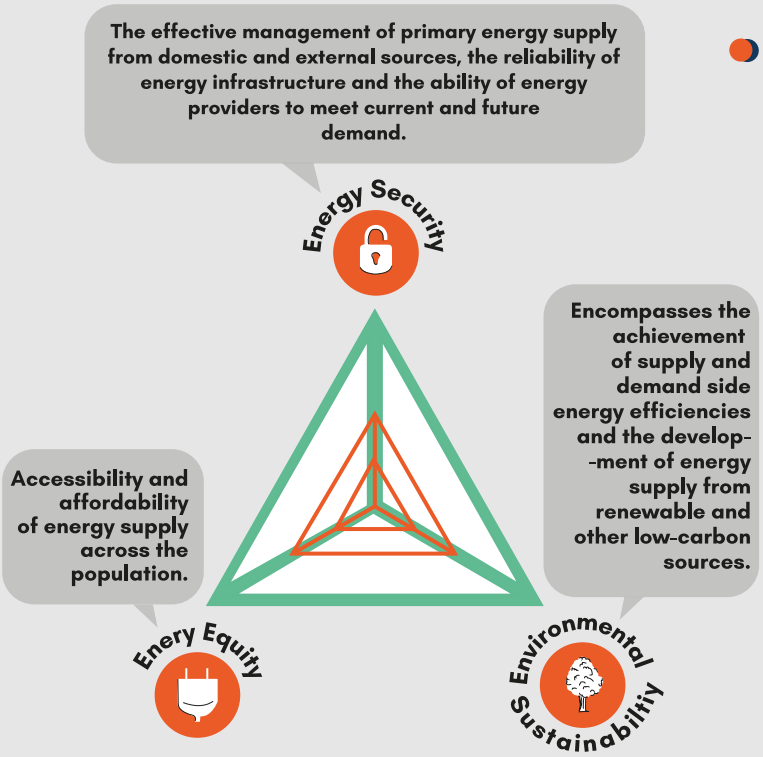
- **Creating a framework for transitioning to Net Zero Emissions (NZE):** India has made a commitment of achieving 'Net Zero Emission (NZE)' targets in energy by 2050, with a concerted strategy and massive investments. Policy has a fundamental role in driving this energy transition. (Energy transition refers to the global energy sector's shift from fossil-based systems of energy production and consumption — including oil, natural gas and coal — to renewable energy sources like wind and solar, as well as lithium-ion batteries.)
  Following can be cited as the key elements of an effective policy framework-

Net Zero Emission (NZE) target implies that all remaining human-caused greenhouse gas (GHG) emissions are balanced out by removing GHGs from the atmosphere in a process known as **carbon removal.**

The phases of the energy transition



- **Driving economy-wide change** by setting credible and robust decarbonization targets and providing a clear trajectory for achieving them. For example, adopting mechanisms like carbon pricing.
- **Accelerating sectoral transitions** by providing timely financial incentives, strengthening the associated infrastructure, creating market for low-carbon fuels and transforming complete sectoral value chains especially in transportation and industrial sectors.
- **Create societal support** by making policies which are clear, predictable, transparent, pair and most importantly which ensures participation of all stakeholders.



- **Creating a balanced energy sector by embracing the Energy Trilemma:** The trilemma, proposed by the World Energy Council refers to the idea that there needs to be a balance between energy security, energy equity and environmental sustainability. Following measures can help enable the Energy Trilemma-
  - **Protection from physical vulnerabilities:** Building resilience to cyberattacks on information technology (IT) systems and operational technology (OT) is an increasingly important area for the energy industry.
  - **Moving towards circular economies:** The issues of CRM supply and material management will become pressing and require appropriate policy and investment responses. Already, some sectors are looking to lower dependence on CRMs, while reuse, substitution and recycling also offer opportunities. Application of these strategies could enhance security of supply for CRMs and form part of the development of the broader move towards circular economies.

- **Climate resilience:** It is essential to the technical and economic viability of the energy sector to ably meet growing energy demand. Therefore, it is essential that climate models are incorporated into the planning of energy infrastructure, particularly infrastructure which has a long design life and may be operating well into an environment of changed climate.
- **Embracing emerging technologies** on both supply and demand sides of the energy system, in areas such as decentralized power, renewable energy, energy storage and electric vehicles, together with data and artificial intelligence would drive the future of energy sector. These technologies are opening new possibilities for energy providers, businesses and consumers.

Emerging Sustainable Energy Technologies	
Hydrogen fuel cell technology	• A hydrogen fuel cell is an electrochemical power generator that combines hydrogen and oxygen to produce electricity, with water and heat as by-products. • However, Hydrogen rarely occurs naturally as a gas on Earth and is almost always combined with other elements. Hydrogen can be produced in a number of ways. One method includes using electrolysis, with electric current splitting water into oxygen and hydrogen. If the electricity used in the process comes from a renewable source such as wind or solar then it's termed "green" or "renewable" hydrogen. ▪ **Green hydrogen:** In addition to its use as a source of energy for the grid, green hydrogen has ample potential to help decarbonise industrial processes, gas heating and heavy transport.
Geothermal Energy	• It is the heat that comes from the sub-surface of the earth. It is contained in the rocks and fluids beneath the earth's crust and can be found as far down to the earth's hot molten rock, magma. • To produce power from geothermal energy, wells are dug a mile deep into underground reservoirs to access the steam and hot water there, which can then be used to drive turbines connected to electricity generators.

Ocean energy	● Ocean energy refers to all forms of renewable energy derived from the sea. There are three main types of ocean energy: **wave, tidal and ocean thermal.** ● All forms of energy from the ocean are still at an early stage of commercialisation. Wave energy remains more costly than the other ocean technologies.
Solar Marine/-Floating Solar power	● Floating solar power systems refer to the deployment of photovoltaic panels on the surface of water bodies. ● They are a viable alternative to land-based solar arrays with applications in many Asian countries. Floating solar systems present a solution that can address land acquisition issues effectively.
Solar Wind Hybrids	● This system is designed using the solar panels and small wind turbines generators for generating electricity. ● A key advantage for wind-solar hybrid systems is that they can produce more consistent power because solar power is produced during the day, while wind power is typically strongest at night.

CONCLUSION

As India continues to battle COVID-19, it must also begin on a new path of economic revival—one that will mitigate the negative consequences of climate change and promote sustainable and inclusive development in the long run. It is important to prioritise investments in sectors that could help in transitioning to a greener economy.

Given the aspirational vision of the Indian government to be a US$10 trillion economy by 2030 and the fact that much of India's development and infrastructure growth is going to unfold in the coming decade, integrating principles of green recovery is a win-win proposition. For India, unlocking a green recovery stimulus that can address the troika of jobs, growth and sustainability while addressing the impacts of climate change presents a huge opportunity.

TOPIC AT A GLANCE

TRANSITIONING TO A SUSTAINABLE ENERGY ECOSYSTEM

A critical aspect of recovering better together from the COVID-19 Pandemic

SUSTAINABLE ENERGY

- It is the **energy produced and used so that it meets the needs of the present without compromising the needs of future generations.** Examples include of renewable energy like Solar, Wind, Geothermal, Hydropower and Ocean energy.
- It is highly competitive and inexhaustible source of energy that helps in fighting climate change, reducing dependence on fossil fuels and preventing environmental degradation.
- **Sustainable Development Goal 7** (SDG 7) under its sub targets offers a framework for realizing sustainable energy future for the achievement of myriad socio-economic developmental objectives.

CO-BENEFITS OF INVESTING IN SDG 7

ECONOMIC BENEFITS	SOCIAL BENEFITS
Employment generation	Access to basic services
Increases Self- sufficiency	Gender Equality
Business opportunities	Better Health
Regional development	Other benefits such as innovations, sustainable production and consumption patterns etc.
Energy savings	

INDIA'S EFFORTS TOWARDS ACHIEVEMENT OF SDG 7

- **Universal access to affordable, reliable and modern energy services** through schemes like SARAL, Saubhagya, One Nation One grid etc.
- **Enhanced International cooperation** through ISA, INDCs under Paris agreement and initiatives like One World, One Sun, One Grid.
- **Improving energy efficiency** through ECB Codes.
- **Promoting investment in energy infrastructure** through National Wind Hybrid Policy, Flue Gas Desulphurization (FGD) norms, Dispute Resolution mechanisms etc.
- **Changes in relevant laws and regulations** to promote overall development of the renewable energy sector.

CHALLENGES FACED BY INDIA

- **Institutional and Governance challenges** such as lack of coordination in policy implementation, Land acquisition issues etc.
- **Technological challenges** such as Integration of distributed energy systems, Necessity of energy storage systems (ESS) etc.
- **Economic challenges** such as Falling solar tariffs, Poor investor sentiment and Lack of funds.
- **Other challenges** such as Vulnerabilities of energy systems to cyberattacks, Fragility in supply of Critical Raw Materials, Problem of waste generation and Social acceptance of renewable-based energy systems.

WAY AHEAD TO CREATE A BETTER ENERGY SYSTEM FOR INDIA'S FUTURE

- **Creating a framework for transitioning to Net Zero Emissions** by driving economy-wide changes, accelerating sectoral transitions and creating societal support.
- **Creating a balanced energy sector** by balancing energy security, energy equity and environmental sustainability **(Energy Trilemma)** by ensuring protection from physical vulnerabilities, moving towards circular economies and developing climate resilient energy systems.
- **Embracing emerging technologies** like Hydrogen Fuel Cells, Solar Wind Hybrids etc.