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# ENERGY FUTURE

The Complete Energy Magazine

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FEATURE

ENERGY SECURITY GOALS AND CLIMATE CONCERNS IN INDIA

VIEWPOINT

THE ROAD TO A SMARTER, GREENER PLANET

COVER STORY

STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT: A WAY FORWARD FOR INDIA'S NUCLEAR ENERGY SECTOR

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# HYDROPOWER ENERGY ALONG WITH CASE STUDIES

Practical aspects of harnessing renewable energy

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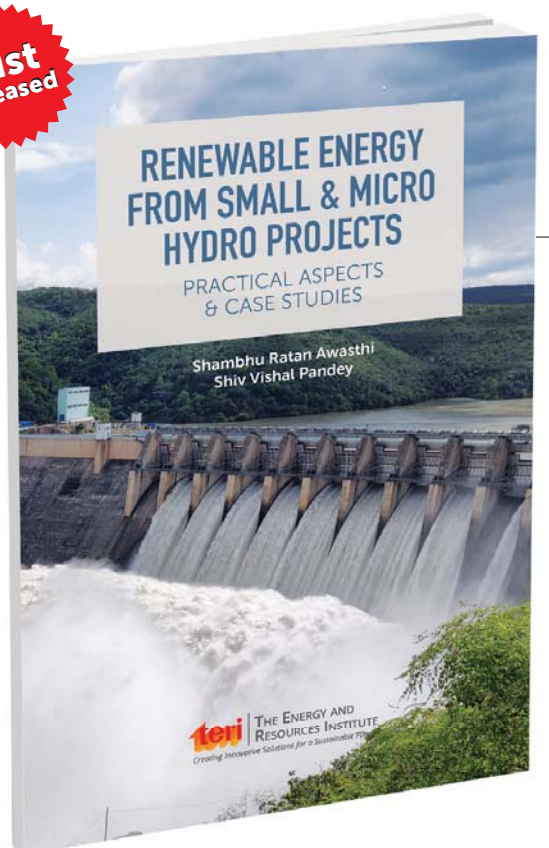


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- Hydraulics
- Feasibility Studies
- Hydro Turbines and Associated Equipments
- Generators and Electrical Systems
- Project Execution and Financial Aspects
- Environmental Aspects
- Policies for Sustainable Development of Hydropower

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Energy production and utilization are directly associated with climate change. Harnessing energy from renewables can provide a viable path towards achieving sustainability and reducing carbon footprints, which can help mitigate the harmful effects of climate change. India is endowed with substantial hydropower potential. Under this light, *Renewable Energy from Small & Micro Hydro Projects: practical aspects & case studies* introduces the process of developing hydropower projects, especially in Indian context. The role of hydroelectric power, as part of water management, in combating climate change also forms the subject matter of this book.

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# Editorial

India has been actively pursuing a sustainable and low-carbon energy transition, and renewable energy plays a vital role in achieving this ambitious goal. To promote the seamless integration of renewables into the national energy mix, the Indian government has implemented a series of comprehensive policies, incentives, and initiatives. These measures aim to create an enabling environment for renewable energy development, attract investments, and address the challenges associated with clean energy integration. In this regard, TERI with the support of Shell India launched a report titled *India transforming to a net-zero emissions energy system*. This report builds on the Shell-TERI India Scenarios Sketch to systematically update sectoral progress towards decarbonization. It highlights key areas of India's energy transition—energy efficiency, low-carbon electrification, and increasing use of decarbonized fuels such as green hydrogen and advanced biofuels—where action needs to intensify in this decade for India to be on course to meet its net-zero targets. This issue of Energy Future largely focuses on the Indian energy scenario, covering our progress and addressing the challenges in the feature articles.

The environmental benefits of renewable energy are obvious, leading to a cleaner environment, mitigating climate change impacts, and reducing healthcare costs of pollution-related illnesses. An equally compelling benefit is that the renewables sector is a major employer, providing opportunities for a diverse workforce across manufacturing, installation, and maintenance activities. The influx of investments further bolsters economic growth, while reducing reliance on imported fossil fuels enhances energy security and positively impacts the balance of trade. Additionally, the technological advancements spurred by the renewable energy sector have a ripple effect, benefiting other industries and enhancing India's overall competitiveness in the global market.

Our cover story, *Strategic Environmental Impact Assessment: A way forward for India's nuclear energy sector*, highlights the potential of the often-overlooked area of nuclear energy. Nuclear energy can help boost the country's growth even further; carrying the potential to radically change the course of energy production and energy security for the nation. Contrastingly, the solar quarterly for this issue underscores the manifold benefits of coupling the power houses of India's renewable scene: solar and wind. The article authored by Dhanush Binu and Dr Jyotirmay Banerjee analyses the potentials of a solar–wind hybrid energy system (SWHES) and concludes that the designed SWHES can produce continuous and constant power supply to the loads without any fluctuations. This is especially significant for off-grid rural areas, where energy supply is already a challenge; heightened even more for clean energy.

Steadily progressing on the path towards a cleaner and secure energy future, India is balancing its needs as a developing nation with the global pursuit of the 1.5 degree target. Continued efforts towards our progress in this direction will surely make India a model for other nations.

**Girish Sethi**
Senior Director – Energy Programme, TERI

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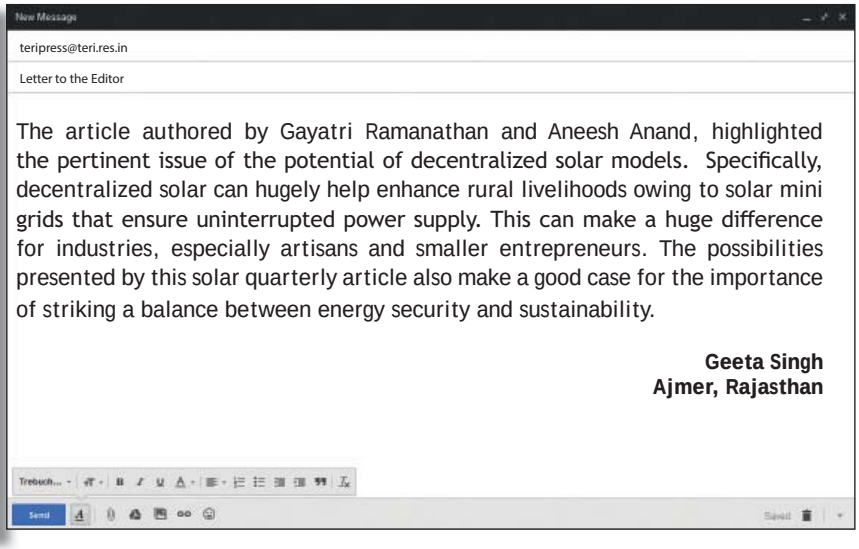
New Message

teripress@teri.res.in

Letter to the Editor

The article authored by Gayatri Ramanathan and Aneesh Anand, highlighted the pertinent issue of the potential of decentralized solar models. Specifically, decentralized solar can hugely help enhance rural livelihoods owing to solar mini grids that ensure uninterrupted power supply. This can make a huge difference for industries, especially artisans and smaller entrepreneurs. The possibilities presented by this solar quarterly article also make a good case for the importance of striking a balance between energy security and sustainability.

**Geeta Singh**
**Ajmer, Rajasthan**

Trebuch...

Send

Saved

"The discussion on CCUS presented by the cover story of this issue is very informative. As pointed out by the authors carbon capture, utilization, and storage (CCUS) can be seen as a key solution for reducing greenhouse gas emissions. The deployment of these technologies have experienced a surge in recent years, fueled by the global recognition of their importance in addressing climate change. I particularly agree with the suggestion that governments and international organizations should collaborate to establish a legal and regulatory framework for CCUS that covers all aspects of the technology: including the storage of carbon, liability and responsibility, and safety standards."

Ankit Sharma
Delhi

Thank you very much for your encouragement. The editorial team of Energy Future will ensure that the magazine caters to your information and knowledge needs. We welcome your suggestions and comments to further improve our content and presentation.

Email: teripress@teri.res.in
Editor
Energy Future

"The necessity of creating a suitable, facilitative policy framework for home charging is aptly underscored in the article titled, Supercharging the EV Home Charging Landscape: Potential policy interventions. Electric vehicle adoption in India is at a pivotal point and its successful rise with largely depend on establishment of an accessible charging ecosystem. I agree with the authors' assessment that the role of home charging is critical, and steps are needed so that the rate of EV deployment can be maximized across varying form factors and among vehicle users.

**Srikant Panikkar**
Mangalore, Karnataka

"I enjoyed reading the feature story on Prospects of Ethanol from Agro-Residues. India produces large quantities agricultural residues and the bioconversion of these residues into biofuels will not only aid in prudent waste management—by minimizing instances of stubble burning—but will also aid India's transition to clean energy. Another interesting point raised in the article was the prospect of utilizing marine bacterial strain V. parahaemolyticus for enzyme hydrolysis and yeast strain P. kudriavzevii for fermentation in the bioethanol production process.

Shashi Gill
Chandigarh

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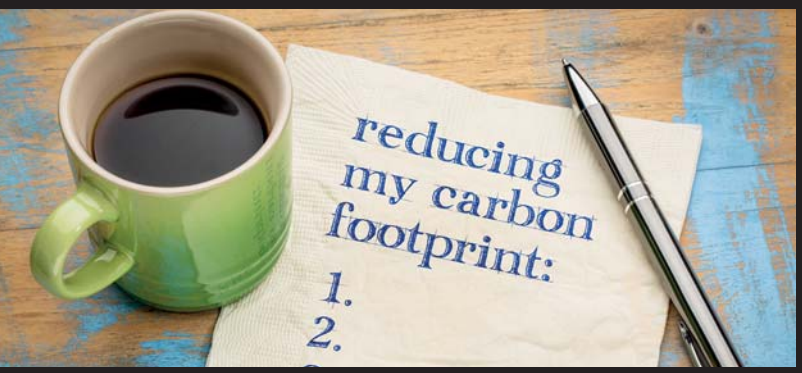


# KARNATAKA ANNOUNCES TAX CONCESSIONS FOR SWITCHING TO ELECTRIC VEHICLES AFTER SCRAPPING OLD VEHICLES

People who scrap end-of-life (old) vehicles in Karnataka are set to get a tax concession ranging from INR 1,000 to INR 40,000 when buying new electric vehicles, Law and Parliamentary Affairs Minister H K Patil said while announcing a cabinet decision. Patil said the concession for two-wheelers would range from INR 1,000 to INR 5,000. For example, vehicles priced up to INR 1 lakh will get a concession of INR 1,000, vehicles priced up to INR 2 lakh will get an INR 2,000 concession, and vehicles costing INR 4–5 lakh will get a concession of INR 5,000.

Similar benefits would apply to those ditching old four-wheelers for new electric four-wheelers. The concession for electric four-wheelers priced below INR 5 lakh is INR 10,000. For those costing INR 5–10 lakh it is INR 20,000, for those priced INR 10–15 lakh it is INR 30,000, for those costing INR 15–20 lakh it is INR 40,000 and for vehicles costing above INR 20 lakh the concession is INR 50,000. EF

*Source: https://indianexpress.com/*

# GREEN $H_2$ TENDER: TWO COMPANIES SEEK ZERO INCENTIVES


Two of the 14 participants in the government's tender for green hydrogen—UPL Ltd and CESC Projects Ltd—have not sought any incentives while, among the rest, a Reliance Industries arm bid for the lowest incentive required by it at INR 18.9 per kg on an average of three years, sources said. Other winners in the tender for 450,000 metric tonnes of green hydrogen per year include Welspun New Energy, HHP Two Pvt Ltd, Acme Cleantech, Greenko ZeroC, and Bharat Petroleum Corporation (BPCL). Reliance Green Hydrogen and Green Chemicals bid for producing 90,000 metric tonnes of green hydrogen per year, which was the maximum capacity limit for a bidder, while UPL bid for 10,000 metric tonnes, the minimum quantity under the tender, and CESC Projects bid for 10,500 metric tonnes, sources said. "We don't know the reason yet as to why bids which do not require any incentive were made," said a senior government official. The bidding was on the least incentive demanded over three years through a competitive selection process by the Solar Energy Corporation of India. EF

*Source: https://economictimes.indiatimes.com/*

# PFC SIGNS MOU WITH GOVT OF GUJARAT FOR POWER PROJECTS WORTH INR 25,000 CRORE

Power Finance Corporation Ltd (PFC), a Maharatna CPSE and the leading NBFC in the power sector, has signed an MoU with the Government of Gujarat (GoG), in Gandhinagar. The chief objective of this MoU is to provide comprehensive financial backing for the state's generation, transmission, and distribution projects.

The collaboration is set to facilitate long-term debt and other critical funding necessities vital for executing these diverse projects. Under the terms of the MoU, the envisaged financial assistance stands at an impressive INR 25,000 crore, dedicated to powering up various projects across Gujarat. This substantial financial from facilitating the expansion of power infrastructure, the MoU shall inter-alia also help employment generation to the tune of 10,000 in the state of Gujarat. This strategic alliance is anticipated to usher in a new era of energy sustainability and efficiency in Gujarat, setting the stage for transformative changes and catalyzing the state's vision for a robust and reliable power infrastructure. EF

*Source: https://pib.gov.in/*

# ARUNACHAL PRADESH SIGNS MOA WITH THDCIL FOR 1200 MW KALAI-II HYDROELECTRIC PROJECT

The Government of Arunachal Pradesh signed a Memorandum of Agreement (MoA) with Tehri Hydropower Development Corporation India Ltd (THDCIL), a central PSU, for developing the 1200 MW Kalai-II hydroelectric project in the Lohit River basin. Ankur Garg, Commissioner (Hydropower) and Bhupender Gupta, Director (Technical) THDCIL, signed the MoA on behalf of the Government of Arunachal Pradesh and M/s THDCIL, respectively.

The Chief Minister Pema Khandu thanked Prime Minister Narendra Modi and Union Power Minister R K Singh for their unflinching support towards restarting the project. He expressed that the state is committed to ensuring full development of the hydropower potential for meeting the energy security of the country and asked all the stakeholders to implement the project in a mission mode. EF

*Source: https://economictimes.indiatimes.com/*

# ONGC BEGINS OIL PRODUCTION IN KRISHNA GODAVARI BASIN DEEP-SEA PROJECT

The Oil and Natural Gas Corporation (ONGC) has started oil production from its much-delayed flagship deep-sea project in the Krishna Godavari basin in Bay of Bengal, helping reverse years of decline in output, the company said.

ONGC has started producing from the Cluster-2 project in KG-DWN-98/2 block and will slowly ramp up output. KG-DWN-98/2 or KG-D5 block sits next to Reliance Industries' KG-D6 block in the KG basin and has a number of discoveries that have been clubbed into clusters. It is situated offshore the Godavari River delta in the Bay of Bengal. This development is set to boost ONGC's overall oil and gas output by 11% and 15%, respectively. According to the reports, the remaining oil and gas fields of the block are expected to become operational by mid-2024. At peak, the field is likely to produce 45,000 barrels of oil per day and over 10 million metric standard cubic meters per day of gas. EF

*Source: https://www.thestatesman.com/*

# PREDICTIONS FOR 2024: NEED AGGRESSIVE ACTION TO MEET GREEN TARGETS, SAYS AMITABH KANT

India must industrialize without carbonizing. Having achieved the first nationally determined contribution (NDC) nine years ahead of schedule, India has set an even more ambitious second NDC. Hard to abate sectors such as steel, fertilizers, cement, and long-haul transport, are just some areas where green hydrogen can drive the energy transition. Through the National Green Hydrogen Mission, the aim is to make India a global green hydrogen hub. During India's G20 presidency, green development took centre stage.

In 2024, popularization of solar rooftops must be undertaken in mission mode. This is India's big opportunity. Despite successes in renewable energy, the country has been unable to make a breakthrough in solar rooftops. Many state electricity regulatory commissions (SERCs) have not yet adopted gross-metering. With gross-metering, consumers will be able to sell excess electricity generated back to the grid, reducing their power bills. Furthermore, the power generated through solar rooftops will be consumed locally, reducing transmission and distribution losses. EF

*Source: https://economictimes.indiatimes.com/*

# MANN GOVT PURCHASES 540MW GOINDWAL THERMAL PLANT FOR INR 1,080 CRORE

Punjab Chief Minister Bhagwant Mann announced that the 540MW thermal plant owned by GVK Group in the Goindwal Sahib area of Tarn Taran district has been acquired by the Punjab Government. Mann announced at a news conference that the plant was bought by the Punjab State Power Corporation Limited (PSPCL) for INR 1,080 crore.

The power purchase agreement (PPA), which was inked during the Shiromani Akali Dal-BJP tenure, states that the Punjab government will save between INR 300 crore and INR 500 crore in generation costs by purchasing this power plant; instead of what it was paying to the GVK Group, Mann added. With this, the power to the consumers of Punjab is likely to get cheaper in the days to come. EF.

*Source: https://www.thestatesman.com/*

# HIMACHAL CABINET GIVES NOD FOR SCHEME TO HELP YOUTH SET-UP SOLAR POWER PROJECTS

The Himachal Pradesh Government decided to start the second phase of the 'Rajiv Gandhi Swarozgaar Start-Up Yojana' to assist the youth in setting up startup units in the State. A government statement said the Cabinet decided to start the second phase of the scheme for setting up solar power projects (SPPs) for people aged between 21 to 45 years, and it also attempts to achieve the clean energy initiatives as formulated by the administration.

"The scheme focuses on the installation of SPPs with capacities ranging from 100 kW (kilowatts) to 500 kW, thereby contributing substantially to the State's renewable energy targets. This will not only provide self-employment opportunities, but will also stimulate economic growth amongst the youth in times to come," it said.

The statement added that under the scheme, the participants will receive a 'monthly income' of around INR 20,000 for 25 years for 100 kW to be installed in three bighas of land, and INR 40,000 and INR 1 lakh per month for the projects with a capacity of 200 kW and 500 kW, to be set up in five and ten bighas of land, respectively. EF

*Source: https://www.thehindu.com/*

# DENMARK'S GREEN FUELS ALLIANCE TO BOOST SUSTAINABLE ENERGY SOLUTIONS SECTOR

At the Global Investors Meet (GIM) 2024, Denmark announced a Green Fuels Alliance India (GFAI) initiative to boost collaboration between the two countries in the sustainable energy solutions sector and advance its joint global goal towards carbon neutrality.

The GFAI's primary objective is to promote sustainable energy growth in India by establishing an ecosystem that encourages collaboration among businesses, government entities, research institutions, and financial stakeholders. Nine pioneering Danish organizations—Maersk, Topsoe, Umwelt Energy, Mash Makes, European Sustainable Solutions, Novozymes, Danfoss, Brdr. Christensen, and Hydrogen Denmark—have committed themselves to the GFAI initiative as founding members. Meanwhile, the GFAI's advisory board members include India Hydrogen Alliance, Energy Consortium at the Indian Institute of Technology–Madras, the Danish Energy Agency, and State of Green. EF

*Source: https://www.thehindu.com/*

# NUCLEAR ENERGY PLAYERS NEED TO TAKE 90% URANIUM PRICE SPIKE BILL OR SHUT PLANTS

At COP28, 22 countries committed to a trebling of nuclear capacity by 2050. The slightly scary result? Globally uranium demand is expected to rise by 28% by 2030 and to double by 2040. The global uranium supply is facing a deficit, with a shortage of enriched uranium as well. Hedge funds, ETFs, governments, and utilities are all vying for uranium, leading to price increases in the market.

Governments appear to have finally grasped that nuclear power is the only cheap and reliable low-carbon power available—and therefore, the only thing that gives them a hope of getting anywhere near their rash net-zero promises. They know they won't get there with unreliable, expensive, and politically divisive wind turbines and solar panels. So, the French have given up on their plan to reduce the share of electricity generated by nuclear. The UK is seriously discussing expanding nuclear capacity and has delayed the closure of four reactors. It has also announced plans to spend hundreds of millions of dollars on producing the high-assay low-enriched uranium (HALEU) needed for the small modular reactors that are to be our low carbon saviors. And the Chinese, say Alpha Portfolio Management, have 55 nuclear reactors, another 24 under construction, and around 150 planned over the next 15 years.

The price of uranium has increased by 90% in 12 months, surpassing its cost in 16 years. However, the demand for uranium is rising due to the need for low-carbon power sources. Shutting the plant down will cost a fortune, says Nick Lawson of advisory firm Ocean Wall; think USD 1 million a day. EF

*Source: https://economictimes.indiatimes.com/*

# CAN SOUTHEAST ASIA AFFORD TO RETIRE ITS COAL PLANTS?

Indonesia announced in December 2023, a technical roadmap laying out how the country would spend a portion of the EUR 18 billion (USD 19.95 billion) pledged to it through the Just Energy Transition Partnership (JETP), a G7-backed investment scheme for sustainable development. A few days later, at the COP28 summit in Dubai, Vietnamese officials laid out their vision of how they would spend the EUR 14.1 billion in equity investments, grants, and concessionary loans that is on offer through JETP.

According to Jakarta's Comprehensive Investment and Policy Plan, Indonesia will increase the share of renewable energy in nationwide power generation to 44% by 2030, up from a previous target of 34%. However, the plan remains a draft and the Indonesian government is currently collecting stakeholder inputs for the formulation of a final investment plan.

Indonesia and Vietnam will need to balance their sustainability ambitions and financing, with the reality that many of the power systems already approved for construction will be coal-fired. In a region of the world where China has pumped tens of billions of dollars into infrastructure projects in recent years—often as direct investment rather than loans—there has been some disappointment in Vietnam and Indonesia about what exactly they could receive. EF

*Source: https://indianexpress.com/*

# WORLD ADDED 50% MORE RENEWABLE ENERGY BUT MORE NEEDED: IEA

The world added 50% more renewable energy capacity in 2023 over the previous year, but more is needed in the battle against climate change, said the International Energy Agency. The increase was the fastest growth rate in the past two decades and the 22nd year in a row that renewable capacity additions set a new record, the Paris-based IEA said. The rise was driven by China, the planet's biggest emitter of greenhouse gases, but also what the IEA called "the world's renewables powerhouse".

Massively scaling up the deployment of solar and wind power, while winding down the use of fossil fuels, is crucial to achieving the goal of limiting global warming to 1.5 degrees Celsius from pre-industrial levels. But the world is not on pace to reach the goal of tripling renewable capacity by 2030—a target agreed by nearly 200 nations at the UN's

COP28 climate summit, the IEA said. The COP28 agreement also called for 'transitioning away' from fossil fuels, but without setting a timeline and sort of a 'phase-out' demanded by many nations, but opposed by oil giant Saudi Arabia. EF

*Source: https://economictimes.indiatimes.com/*

# NAVIGATING THE TRADE AND ENVIRONMENT NEXUS: A CALL FOR ACTIONABLE EQUITABLE POLICIES

In the complex web of international trade policies, the intersection with environmental and other considerations has become a pressing concern, particularly for the developing and emerging world. As the global community grapples with climate change, plastic waste, biodiversity loss, and pollution, the need for a balanced approach that fosters sustainable development—meaning the triumvirate of economy, equity, and ecology—is more crucial than ever. The intersection of trade and the environment stands as a recurring focal point in international forums, where assurances of equitable treatment and a recognition of the developmental hurdles faced by emerging economies echo through the discourse.

Within the World Trade Organization (WTO) regime, the principles of Special and Differential Treatment (SDT) strive to embed a developmental perspective. Similarly, Multilateral Environmental Agreements (MEAs) hinge on the concept of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC) to underscore the unique challenges faced by developing nations. This principle is vital in addressing the imbalance between the rich and the poor of the world. Nevertheless, the assurance of support and consideration often falters when it comes to translating these principles into actionable policies. EF

*Source: https://economictimes.indiatimes.com/*

# CHINA'S WIND, SOLAR CAPACITY SET TO OUTSHINE COAL IN 2024

The China Electricity Council (CEC) in a yearly report said, grid-connected wind and solar would make up around 40% of installed power generation capacity by the end of 2024, compared with coal's expected 37%. By comparison, wind and solar together were around 36% of capacity at the end of 2023, and coal was just under 40%. China will have built around 1,300 GW of wind and solar capacity by the end of 2024, the CEC expects, meaning it will have already exceeded its official target of 1,200 GW by 2030. The CEC also said generating capacity from all non-fossil fuel sources (including nuclear and hydro) made up more than half of total for the first time in 2023. However, it did not give a forecasted breakdown for actual power generation, which is still dominated by coal that provided nearly 60% of electricity consumed last year. EF

*Source: https://economictimes.indiatimes.com/*

# AMID RED SEA TENSIONS: ASIAN FUEL EXPORTS TO EUROPE HIT, RUSSIAN OIL CARGOES SAIL STRONG

Even as west-to-east crude oil flows—mainly Russian oil headed to India and China—via the Suez Canal have not been majorly impacted by the Red Sea troubles, refined petroleum product exports to Europe through the crucial trade route have seen disruptions, according to commodity market analytics firm Kpler. The trend is significant for India as the country is a top destination for Russian crude and also an important source market for fuels, particularly aviation turbine fuel (ATF) or jet fuel, for Europe.

Over the past couple of months, a number of cargo ships have come under attack from the Iran-backed Houthi rebels of Yemen around the Bab el-Mandeb strait, which leads to the Red Sea and Suez Canal, forming the shortest, albeit narrow route to the Mediterranean Sea and beyond from the Arab Peninsula, North-East Africa, and the Arabian Sea. The route is seen as an important artery of global goods and energy supplies. The Houthis have so far claimed that they are targeting vessels with links to Israel and its allies in view of its military offensive in Gaza. EF

*Source: https://indianexpress.com/*

# GERMANY EARMARKS UP TO USD 3.8 BILLION FOR FUTURE GREEN HYDROGEN IMPORTS


Germany will earmark up to EUR 3.53 billion (USD 3.8 billion) of public funds to procure green hydrogen and its derivatives between 2027 and 2036, the economy ministry said, as Berlin bets on the fuel to help decarbonize Europe's biggest economy. "The aim of the funding measure is to bring together supply and demand, both in terms of quantities and prices," the ministry said in a statement, adding that money will come from the government's Climate and Transformation Fund.

Germany is seeking to expand reliance on hydrogen as a future energy source to cut greenhouse gas emissions for highly polluting industrial sectors that cannot be electrified, such as steel and chemicals, and reduce dependency on imported fossil fuel. Berlin will have to import up to 70% of its hydrogen needs in the future as Europe's largest economy aims to become climate neutral by 2045, according to the government's updated hydrogen strategy published last summer. EF

*Source: https://www.reuters.com/*

# STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

## A way forward for India's nuclear energy sector

The area of nuclear energy can help boost the India's renewables growth even further; carrying the potential to radically change the course of energy production and energy security in the ountry. However, a thorough analysis and policy ecosystem for this sector is missing. In this article, **Raagya Zadu** proposes strategic environmental impact assessment as a tool to augment the required advancements in India's nuclear energy sector.

## Introduction

The United Nations Conference on the Human Environment—more popularly known as the Stockholm Convention of 1972 was a historic event. It not only provided a new perspective of sustainable development, but also added to the concept of 'Precautionary Principle'. The world understood that the most pivotal task in front of them, to coexist with nature, was to balance two very important human rights: the right to development and the right to a clean environment. The debate on this matter is still ongoing, about who needs to cut down more on their development to ensure the right to a clean environment is guaranteed to the others. This is also understood as the Great Contemporary East and South Divide. The developed and the developing countries, till date, are trying to balance each other's requirements regarding this; thus giving birth to the concept of 'Common But Differentiated Responsibilities'.

With the progressing time, the population has exploded in a boundless manner across the world and in not enough time for the Earth to replenish its limited resources. Meeting the rising demands of humanity requires energy. This energy sector is common and the backbone of all other sectors for their development as everything needs power to function. Traditionally, coal or fossil fuel has dominated the energy sector worldwide. Oil as well, has been the greatest driving factor for the energy sector as the first choice for fuel for a majority. The greatest challenge with fossil fuel is the expulsion of many noxious gases and toxic pollutants in the ground which cause a greenhouse effect on Earth's atmosphere. They not only pollute the ground with poisonous sludge, but also create a perfect situation for the Earth to experience what is called global warming—the biggest result of which is climate change.

In the million years of its existence, the Earth has experienced climate change numerous times before.

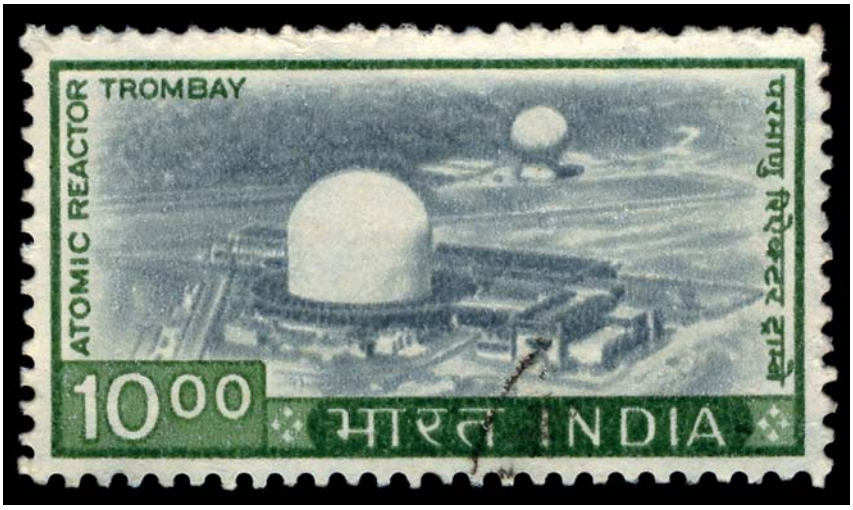
It has caused for entire ecosystems and environments to suffer catastrophic events causing the extinction of billions of species of flora, fauna, and possibly human life. Since the industrial revolution, increased use of fossil fuel has been a steady catalyst for climate change.

After the declaration and adoption of Sustainable Development Goals in 2015 by the United Nations[1], many innovations took place in energy generation technologies. Although the solar sector grew exponentially, alongside wind and hydroelectricity, the main issue of developing a sustainable energy source which could become a substitute for coal remained. Limiting our scope to India, coal remains and is likely to remain the main source of electricity as it is the baseload of majority of energy generation. Thus, consideration should be given to the development of nuclear energy as a steady and stable source of clean energy. In the generation of nuclear energy, there is comparatively much less (almost minimal) generation of carbon emissions. Nonetheless, this sector has many challenges of its own.

Many western countries have developed the legal and security framework for nuclear energy. In India, however, this sector lacks a constructive and competitive legal framework. The technology remains unique to the standards of the world, but the legal and, especially, the environmental concerns surrounding nuclear energy remain unaddressed. While the construction of a nuclear power plant is not very different from the construction of any other large scale power plant—involving the use of electricity, water, natural resources, man-hours, along with technological and logistical inputs—it is different from all other sectors on two counts: the development of its reactor building and the operation of the plant.

The nuclear energy sector is a highly sensitive and potentially risky sector, which, if proper precautions are not taken, could be the cause of a widespread disaster. The smallest of error can result in severe radioactive poisoning and death. Thus, the regulators and operators cannot afford to ignore even the slightest possibility of negligence. An environmental impact assessment (EIA) is required by law for nuclear power plants in India, along with all other developmental projects.

1 United Nations Sustainable Development Summit 2015, https://www.un.org/sustainabledevelopment/blog/2015/09/summit-charts-new-era-of-sustainable-development-world-leaders-to-gavel-universal-agenda-to-transform-our-world-for-people-and-planet/




The law that governs and regulates the nuclear energy sector dates back to 1962 and the rules and notifications issued under this Act have not been updated in many years. Additionally, because this sector is sensitive, certain special privileges have been granted to the authorities for protecting people's health and the environment, such as preventing unauthorized disclosure of information. The environmental impact assessment is an important tool for identifying potential risks and ensuring sustainable development; however, it is only applicable during a project's construction phase and not earlier. The EIA model which exists today considers all projects individually and does not consider the whole sector and its development in a holistic manner.

Nuclear energy is an area that has long term advantages, alongside the many dangers it poses to the environment, and carries the potential to radically change the course of energy production and energy security for the nation. Due to this, its functioning is governed by discrete and unique regulations and guidelines, that supersede the others—like the idea of *lex specialis*. A further developed component and technique of leading an evaluation of nuclear energy plants ought to be set up. This makes us want to question whether the simple process of EIA is sufficient for a sensitive sector like nuclear energy, especially in the times, where the government plans to further expand this sector for clean energy generation? Is it adequate to only study the impact of individual nuclear energy plants? Or should the process of impact assessment be more strategic in nature and begin its study while laying down the plans and policies for the sector's development?

Environment impact assessment studies are viewed as more specialized and to a greater extent a logical gathering of information relating to air, water, soil, groundwater, and other ordinary contamination. Presently, the EIA mechanism—with reference to the ones done for our nuclear power plants—is not as per prescribed standards, as these studies were done a decade ago and the construction of the plant has not started till date.[2] The flora and fauna, along with the demography of the area and its environment are not the same anymore, rendering those studies inadequate and obsolete.

Despite the fact that it is called an 'Environment Impact Assessment', ample attention isn't given to the environmental challenges as well as the administrative and legitimate systems set up; neither does it take into consideration the changing elements of ecological regulation in the current times. The topic of public awareness and interactions with the local and project-affected people is also not covered in detail—even though the main stakeholders are the locals who shall be deriving the most (and are impacted the most) out of the proposed project. Incorporating social assessment into effective evaluation studies will help even more when done from the very beginning, i.e., the making of the policies and plans to expand the nuclear energy sector as a whole.

An absence of communication and the free flow of information in this sector has been a great obstacle in the

2 Ref. to the EIA of Jaitapur Nuclear Power Plant, which was completed in 2010, but the construction of the same has not yet begun owing to governmental and diplomatic reasons.

development and acknowledgment of nuclear power in India. The EIA reports are, for the most part, uniform in nature with all archives—being of similar configuration, posing similar inquiries, and including similar boundaries—starting from the primary EIAs finished for the Narora Nuclear Power Station[3] up to the EIA for the Kudankulum Atomic Energy Station[4]. Narora Atomic Station's EIA was one of the first published mandatory EIAs to be done in the post-1994 EIA notification era, while the Kudankulum EIA was the most recent one (2003), done for a plant that is now operating commercially. The process for these assessments has not been environmentally specific and focused more on the collation of data for flora and fauna and the socio-economic nature of the demography in the area. The nuclear power plants proposed now for the future are more advanced and are categorized as Generation IV[5]. These advanced reactors will have a varied effect on the environment; thus, a standard universal EIA study for them would not be entirely sufficient.

This kind of equivocalness in the method of EIA for a specialized sector does not seem very confidence inspiring and gives reason for a new institutionalized system to be put in place, or at least to be suggested. Consequently, the author expresses a planned strategy for directing strategic environmental impact assessments (SEIAs) for the nuclear energy sector in India. This article will further elaborate the significance of SEIA: how it is not the same as an ordinary EIA study and about its application and extended execution in the nuclear energy sector—from an environmental regulation and strategy-making viewpoint.

## Strategic Environmental Impact Assessment: a genesis

Strategic environmental impact assessment, or SEIA, refers to a formal, systemic process to analyse and address the environmental effects of policies, plans, and programmes as well as other strategic initiatives.[6]

3 www.npcil.nic.in/WriteReadData/userfiles/file/Environmental_Impact_Assessment_Nuclear_Power_Plant_Narora.pdf

4 *'Updation of the Environmental Impact Study for Proposed 3, 4, 5, 6 units of KKNPP'* (Kudankulam, Volume-I, Engineers India Limited, Document No. A189-EI-1741-1101 Rev No. 0)

5 Generation IV reactors are characterized as being more environmentally safer as their coolant is more stable in nature. Their design is more advanced and diverse making them safer options than the present Generation III and III+ reactors. These reactors shall also be used to make green hydrogen for future green energy use, among other such byproducts.

6 Hussein Abaza, Ron Bisset, & Barry Saddler, '*Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated Approach*' (2004) UNEP ISBN: 92-807-2429-0 86

It is popularly defined as "*… a systemic process for evaluation of the environmental consequences of proposed policy, plan, or programme initiatives in order to ensure they are fully included and appropriately addressed at the earliest appropriate state of decision making on par with economic and social considerations*"[7]. The OECD defines SEIA as "*a range of analytical and participatory approaches that aim to integrate considerations into policies, plans, and programmes and evaluate the inter-linkages with economic and social considerations*"[8]. The United Nations Environment Programme defines SIEA as "*a formal process of systematic analysis of the environmental effects of developmental policies, plans, programmes, and other proposed strategic actions. This process extends the aims and principles of EIA upstream in the decision-making process, beyond the project level and when major alternatives are still open.*"[9] SEIA essentially aims to benefit sectors that are conceived to have significant environmental impacts, such as transport, energy, and those involving land-use changes. Like the meaning of EIA has developed and is interpreted in a broad manner, SEIA should be interpreted as a more advanced form of EIA that will not look at the project individually, but be inclusive of social, health, and other consequences of a proposed action and its relationship to sustainable development concepts and strategies of the entire sector.

As discussed above, SEIA is a concept applied on a plan, policy, or programme level; however, these terms have different meanings in different countries. Policy is more or less understood as a general directive which outlines, guides, or sets context for the proposed actions that a government or organization intends on performing. It may or may not be transformed into a legislation/regulation at a later point of time. To summarize, in effect, policy means making a framework that may later lead up to programmes which will be carried out in a particular sector. Therefore, it (policy) maybe stated here generally, to imply that SEIA aims to extend the basic structure and concept of EIA to a wider scope of decision making. This application of SEIA makes sector governance a bit more flexible as it forces the consideration of alternative options as well. One of the biggest advantages of SEIA is that this mechanism identifies the stakeholders of the particular sector much in advance and incorporates their inputs from the beginning. It also makes public consultation a recurring procedure in all stages, unlike EIA which conducts public consultation in a quick manner only towards the end of the study: when the EIA report is already made.

To briefly present the major difference in SEIA and EIA, EIA is done just before the project construction is to be set in motion; while SEIA is carried out right when a policy is to be made for the development of a particular sector for any number of projects that may be taken up for that sector. The objective is to involve an environmental impact assessment right at the time of policy-making, include it even while making plans, and eventually while carrying out said plans.

Environmental goals and objectives are presumed to be better achieved and integrated if the assessment starts right in the beginning. Project-level impacts are more mitigation oriented; while policy and planning level impacts, when foreseen, enable leeway so that minimal environmental loss takes place.

7 B. Sadler and R. Verheem, 'SEA: status, challenges and future directions' (Report 53, The Netherlands: Ministry of Housing, Spatial Planning and the Environment 1996); M. Desmond, '*Strategic Environmental Assessment (SEA): A Tool for Environmental Decision-Making Irish Geography*' (2007) Volume 40 (1), pp. 63–78

8 Asha Rajvanshi, '*Strategic Environmental Assessment: A Guidance Tool for Mainstreaming Biodiversity and Sustainability in Development Planning*' (2015) Wildlife Institute of India

9 ibid.


SEIA is anticipated to provide early warning of large scale and cumulative effects, including those resulting from a number of smaller scale projects that individually would not fall under the ambit of EIA studies.[10] SEIA in its nature and procedure takes into consideration the cumulative effects of the PPP[11] on the human and natural environment, along with all socio-economic and socio-cultural factors that are aligned together. EIA, on the other hand, is designed to factor in the effects of the proposed project on the existing and neighbouring environment and demography.

## Covering gaps in current mechanism

SEIA is a very commanding tool, in shaping the way for energized and proactive environmental governance. This mechanism, if applied in the early stages of infrastructure development, like in policy planning and programme levels, has the competence to change environmental governance and decision-making as we know it today. This can be accomplished by assessing the likely results of their execution regarding financial, ecological, and arranging objectives and needs. SEIA can assist with guaranteeing that authorities or developers will enhance their PPPs in a manner that amplifies the drawn-out advantage for the climate and human prosperity, at the same time distinguishing and conveying likely dangers. When SEIA is directed after a proposed strategy, plan, or program has just been figured it can still help assess, change, and improve the PPPs during their usage. SEIA can likewise significantly raise the profile of usually disregarded parts of the environment during the SEIA cycle, such as, biodiversity and other cultural concerns.

To elaborate, let us use India's solar energy sector as an example. In 2017, the MoEF CC stated through a notification that environmental clearance rules and necessary compliances for solar and PV, solar cum thermal power projects, and solar parks shall be watered down and EIA shall cease to be mandatory. Thus, declaring this entire sector a white category industry.[12] A hidden potential environmental hazard owing to the enormity and the mass production of solar sector, the PV panels and cells, is the danger of discarded solar panels. They contain compounds of silica, among other chemical products which have the potential to harm the environment. Currently there are no legal regulations or rules in India to classify solar waste specifically, or to

[10] Ibid.
[11] Plan, Policy, and Programme
[12] *'Government Eases Environment Clearance Rules for Solar Projects'*, www.livemint.com/Politics/QW4cJ9yjhmvUtOZCPyOt3J/Govt-eases-environment-clearance-rules-for-solar-projects.html

designate the chemical materials inside the solar panels as hazardous chemical waste. How does one manage the waste generated by the discarded panels then? Owing to the enormous scale of solar energy today, it is easy to fathom the enormity of the solar waste situation lying in the future.

If the SEIA system would have been implied for this initiative, the impact of solar energy on the environment would have been assessed from both fronts: the advantages and the disadvantages. The weaknesses of the sector, such as a lacking waste management framework, would have been addressed and the policy directives could have helped in formulating an effective legal mechanism. With thorough public consultations, the involved stakeholders could have monitored the cumulative effects of the sector; that way, the gaps in the present litigation could have been filled. From this analogy, it can be observed that the nuclear energy sector may be making a similar mistake. If the SEIA process is chosen for this sector, it will identify and manage, if not eliminate, the gaps present in the legislative procedure. This could definitely benefit the growth and development of nuclear energy power in the country. In fact, the entire energy sector of the nation can benefit from this mechanism of impact assessment. Not only does SEIA make the environment a concern during the PPP level, valuable time, effort, and money shall be saved by planning for future roadblocks. Moreover, the flow of information would be transparent, efficient, and will entail accountability.

The following challenges make SEIA a better practice for the nuclear energy sector—

i) **Directed policy for the nuclear energy sector**: Compared to the ambitious targets set by the Government of India, there aren't any unique policy measures and directives for the sector as a whole yet. The energy policy in existence is the Integrated Energy Policy (IEP)

of 2006[13] which was prepared by the Planning Commission of India. The IEP identifies multiple energy challenges that the administration must address, including meeting energy demands, securing supply, mitigating climate change, and promoting renewable and alternative energy.[14] The IEP sets forth several policy choices that the government can pursue to address these challenges.[15] These choices primarily comprise four strategies:

- energy diversification and efficiency;
- catalysing investment in energy diversification and energy by a combination of market competitiveness, regulatory intervention, energy pricing changes, and effective subsidies;
- strengthening diplomacy;
- and demanding accountability for environmental externalities.[16,17]

[13] www.planningcommission.nic.in

[14] '*Integrated Energy Policy: Report of the Expert Committee*' (2006) http://planningcommission.gov.in/reports/genrep/rep_intengy.pdf, accessed: 20 July 2020

[15] Deepa Badrinarayana, '*India's Integrated Energy Policy: A Source of Economic Nirvana or Environmental Disaster?*' (2010) Environmental Law Reporter

[16] Deepa Badrinarayana, '*India's Integrated Energy Policy: A Source of Economic Nirvana or Environmental Disaster?*' (2010) The Environmental Law Reporter

[17] ibid xiii-xiv.

There were targets and not pathways; further highlighting a lack of focus on nuclear energy.

Projections of the growth potential of nuclear power are not done only by India, but by the International Atomic Energy Agency (IAEA) and the International Energy Agency (IEA) as well, which see South Asia as the next driver for nuclear energy. Enjoying developmental hegemony in South Asia, India is the next trend setter for the development of nuclear energy.

The application and induction of an SEIA for this sector will enable the Department of Atomic Energy, along with the Government of India, to make a policy directive for nuclear energy and give impetus to environmental considerations. SEIA will drive the hand of the policy-drafters and legislators to contemplate the ecological results which the nation will need to look into, beyond the advantages of atomic power. Some of the aspects reviewed can help in mitigating the carbon-ridden air, the energy security of this potent power source, siting of the plant, the rehabilitation of people, employment of skilled and unskilled people causing an improvement in the quality of life, along with the environmental impact of waste disposal methods and decommissioning. Decommissioning of atomic energy stations doesn't find

place in the current EIA reports and/or plans of the administrators.

**ii) Gap analysis of current legal regulations:** Two aspects of nuclear energy are most concerning, one of them is the safety of its design and the second is mitigation of environmental impacts during its lifecycle. The safety features of the nuclear power programme are technical in nature[18], response and mitigation mechanisms subsequent to an accident and the risk associated with the entire programme can be secured through strong legal and institutional measures[19]. The SEIA document will be a tool shaping the amendment of the present laws and rules that need updates.

This assessment will involve an in-depth analysis of the current structure, both legal and administrative, of the nuclear energy sector. It shall also highlight the absence of environment protection rules within the sector and underscore the requirement for the same. Neither does the Atomic Energy Act of 1962, nor the 'Rules' therewith, contain any provisions mandating conservation and protection of environment. For that matter, even the Environment Protection Act of 1986 and the rules under it do not have any special regulations for nuclear power plants and their impact on the environment. With an SEIA document in place, the studies which will precede the final SEIA report will highlight this issue, making it easier to inculcate amendments and additions in a timely fashion.

**iii. Increasing stakeholder and public participation in the development of civil nuclear facilities:**

It is inherent in SEIA's principles to have a major focus on the engagement of relevant stakeholders and incorporate input from the public; especially those which will be primarily affected by the sector. The current EIA regime is riddled with this discrepancy. Public participation is suboptimal and the relevant stakeholders' opinions are not considered. This has further been elaborated and described by renowned physicist M V Ramana in various articulations.[20] He has written extensively about the inadequacies in the public hearing methods in India concerning nuclear plants. Even the public participation and public hearing documents and video recordings—which are mandatory to be stored and uploaded by the concerned State's Pollution Control Board website—are not maintained.

In India, only the project affected people and no others are identified as stakeholders. Roles of the vendors for the nuclear power plants, the CPCB in monitoring safety in release of toxicity, the involvement of the groundwater authority, and the like are presently not recognized. Their inclusion would greatly benefit environmental safety in the long run. Such detailed stakeholder engagement at the PPP stage would enable the 'Make in India' narrative in the nuclear energy sector; the current state of which is seeing a stunted and stalled growth because of undue delays in construction work. If the Indian

18 M P Ram Mohan, Kd Raju, & M V Shiju, '*A Nuclear Liability Framework for South Asia: Formation of South Asia Association for Regional Cooperation (SAARC) Nuclear Risk Community*' (2013) International Journal of Nuclear Law

19 ibid

20 M V Ramana, Divya Badami Rao, '*The environmental impact assessment process for nuclear facilities: An examination of the Indian experience*', Environmental Impact Assessment Review, Volume 30, Issue 4, (2010). pp 268–271. ISSN 0195-9255

vendors, that are currently supplying to the Nuclear Power Corporation of India (NPCIL), are invited to help in the planning and policy-making, their engagement during this initial stage would enable in the identification of lacunae which exist, along with the challenges that can arise in the future. This can help in avoiding unprecedented delays in the stalled projects. Others, too, have reiterated the importance of active and strengthened public participation in the development of nuclear energy.[21]

Another legally distressing fact about the atomic energy sector is the legally binding mechanism. In India, legally binding mechanism for environmental risk consideration is a prior environmental clearance, as per the Environment Protection Rules and the EIA Notification of 2006. The Atomic Energy Act of 1962 makes the impression of an outdated and obsolete law for the current nuclear sector, as there is no accommodation for engaging stakeholders as participants in the process of the power generation. There is lack of public participation in an institutionalized fashion, which ideally should be through an independent legislation—which would be compulsory in the long run for the authorities to comply with at all stages.

In the United States of America for instance, the US NRC has made rules of practice for domestic licensing proceedings and issuance of orders that govern almost all proceedings and public hearings under the Atomic Energy Act and the Energy Reorganisation Act. There is even a different Act for rulemaking under the Atomic Energy Act, for the grant, suspension, revocation, amendment, among others with respect to a licence towards making construction permits, and application to transfer the licence as well.

21 L D Mlynarkiewicz, *'Public Awareness and Stakeholder Engagement in India's Nuclear Energy Regulatory Process',* International Journal of Nuclear Law Volume 4, Issue 1 (2013).

Taking this as a best practice model, the Indian law-makers and policy directors must establish a similar procedure.

## Conclusion

The Government of India has made it a priority to meet the Paris Agreement's emission standards. Numerous ambitious goals have been established since 2015 and India has achieved 21% of its pledge to reduce emissions by 33–35%. A majority of the clean energy is provided by solar energy; India intends to aggressively introduce non-conventional power of 175 gigawatts (GW) by 2022 and 450 GW by 2030. India currently has 90 GW of non-conventional power, or 24% of the total aim that has been set. In addition, India has one of the lowest solar power taxes in the world, at INR 2.36 (USD 0.0316)/kWh, and the warm limit has decreased from 70% in 2015 to 61% in 2020[22]. At the public level, the India Cooling Action Plan and progress on building productive structures and cool roofs at the state level are also driving efforts to reduce heat-absorbing hydrofluorocarbons (HFCs) and save energy.

As promising as this sounds, the nuclear energy sector's contribution has been below par, despite the Department of Atomic Energy's efforts to support the nation's plan to increase its energy mix. There has been an unprecedented amount of delay in the construction of ten new nuclear power plants, despite budgetary announcements for them in 2017–18[23]. The Indian Liability Act of 2010's non-compliance with international standards for channelling liability and, most importantly, the lack of communication between the public and the government have been the primary contributors to the problem. These factors include a lack of agreement among the partner nations regarding liability issues, a lack of confidence in the law, and a general lack of trust. Moreover, there is concern regarding the nuclear reactors' effects on the surrounding environment and the health of the people involved.

As a result, nuclear energy remains an underutilized power source that, when utilized, can guarantee energy security—not only for this generation, but also for future generations. While solar energy is a good source of energy, it cannot become the primary source of electricity for the grid's upkeep. A good backup or substitute is essential. For the nation to run it needs a reliable, green, and low-carbon source of electricity. Nuclear energy can be that source. The United Kingdom can be seen as an example of this, where all the coal-fired power plants were shut down in June 2020, leaving the country to rely solely on clean energy for two months. The proportion of nuclear energy in UK's mix was 17%[24].

India's aim to achieve energy security must take into account environmental concerns, energy production, and economic and social factors (3E). SEIA appears to be a tailored, individualized, and sustainable approach of achieving this goal. EF

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22 Anjali Jaiswal and Madhura Joshi, '*Climate Action: All Eyes on India*' (NRDC, December 2020). www.nrdc.org/experts/anjali-jaiswal/climate-action-all-eyes india#:~:text=First%2C%20India%20has%20already%20reduced,33%2D35%25%20by%202030.&text=On%20the%20domestic%20front%2C%20India,and%20450%20GW%20by%202030, Accessed: 1 January 2021.

23 Niharika Tagotra, '*India's Ambitious Nuclear Power Plan And What's Getting in its Way'* (The Diplomat, 9 September 2020) <https://thediplomat.com/2020/09/indias-ambitious-nuclear-power-plan-and-whats-getting-in-its-way/, Accessed: 30 September 2020

24 Katie Pavid, '*Britain goes two months without burning coal amid lockdown*' NEWS (15 June 2020) www.nhm.ac.uk/discover/news/2020/june/britain-goes-two-months-without-burning-coal.html, Accessed: 1 August 2020.

# ENERGY SECURITY GOALS AND CLIMATE CONCERNS IN INDIA

## Driving towards a green regime

India is a rapidly developing economy, facing increasing energy demands due to its growing population and expanding industrial sector. **Dr Mirza Juned Beg** and **Mohd Sufiyan Khan**, in this article, present an overview of the Indian energy scenario, underscoring the importance of achieving a balance between energy security and climate concern.

### Introduction

Energy security goals refer to the objectives that a country or organization aims to achieve, in order to ensure its access to sufficient, reliable, and affordable energy supplies. Energy security goals and climate concern are often intertwined, as both are important factors in ensuring sustainable and reliable energy sources.

Energy security goals aim to ensure that a country has a stable and uninterrupted supply of energy to meet its needs. This includes diversifying sources of energy, reducing dependence on a single source or supplier, and investing in infrastructure to improve efficiency and reliability. Climate concern, on the other hand, focuses on reducing greenhouse gas emissions to mitigate the effects of climate change. This includes shifting to cleaner energy sources such as renewable energy and reducing reliance on fossil fuels, which are major contributors to greenhouse gas emissions.

Many countries are recognizing the importance of both energy security and climate concern and are making efforts to balance their goals in these areas. For example, some countries are investing in renewable energy sources, such as solar and wind power, to reduce their dependence on fossil fuels while also increasing their energy security. Others are promoting energy efficiency measures to reduce energy consumption and emissions—simultaneously improving their energy security goals.

Ultimately, achieving a balance between energy security and climate concern will require a concerted effort from governments, businesses, and individuals. It will require innovative solutions that promote sustainable and reliable energy sources and also reduce

greenhouse gas emissions to combat climate change.

India is a rapidly developing economy that is facing increasing energy demands due to its growing population and expanding industrial sector. To achieve sustainable development, the country needs to balance its energy security with climate concerns. India's energy security goals are primarily focused on increasing access to electricity and reducing dependence on imported oil. It has set a target of achieving 24x7 electricity access for all households by 2022, and this requires significant expansion of the power sector. To achieve these goals, India has significantly increased its renewable energy capacity in recent years; with a target of achieving 175 GW of renewable energy capacity by 2022, of which 100 GW will be solar, 60 GW wind, 10 GW biomass, and 5 GW small hydro. This will help reduce the dependence on fossil fuels and improve energy security.

However, India is highly vulnerable to the impacts of climate change, including increased frequency and severity of extreme weather events, sea-level rise, and water scarcity. To mitigate the impact of climate change, India has set a target of reducing greenhouse gas emissions intensity by 33–35% by 2030, compared to 2005 levels. The country has also launched several initiatives to promote renewable energy and energy efficiency. The Indian government offers various incentives and subsidies to encourage the adoption of rooftop solar panels, solar water-heaters, and LED lights. The government has also mandated energy efficiency labelling for appliances and established the National Mission for Enhanced Energy Efficiency (NMEEE) to promote energy efficiency in industries, buildings, and agriculture.

Despite these efforts, India is still heavily dependent on fossil fuels, primarily coal which accounts for around 70% of electricity generation. The continued use of coal is a significant contributor to India's greenhouse gas emissions. Moreover, India's coal reserves are concentrated in ecologically sensitive regions and contribute to air pollution and adversely impact health.

## *Energy security goals and climate concern in India*

India has set several energy security goals to ensure access to reliable, affordable, and sustainable energy for its growing population. Some of the key energy security goals are:

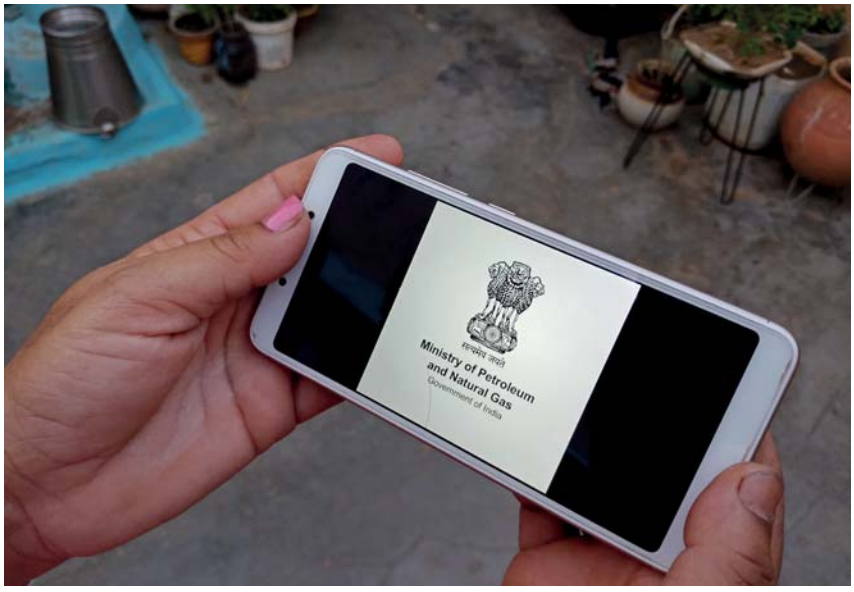
1. *Diversification of energy sources*: India aims to diversify its energy mix by increasing the share of renewable energy sources such as solar, wind, hydro, and bioenergy. The government has set a target to achieve 175 GW of renewable energy capacity by 2022.
2. *Enhancing energy efficiency*: India aims to improve energy efficiency across sectors through various measures such as energy-efficient appliances, building codes, and industrial processes. The government has set a target to reduce energy intensity by 33–35% by 2030.
3. *Increasing domestic production*: India aims to reduce its dependence on imported energy by increasing domestic production of oil and gas. The government has launched various initiatives like the Hydrocarbon Exploration and Licensing policy, 2019 and the Natural Gas Marketing Reforms, 2020 to promote exploration and production of oil and gas reserves in the country.
4. *Strengthening energy infrastructure*: India aims to enhance energy infrastructure by expanding the pipeline network, building new power plants, and improving transmission and distribution networks. The government had set a target to provide electricity to all households by 2022, under flagship programs of the Pradhan Mantri Sahaj Bijli Har Ghar Yojna, or the Saubhagya Yojna.
5. *Promoting energy security diplomacy*: India aims to secure its energy supplies through diplomatic engagement with other countries. The government has entered into various energy security agreements with countries such as the US, Russia, and Japan. For instance, ONGC Videsh and the Russian company Rosneft have partnered in various exploration projects. Another successful example of promoting energy security diplomacy is Japan and India's clean energy partnership, where both the countries target to reduce carbon emissions. India targets to achieve net zero by the year 2070, while Japan aims to fulfil the same by 2050.

6. *Energy storage*: Investing in energy storage technologies, such as batteries and pumped hydro storage can help ensure a reliable energy supply during periods of high demand or supply disruptions. India has already made some strides in this regard, like the India One Solar Thermal Energy Storage System situated in Rajasthan, which was commissioned in the year 2017. Similarly, the Makkuva Solar PV Park, which adopts the technology of energy storage via lithium ion, was announced in the year 2017 and the same will be commissioned in the year 2024.
7. *Disaster preparedness*: Developing contingency plans and emergency response measures to address energy supply disruptions, such as natural disasters, geopolitical conflicts, or cyber-attacks, can enhance a country's energy security.

### *Need for energy security goals*

Energy security is crucial for India owing to several reasons:

1. *Sustaining economic growth:* As India's economy continues to grow, the demand for energy is also increasing. Energy security is critical to support this growth and ensure a stable energy supply for various economic activities.
2. *Meeting the energy needs of the population:* India's population is set to surpass China's by 2027, and the increasing population will require a significant amount of energy to meet its needs. Energy security is essential for ensuring that the country has access to reliable, affordable, and sustainable energy to meet the demands of its citizens.
3. *Reducing dependence on imported energy:* India is heavily dependent on imported oil and gas, which accounts for a considerable portion of its energy needs. Energy security is essential to reduce this dependence and secure the country's energy supply through domestic production and diversification of energy sources.




4. *Reducing the impact of energy price volatility:* Energy price volatility can have a significant impact on India's economy. Energy security is critical to reduce this impact by ensuring stable energy prices and reducing the vulnerability of the economy to global energy market fluctuations.
5. *Improving energy access and affordability:* India has a large population that still lacks access to electricity and modern energy services. Energy security is essential to address this issue, by ensuring that energy is accessible and affordable to all segments of society.

## International Legal Norms

There are several international conventions and treaties that aim to address energy security goals and mitigate climate change. Some of these include:

1. *United Nations Framework Convention on Climate Change (UNFCCC):* The UNFCCC is a convention signed in 1992 that aims to stabilize greenhouse gas concentrations in the atmosphere to prevent dangerous anthropogenic interference with the climate system. The Paris Agreement, which was signed in 2015, is an extension of the UNFCCC and aims to limit global temperature rise to below 2°C above pre-industrial levels.
2. *International Energy Agency (IEA)*: The IEA is an intergovernmental organization that was established in 1974 to promote energy security and sustainable energy policies. The IEA works with its member countries to coordinate energy policies, share best practices, and provide analysis and advice on energy issues.
3. *Energy Charter Treaty (ECT)*: The ECT is a multilateral treaty signed in 1994 that aims to promote cooperation and investment in the energy sector in Europe and beyond. The ECT establishes a legal framework for energy transit, trade, and investment, and includes provisions for dispute resolution.
4. *Kyoto Protocol*: The Kyoto Protocol is an international treaty that was signed in 1997 and aimed to reduce greenhouse gas emissions. The treaty sets binding targets for developed countries to reduce their emissions by a certain percentage below 1990 levels.
5. *United Nations Sustainable Development Goals (SDGs):* The SDGs are a set of 17 goals adopted in 2015 by UN member states to promote

sustainable development, including access to affordable and clean energy. SDG 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030.

## Indian Legal Norms and Policies

India has a legal regime in place to address energy security goals. Some of the key laws and policies include:

1. *The Electricity Act, 2003:* The Electricity Act is a comprehensive legislation that aims to promote competition, efficiency, and transparency in the electricity sector. The act provides a framework for the development of renewable energy sources, promotes energy conservation, and ensures the provision of reliable and quality power supply.
2. *National Action Plan on Climate Change (NAPCC):* The NAPCC, launched in 2008, is a comprehensive plan aimed at addressing climate change and promoting sustainable development. The plan includes eight missions, including the National Solar Mission, which aims to promote the development and use of solar energy, and the National Mission for Enhanced Energy Efficiency, which aims to improve energy efficiency across sectors.
3. *The Energy Conservation Act, 2001*: The Energy Conservation Act aims to promote energy efficiency and conservation by setting energy efficiency standards for equipment, appliances, and buildings. The act also provides for the creation of a Bureau of Energy Efficiency (BEE), which is responsible for implementing energy efficiency programs and policies.
4. *Policy for Development of Renewable Energy for Power Generation, 2015:* This policy aims to promote the development of renewable energy sources—including solar, wind, biomass, and small hydro—for power generation. The policy provides incentives for renewable energy projects and aims to achieve a cumulative renewable energy capacity of 175 GW by 2022.
5. *Petroleum and Natural Gas Regulatory Board Act, 2006:* This act provides for the establishment of the Petroleum and Natural Gas Regulatory Board (PNGRB), which is responsible for regulating the refining, processing, storage, transportation, distribution, marketing, and sale of petroleum products and natural gas in India.
6. *National Biofuel Policy, 2018:* This policy aims to promote the use of biofuels (including ethanol, biodiesel, and bio-CNG) as a substitute for fossil fuels. The policy provides for the setting of targets for biofuel blending, the promotion of research and development in the biofuel sector, and the creation of a biofuel fund.


### *Role of higher judiciary in ensuring energy security*

Indian judiciary has played an important role in ensuring energy security and addressing related issues. Of the notable cases decided by the courts related to energy security goals, *Renewable Energy Certificates (RECs) Case (2010)*, is a prime example of how the Supreme Court of India upheld the legal validity of RECs under the Electricity Act, 2003. RECs are tradable certificates that represent the environmental benefits of renewable energy generation, such as reduced greenhouse gas emissions. The court's decision helped to promote renewable energy development in India by providing market-based incentives for renewable energy producers.

Another example is the *Vedanta Resources Case (2013)*, where the Supreme Court of India cancelled the environmental clearances for a bauxite mining project proposed by Vedanta Resources in Odisha. The court found that the project would have a significantly adverse impact on the environment, particularly air and water pollution. The decision highlighted the importance of environmental protection in ensuring sustainable development and energy security.

In the *Delhi Air Pollution Case (2016)*, the National Green Tribunal (NGT) issued several orders to address the air pollution crisis in Delhi, including banning the use of diesel generators, regulating the use of firecrackers during festivals, and implementing measures to control vehicular emissions. The NGT's

decisions emphasized the importance of clean air for public health and well-being and underscored the need to promote sustainable energy sources to reduce air pollution.

In the *Tata Mundra Ultra Mega Power Plant Case (2017)*, the Gujarat High Court upheld a complaint filed by local fishermen against the Tata Mundra Ultra Mega Power Plant, which alleged that the project had caused significant damage to the environment and livelihoods of local communities. The court ordered the project to be subjected to an environmental impact assessment and required the project proponent to compensate the affected communities. The case highlighted the importance of balancing energy development with environmental and social concerns.

These and other legal cases have contributed to the development of India's legal framework for energy security and underscored the importance of balancing energy security goals with social and environmental concerns.

### *Future impact of energy security goals*

Energy security is critical for economic growth, social development, and environmental sustainability. As countries look towards a sustainable future, energy security will play an increasingly important role in shaping energy policies and investments. Here are some of the impacts of energy security on the future—

1. *Increased adoption of renewable energy:* Energy security concerns, coupled with the need to mitigate greenhouse gas emissions, will drive the adoption of renewable energy sources such as solar, wind, hydro, and geothermal, even further. This will help India in diversifying the energy mix and reducing its dependence on fossil fuels, in turn enhancing energy security and promoting sustainable development.
2. *Energy efficiency and conservation:* Energy efficiency and conservation measures, such as building insulation, energy-efficient appliances, and LED lighting, can reduce energy demand. With the rise of smart grids and digital technologies, consumers and businesses will have more control over their energy use, allowing for more efficient and cost-effective energy management.
3. *Energy storage and grid modernization:* Energy storage technologies such as batteries, pumped hydro, and hydrogen fuel cells will become increasingly important as intermittent renewable energy sources become more prevalent. Modernizing the grid will also be essential to ensure reliable and resilient energy supply: including incorporating distributed energy resources such as rooftop solar and smart grids.
4. *Geopolitical impacts:* Energy security is intrinsically linked to geopolitical considerations, as countries rely on each other's energy resources for economic and political stability. Future energy policies and investments will need to balance domestic energy needs with international energy trade to ensure long-term energy security.
5. *Economic opportunities:* The transition to a low-carbon and sustainable energy system will create new economic opportunities, such as job creation in the renewable energy industry, development of energy-efficient technologies and infrastructure, and innovation in energy storage and grid modernization. Investing in energy security will help to drive economic growth and competitiveness, while promoting sustainability and resilience.

## Conclusion

It may be concluded that India's energy security goals and climate concerns are closely intertwined, and both need to be addressed to achieve sustainable development. While India has made significant progress in increasing renewable energy capacity and promoting energy efficiency, there is a need for greater efforts to reduce the dependence on fossil fuels and address air pollution. India needs to focus on a low-carbon energy system that is environmentally sustainable and socially inclusive. EF

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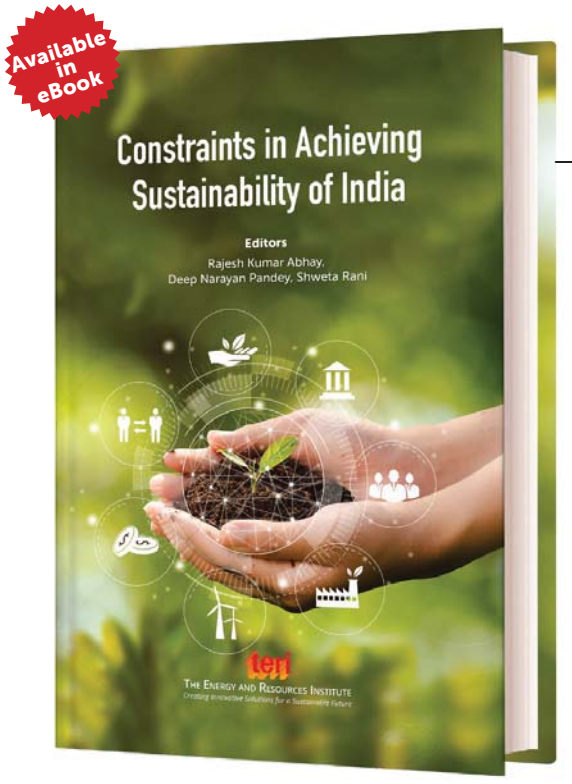
# Study of the challenges to sustainable development via scientific means

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- Sway of Indian Cinema in Diffusing Environmental Sentience
- Poverty Lines and Poor in India
- Sanitation Workers and Associated Problems for the Sustainability of Religious Events
- Assessment of Basic Infrastructure Development and Associated Issues in India

ISBN: 9789394657120 • Price: ₹550.00

Purpose of the book is to develop, contribute, and disseminate scientific knowledge pertaining to the issues related to sustainable development. The chapters are developed so that the contents can facilitate comprehension of the major constraints in achieving sustainability including but not limited to environmental, social, economic, and governance-related issues from local, regional, to national level. Resource management, climate change, agriculture, population, education, women, poverty, infrastructure, crime, corruption, governance, are the other relevant topics that have been both identified and suitably discussed. *Constraints in Achieving Sustainability of India* can be utilized as a guiding tool for realizing sustainability in development, especially, in the Indian context.

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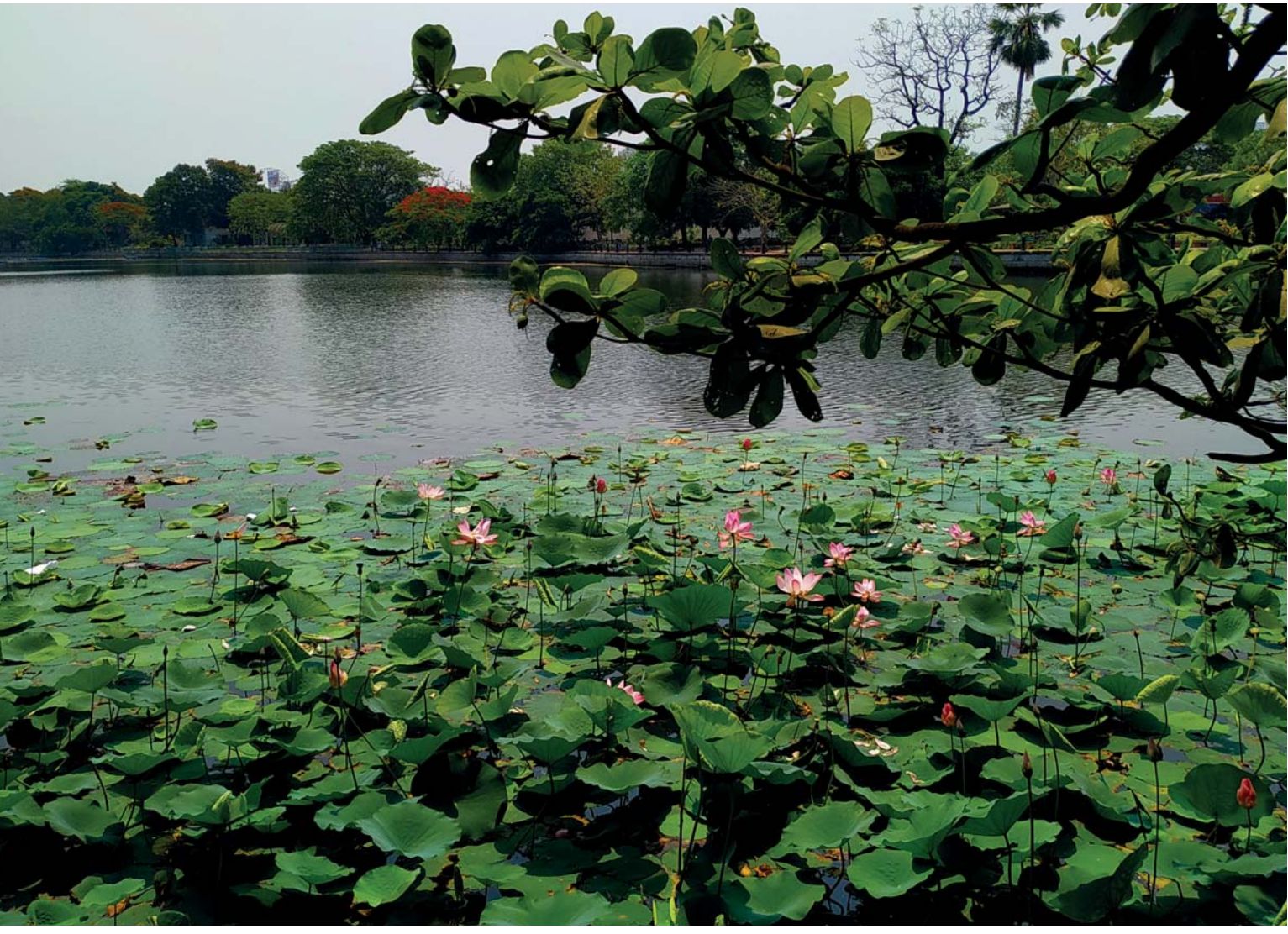

# CHANGING DYNAMICS OF BLUE AND GREEN CONSERVATION IN GLOBAL SOUTH: KOLKATA

In this article, **Dipanwita Ghosh** sheds light on the significance of water and vegetation, especially, in the urban areas where there is paucity of space and resources. The text has been authenticated with a case study on Kolkata, outlining limitations and future plans for conserving the blue and green of the city.

Blue conservation can be defined as a means to achieve water security in order to mitigate the water crisis, while green conservation focuses on vegetation security to develop the balance between nature and human-made world. Urban areas are an apt example of human-made development, where most of the structures are made on artificial basis. These artificial developments mostly consume natural blue and green structure that brings the crisis of the sustainability. Therefore, there is a high conflict between the blue and green conservation and urban construction development. Different techniques are being developed to deal with the issues pertaining to blue and green conservation. In this regard, the issues of conservation appear due to the space limitation in the urban areas. Most of the space is occupied for strengthening the economic sector, hence space for nature is limiting. However, the awareness and concern for nature is increasing, especially in the urban areas of the developed countries, which are investing in developing new technological innovations in the blue and green conservation. In this regard, through the technological enhancements, the dynamics pertaining to blue and green conservation are changing. Therefore, due to the limitation of space in the urban areas, the new technological sustainability execution strategies are occurring.

### *Objectives*

- To access blue and green conservation techniques
- To evaluate of blue and green techniques of Kolkata
- To rectify current status of blue and green conservation of Kolkata

## Traditional Blue Conservation Techniques

There are traditional ways to save the water in the urban areas. Examples include turning off the tap after the use of water, taking shorter time for shower, and reducing the tap mouth to minimize the unnecessary flow of water. Reduction of waste discharge from the industries to the river and the execution of large refiners for chemical wastes refining before adding to the river water are other viable solutions. Additionally, harvesting rainwater via the old process and reducing wastage of water on a regular basis are not enough for saving the water as freshwater availability is reducing day by day.

## Traditional Green Conservation Techniques

Green conservation techniques like plantation, developing green space, and canopy formation, are the most traditional ideas, also gradually undergoing modification, notably in the urban areas. Additionally, establishment of rural and urban linkages to reduce transport use, followed by decrement in fuel usage is on a continuous rise to increase the oxygen rate from the urban environment. However, concerning the green conservation in the urban areas, all these monotonous strategies are time consuming and tend to fail in successful execution.

### *Challenges of the traditional blue and green conservation*

A major limitation in the traditional blue and green conservation is: it takes time in successful execution. Regarding this, monotony of sustainability techniques reduces the enthusiasm for the blue and green conservation of the urban population. On the other hand, to lessen the space, most of the sustainable-based strategies are not able to get implemented. The strategy of green space development is not enough to mitigate the pollution and intensity of the heat island, as the quality of the green space is limited. In addition to this, use of rainwater harvesting and technologies of refining of the chemicals of the industries before adding to the river water are not able to deal with the water pollution appropriately. One of the significant drawbacks of these sustainable strategies is the lagging of awareness and technological modification. Poor systematic modification is also a part of the challenges of the blue and green conservation. Infrastructural lagging and the lack of restrictions are interlinked with the systematic issues of an urban area. Besides that, financial instability and education are mutually linked with lagging of the application

of traditional strategies to execute blue and green conservation. Challenges associated with blue and green conservation are shown graphically in Figure 1.

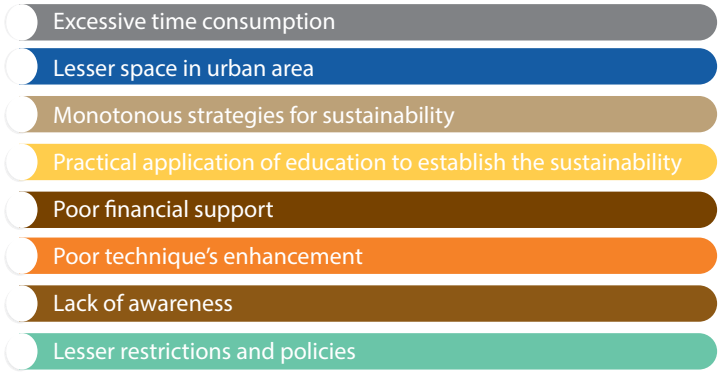


**Figure 1:** Challenges of the blue and green conservation

## Modern Techniques to Execute Blue and Green Conservation

Blue conservation defines recycle and reuse strategies of the used water which limits the use of freshwater. In the developed nations, used water is recycled and used multiple times, even for drinking purposes. In this regard, different viable technologies have been developed for effective realization of water conservation. Brief analysis of water recycling and conserving process is given in Figure 2.

## Blue Conservation

### *Recycling system of greywater*

In the construction sector, instead of using clean and freshwater, use of sewage water and impure water has emerged as a viable strategy for blue conservation. The fundamental motive of the practice is to conserve freshwater by limiting the use of it. Concerning this, in order to reuse the greywater the division of light and dark greywater is essential (Soong *et al*. 2021). Light greywater contains lesser pollutants while the dark greywater has higher pollutants and can be used in the construction sector.

### *Rainwater harvesting*

Rainwater harvesting with automated techniques like electrical linkages with the water shortage tank to the domestic appliance boosts rainwater usage. Concerning this, rainwater harvesting in large quantity, in a particular region, impacts negatively, as the practice hinders the natural ecology.

### *Smart irrigation system*

In urban areas, to maintain the green lawns, sprinkling water irrigation system is essential. Utilization of smart water controller system helps to measure the temperature, as well as moisture of the atmosphere and ground. Based on this information, water is irrigated to the plants. This practice reduces overwatering because water is sprinkled by the drip irrigation system. This leads to reduction in water consumption. In the long run, this smart irrigation system is advantageous in effective realization of blue conservation.

### *Use of water meters*

Use of water meter is counted amongst the modern and common techniques that could save extra water.These water meters track use of water and balance the water consumption for every apartment of a locality.

### *Reduction of valves pressure*

It has been observed that due to high speed and pressure of water, an ample Amount of water gets wasted. Therefore, the reduction of pressure in the water valve conserves water for longer use. In the modern age, this strategy is implemented in domestic, institutional, and commercial purposes.

### *Insulated pipes*

Insulated pipes hold a particular temperature of water for a long time, whereas non-insulated pipes normalize the temperature of water as per the surrounding atmosphere. The use of insulated pipes in high-rise buildings

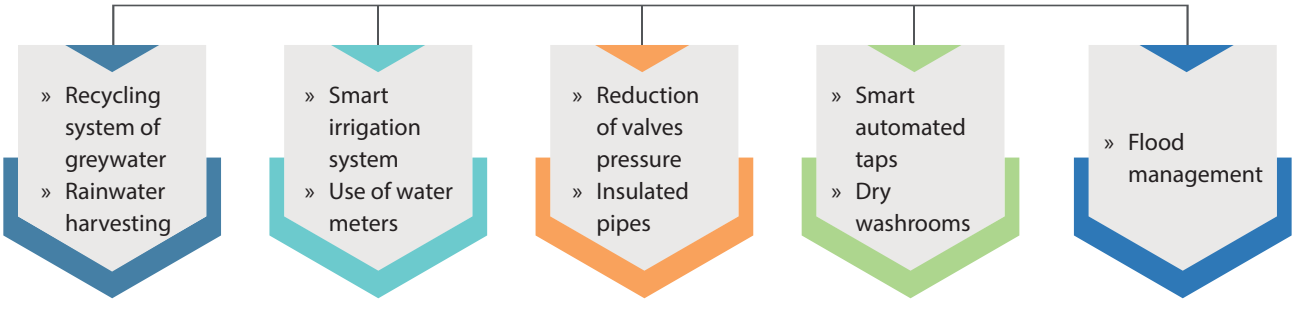


**Figure 2:** Process of blue conservation

establishes sufficient and immediate hot water service as it maintains the temperature of water. In normal pipes, due to non-insulation, electricity is required to heat the water again. Even the existing water in the pipe is not of the desired temperature as the water gets wasted at the end of building inhabitants. Therefore, use of insulated pipes reduces energy consumption and saves wastage of the cold water.

### *Smart automated taps*

The sensor technology in the taps is a smart technology for water saving. In the commercial sector, the wastage of water mostly occurs due the lack of restrictions and awareness, as water taps are left opened. At many times, water leaks happen from the mouth of the water tap. Therefore, automation techniques like the sensors save maximum water.

### *Dry washrooms*

Water used in washrooms is hard to reuse for other purposes because of being unfit for living beings. Regarding this, the concept of waterless urinals is appearing fast with the no-flushing system in the washrooms. The effective strategy reduces the contamination of harmful bacteria. Additionally, to execute the waterless washrooms, disposable cartridge and system of plumbing drain is essential.

### *Flood management*

Establishment of modern technologies forms the external methods to save water, however, to execute the conservation internally the control of natural disasters like flood is significant.

As a consequence of flood, significant greywater accumulates in regions that contaminates the sources of freshwater and spreads dieses. Therefore, the preplanning of infrastructure for dealing with flooding is the crucial way to conserve blue as well as green infrastructure.

### *Population control*

Population control is both directly and indirectly related to water conservation. A vast amount of population uses plenty of water, which can be reduced my limiting the population. Furthermore, reduction of population in a water-less region is essential, for the well being of every citizen.

From the discussion and relevant examples, it can be established that, recycling of water is taking place highly in the developed region. Additionally, the awareness of water conservation is also taking place gradually in the developing nations like India.

## Green Conservation

Green conservation defines the support and awareness to secure the vegetation and plants to balance the ratio of oxygen in environment. Green conservation is emerging with different technologies and forms a part of the developed nation's urban area discussed in the ensuing section (see Figure 3).

### *Electric transport*

The fundamental aim of using an electric vehicle (EV) is to reduce the use of non-renewable resources, effectively to curb air pollution. The associated initiatives (directly or indirectly) impact the development of green infrastructure in the urban areas. Owing to the high air population, green vegetables and forests are facing threats which could be only restored by the extensive use of EVs.

### *Self-sufficient residence*

The high urban buildings are being constructed to assure self-sufficiency.


**Figure 3:** Processes of green conservation

The strategy limits horizontal expansion, which supports the growth of the green infrastructure. Additionally, a self-sufficient high-rise building is constructed with green spaces, like green roof, vertical gardening, and many more.

### *Low-carbon construction*

In an urban area the uses of ecofriendly materials rather than coal-based products are relatively environmentally benign. A low-carbon construction implies lesser investments and works towards planet's well-being. The strategy helps to reduce carbon emissions and effectively deals with global warming.

### *Vertical farming*

Vertical farming produces food and also establishes a balance with nature, especially in the urban areas. The technology of vertical farming requires less space apart from serving as a good source of oxygen. Additionally, a vertical garden uses fewer amounts of natural resources which saves money and environment. Vertical farming could be established by using the hydroponic method which is largely water dependent.

### *Urban agriculture*

Utilization of waste materials and use in peri-urban area in agriculture is a remarkable strategy. Additionally, urban agriculture supports green infrastructure and generates job opportunities in the urban area. The consumption of organic food increases due the urban agriculture which benefits health and well-being of the urban areas.

### *Rooftop gardening*

A man-made garden on the top of a building roof is called a rooftop garden. The strategy has positive associations with green sustainability and contributes towards limiting carbon emission in the urban area. Additionally, the technology naturally cools the concrete building which otherwise would require an electricity-run cooling solution.

### *Plantation for beautification*

In urban areas, usage of numerous plants for beautification enhances the scenic beauty of a city and supports sustainability. In this regard, plantations in highways, vertically in the high-rise buildings, and in the open spaces complements green infrastructure, especially in the developed nations.

## Evaluation of Blue and Green Techniques of Kolkata

In Kolkata, there are 138 species of trees, 26 types of Chinese vegetables and 33 types of medicinal plants in all over 144 wards (Times of India 2022). As per People's Biodiversity Register (PBR), Kolkata is the first metro city where theses many types of plants are available. On the contrary, Kolkata is declining green cover, and the city is taking best action to maintain at least 7 acres of green cover in the urban sprawls to mitigate the issue (Basu, Basu, Barbosa, *et al.* 2022).

However, the blue conservation is terrible in Kolkata—where 211 freshwater sources are facing massive contamination (Times of India 2022). Additionally, water scarcity is arising in south and eastern parts of the city. In Kolkata, the groundwater level has declined from 7 to 11 metres during 1998–2003 period (Majumdar 2021).

Additionally, in every monsoon the city faces massive waterlogging due to the poor drainage system which also reflects in lagging of water services in the city. The huge waterlogging also contaminates freshwater and, therefore, the slum dwellers are the worst sufferers of it. There are different challenges of blue conservation in Kolkata, like unequal distribution of water in urban area. Facilities of freshwater are mostly accessed by the high-standard population rather the slum counterpart. Additionally, due to limited awareness on the legal acts, the green cover areas are often cleaned without any scientific basis. Therefore, the ratio of destruction of blue and green, actions taken, and technologies for recycling the water and vegetation are not in a balance in Kolkata. In the city, there has been a noticeable increase in the count of high-rise buildings and new technologies are arising. However, this has not been able to fill the void of natural green cover due the restrictions and limited human awareness. However, in the present day, some of new initiatives are being taken by the city authority, discussed in the next section.

## Current statues of blue and green conservation of Kolkata

In this context, the New Town Kolkata Development Authority (NKDA) project has been established in Kolkata to ensure planned development that also includes water recycling. The purpose of the project is reusing the wastewater which will secure 25% of water from daily usages of freshwater in Kolkata. Additionally, in the next five years, the pilot project will take initiatives to secure the issues of drinking water. The primary aim of the project is to limit water leakage within next five years (smartcitycouncil.com 2023). Wastewater management in Kolkata has been initiated in the east Kolkata wetland region after inclusion in Ramsar sites in 2022. The main purpose of the conservation is to reduce the sewage and garbage dumping in the region to secure the ecological balance. Additionally, Unitech Water Technologies (UWT) consists of three major water recycling plants—sewage treatment plant (STP), effluent treatment plant (ETP), water treatment plant (WTP). The principal aim of the process is to reduce water contamination, to execute recycling of wastewater, to secure drinking water sources (Unitech Water 2023).

In the context of green conservation in Kolkata, 1000 plants were planted in Newtown area which is considering contemporary green revolution as part of NKDA planning authority (Times of India 2022). Besides that, in West Bengal Tree Act 2007 came into being and the plan was restructured in 2007 where urban beatification with plants,

green parks, and tress, was mentioned. Additionally, rules and restrictions were set to deal with ethical removal of trees (westbengalforest.gov.in 2007). Another tree plantation project was initiated in 2018 by KMDA, KMC, NKDA, PWD, corporate house, and others in Kolkata. In this project 10,000 trees were planted in Maidan, Rabindra Sarobar Park, and other parks of Kolkata (ccckolkata.org 2018). Furthermore, for beautification NKDA is using ecofriendly products like, bamboo fencing, and different plants like palm tree, fox tail, Mexican grass, bakul tree, kamini hedges are also utilized. Axis Mall, Rupashree Complex, and in other parts of the city, the planning is taking place by NKDA (nkdamar.org 2022).

## Conclusion

Blue and green conservation is essential for urban sustainability which is also modernization. The old process of recycling and reuse of water and the monotonous process for vegetation conservation in urban area needs reconstruction. The different new processes of blue and green conservations are established in the study and the objectives are fulfilled. In Kolkata, different organizations are taking effective actions for the blue and green conservation which may enhance the pathway of sustainability in future. EF

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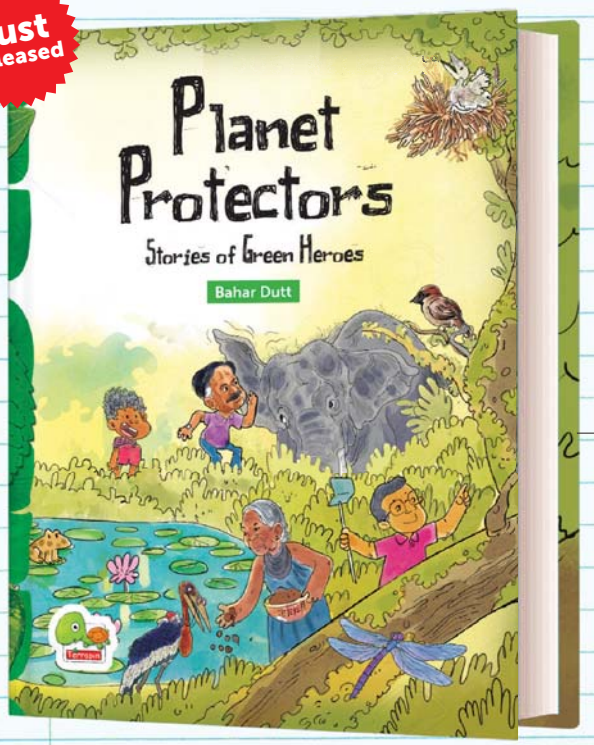


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# RENEWABLE ENERGY INTEGRATION IN INDIA

## Challenges, policies, and success factors

Examining the current state of renewable energy deployment and analyzing existing policies and frameworks, in this article **Dr M Jayanthi** and **Dr S Saravanakumar** shed light on the opportunities and barriers faced by India in achieving a sustainable energy future.


## Introduction

Renewable energy integration has emerged as a crucial aspect of sustainable development goals of India, as the country strives to meet its energy demands while mitigating environmental impacts and reducing carbon emissions. India's energy landscape has witnessed a notable shift towards renewable sources, such as solar, wind, biomass, and hydropower, in recent years. This transition is driven by the recognition of renewable energy's potential to enhance energy security, reduce dependence on fossil fuels, and foster economic growth. However, the successful integration of renewable energy into India's energy mix is not without its challenges.

As the government and stakeholders pursue ambitious renewable energy targets, they encounter a myriad of technical, financial, regulatory, and social complexities. These challenges demand a comprehensive understanding of the policies, regulations, and factors that

influence the effective integration of renewables. The article seeks to delve into the challenges, policies, and success factors of renewable energy integration in India.

Examining the current state of renewable energy deployment and analyzing existing policies and frameworks, this article aims to shed light on the opportunities and barriers faced by India in achieving a sustainable energy future. The primary challenges lie in the intermittent nature of renewable energy sources, particularly solar and wind power. Integrating these variable sources into the grid requires robust grid management, energy storage solutions, and demand-side management strategies to ensure a stable and reliable power supply. Moreover, the geographical dispersion of renewable resources across the country necessitates the development of smart and flexible grid infrastructure, to enable efficient power transmission and distribution.

Another critical aspect that demands attention is the financial viability of renewable energy projects. The high upfront costs associated with setting up renewable energy infrastructure can deter investment, despite the potential for long-term cost savings and environmental benefits. Therefore, understanding the financial mechanisms, incentives, and subsidies that support renewable energy deployment is essential to attract private sector investment and foster growth in the sector. In addition to technical and financial challenges, policy and regulatory frameworks play a pivotal role in shaping the renewable energy landscape.

India has introduced several progressive policies, and various state-level initiatives to promote renewable energy adoption. This study will assess the effectiveness of these policies, types of energy, challenges, and success factors towards renewable energy integration in India. Learning from real-world case studies and

experiences can provide valuable insights into replicable models and strategies that can be adapted and scaled up across the country.

## *Types of renewable energy sources*

India is blessed with diverse geographical features and abundant natural resources, which make it suitable for harnessing various types of renewable energy sources. As part of its sustainable energy strategy, India is actively utilizing and exploring several renewable energy sources. The types of renewable energy sources in India:

- *Solar Energy:* Solar energy is one of the most abundant renewable resources in India due to its vast land area and ample sunlight. Solar energy is primarily harnessed through photovoltaic (PV) technology, which converts sunlight directly into electricity. India has installed a significant capacity of solar PV systems; ranging from large-scale solar farms to rooftop solar installations.
- *Wind Energy:* India has substantial onshore wind energy potential, especially in coastal and hilly regions. Wind turbines capture the kinetic energy of wind and convert it into electricity. Wind energy has been a significant contributor to India's renewable energy capacity, with several wind farms and wind parks established across the country.
- *Biomass Energy:* Biomass energy utilizes organic materials, such as agricultural residues, forest biomass, and organic waste, to produce heat and electricity. Biomass is burned or converted into biogas through anaerobic digestion, providing a reliable source of renewable energy in rural areas and industries.
- *Hydropower:* India has several large rivers and hilly regions, making it suitable for both large-scale and small-scale hydropower projects. Hydropower has been a traditional and significant source of renewable energy in the country.
- *Geothermal Energy:* India is still exploring its geothermal energy potential, which involves tapping into the Earth's heat for electricity generation, or direct applications like heating and cooling. While geothermal resources are relatively limited in India, there is ongoing research and exploration to identify viable sites.
- *Biofuels:* Biofuels are derived from renewable biomass sources and can be used as an alternative to fossil fuels. India has been promoting the