POSSIBILITIES OF ACHIEVING ELECTRIC ENERGY SUSTAINABILITY IN INDIA: A CRITICAL APPRAISAL OF THE LEGAL FRAMEWORK

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ABSTRACT

The necessity of achieving sustainable energy solutions is one of the vital concerns of the world in the present day. On one hand, we are witnessing rapid development in science and technology, rapid urbanization and the quest for economic development on the other hand, the world is also witnessing the challenges posed by climate change. Access to sustainable energy is not only a key facet for sustainable development but is also an indicator of socio-economic development. It is a basic human right necessary for attaining numerous other human rights like the right to life, right to dignity, right to a decent standard of living, right to health, right to education, right to work, and right to environment. This present article aims towards critically analysing the legal framework, policies and practices and explore the possibilities and challenges of achieving electric energy sustainability in India. This article is aimed to study the concept of electric energy sustainability and role of law in achieving sustainability. The article also aims to find out the challenges and opportunities in achieving energy sustainability in India. The article highlights the role of law by analysing legal frameworks. Finally, the article would like to explore the global best practices and lessons that can be drawn from them to strengthen India's scenario to achieve a sustainable energy future.

Keywords: Sustainable Development, Energy Sustainability, Access to Sustainable Energy, Electric Energy Sustainability.

Introduction

Electricity has become an important part of modern life as it is required for most of the modern society activities. Energy is used in various forms like wood for fire, fossil fuels and electricity that helps in the production of goods and services. Energy also helps societies sustain by powering various functions like transportation, healthcare, food production, quality of life, etc. Energy has become a key foundation stone in the current industrial economy. The correlation of energy with economy and development was long before the industrial era. The pre-industrial era depended on energy sources that were organic such as firewood, manpower, etc. for their development and betterment of economy. The industrial era saw the rise in demand of coal as a source of energy. The industrialisation led to increase in production and energy was an important source as it was needed to make machineries functional that supported the rising production. This made energy and important part of the industrialisation which further due to technological advancement increased making energy an important factor in the modern day industrial economy. This led energy to become an important factor of industrial nations like United Kingdom, France etc. The industrial nations with help of energy produced goods and service that were sold to other nations worldwide especially their colonies leading to their economic development and prosperity. This development led to use of natural resources like coal and other fossil fuels to produce energy. This consumption of fossil fuels lead to greenhouse gas emissions and other pollutions causing the current issue of climate change.

The last few decades has witnessed rise in global warming, due to such reason various studies have been conducted focusing on the negative impacts of global warming. Studies show that environmental conditions, production of food and access of water are being seriously impacted and already some damage has been done to it. The rise of cardiovascular disorders, heatwaves and air pollution has increased due to industrial purposes and one of the main reasons for such is electric generation. This has led to shifting of focus from non renewable sources to renewable sources which are considered sustainable energy[1]. According to report by Intergovernmental Panel on Climate Change global warming needs to be limited so that earth can be in liveable condition and to safeguard ourselves from negative impacts of climate change[2]. This has led to

[1] Krishna Kumar Jaiswal et al., Renewable and sustainable clean energy development and impact on social, economic, and environmental health, vol 7, 2022, Science Direct, https://www.sciencedirect.com/science/article/pii/S2772427122000687#bib0017 (last visited 12 Mar, 2025).

[2] United Nations Climate Action, 1.5°C: what it means and why it matters, https://www.un.org/en/climatechange/science/climate-issues/degrees-matter, (last visited 15 Mar, 2025).

the rise of the concept of energy sustainability.

The rising climate change can be addressed by making transition to sustainable energy because 75.7 percent of global green house gas emissions come from the energy sector according to reports by World Resources institute[3].Therefore energy sustainability not only leads to environmental benefits also economic and social development.

The rise in electricity demand has led to rising greenhouse emissions which has been the main contributor to climate change. According to data by International Energy Agency, India is the third largest emitter of greenhouse gas emissions[4] and electricity accounts for 53 percent of emissions as per capita electricity consumption rises[5]. This has led to negative impact on the environment. India being a developing country must cater to its rising energy needs to meet development while addressing the climate change issues coupled with it. This has pushed for adoption of sustainable energy which includes sources that cannot be depleted and will remain viable forever.

According to International Energy Agency report "India Energy Outlook 2021" the growing industrialisation and urbanisation in India has doubled the consumption of energy from the 2000s level. The rise in industrialisation and urbanisation is leading to huge demands for energy even though India is lacking behind in per capita energy consumption. India being a developing country needs energy to fulfill its economic development plans, energy security, access to energy and mitigation of climate change. This can be done only by doing sustainable development by using energy that is sustainable. India also needs sustainable energy as it is world's third largest emitter of Green House Gases (GHG) according to reports by World Resources institute[6] and energy sector including the generation of electricity remains the largest contributor to GHG. The reason for such high carbon intensity is India's energy mix which is mainly based on fossil fuels like coal, oil, etc.[7]. To address the high carbon intensity requires

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[3] Mengpin Ge et al., Where Do Emissions Come From? 4 Charts Explain Greenhouse Gas Emissions by Sector, Dec 5 2024, World Resources Institute, https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors.

[4] Emissions, International Energy Agency, https://www.iea.org/countries/india/emissions (last visited 20 Feb, 2024).

[5] India, Electricity, International Energy Agency, https://www.iea.org/countries/india/emissions (last visited 20 Feb, 2024).

[6] This Interactive Chart Shows Changes in the World's Top 10 Emitters, WORLD RESOURCES INSTITUTE, 2nd March 2023, https://www.wri.org/insights/interactive-chart-shows-changes-worlds-top-10-emitters (last visited 26 Jan, 2025).

[7] Energy in India Today, International Energy Agency, https://www.iea.org/reports/india-energy-outlook-2021/energy-in-india-today (last visited Jan. 21,2025)

countries including India to become more sustainable. As electricity and energy is required for human development so efforts have to be made to make it sustainable. India also has various sectoral laws such as Electricity Act 2003, Energy Conservation Act 2001, Environment Protection Act 1986 etc. which have made efforts to integrate climate action and adopt sustainable energy by promoting renewable energies. However, these laws treat climate action and emission reduction as secondary goals[8].

India has made efforts to promote renewable energy and energy efficiency with the help of various initiatives like National Solar Mission, The National Wind Energy Mission and the Perform, Achieve, and Trade (PAT) scheme which is for increasing energy efficiency but still challenges persist. Stronger legal and policy frameworks is crucial for achieving energy sustainability. India taken proactive steps for introduction of plans and policies like the National Action Plan for Climate Change (NAPCC), the State Action Plan for Climate Change (SAPCC) and various other strategies to show its commitment towards climate action. The Climate Change Division of Ministry of Environment, Forest and Climate Change has launched Sustainable Development Goals (SDGs) India index, it was implemented by making cooperation with the United Nations and was launched in the year 2018. This index ranks the progress made based on 115 indicators in States and Union Territories in India for achievement of SDG goals[9]. India has also made progress in reducing emissions based on the targets under Paris Agreement but according to International monetary fund the GHG emission is going to increase to about 40 percent by the year 2030[10]. It is a major challenge for India to cater the rising demand for electricity while focusing to reduce carbon emissions.

The Concept of Electric Energy Sustainability

It is the process to find balance between making economic growth, protecting environment and social responsibilities so that quality of life of current and future generation can be met without

[8] Dhruba Purkayastha and Aanandita Sikka, Developing a Legal and Regulatory Framework for Low Carbon Transition of Indian economy on the path to Net Zero, CLIMATE CHANGE POLICY INITIATIVE (19 MARCH,2024),https://www.climatepolicyinitiative.org/developing-a-legal-and-regulatory-framework-for-low-carbon-transition-of-indian-economy-on-the-path-to-net-zero/#_edn3 (last visited 25 Jan, 2025).

[9] Environmental Technology, International Trade Administration, https://www.trade.gov/country-commercial-guides/india-environmental-technology? (last visited Jan. 21,2025)

[10] India Can Balance Curbing Emissions and Economic Growth, International Monetary Fund (2023). https://www.imf.org/en/News/Articles/2023/03/06/cf-india-can-balance-curbing-emissions-and-economic-growth

compromising the needs of the future[11].Energy sustainability has three aspects which are interconnected in which environmental aspect consists of share of renewable energy in energy mix, reduction of GHG emissions and increasing energy efficiency. Social aspect consists of accessibility, affordability, reliability, equity and creation of jobs in the renewable energy sector. The economic aspect can achieved by assessing the cost effectiveness of energy solutions, increasing investment in renewable energy infrastructure[12] like smart grids that use digital technologies, sensors and software[13] to match the demand and supply leading to reduced cost and improved resilience of energy systems to against market fluctuations.

Sources of Electricity Generation

Electricity generation is the process in which electricity is generated from fossil fuels, hydro power plants, solar panels etc. The India power generation is sources from both non renewable and renewable energy sources.

According to data by India Climate and Energy Dashboard India's power source mix for electricity generation consists of around 78 percent from non renewable energy sources that consists primarily of coal along with other fossil fuels and nuclear energy. Renewable energy sources account for 22 percent of power sources mix which consists of solar, wind, bio power and hydro[14].

Globally fossil fuels account for majority of energy mix, according to survey by Statista fossil fuel accounted for 60.7 percent of electricity generation for the year 2023 and coal accounting for 36 percent of the generation[15].

Electricity we use is neither renewable nor non-renewable, but the primary sources can be classified into non-renewable and renewable sources. Renewable energies are non-finite and

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[11] Bahman Zohuri, Patrick McDaniel, Energy insight: an energy essential guide, chap 9, 2021, pp. 321-370, Science Direct, https://www.sciencedirect.com/science/article/abs/pii/B9780323901529000098 (last visited 1 Mar,2025).

[12] Rafael Ninno Muniz, et al., The Sustainability Concept: A Review Focusing on Energy, Sustainability, vol 15 (19), 14049 (22 Sep, 2023), https://doi.org/10.3390/su151914049.

[13] Smart Grids, International Energy Agency, https://www.iea.org/energy-system/electricity/smart-grids (last visited 3 Mar, 2025).

[14] Electricity Generation, Energy, India Climate & Energy Dashboard (2024). https://iced.niti.gov.in/energy/electricity/generation.

[15] Fossil fuel share in electricity production worldwide from 2000 to 2023, Statista, https://www.statista.com/statistics/1303803/global-fossil-fuel-share-in-power-generation/#:~:text=The%20fossil%20fuel%20share%20in,in%20the%20past%2022%20years. (last visited 26 Jan,2025)

can contribute towards addressing the current rising environmental, social and economic concerns and think for the future generation needs. Renewable energy sources are clean energies as it is available all around us and are abundant as it is sources from sun, water, waste and heath available on the planet Earth. These sources are replenished by the nature itself and emit very little GHG or pollutants into the environment[16]. Some of the common renewable energy sources are:

- **Solar Power:** it can be used with the help of using photovoltaic cells that can be placed on rooftops or in ground. This is a clean and renewable energy source which is becoming affordable as the costs related to it are deceasing day by day. According to Ministry of New and Renewable Energy, solar power cumulative capacity in India is around 102.57 Gigawatt[17].

- **Wind Power:** It is also another popular source of renewable energy source which are harnessed with the help of wind turbines. It is best suited for areas where strong and continuous flow of wind is available like the coastal areas. The 7500 kilometres of coastline of India have a huge opportunity for harnessing wind energy. States like Tamil Nadu and Gujarat have already started to take initiative to enhance its wind energy capacity[18].

- **Hydroelectric Power:** This is an another form of renewable energy source which harnessed from the flow of water with help of turbines. It is mostly used in areas where there is river or other water bodies available. It also doesn't produce any GHG. According to Ministry of New and Renewable Energy, cumulative capacity of hydro power in India is around 5.1 Gigawatt.

- **Geothermal Energy:** It is a form of energy that uses the thermal energy available in

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16 United Nations, Renewable Energy, United Nations Climate Change. https://www.un.org/en/climatechange/raising-ambition/renewable-energy#:~:text=Renewable%20energy%20sources%20%E2%80%93%20which%20are,or%20pollutants%20into%20the%20air (last visited 14 Mar,2025).

17 MIT Professional Programs, Defining Sustainability, MIT Blog. https://professionalprograms.mit.edu/blog/sustainability/defining-sustainability/ (last visited 14 Mar,2025).

18 DADB, What Is the Future of Wind Power in India? Opportunities and Scope for a Sustainable Tomorrow. https://dadb.com/in/blog/what-is-the-future-of-wind-power-in-india-opportunities-and-scope-for-a-sustainable-tomorrow/#:~:text=India's%20coastline%20of%20over%207%2C500,Gujarat%20could%20significantly%20enhance%20capacity (last visited 14 Mar, 2025).

Earth's interior. It is extracted from reservoirs. Electricity is produced from the fluids extracted from the reservoirs. It is one of the most technologically reliable source of electricity generation. Based on the report titled "Geothermal Atlas of India, 2022" by Geological Survey of India, India has a potential of 10,600 Megawatt of geothermal power[19].

- **Ocean Energy:** This is derived by using technologies which with the help of kinetic and thermal energy of seawater i.e. waves or currents, electricity is generated. It is still at the early stage of development but if harnessed then ocean energy holds the potential to easily cater the current energy needs of human beings[20]. According to study conducted by The Indian Institute of Technology, Chennai in association with Credit Rating Information Services of India Limited (CRISIL), India has potential for 12,455 Megawatt of tidal energy and 41000 Megawatt of wave energy[21].

Reducing Energy Consumption and Improving Energy Efficiency

Energy efficiency is the process of using less energy to perform the same task that helps to reduce or eliminate wastage of energy. Energy efficiency helps to reduce GHG emissions, decrease energy imports, reduction of costs at household and economy wide level. It is one of the best way for reducing the use of fossil fuels. Under the Sustainable Development Goal 7.3, target has been set to double the improvement of energy efficiency globally[22]. There is a huge opportunity to improve energy efficiency in every sectors of economy which includes energy generation. According to International Energy Agency energy efficiency is "first fuel" in achieving clean energy transition. It is considered as on of the most cost effective method of mitigation of carbon dioxide along with lower energy costs and stronger energy security. It is also the main factor to tackle the energy demand in the Net Zero Emissions by 2050 scenario.

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[19] Ministry of New and Renewable Energy, GEOTHERMAL ENERGY (RDD&D) PROJECTS (24 Jul, 2024), https://pib.gov.in/PressReleasePage.aspx?PRID=2039089#:~:text=GSI%20has%20studied%20381%20thermally,been%20estimated%20in%20the%20country (last visited 14 Mar, 2025).

[20] United nations, Climate Action, What is renewable energy?, https://www.un.org/en/climatechange/what-is-renewable-energy (last visited 14 Mar, 2025).

[21] MINISTRY OF NEW AND RENEWABLE ENERGY, New Technologies, https://mnre.gov.in/en/new-technologies/ (last visited 14 Mar, 2025).

[22] United nations Environment Programme, Goal 7: Affordable and clean energy, https://www.unep.org/topics/sustainable-development-goals/why-do-sustainable-development-goals-matter/goal-7-affordable, (last visited 14 Mar, 2025).

At the COP28 summit around 200 nations made a landmark agreement to double the global energy efficiency average by the year 2030[23].

As energy is the life line for economic growth, the available fossil fuel are unable to produce energy as per the demand. Even though India's per capita energy consumption is not as high as developed nation but the energy intensity is very high. The gap between demand and supply can be reduced by increased efficiency and conservation. The efficiency can be increased by adopting efficient technologies along with better consumption habits of the households that would lead to energy conservation. Energy efficient appliances helps in reduction of household expenditure on energy. Households can save their energy costs substantially by replacing appliances which consume lot of energy like refrigerators, air conditioners and washing machines with more energy efficient alternatives. This would lead to lowering of energy demand, which is mainly produced from fossil fuels that would cause to lower carbon footprint and contribute to electric energy sustainability[24].

In India, Bureau of Energy Efficiency (BEE) setup by the Government of India on 1st march 2002 helps in making policies and strategies to reduce the energy intensity of the Indian economy and paving way towards sustainable development. BEE is a statutory body that derives its authority from the Energy Conservation Act, 2001 (EC Act)[25]. The EC Act was enacted for reduction of energy intensity in India's economy. The act provides for regulatory mandate for Standards & labelling of equipment and appliances; Energy conservation building codes for commercial buildings; and Energy consumption norms for energy intensive industries. The act also give direction to states for setting up agencies at the state level so that energy efficiency can be promoted and the EC Act can be implemented properly. The act also provides energy savings certificate to designated consumers who consume energy less than the prescribed norms and standards[26].

In industrial sector energy efficiency can help separate economic growth and environmental impact along with reduction of energy intensity and improved competitiveness. Industrial

[23] International Energy Agency, Energy Efficiency, https://www.iea.org/energy-system/energy-efficiency-and-demand/energy-efficiency, (last visited 14 Mar, 2025).

[24] Tosin Olatunde et al., Reviewing the impact of energy-efficient appliances on household consumption, 6(2), 001-011, IJSTRA (April,2024). https://doi.org/10.53771/ijstra.2024.6.2.0038 (last visited 14 Mar, 2025).

[25] Government of India Ministry of Power, Energy Efficiency, https://powermin.gov.in/en/content/energy-efficiency (last visited 14 Mar, 2025).

[26] International Energy Agency, Energy Conservation Act (9 Nov, 2023), https://www.iea.org/policies/1975-energy-conservation-act (last visited 14 Mar, 2025).

sector consumes one third of global energy and also responsible for carbon emissions. In developing countries and rising economies, 50 percent of the energy supply is consumed by its industries which leads to rise in tensions between economic development goals and its limited energy supply. Improving energy efficiency in industrial sector can help the developing nations cater their rising energy demands and separate economic growth from climate change or environmental degradation. According to estimates energy efficiency in industries can decrease energy intensity by 26 percent, 8 percent decrease of global energy use and 12.4 percent decrease in carbon dioxide emissions[27].

As India has energy intensive sectors, energy savings can be increased in various sectors like industrial sectors, agricultural sectors, transport sector and commercial along with municipal sectors. It can be understood that all citizens of India are stakeholders in this scenario as human survival and existence is depended on the availability and accessibility of energy sources. Energy policies and strategies are implemented in various policies and documents of the Planning Commission and the Five Year Plan proposal of Government on India that keeps a balance between management of energy resources and development. Quality of policies implemented by the top management determines how effectively and efficiently energy resources are utilised.

The stakeholders in the industrial sector which also include ministries and departments at both the state and central level, workers in various level of the organisation, industries whether large or small should have an effective energy management cell with an efficient energy manager at different levels of the management based on the size of the industries. It can be improved by Policy directions, implementation, review and evaluation of the goals set.

Energy planning and conservation programmes provide positive results in productivity and profitability along with taking care of quality of life and environment. Energy audits should be done periodically by reputed energy auditors. The expenditure made for this purpose wont be in vain as it will help in reducing cost of energy bill and reduction of carbon footprints and pollutions. Industries that shift to efficient technologies will have advantage over other industries also they can become promoters of efficiency. The Perform Achieve and Trade (PAT) which is an instrument brought to reduce consumption of energy in energy intensive industries

[27] United Nations Industrial Development Organization (2025), https://www.unido.org/our-focus-safeguarding-environment-clean-energy-access-productive-use/industrial-energy-efficiency-and-climate-change, (last visited 15 Mar, 2025).

in India. It is a market based mechanism that enhances cost effectiveness by providing certificates for extra energy savings which can be traded. Under this scheme high energy intensive industries have to appoint energy manager who file energy consumption of the industry every year and conducts energy audits on a regular basis[28]. Products and services coming from this industries are going to have labels on them providing information about the energy saving and efficiency helping consumers in making wise choices as customers are also stakeholders in energy efficiency and conservation[29].

Grid Modernisation and Smart Grids

Power grids are considered as arteries and veins of electricity supply. The rise of energy demand and increased transition to renewable energy has bought the concept of grid modernisation. An electric grid is an interconnected network that help in supplying electricity generated from power plants to the consumers. A strong and reliable grid is necessary so that electric supply can be done without any interruption. As the global temperature rises due to climate change need for cooling solutions and energy required for it increases. Also the rise in natural disasters due to climate change.

The rise of low cost renewable energy is also going to increase the demand for electricity. The International Energy Agency has a warned that if grid modernisation and investments are delayed then it would lead to stronger reliance on fossil fuels which will contribute to increased GHG emissions. The International Energy Agency has said that 600 billion dollars needs to be invested in electric grids so that climate targets can be met by the year 2030[30]. Poor grid infrastructure has lead to slow integration of renewable projects, according to reports by International Energy Agency, 1500 Gigawatts of renewable projects are in queue to get connected with power grid[31].

Grid Modernisation will lead to increased reliability and resilience as disruption of power supply and time taken to respond to power outages can be improved which will lead to

[28] BUREAU OF ENERGY EFFICIENCY, Government of India, Ministry of Power, Perform Achieve and Trade (PAT), https://beeindia.gov.in/en/perform-achieve-and-trade-pat-0, (last visited 15 Mar, 2025).

[29] Razia Parvez, Energy Security and Conservation in India (2013).

[30] The Gaurdian, Global electricity grid must be upgraded urgently to hit climate goals, says IEA (17 Oct,2023), https://www.theguardian.com/environment/2023/oct/17/global-electricity-grid-climate-iea, (last visited 15 Mar, 2025).

[31] International Energy Agency, Lack of ambition and attention risks making electricity grids the weak link in clean energy transitions (17 Oct, 2023), https://www.iea.org/news/lack-of-ambition-and-attention-risks-making-electricity-grids-the-weak-link-in-clean-energy-transitions, (last visited 15 Mar, 2025).

increased energy efficiency which is an important aspect of energy sustainability, reduction of transmission and distribution losses for eg. Indian power distribution sector suffered from 15.37 percent loss in the year 2024 based on the press release by Ministry of Power[32]. Grid modernisation will also help in reduction of GHG emissions as the problem of clean renewable energy integration can be resolved and more renewable energy sources can be adopted[33].

Grid modernisation can be further facilitated by adopting smart grids. Smart grids are electricity network that with the help of digitalisation and other advanced technologies help for better management and distribution of electricity from its generation source. It also helps to cater the continuous changing demands of the consumers. Smart grids with the help of data and coordination manage the needs and capacities of the market stakeholders. It helps in increasing efficiency, minimise the environmental impacts leading to better reliability and resilience of the power system. Investment in smart grids needs to be doubled to achieve Net Zero Emission targets specially in developing nations and emerging economies[34].

Promoting Research and Development(R&D) in Clean Technologies

The promotion of research and development (R&D) in clean technologies is an important factor in achieving electric energy sustainability and has various benefits as high level of R&D will help in advancement of renewable energy and diversify the renewable sources as countries that allocate higher funds in R&D have advantage in expansion of wind solar, bioenergy and geothermal energy which are relatively new technologies in comparison to countries that have low funds for R&D focusing on hydropower. The need for R&D can be promoted by making policy interventions so that funding for R&D can be increased. R&D also helps in improving financial sector as R&D policies can help in directing credit and investment towards clean energy technologies because low R&D leads to increased failures, low liquidity and high risks that discourages investments. R&D can be further improved by reducing cross border trader barriers as it will help in knowledge exchange and international cooperation leading to increased speed of innovations. This brings focus on the common but differentiated responsibilities (CBDR) that emphasises global cooperation and technology sharing initiatives.

[32] Ministry of Power, YEAR END REVIEW – 2024, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2089243, (last visited 15 Mar, 2025).

[33] SDCOURSES, Grid Modernization: Empowering Renewable Energy Integration (6 Oct, 2023), https://sdcourses.org/grid-modernization-renewable-energy/, (last visited 15 Mar, 2025).

[34] International Energy Agency, Smart Grids, https://www.iea.org/energy-system/electricity/smart-grids, (last visited 15 Mar, 2025).

According to this cooperation, developed nations have agreed to provide billions of dollars to climate change mitigation and adaptation like the Green Climate Fund. Thus by making policies for promoting R&D can help in increasing investments that can ultimately contribute to achieving electric energy sustainability globally[35].

Role of Law in Achieving Electric Energy Sustainability

Energy law helps in setting up legal frameworks that facilitate governance of energy production, distribution and consumption. Legal frameworks helps in shaping policies that drives the renewable energy adoption leading to sustainability. As renewable energies sources are continuously evolving law needs to be adaptive so that smooth and successful integration of such sources can be done into existing systems. Adaptive legislations will facilitate speedy deployment of clean technologies which may not be possible with laws that are rigid and outdated causing obstruction to progress. As clean energies need continuous research, law can help in promoting innovations and development of newer technologies that will help in achieving sustainability[36]. Laws can also help in establishing tariff structure and mechanisms that can help renewable energy producers get fixed payments. Laws can also help in providing incentives and subsidies that help promote renewable energy sources leading to solving the issues of high upfront costs regarding renewable energy technologies. Law also helps in promoting environmental standards and impact assessments which will facilitate in carrying out renewable energy projects in environmentally responsible manner.

Renewable Energy Legislations

Renewable energy legislations are bought by nations to achieve various objectives which are, security objectives; environmental objectives; economic objectives; social objectives; industrial policy objectives; education and research objectives; international/regional objectives. Different nations based on their personal objectives, resources and concerns make their renewable energy legislations[37].

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[35] The role of R&D in the effectiveness of renewable energy determinants: A spatial econometric analysis, Energy Economics, vol 99, Elsevier (July, 2021). https://doi.org/10.1016/j.eneco.2021.105287.

[36] Kaisa Huhta, *The Contribution of Energy Law to the Energy Transition and Energy Research,* 73 Glob. Envtl. Change 102454 (2022), https://doi.org/10.1016/j.gloenvcha.2021.102454.

[37] Penelope Crossley, Why Do Countries Legislate to Accelerate the Deployment of Renewable Energy?, in Renewable Energy Law, 98-163 (2019).

Renewable energy legislation may provide for:

- **Improved access to electricity:** With the help of legislation, renewable energy can used to address energy poverty and give access to population who don't have access to electricity. Access cannot be only improved by mere connection but reliability and affordability of the electricity needs to be maintained so that energy poverty be solved.

- **Subsidies and Incentives:** This helps in addressing market failures and encourage investments in the renewable energy sector and clean energy technologies. India is adopting various policies with the intention to incentivise and subsidize renewable or cleaner electricity. The government has been planning to to introduce feed in tariffs for solar energy as it will provide fixed payments to the distribution companies[38] which will help in making renewable energy projects financially viable ultimately incentivise private sector to make investments. Subsidy schemes like PM Surya Ghar Muft Bijlee Yojana has been brought to increase solar rooftop capacity in India by providing subsidies of 60 percent of the solar unit cost for systems up to 2 kilowatt capacity and additional 40 percent for cost of systems between the capacity of 2 kilowatt to 3 kilowatt which will incentivize solar installations[39].

- **Renewable Energy Targets:** This is used to set time bound targets in the legislative framework by the government to reduce GHG emissions, to decrease the share of fossil fuels and increase the share of renewable energy sources in electricity generation, production of clean energies etc. This targets are based on international agreements or regional strategies. For e.g. European Unions (EU) Renewable Energy Directive that makes a binding renewable energy target of up to 42.5 percent by the year 2030. This was brought to increase energy savings, to produce clean energy and diversify the EU's energy supplies[40].

- **Renewable Energy Standards:** It is used by some nations to implement standards which mandates energy utilities to either generate or source some percentage of

[38] Development Asia, Feed-In Tariffs vs Reverse Auctions: Setting the Right Subsidy Rates for Solar, https://development.asia/insight/feed-tariffs-vs-reverse-auctions-setting-right-subsidy-rates-solar, (last visited 15 Mar, 2025).

[39] National Portal of India, PM Surya Ghar - Muft Bijli Yojana, https://www.india.gov.in/spotlight/pm-surya-ghar-muft-bijli-yojana, (last visited 15 Mar, 2025).

[40] European Union, Renewable Energy Targets, https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en, (last visited 15 Mar, 2025).

electricity from renewable energy sources. For e.g. the Renewable Purchase Obligation is an obligation which has been mandated by the Central/State Regulatory Commission which sets standards for power distribution companies (DISCOMs), open access consumers and captive consumers to obtain certain amount of electricity generated from renewable energy sources based on prescribed manner. This was brought under the Electricity Act, 2003 and National Action Plan in Climate Change (NAPCC)[41].

- **Reduction of Emissions and Carbon Pricing:** Emission reduction is a key objective of renewable legislation as ultimately all of this are being done to solve the issue of climate change and environmental degradation caused by GHG emissions along with various other factors. For e.g. India has a target to reduce its emissions intensity by 45 percent by the year 2030 and a long term goal has been set to achieve net zero emissions by the year 2070[42].

  Carbon pricing is an instrument made to reduce GHG emission by assigning a cost on the emissions which incentivise consumers and businesses to opt for clean renewable energy sources. It is aimed to make activities which are polluting more expensive and alternatives from clean energy more competitive. Carbon pricing are of various types out of which these two are main types which are carbon tax that puts direct tax based on carbon content and Emission trading System (ETS) is a system where emitters can trade their emission units to meet their targets[43]. India has not levied any carbon price explicitly till date.

Legal Frameworks

International Legal Frameworks

After the first assessment report given by the **Intergovernmental Panel on Climate Change (IPCC)** in the year 1990 to balance the concentration of GHG "at a level that would prevent

[41] Assam Electricity Regulatory Commission, RENEWABLE PURCHASE OBLIGATION (RPO), https://aerc.assam.gov.in/information-services/renewable-purchase-obligation-rpo, (last visited 15 Mar, 2025).

[42] United Nations Development Programme Climate Promise, India, https://climatepromise.undp.org/what-we-do/where-we-work/india#:~:text=India%20has%20committed%20to%20reducing,net%2Dzero%20emissions%20by%202070., (last visited 15 Mar, 2025).

[43] World Bank Group, What is Carbon Pricing, https://carbonpricingdashboard.worldbank.org/what-carbon-pricing, (last visited 15 Mar, 2025).

dangerous anthropogenic (human-induced) interference with the climate system" a multilateral treaty called the **United Nations Framework for Climate Change** was adopted in the year 1992. This treaty has helped in various international climate negotiations and landmark agreements like the **Kyoto Protocol (!997)**[44].

The need to address climate change globally with the cooperation of Global North and Global South had led to creation of a legally binding treaty on climate change i.e. **Paris Agreement (2015)**. The goal of the agreement is to stop the global average temperature below 2 degrees Celsius above the preindustrial levels and to make efforts to limit the temperature increase to 1.5 degree Celsius as crossing this temperature limits would lead to severe climate change impacts, including more frequent and severe occurrence of natural calamities. To achieve these targets countries including India have pledged to National Determined Contributions (NDCs) to reduce emissions[45].The Paris Agreement has led to creation of **Sustainable Development Goals (SDGs)** at the United Nations Conference on Sustainable Development in Rio de Janeiro in the year 2012. SDGs created 17 goals that were meant to address the urgent economic, political, social and environmental challenges faced by the world using global cooperation. The scope of energy sustainability is primarily based on SDG 7 which talks about universal access for all, ambitious scale up of renewable energy and energy efficiency.

National Legal Frameworks

India has taken various steps to promote renewable energy, energy efficiency through various legal frameworks but still faces various challenges and drawbacks that limits their capacity to achieve sustainability. Following is an analysis of key legal frameworks in India:

- **Electricity Act, 2003:** The act deals with laws related to generation, transmission, distribution, trading and use of electricity. The act also takes measures so that development of electric industry, promoting competition, protection of consumers rights, supply of electricity to all, setting tariffs, promoting efficient environmental policies etc. It also constituted various statutory bodies which are Central Electricity Board, Regulatory Commissions and Appellate Tribunals to deal matters related to this

[44] United Nations, UN Climate Change Conferences, https://www.un.org/en/climatechange/un-climate-conferences, (last visited 17 Mar, 2025).

[45] What is the Paris Agreement?, United Nations Climate Change, https://unfccc.int/process-and-meetings/the-paris-agreement

act. However the act faces certain challenges which are weak enforcement of open access provisions has lead to rising issues for the renewable energy generators, weak enforcement of renewable purchase obligations that was brought to reduce emissions also to promote renewable energy sources[46]and even though the act explicitly deals with transmission and distribution of electricity but doesn't talk about the rising grid integration issues regarding renewable energy integration.

- **Energy Conservation Act, 2001:** The act deals mainly with efficient use of energy and its conservation. It also created the Bureau of Energy Efficiency (BEE). The act also mandates energy audits for large energy intensive industries. The act was brought after energy conservation gained importance due to the oil shock of the year 1973. It was also brought so that consumption of energy can be regulated and conserved so that the non finite resources don't get depleted due to irresponsible consumption of the rising population of India. There are certain challenges faced by Energy Conservation Building Code under this framework which are complex institutional structure of enforcement and implementation organisations, lack of resources and finances. The act focuses on large scale industries and commercial buildings but don't focus on residential and the informal sector where energy efficiency can be increased to a great extent if done properly[47].

- **National Action Plan on Climate Change:** This was brought on 30th June, 2008, it outlines strategies which at the national level is meant to mitigate climate change and improve environmental sustainability of India while achieving the development aspects as well. It focuses on maintaining high growth rate so that standard of living can increase while reducing their vulnerability to the impacts of climate change. There are eight missions under this which are National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Eco-system, National Mission for a Green India, National Mission for Sustainable Agriculture and National Mission

[46] Compliance with Renewable Purchase Obligation and availing benefits of Clean Development Mechanism, Comptroller and Auditor General of India, https://cag.gov.in/uploads/download_audit_report/2015/Union_Civil_Performance_Renewable_Energy_Report_34_2015_chap_2.pdf (last visited 27 Jan,2025).

[47] Abhash Kumar & Akshay Kumar, Evaluation & Analysis of PAT Scheme: An Initiative by Govt. of India, 5 Int'l J. Multidisciplinary Trends 5 (2023), https://www.multisubjectjournal.com/article/353/5-12-2-381.pdf.

on Strategic Knowledge for Climate Change. This also has certain issues which are NAPCC focus on large scale renewable energy projects but give no importance to decentralized renewable energy systems which can be beneficial for energy access and rural electrification, it talks about solar and energy efficiency missions but doesn't talk about the challenges with regards to integration of renewable energy into the grid and need to improve technologies for increased efficiency[48].

Challenges

- Despite progress in electrification, many people face energy poverty in India. Based on report of Household Energy Poverty Index, 65 percent of households faced energy poverty in the year 2020[49] even though based on data by World Bank electricity access is about 99.2 percent for the year 2022. This indicates that while access has been provided by affordability and reliability remains a challenge.

- Poor grid infrastructure has caused rising issue of grid integration where renewable energy projects are ready but they are not getting access to grids which is limiting the access to reliable electricity and increasing the dependence on fossil fuel sources.

- India faces huge technological barrier as it is heaviliy depended on imports for technologies and minerals required for advancing transition to renewable energy.Based on report by Institute for Energy Economics and Financial Analysis, India is 100 percent depended on critical minerals such as lithium, cobalt, nickel etc. This has lead to increased dependence on foreign sources which may be impacted due to disruption of supply chains, volatile prices and geopolitics[50].

- The renewable energy sector faces financial constraints like huge gap in required and actual investment to increase renewable energy capacity, increased cost of loan as government charges a guarantee fee up to 1.2 percent to provide guarantee on loans,

[48] India's Climate Change Policy: Challenges and Recommendations, Indian Soc'y of Pub. Pol'y (2023), https://www.ispp.org.in/indias-climate-change-policy-challenges-and-recommendations/, (last visited 17 Mar, 2025).

[49] Addressing Energy Poverty in India, The Borgen Project (10 Sep, 2024). https://borgenproject.org/energy-poverty-in-india-2/?

[50] What's Holding India Back in Its Renewable Energy Transition?, Inst. for Energy Econ. & Fin. Analysis (2023), https://ieefa.org/resources/whats-holding-india-back-its-renewable-energy-transition, (last visited 17 Mar, 2025).

the seasonal nature of renewable energy projects limits the ability to pay dues due to low power generation leading to categorisation of renewable energy projects in non-performing assets (NPAs) due to Reserve Bank of India Guidelines etc[51]. India also faces Green Climate finance issues, according to the financial year 2021/22 report by Climate Policy Initiative, the Indian green finance only got 17 percent of it finance from international finance despite commitments by developed nations to help developing nations. The report also indicates that 83 percent of the green finance was made from domestic sources proving India's strong commitment towards climate targets, but it also brought light on the international funding scenario which needs to be increased more so that 2030 clean energy targets can be met[52].

- The need for expansion of renewable energy is facing challenges due to rising concerns about availability of lands and issues related to it. For solar parks and wind farms huge areas of land are required in which most of the land are used for farming by the local communities and due to poor maintenance of ownership records have led to rising land disputes. According to Jason Pellmar, regional industry manager for infrastructure in India, Bhutan and Maldives at the World Bank's International Finance Corporation, land poses a serious challenge, and it will further increase as more renewable energy projects are developed. According to World Bank land dispute is a critical concern for renewable energy projects because 60 percent of land in India is used for farming which is much higher than the global average of 37 percent and agriculture is the main source of income[53].

- According to a report by International Forestry Resources and Institutions, distribution companies (DISCOMs) which are 90 percent owned by states and supply electricity to meet 80 percent of the country's need are fragile. The DISCOMs are suffering from rising costs and shortage of revenues along with poor management of supply and demand needs. The long-term Power Purchase Agreements (PPAs) are expensive and are under financial burden due to rising coal prices and frequent renegotiations. This

[51] Standing Committee Report Summary, Financial Constraints in Renewable Energy Sector, PRS Legislative Research, https://prsindia.org/files/policy/policy_committee_reports/SCR%20Summary_Financial%20Constraints%20in%20Renewable%20Energy.pdf (last visited 27 Jan,2025).

[52] Climate Policy Initiative, Landscape of Green Finance in India (2024).

[53] The fight over land holding back India's green energy revolution, FINANCIAL TIMES, https://www.ft.com/content/a8528845-dfe9-4121-a115-c475d0302d3e (last visited 9 Feb, 2025).

also limits the upgradation the electricity sector and poor maintenance. Lack of regulations on payments and poor revision of tariffs are also leading cause of financial constraints. This also make the loans costly which are taken by DISCOMs ultimately causing increase in consumer prices for electricity. The current state of DISCOMs has affected the credit rating negatively leading to expensive borrowing which further fuels the unstable finances also affecting the generating companies. According to a report by a committee formed under Ministry of power in the year 2019[54], the weak finances of the DISCOMs are also affecting the power generating companies also para 4.3 of the report states that one of the main reasons of weak finances are the over-dues from the local and government bodies which in some states is almost same as the amount payable to the generation companies. This poor finance has also impacted the renewable energy projects as private sectors are less interested which has lead to increased dependence on thermal power plants[55].

- The acts and policies fail to promote subsidies for clean energy and strict regulations to mandate this. According to data by Indian Institute of Sustainable Development the financial year 2023 witnessed subsidies for clean energy accounted for less than 10 percent of the total energy subsidies while fossil fuels like coal, oil and gas subsidies accounted for 40 percent of total energy subsidies. The subsidies for fossil fuels increased about 63 percent in comparison to subsidies provided in the financial year 2022. This not only leads to dependence on fossil fuels that are price volatile based on geopolitics but also causing delay in meeting India's clean energy goals of 2030[56].

India's Position with Respect to International Instruments

- India being a party to the UNFCCC has advocated for common but differentiated principle (CBDR) which recognises that developed nations should help the developing

[54] Report of the Committee on Delayed Payment by DISCOMs to GENCOS/IPPs, Central Electricity Authority, (Aug.2019), https://cea.nic.in/wp-content/uploads/f___ca/2020/10/D_754_1603265813247-1.pdf#:~:text=1.3%20Impact%20of%20delayed%20payment:%20This%20delay,and%20leads%20to%20exhaustion%20of%20working%20capital.&text=2%20Delayed%20payments%20from%20DISCOMs%20is%20causing,for%20meeting%20routine%20O&M%20expenses%20including%20salaries. (last visited on 12 Feb,2025)

[55] Akul Raizada, India's Broken Power Economics Addressing DISCOM Challeneges, IFRI MEMOS (Oct. 15,2024), https://www.ifri.org/sites/default/files/2024-10/ifri_raizada_india_broken_power_economy_2024_1.pdf (last visited 10 Feb, 2025)

[56] India Faces Clean Energy Challenges as Energy Demand Soars and Global Fossil Fuel Subsidies Rise, Indian Institute of Sustainable Development, https://www.iisd.org/articles/press-release/india-clean-energy-challenges-energy-demand-fossil-fuel-subsidies? (last visited 27 Jan,2025).

nations in combating climate change as developed nations were the main reason for historical emissions. Also developed nations have greater financial and technological capacity.

- India is a signatory of Kyoto Protocol which is not binding for developing nations. Still India has taken voluntary measures to reduce emission and promote renewable energy along with efficiency.

- India being a signatory to Paris Agreement have taken various targets under NDCs which are:

  - to reduce emissions intensity of its GDP by 45 percent by the year 2030 from the level in the year 2005.

  - To produce 50 percent of electric power from non fossil fuel based energy resources by the year 2030. It will be done by taking help of technology transfer and availing low cost financing from Green Climate Fund[57].

  - India has set a target to achieve net zero emissions by the year 2070 at the COP-26[58].

- India has also recognised SDGs and has actively worked to achieve the 2030 goals while aligning to the sustainable development commitments. India has launched SDG India Index under the Sustainable Development Goals.

- India in collaboration with France has launched a treaty based international intergovernmental organisation known as International Solar Alliance (ISA) which is aimed to gather funding of more than 100 billion dollars for massive deployment of solar energy by the year 2030. It is aimed to increase the scale of solar energy, cost reduction of power generation from solar sources etc.

[57] International Energy Agency, Nationally Determined Contribution (NDC) to the Paris Agreement: India, https://www.iea.org/policies/6025-nationally-determined-contribution-ndc-to-the-paris-agreement-india, (last visited 17 Mar, 2025).

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Global Best Practices

- Germany's Renewable Energy Act (EEG) that is used in feed in tariffs and better grid access to become global leader of renewable energy. The EEG has led to increased investments in the renewable sector due to increased investment security this has made renewable energy accounting for over 40 percent of its energy mix in the year 2020.

- California's Renewable Portfolio Standards makes it binding to procure some percentage of electric power sold by power utilities should come from renewable source. This has led California to achieve it target of 60 percent of its pwoer from renewable energy and after that a target of 100 percent by the year 2045.

- Denmark had set targets for renewable energy expansion with an aim to be fossil fuel by the year 2050. Denmark's Energy Agreement if 2012 brought in various measures to support subsidies, tax incentives, expansion of grid and renewable energy[59]. As of 2022, Denmark is the global leader of wind energy generation, wherein wind energy accounts for 53 percent of the energy demand based on data by International Energy Agency Wind TCP 2022 Annual Report[60].

- Sweden's carbon tax was introduced in the year 1991. It is based on the polluter pays principle. This has lead to reduction of emissions in a cost effective way along with deployment and development of new clean technologies. This tax system allowed businesses and household to adapt to the changing landscape. This has decreased GHG emissions by almost 27 percent between 1990 and 2018[61]. It has also been found without this tax system carbon emissions in the year 2015 would have been 30 percent higher in Sweden[62].

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[59] Portia Oduro et al., Renewable energy expansion: Legal strategies for overcoming regulatory barriers and promoting innovation, 6 Int'l J. Applied Res. Soc. Sci.(2024). https://www.researchgate.net/publication/380781287_Renewable_energy_expansion_Legal_strategies_for_overcoming_regulatory_barriers_and_promoting_innovation

[60] International Energy Agency, Wind Energy in Denmark, https://iea-wind.org/about-iea-wind-tcp/members/denmark/#:~:text=Denmark%20produces%2019.002%20TWh%20from,of%20the%20country's%20electricity%20consumption, (last visited 17 Mar, 2025).

[61] Government Offices of Sweden, Sweden's Carbon Tax, https://www.government.se/government-policy/taxes-and-tariffs/swedens-carbon-tax/#:~:text=The%20carbon%20tax%20was%20introduced,all%20Swedish%20fossil%20carbon%20emissions, (last visited 17 Mar, 2025).

[62] Swedish House of Finance, Carbon Pricing Significantly Reduces Emissions: New Study (16 Jan., 2024), https://www.hhs.se/en/houseoffinance/research/featured-topics/2024/carbon-pricing-significantly-

Conclusion

India's journey towards achieving energy sustainability is challenging. India has taken various steps and action to promote renewable energy and energy efficiency with the help of various legal framework and policies such as the Electricity Act, 2003, the Energy Conservation Act,2001 and National Action Plan on Climate Change. India has demonstrated its committent to achieve sustainability and mitigate climate change by ratifying the Paris Agreement, International Solar Alliance and setting ambitious target in its Nationally Determined Contributions (NDCs) which includes reduction of emissions intensity and achieving carbon neutrality by the year 2070.

Despite all of these India faces various challenges like energy poverty, poor grid infrastructure, technological barriers, financial challenges etc. It also further complicated due to the rising reliance on fossil fuels as low subsidies for clean energy may hinder the clean energy transition goal.

India has also tried to take leadership role with respect to international instruments like UNFCCC which proves its commitment towards global climate action. However even after this India faces challenges from international mechanism like the Green Climate Fund.

Way Forward

To address the challenges and accelerate India's transition to a sustainable future, various steps need to be adopted which are:

- Strengthening the legal enforcement of Renewable Purchase Obligations so that share of renewable energy can be increased in the energy mix.

- By introducing carbon taxes people and businesses can be incentivised to opt for cleaner energy sources. Also it should be done in such a manner that it doesn't lead to negative implications.

- To increase the subsidies of renewable energy and reduce the subsidies of fossil fuels

reduces-carbon-emissions/#:~:text=The%20study%20found%20that%20carbon,have%20been%20about%2030%25%20higher., (last visited 17 Mar, 2025).

so that renewable energy can be made economically viable and reliance on fossil fuel can be decreased.

- Grid infrastructure needs to be modified and smart grids need to be promoted so that renewable energy integration can be done smoothly and losses related to distribution and transmission can be reduced.

- Along with large renewable energy systems, decentralised energy systems like rooftop solar, micro grids need to be focused.

- Domestic finances needs to be increased along with international finances for renewable energy project so that faster deployment can be done for renewable energy projects.

- Financial guarantees and cost of loans ned to be reduced so that private sector investment and easy financing can be done.

- Focus should be directed to development of indigenous research and development so that dependence on imports for technologies can be reduced. This can be further facilitated by sharing of technologies related to climate change through partnerships and multilateral agreements

- To develop and implement better land related policies so that needs for renewable energy projects along with agricultural and community interests can be balanced. Also better maintenance of land records need to be done so that land disputes and land acquisition can be done without any hindrance.

- Revised tariffs, stricter regulation needs to be implemented along with payment mechanism so that timely payments can be received from government bodies and consumers which will help in solving the poor financial condition of DISCOMs.

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