INDIA’S ODYSSEY TO SUSTAINABLE ENERGY TRIUMPH—ASSESSING THE IMPACT OF ACCESS TO ENERGY AND RENEWABLE POWER IN THE INDIAN ELECTRICITY SECTOR

Karan Kataria

ABSTRACT

Purpose: The purpose of this paper is to comprehensively examine the challenges hindering India's sustainable energy development, focusing on access to electricity, competition within the energy market, and the pivotal role of technology transfer and energy storage in overcoming growth hurdles.

Theoretical Reference: The theoretical framework revolves around the intersection of Indian legislation and energy access, emphasising the significance of competition law in fostering a fair and inclusive energy landscape. The paper also draws on the theoretical foundations of technology transfer and energy storage as catalysts for sustainable growth in the renewable energy sector.

Method: The methodology involves an in-depth analysis of India's renewable energy sector, exploring the impact of monopolies, anti-competitive practices, and the rapid expansion of solar power facilities. The study considers the role of competition law, technology transfer, and energy storage as key components in navigating the challenges of sustainable energy development.

Result and Conclusion: The results underscore the interconnected nature of technology, energy storage, and competition legislation in India's energy revolution. The conclusion highlights public policy imperatives, emphasising demand-side management, resolution of contractual disputes, and the imperative need for efficient and cost-effective energy storage systems. The paper concludes with a call for a policy framework encouraging private sector participation and capacity building in the power sector.

Implication of Research: The implications of this research extend to shaping public policy imperatives in the electricity sector, emphasising the need for demand-side management, resolution of disputes, and a policy framework to promote private sector participation. The research highlights the significance of these imperatives in developing efficient and cost-effective energy storage systems and achieving 'Round the Clock' renewable power.

Originality/Value: The originality and value of this research lie in its comprehensive examination of the interconnected challenges and solutions in India's renewable energy sector. The findings contribute to the discourse on public policy imperatives, technology transfer, and competition law, offering insights that can guide policymakers, regulators, and businesses in fostering a competitive, sustainable, and resilient energy system. The study provides valuable guidance for maximising the benefits of renewable energy, ultimately contributing to increased energy access, sustainability, and economic growth in India.

* Lecturer, Jindal Global Law School, O.P. Jindal Global University, India, E-mail: Karan.kataria@jgu.edu.in
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ODISSEIA DA ÍNDIA AO TRIUNFO DA ENERGIA SUSTENTÁVEL - AVALIANDO O IMPACTO DO ACESSO À ENERGIA E À ENERGIA RENOVÁVEL NO SETOR DE ELETRICIDADE INDIANO

RESUMO

Propósito: o objetivo deste documento é examinar de forma abrangente os desafios que impedem o desenvolvimento de energia sustentável da Índia, com foco no acesso à eletricidade, na concorrência no mercado de energia e no papel fundamental da transferência de tecnologia e do armazenamento de energia na superação dos obstáculos de crescimento.

Referência teórica: O quadro teórico gira em torno da interseção da legislação indiana e do acesso à energia, enfatizando a importância do direito da concorrência na promoção de um cenário energético justo e inclusivo. O documento também se baseia nos fundamentos teóricos da transferência de tecnologia e do armazenamento de energia como catalisadores para o crescimento sustentável no setor de energias renováveis.

Método: A metodologia envolve uma análise aprofundada do setor de energia renovável da Índia, explorando o impacto de monopólios, práticas anticompetitivas e a rápida expansão de instalações de energia solar. O estudo considera o papel do direito da concorrência, da transferência de tecnologia e do armazenamento de energia como componentes-chave na condução dos desafios do desenvolvimento de energia sustentável.

Resultado e conclusão: Os resultados enfatizam a natureza interconectada da tecnologia, do armazenamento de energia e da legislação da concorrência na revolução energética da Índia. A conclusão destaca os imperativos de políticas públicas, enfatizando a gestão do lado da demanda, a resolução de disputas contratuais e a necessidade imperativa de sistemas de armazenamento de energia eficientes e econômicos. O documento conclui com um apelo a um quadro político que incentive a participação do setor privado e o reforço das capacidades no setor energético.

Implicação da investigação: As implicações desta investigação estendem-se à formulação de imperativos de política pública no setor da electricidade, enfatizando a necessidade de gestão do lado da procura, resolução de litígios e um quadro político para promover a participação do setor privado. A pesquisa destaca a importância desses imperativos no desenvolvimento de sistemas de armazenamento de energia eficientes e econômicos e na obtenção de energia renovável em tempo integral.

Originalidade/valor: A originalidade e o valor desta pesquisa residem em seu exame abrangente dos desafios e soluções interconectados no setor de energia renovável da Índia. As conclusões contribuem para o discurso sobre os imperativos das políticas públicas, a transferência de tecnologia e a lei da concorrência, oferecendo perspectivas que podem orientar legisladores, reguladores e empresas na promoção de um sistema energético competitivo, sustentável e resiliente. O estudo fornece orientações valiosas para maximizar os benefícios da energia renovável, contribuindo, em última análise, para o aumento do acesso à energia, a sustentabilidade e o crescimento econômico na Índia.

Palavras-chave: energia renovável, acesso à energia, direito da concorrência, transferência de tecnologia.
1 INTRODUCTION

India is a country rich in culture and diversity, but it is also battling with some of the world's most pressing energy issues. India has been working hard to increase its renewable energy sector and give its inhabitants access to clean energy. This goal is easier said than done. This article examines some critical issues India must address to achieve sustainable growth regarding access to electricity and clean energy.

Any nation's success and advancement depend on its residents' capacity to get and use energy efficiently. Two issues must be addressed in India: access to electricity and competition among market participants. Monopolies and anti-competitive tactics in India's electrical sector impede equitable access to energy. In the marketplace, competition law assures that everyone is playing on an equal playing field. This article discusses various topics relevant to India's electricity sector, such as the intersection of Indian legislation and energy access, the challenges of quickly growing solar power facilities, and the necessity for practical energy storage.

The article also discusses the importance of technology transfer in breaking down growth hurdles. In addition, the paper emphasises the need for energy storage in the constantly increasing solar power infrastructure. This is critical because solar power is one of India's most potential renewable energy sources. Unfortunately, the country’s large population demands more electricity than the sun can give during peak hours. It is critical to have the means to store energy for later usage to maintain a continual flow of electricity.

This article is a comprehensive overview of renewable energy concerns, such as the importance of technology transfer, energy storage, and the relationship between energy access and competition legislation. As the Latin phrase "Scientia potestia est" puts it, knowledge is power. By understanding these critical issues and working towards their resolution, India can power towards a brighter, more sustainable future.

2 RENEWABLE ENERGY AND UNIVERSAL ACCESS: OVERCOMING CHALLENGES FOR SUSTAINABLE DEVELOPMENT

Renewable energy is taking centre stage as global awareness of sustainability grows. With the improvements in the renewable energy sector, it is becoming more user-friendly. Yet, access to energy is a significant challenge in "providing economical, reliable, and socially acceptable energy services," which are required to meet sustainable
development goals. Energy availability is a necessary component for meeting fundamental human requirements. The absence of such access impedes the country's overall development.

The climate change report and the United Nations advisory committee report divide energy availability into three categories. First, basic human needs, then productive uses; and last, present societal demands. Estimated costs for establishing universal energy access are based on the breadth of "basic human requirements." The human demand includes a variety of heating and cooking fuels as well as technologies. In addition, it includes energy used for education, communication, health, lightning, and other comparable uses.

According to India's Census Report 2011, Previously, more than a third of Indian households had electrical lighting, while more than two-thirds of homes used old and traditional cooking fuels such as firewood, charcoal, and cow dung cake\(^2\). Conventional cooking fuels are bad for the environment and cause adverse health issues for rural women. As a result of these insufficient modern energy resources, many people meet their energy needs by utilising conventional or "black" energy sources. Rapid progress has been made in the last decade, with nearly every village in India having access to electricity by 2019\(^3\). According to International Energy Body report data, about 900 million additional people now have access to electricity\(^4\).

The government's Ujjwala initiative is a cornerstone project that aims to provide rural and low-income families access to clean cooking fuels like LPG, which would otherwise rely on conventional cooking fuels, including cow-dung cakes, coal, firewood, etc. This scheme has made a significant difference in recent years\(^5\). While the gas cylinder is an improvement over more traditional methods, it has yet to be a sustainable energy choice.

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In September 2010, former Secretary General of the UNO Ban Ki Moon set the goal of universal energy access by 2030, citing its significance in reducing poverty and achieving the SDGs. He stated that despite access to energy being an essential agenda for the International community, more reliable sources should be needed. It can leave people with low incomes without even the most fundamental necessities. Low-income people will be denied access to basic human rights and opportunities for economic growth. As a result, they would be forced to reside in and contribute to hazardously contaminated communities at home and in the workplace. Energy shortages also have severe effects on forests, soils, and rangelands. In a nutshell, it impedes progress towards the SDGs.

Regarding energy, the sustainability concept necessitates using existing resources to positively impact lives without jeopardising coming generations' interests in resource availability and environmental degradation beyond the ability of natural processes to correct the situation. Many societal concerns, like poverty, overpopulation, urbanisation, and a shortage of development potential, are inextricably linked to energy use. It is now widely understood in the global community that access to electricity is essential for alleviating poverty; without it, people are doomed to remain poor.

Since the first publication of the Brundtland Report in 1987, energy has been widely acknowledged as a crucial component of equitable and sustainable development, a report of the International Commission on Environment and Development. As outlined in them, national goals and strategies for long-term growth should prioritise energy. Yet, the World Energy Assessment: Energy and the Challenges of Sustainability study opined for global cooperation to ensure everyone can access these services and emphasised the inextricable link between energy, poverty, and other social issues. This report illustrates the significance of energy.

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7 ibid
3 THE INTERSECTION OF INDIAN LAW AND ACCESS TO ELECTRICITY

An individual's personal liberty and life shall not be compromised or deprived unless it is by the law, as stated in Article 21 of the Constitution of India. Said Article has both positive and negative features, has expanded into an inexhaustible supply of additional rights, and has been given the broadest possible interpretation by the judiciary\textsuperscript{10}. Furthermore, the court has enlarged the scope of the phrase "life" to provide the term "life" a good definition in Article 21\textsuperscript{11}.

Recent cases have clarified that the right to life is more than skin deep. Coralie v. Union Territory of Delhi\textsuperscript{12} established that every individual has the right to live to the fullest, with dignity and good health, regardless of circumstances. Justice Bhagwati went a step further, arguing that this right encompasses more than just basic necessities like food, clothing, and shelter. It also includes the freedom to move, associate with others, and engage in activities that elevate and enrich our lives\textsuperscript{13}.

Electricity is a fundamental human right under Article 21 of the Indian Constitution. Access to electricity is an integral part of this right. The courts have reinforced this in various cases, including Molay Kumar Acharya v. West Bengal State Electricity Distribution Co. Ltd. & Ors\textsuperscript{14}, and Bihar State Electricity Board v. Bihar State Human Rights Commission\textsuperscript{15}. The lack of access to electricity is like a thorn in the side of poor health, education, and economic inequality, hindering the realisation of other fundamental rights\textsuperscript{16}.

The right to life is about more than just survival. It includes the finer things in life that make living worthwhile. And electricity is an essential part of this equation, a real game-changer that brightens our existence and electrifies our path to a better future.

Using a broad interpretation of Directive principles of state policies, the Indian Judiciary has given new significance to the right to life as a fundamental human right. Many rights not explicitly specified in the Indian constitution have been incorporated by

\textsuperscript{10} Bhat S, Energy Law and Policy in India (National Law School of India University Bengaluru) available at https://ceerapub.nls.ac.in/journal-of-law-public-policy-vol-5/ (last visited 20 May 2023)
\textsuperscript{11} ibid
\textsuperscript{12} 1981 AIR 746, 1981 SCR (2) 516
\textsuperscript{14} AIR 2008 Cal 47
\textsuperscript{15} Civil Writ Jurisdiction case No. 7678 of 2012
interpreting DPSP\textsuperscript{17}. The courts have affirmed that people must save the environment and exercise their right to reliable energy service. The Apex Court's constitution panel held in the case of Bombay Municipal Corporation\textsuperscript{18} that the word "life" in Article 21 includes the "right to livelihood." The state must comply with Article 39(e) to protect its inhabitants' well-being\textsuperscript{19,20}.

Article 39(f) mandates the state to facilitate the means and environments necessary for the healthy growth of children. A new Article 21A in the Constitution furthers the goal of Article 39(f). The purposes outlined in the Directive Principles and the rights acknowledged as fundamental rights cannot be attained without modern energy services. Achieving the other rights the constitution grants will be challenging if the right to energy is not acknowledged. It is also worth noting that the objectives specified in many International human rights treaties cannot be realised in isolation without access to energy services. Hence, some argue that various existing human rights criteria already contain an implied right to cutting-edge energy services. Respectable living and the fulfilment of other rights depend on access to reliable and affordable energy sources. It is necessary to have access to reasonably priced, reliable, clean energy to realise one's goals and the various other rights outlined in the Indian Constitution and other laws. As a result, the right to access energy satisfies all requirements to be recognised as a right under Indian law.

4 POWERING THROUGH: INDIA'S UPHILL BATTLE FOR ACCESS TO CLEAN ENERGY

Energy serves as the connecting factor between increased social justice, global environmental sustainability, and economic progress. Inclusionary and long-term economic growth requires that all members of society have ready access to renewable energy. Providing affordable, reliable, and renewable energy to everyone is a long-term investment in our community because it multiplies economic growth at the national level by reducing economic inequality, expanding access to markets, fostering personal autonomy and ultimately empowering individuals.

\textsuperscript{17} Kundan, C., 'The Increasing Importance of the Directive Principles of State Policy and Judicial Activism' (2020) 3 IJSRED http://www.ijsred.com (last visited 20 May 2023)
\textsuperscript{18} 1986 AIR 180, 1985 SCR Supl. (2) 51
\textsuperscript{19} ibid
\textsuperscript{20} Naukarkar P. ‘Case Comment: Olga Tellis v Bombay Municipal Corporation ’[2022] Jus Corpus Law Journal
The United Nations General Assembly hit the nail when it declared 2014-2024 the "Decade of Sustainable Energy for Everyone." This campaign shows that we must harness the potential of clean & green energy to safeguard our future by recognising the benefits of renewable energy.

The Post-2015 Development Agenda aims to succeed in the Sustainable Development Goals and highlights the importance of accessible, affordable, reliable, and sustainable energy for all. This objective has been given the same weight as other essential rights, like the right to a secure environment and clean water.

However, for many Indians, this is still a distant dream. In a recent survey by the National Sample Poll Organization (NSPO), respondents indicated that they expected electricity to replace kerosene as the primary source of household lighting in rural areas by 72.7%. Kerosene is a primary illumination source in the homes of 3.2% of urban Indians. Perhaps the administration will take comfort in these figures, given that the rural sector contributed 62% in 1993–1994. Around 300 million Indians still rely on polluting and inefficient energy sources for their homes' lighting needs, which is hardly something to celebrate.

India continues to face the following difficulties:

5 ACCESSIBLE CLEAN ENERGY

Natural gas, oil, and coal account for most of the global electricity generation. The significant climate change, ozone layer depletion, melting of the polar ice caps, and rapid rise in sea levels are all attributable to the greenhouse gas emissions produced by burning these fossil fuels, which account for over 1/3 of total emissions. Despite technological and infrastructural developments, it is astounding to learn that there are still 1.3 billion people globally who lack access to power, with a sizable fraction living in rural India.

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23 ibid
The severity of this problem is shown by the fact that 300 million people in India alone are without power.\textsuperscript{26}

To successfully switch to renewable energy, India must first overcome several obstacles. Some of these issues include the extensive use of outdated technology, the poor quality of electricity transmission, and the excessive reliance on dirty and archaic energy sources.

6 STUCK IN THE DARK AGES: INDIA'S OVER-RELIANCE ON TRADITIONAL ENERGY SOURCES

For a plethora of reasons, cleaner alternatives are underutilised. Electricity is more expensive for rural households than other fuels; therefore, affordability and availability are critical. Rural energy distribution infrastructure needs to be more robust, resulting in consistent supply and low demand.

Although the government's Ujjwala project has connected 97.5\% of homes to LPG\textsuperscript{27}, maintaining LPG use is tough. Despite government subsidies, low-income families find LPG conversion costly due to bulk purchase limitations. Their revenue structure is suited to less expensive, smaller-quantity, and readily available subpar alternative fuel.

LPG bottling and distribution infrastructure needs to be improved to meet demand. This infrastructural gap inhibits LPG consumption, even with connections\textsuperscript{28}. Private distributors, who are critical to rural LPG supplies, suffer from low financial returns\textsuperscript{29}.

Due to underinvestment in renewable energy sources, much of the population has been reduced to using agricultural waste products, most notably sugar cane dregs and rubber tyres, as fuel sources\textsuperscript{30}. The combustion residue of these fuels poses numerous environmental and health risks, including soil contamination, aquatic life mortality, air pollution, odour production, and eutrophication of lakes and rivers\textsuperscript{31}.


\textsuperscript{27} Indian Petroleum & Natural Gas Statistics 2020-21, Ministry of Petroleum and Natural Gas, Economic and Statistical Division, Government of India, available at: https://mopng.gov.in/files/TableManagements/Indian-Petroleum--Natural-Gas_2020-21.pdf (last visited 20 May 2023)


\textsuperscript{29} ibid


\textsuperscript{31} ibid
The widespread use of biomass as a primary energy source in rural areas significantly strains scarce natural resources, adding another obstacle to the government's efforts to replace fossil fuels with renewable energy. Production of biomass fuel was initially considered a sustainable energy source, but researchers have since learned that the process could be more efficient and carbon neutral.

Concerns have been raised about the added biomass and possible detrimental influence on carbon emissions from the combustion of other fossil fuels like coal, as much of the coal used in India's power generation industry comes from the Gondwana Coal Deposits. Due to its high ash content and low calorific value, this coal is of low quality. Many here still need to use tungsten lamps, outdated air conditioners, and refrigerators despite the widespread availability of electrical power. Appliances in India are often less energy efficient than those in industrialised countries.

7 WASTING AWAY: POWER GENERATION INEFFECTIVENESS

The inefficient distribution of power is one of the country's most critical problems today. However, a remarkable transformation has been attempted in the last decade. Until 2001, electricity distribution networks did not reach or did not reach sufficiently to serve significant consumption hubs in the Indian states of Bihar, Orissa, and West Bengal. The subsequent development in the power industry raised annual per capita energy consumption from 15 kWh in 1950 to 814 kWh in 2011. Yet, power outages are still common in metropolitan areas, and some rural regions remain without electricity. Even though it has the world's third-lowest electricity tariffs, the country ranks only tenth in global power output.

The State Electricity Boards, responsible for delivering power to most houses in India, have racked up massive losses and liabilities in recent years. Liabilities and losses come from inadequate investment and high transmission and distribution losses from power theft, erroneous or nonexistent billing, system leakage, and other issues. As a result

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36 Ibid
of these setbacks, the board's financial situation is currently precarious. To survive, they had to resort to tariff changes to increase revenue. Given that state energy boards lack the resources to increase their distribution capacity, many rural communities still require connectivity to the grid. India's policy aligns with the country's goal of encouraging private sector involvement in generating sustainable energy, especially solar electricity. The government is creating an investment-friendly climate through initiatives like the JNNSM\(^{37}\), the private sector, and many other policies like the policy on concentrated solar thermal (CST) plants\(^{38}\). The incentive package has been successful nationwide, particularly in Rajasthan and Andhra Pradesh.

Some technical issues and inconsistencies, such as a deficient infrastructure for producing raw materials and components, plague investors. According to the World Bank study, tailoring incentive structures to specific circumstances is essential for developers to maximise the particular CST capabilities\(^{39}\). This could mean circumventing capacity constraints on individual plants and reducing the need for storage due to the massive economies of scale that may be realised for individual plants.

Long-term power purchase agreements with open, competitive, and stable pricing have proven to be the most effective method of captivating investors to renewable energy. The disproportionate focus on megawatt-scale grid-connected SPV projects, rather than off-grid and decentralised small solar applications, suggests a need for a more strategic vision. If smaller, decentralised, and off-grid applications are more relevant in the Indian context, then subsidies or financial help should be directed towards those.

**8 OUTSHINED BY WTO: INDIA'S SOLAR POWER REFORMS IN JEOPARDY**

India's efforts to transition away from its heavy use of fossil fuels and towards more sustainable energy sources have been hampered by a recent World Trade Organization judgement against the country's solar power programme (JNNSM)\(^{40}\). The decision was taken after the United States filed grievances with the WTO's dispute settlement panel\(^{41}\). The United States claims India's JNNSM incentive structure violated


\(^{39}\) ibid

\(^{40}\) Rosario Montella and Vera Domenica Giustino, “Barriers to Renewable Energy Development in Nigeria and how to overcome them” (Copenhagen Business School, 2021).

international trade regulations because it favoured Indian firms over American ones. The WTO ruling outraged those who fought for workers' rights and the environment\textsuperscript{42}.

JNNSM, a significant programme that promises to generate 100,000MW of energy, is one solution to India's continuously expanding demand for electricity. This energy is vital to the nation's economy and the expansion of its manufacturing sector. JNNSM's clean solar energy production programme is crucial for India's policies on climate change and energy security. Furthermore, there has always been an energy gap in India. A recent example of the country's significant shortfall during the summer is the 2014 power outage. It resulted in widespread power outages throughout North India, lasting more than 15 hours.

The Indian government places a premium on providing its citizens with reliable power, and renewable resources contribute significantly to the nation's electricity sector. As a result, the WTO ruling is widely expected to devastate the United State’s plans to modernise its energy infrastructure. This was exacerbated by the Supreme Court's decision to invalidate coal block licences obtained illegally or unfairly. Environmental and civil society organisations across the globe are condemning the decision, even though the full repercussions on the public and the nation's economic progress will only become apparent in the ensuing years\textsuperscript{43}.

The success of numerous international climate change summits and conferences, including the Brundtland Report, Agenda 21, and the Rio Summit, hinges on the widespread adoption of clean energy and solar initiatives. It is commonly held that all nations, particularly affluent ones where industrial activity is predominately responsible for the most significant carbon footprints, have this responsibility. Some think the World Trade Organization should stop interfering with efforts to combat climate change in different countries. Instead of imposing trade barriers in the name of free trade ideas, industrialised countries like the United States should appreciate India's accomplishments.

To add insult to injury, trade agreements like the Trans-Pacific Partnership and the Transatlantic Sale and Investment Partnership\textsuperscript{44}, which negotiate antiquated trade regulations, encourage the export of fossil fuels while discouraging the development of

\textsuperscript{42}ibid
\textsuperscript{43}ibid
\textsuperscript{44}Ashwini Arun Anita Yadav, Energy Law & Policy in India, Sairam Bhat (ed.), Manjeri Subin Sunder Raj and Pratham Guthi (assistant eds.), Book Series-2 (National Law School of India University Bengaluru, 2016).
nations' indigenous clean energy infrastructure. These rules make it harder for renewable energy to grow and don't show how bad the global disaster is.

9 ACCELERATING SOLAR POWER INSTALLATIONS FOR INDIA'S ENERGY SECURITY AND ACCESS TO ELECTRICITY

India's ambitious targets for renewable energy are a testament to the country’s commitment to clean energy and sustainable development. The country's progress in this area is impressive, with the cumulative installed capacity of renewable energy sources reaching 151.37 GW as of December 2021.45

India's vast potential for solar energy is highlighted by the IESS forecast, which estimates a solar power generation capacity of 756GW and 229GW46, depending on the threshold of direct normal irradiance.47 With the reduced cost of photovoltaic modules and technological advancements in the field of photovoltaic cells, the growth of solar installations in India is poised to accelerate.48 The doubling of capacity globally has resulted in a twenty per cent reduction in the cost of photovoltaic modules, making solar energy more affordable and accessible.49 Moreover, advancements in the conversion efficiency of photovoltaic cells by twenty-five per cent over the past four decades have made solar power generation more efficient and cost-effective. These advances encourage India’s future in the renewable energy sector and provide credence to the country's ambitious goals in this area.

The benefits of boosting the expansion of solar power installations in India are not confined to those suitable for the environment; they also substantially influence the nation's energy security. The reduction of hydrocarbon imports by 54% by 2047 (fig 6A) through a solar capacity addition rate of 8GW/year50, as computed by IESS, is a

46 ibid
prime example of the potential benefits. This will help India become more energy independent, reducing its reliance on imported oil and gas.

Moreover, the acceleration of solar power installations would also greatly benefit rural communities and those living in areas without reliable electricity. By expanding access to renewable energy sources, such as solar power, India could bridge the energy gap in remote and rural areas and provide electricity to millions without access. This would improve living conditions, promote economic development, and create new opportunities for these communities. Overall, the expansion of India's renewable energy infrastructure, specifically the growth of solar power installations, has numerous advantages, ranging from environmental benefits to energy security and improved access to electricity. As India continues to move towards a more sustainable and self-sufficient future, the importance of renewable energy sources, such as solar power, cannot be overstated.

![Graph showing the percentage of energy generation from different sources](image)

**10 TECHNOLOGY TRANSFER AND OVERCOMING BOTTLENECKS FOR ACCESS TO ENERGY AND ECONOMIC DEVELOPMENT**

The USA is making considerable progress in renewable energy with the launch of the two billion green energy corridor project, which can evacuate the power generated by a 20 GW renewable energy project. This project comprises 9,400 circuit kilometres of intra-state transmission lines and substations, with a capacity of 19,000 MVA\(^2\). The

\(^{52}\) ibid
project is expected to reduce 24 GtCO GHG emissions and reduce hydrocarbon imports by $0.7 trillion by 2027.

![Power generation Through fossil Fuels 2021](source: India energy security scenario calculator)

Energy access is vital to sustainable development, and securing universal energy access is a significant concern for many nations, including India. The Indian Renewable Energy Development Agency's unique strategy to encourage renewable energy development in the nation exemplifies how creative finance might aid in addressing this difficulty. The Indian Renewable Energy Development Agency fosters the establishment of renewable energy projects in the country by providing banks with two per cent interest money, which is then financed at a concessional rate for renewable energy projects. An enhanced capacity for renewable energy sources is essential for filling the energy gap in India's rural and remote regions, and this will help achieve that goal.

The availability of reliable, affordable, and clean energy will improve the lives of millions of people, providing access to electricity for households, schools, hospitals, and small businesses. Energy sources, such as wind and solar, can be installed in remote areas...
where grid electricity is unavailable, providing power to previously off-grid communities.

The innovative financing approach adopted by the Indian Renewable Energy Development Agency is a critical step towards revolutionising access to energy in India. It will assist millions of people in gaining access to electricity, particularly in rural regions, and will impact greenhouse gas emissions.

Although the United States and India approach renewable energy from distinct perspectives, each country possesses strengths that could help increase energy availability and contribute to developing a sustainable future. In addition, governments must establish a balance with their investments in innovative renewable energy technology and infrastructure.

There is a shortfall in solar panels due to the increasing demand in India, which is putting a strain on domestic producers. Many solar projects in India require imports due to a lack of thin-film technology. About 90% of India's current solar panels were imported to fill this void. This influences corporate earnings as well as developer and investor confidence.

The incorrect disposal of cadmium telluride film modules, which could harm the ecosystem, exacerbates the current situation. Tax reform may stimulate investment. The government must support research and assist India in acquiring technologies from advanced nations such as the United States and Europe. Moreover, more regulations to safeguard foreign enterprises, on the other hand, are impeding technology transfer.

To fully benefit from renewable energy sources through technology transfer, the Indian government must establish a stable and comprehensive regulatory framework that safeguards foreign investment while promoting the power industry. Sonia Baldia argues that US companies transferring technology to India must assess the legal landscape before signing a contract. The backlog in the Indian judicial system impedes litigation. Because Indian legislation supports domestic firms, technology transfer is more complicated.
Despite these challenges, technology transfer is essential to modernising India's economy. To avoid economic stagnation, the government must invest in cutting-edge technologies. The lack of regulation hinders India's overseas collaboration attempts. Therefore, if technology transfer is properly regulated and promoted, it has the potential to be an instrumental factor in reaping the social and economic benefits from the transferred technologies\(^\text{57}\).

By 2030,\(^\text{58}\) the Indian government intends to boost renewable energy capacity to 500 GW, meet 50% of its energy demands with renewables, reduce cumulative emissions by one billion tonnes, and lower GDP emissions intensity by 45%. This is an ambitious goal.

As the saying goes, "When there is a will, there is a way." to meet this target, India must address the challenges related to technology transfer and import dependence and develop a comprehensive legal regime that safeguards the interests of foreign companies while promoting the growth of the renewable energy space. India needs to take advantage of the benefits of technology transfer and take measures to protect its interests and reduce environmental impact. With the right policies and initiatives, India can achieve its renewable energy goals and ensure access to energy for all.

\section*{11 RESULT AND DISCUSSION}

\subsection*{11.1 COMMITMENT TO RENEWABLE ENERGY AND TECHNOLOGY TRANSFER FOR ENERGY STORAGE}

During the 2015 Paris Climate Conference, India pledged to fulfil 35% of its energy needs with renewable resources by 2030. Several governmental actions to boost the percentage of renewable energy will need to be implemented to accomplish this pledge. One of the key challenges in integrating renewable energy into the grid is the need for a reliable and efficient energy storage system. Without such a system, it isn't easy to maintain the grid's stability with fluctuating renewable energy inputs.

To address this challenge, the Indian government launched the Transformative Mobility and Energy Storage Mission in 2019. The mission's ultimate objective is to promote the usage of electric vehicles and enhance the adoption of energy storage

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\footnotesize{57 Sonia Baldia, Navigating Cross Border Legal Risks in IP Licensing and Technology Transfer to India, 191 PLI 335 (2009), available at http://works.bepress.com/sonia_baldia/5/ (last visited March 1, 2023).}

\end{footnotesize}
technology in India. To investigate and assess the 40 GW grid integration of solar roofs to be linked to the medium and low voltage grid\textsuperscript{59}, the Ministry of New and Renewable Energy worked with the Indian Smart Grid Forum to produce the Energy Storage Roadmap for India 2019–2032.

The programme outlines a staged approach to implementing energy storage systems, with a projected installed capacity of 10 GW by 2022 and 50 GW by 2030. The roadmap highlights the need for various energy storage technologies, including thermal energy storage, battery energy storage, and pumped hydro. In addition to this, it highlights the importance of having a legal framework to develop and implement new technologies.

Many energy storage measures have lately been deployed in India. Permit requirements for hydro-pumped storage facilities and battery energy storage systems that meet specified criteria are waived by the Ministry of Power. Furthermore, until 2025, solar and wind energy projects are exempt from interstate transmission taxes. Energy storage is critical to India's renewable energy ambitions. A precise action plan is required to harness energy storage's potential in a constantly evolving technological world. The Energy Storage Roadmap and Transformative Mobility and Energy Storage Mission demonstrate the government's dedication to energy storage, which will assist India in achieving a sustainable energy future.

By 2030, India plans to have met 35\% of its energy needs using renewable sources. Integrating renewable energy into the grid requires an active demand response and energy storage system to maintain stability.

Despite no specific legislation governing the regulation of energy storage in India, the government has taken significant steps towards its development. In collaboration with the Indian Smart Grid Forum, the Ministry of New and Renewable Energy (MNRE) has prepared the Energy Storage Roadmap for India 2019-2032 to study and analyse the grid integration of solar rooftops. Moreover, the government has been issuing tenders for energy storage, and Renewable Energy Limited (NREL) is set to build a 3000MWh battery storage\textsuperscript{60}.

India's commitment to low-carbon growth was communicated through its Intended Nationally Determined Contribution (INDC), aiming to reduce carbon

emissions by 25% by 2030. With the challenge of climate change, the government seeks to improve energy security by achieving the objective of lowering reliance on fossil fuels with the infinite technological potential of solar energy in India. The success of the Jawaharlal Nehru National Solar Mission in achieving its PV target and cost-effectiveness through the reverse bidding process has been an essential step towards meeting the renewable energy targets set by the government.\(^{61}\)

India is committing itself to a cleaner, greener future, setting ambitious targets for reducing emissions and increasing renewable energy.\(^{62}\) India has demonstrated success in solar energy. But as the saying goes, "Rome wasn't built in a day" - achieving these goals will require the transfer of technology and a legal framework that can support and encourage innovation. Policy interventions are needed in the sector to achieve what India has committed to attaining net zero by 2070. To get net zero emissions, Professor Martin Cave stresses energy policy reform. Power production, networks, and retail need these adjustments.

According to the interpretation of Professor Martin Cave's lecture, I propose and resonate with the view that carbon emissions must be reduced by switching to clean energy. Energy authorities must promote renewable energy and penalise carbon-intensive sources. Grid improvements, storage, and new transmission lines are needed to support renewable energy.

Increased power consumption necessitates transmission and distribution network enhancements. Regulators must plan for increased power capacity and renewable energy integration. New rules are needed to stabilise the grid and integrate new distributed energy resources like electric cars and energy storage devices. Regulators must decide whether to phase out natural gas or switch to low-carbon alternatives like hydrogen. Retailers reduce energy consumption and capacity. Businesses and regulators must create energy efficiency and low-carbon technology regulations.

In the race to move away from non-renewable energy sources, it's clear that renewable energy is the winning horse. Developing countries, in particular, need new technology to make this switch, but the cost can be daunting. There are organisations like

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the Green Climate Fund and developed nations that can offer low-cost financing and technical assistance to countries like India.

The writing regarding renewable energy is on the wall - it's necessary for the future. And yet, the transfer of technology is an expensive and complex process that requires a great deal of investment. Developed nations, with their concentration on research and innovation, are in a position to lead the way in this field. But without adequate regulations, the transition to renewable energy could be hindered. This is where competition law comes in, ensuring that new technologies are introduced in a way that fosters growth and innovation.\(^{63}\)

It is well known that international cooperation can spur innovation and development. This entails working with multinational corporations to advance indigenous research and technology in India. There is still work to develop a comprehensive technology transfer framework to remove obstacles and facilitate this crucial transformation, even though India has historically been a top recipient of technology transfer from Europe. It is essential to take lessons from previous judgments and ensure that new rules connect policies with current legal frameworks as we traverse the complexity of competition law and technology transfer.\(^{64}\)

11.2 INDIA'S AMBITIOUS RENEWABLE ENERGY GOALS AND THE CRUCIAL ROLE OF ENERGY STORAGE

India has made considerable progress in renewable energy deployment, with the government setting a target of reaching 500 GW through renewables by 2030.\(^{65}\) However, energy storage is crucial in integrating renewables with the country's power system. The Indian government, with the help of expert committees, has formulated policies encouraging the energy sector to foster battery manufacturing, expand supply chain tactics, and increase battery cell production. The aim is to build a framework that aligns with manufacturing, storage, and innovation and supports the country's efforts to deploy renewable energy.


\(^{65}\) https://pib.gov.in/FeaturesDetails.aspx?NoteId=151141&ModuleId%20=%202 (last visited on April 22, 2023)
In 2018, the government committee formulated a policy on energy storage to provide a roadmap for India's energy infrastructure. The policy encourages energy storage and creates a framework that supports manufacturing, storage, and innovation. Additionally, through the think tank NITI Aayog, the government developed a report outlining India's energy storage mission, proposing a three-stage solution that fosters battery manufacturing environments, expands supply chain tactics, and increases battery cell production.

Although the coordinated efforts of the government were able to achieve 66% of the 175 GW target by August 2022, more resilience and thrust are needed to accomplish the remaining target. The data shows that the new solar installation was 22% more than the previous year, with solar constituting 89% of the renewable energy installed. If the target had been achieved, it could have gained 19.44% of India's total potential of 900 GW of renewables and about 20.3% of its total electricity demand. India can surpass several advanced nations in its production of green energy if it places a greater focus on energy storage.

11.3 EVOLUTION OF INDIA'S POWER SECTOR: FROM MONOPOLY TO PRIVATISATION

India's power sector has long suffered from endemic power shortages, with the electricity board and companies operating in the sector experiencing constant losses due to inefficiencies, lack of technology, and colossal commercial losses. Despite this, the government has continued to grant subsidies as a mere appeasement technique, highlighting the growing commercial revenue deficit in the sector.

The Indian government had a stranglehold on the power sector, with the Industrial Policy Resolution of 1948 giving them a dominant role in initiating and regulating major economic areas, including electricity. The Central Electricity Authority and the State Electricity Boards were set up by the Electricity Supply Act of 1948 to ensure reliable and safe power distribution throughout the country and the states. The state boards were

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autonomous institutions responsible for developing and implementing power generation, transmission, and distribution. As a result, the government held a tight grip on the electrical market, with little participation from private companies and a monopoly on the industry.69

Until 1980, the electricity services in most developing nations and several developed countries in Europe were generated and distributed primarily by state-owned monopolies. India followed and continued a similar trend until 1991.70 In India, the power sector was governed mainly by a vertically integrated entity that operated under individual state governments. State-owned integrated electric utilities were founded on the premise that the power business is a natural monopoly, except in the United States and Japan. However, natural monopolies often did not serve the people's best interests. The denial or restriction of competition in the power sector resulted in poor service delivery, inefficient resource utilisation, and little emphasis on customer benefits.71

The inability of state-owned monopolies to deliver power cost-effectively and efficiently necessitated evaluating and reforming current policies and considering the opinions of corporations in the sector.72 The government acknowledged the significance of a framework to balance and give fair recognition to diverse stakeholders to sustain the electricity sector's profitability and reduce the transaction costs that would be paid due to the privatisation process.

Recent international experience has taught India that power generation is not and should not be a natural monopoly. The government can differentiate between the process of electricity generation and distribution and establish competition in electricity generation. As new methods of energy generation are being created, introducing competition to this sector is crucial, and renewable energy sources are just one of them. Consumers will have a myriad of options from which to choose.

In addition to the efforts towards boosting renewable energy, the Indian government has also been taking steps to promote competition in the energy sector. The Competition Commission of India (CCI) has been actively involved in regulating and enforcing competition law in the energy sector, including addressing anti-competitive

72 ibid
practices and ensuring a level playing field for all players. This has led to the breaking up of monopolies and the promotion of healthy competition, further boosting the growth of renewable energy.\(^\text{73}\)

Competition law protects the interests of both consumers and competitors in the renewable energy market.\(^\text{74}\) Moreover, the Electricity Act of 2003 has facilitated competition by allowing open access to transmission and distribution networks and promoting power trading. These measures have attracted private players in the energy sector, resulting in increased investment and greater consumer access to energy.\(^\text{75}\) The combination of renewable energy growth and competition in the energy sector will significantly impact India's overall development, leading to increased energy access, sustainability, and economic growth.\(^\text{76}\)

Tariff-based competitive bidding (TBCB) was introduced in 2006. As of 31\textsuperscript{st} January’2023, 68 transmission projects are under TBCB. Out of which, 44 are commissioned, 24 are under construction, and out of 24 are under construction projects, eight are to PGCIL, and 16 are to private players. The leading private players include PGCIL, Adani, Sterlite, Resurgent, and ReNew Power. There are BCB projects that form about 6% of the power grid’s assets and only a handful of Intra-state projects under TBCB.\(^\text{77}\)

The relationship between competition law and renewable energy is dynamic, and there are ongoing debates about how to strike the right balance between promoting competition and promoting renewable energy. Some critics argue that competition law is too focused on short-term market efficiency and does not adequately account for the long-term benefits of renewable energy. Others argue that renewable energy subsidies and incentives distort competition and undermine the effectiveness of competition law.


\(^{76}\) ibid

12 CONCLUSION

There are public policy imperatives in the electricity sector. Firstly, demand-side management, including intra-day demand-based differential rates and energy efficiency practices, should be prioritised—secondly, Fast-tracking resolution of Contractual and tariff-related disputes. Thirdly, Change in Law and Force Majeure issues must be addressed with due diligence. All the above imperatives are required to develop efficient and cost-effective Energy Storage Systems to have ‘Round the Clock’ renewable power. The accessibility to electricity to each household is possible by increasing the share of the short-term power market and developing a common understanding of policy requirements across geographies. Policy framework to encourage the participation of the private sector in all spheres: Generation, Transmission and Distribution are needed to promote competition in the market by honouring contracts. Capacity building of the power sector (including regulatory commissions) and achieving political consensus to treat electricity as ‘commercial’ goodwill cater to the market with efficient and effective competition.

The Indian government has increased renewable energy development and given customers more alternatives by breaking up monopolies and encouraging healthy competition. The combination of renewable energy growth and competition in the energy sector will significantly impact India's overall development, leading to increased energy access, sustainability, and economic growth. To maximise the benefits of renewable energy, policymakers, regulators, and businesses must work together to ensure that competition law is adequately enforced and updated to reflect the changing realities of the renewable energy market. By doing so, they can help create a more competitive, sustainable, and resilient energy system that benefits everyone and achieves access to energy in the true sense.
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