A Balancing Act: The Challenges of Fostering Both Climate Change Mitigation Strategies and Sustainable Development Projects in Rural India

by

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Abstract

Climate change is considered one of the most threatening and challenging environmental issues of today and is one of the vital public and political concerns of our time. India's government has made several international commitments in response to this global crisis to establish itself as a frontrunner in climate action; however, it is at crossroads of sorts, as its energy and development requirements moving forward will undoubtedly shape its response to climate change. With roughly 70 million residents of India living in extreme poverty and another 300 million without access to electricity, India is struggling to balance environmental sustainability efforts with its socio-economic responsibilities, as it is still heavily reliant on non-renewables for its energy production capacities and development initiatives. This major research project examined India's response to this balancing act and its use of innovative policy initiatives to create an inter-linkage between sustainable energy and development to address a challenging aim: implement mitigation and adaptation strategies that provide economic growth opportunities while simultaneously intending to reduce emissions intensity. By conducting a research synthesis, the study found that through decentralized energy projects and aggressive environmental policy, India can provide electricity for marginalized communities and boost their renewable-energy capacity. However, questions still surround energy access, energy efficiency, and energy security in rural parts of the country. Ultimately, this study found that mitigation and adaptation efforts guiding these initiatives require a balance between energy policy, finance, and investments in capacity and opportunity to meet development needs best and the challenges of climate change.

Keywords: climate change, sustainable development, renewable energy, development

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Conversations surrounding poverty reduction strategies that mitigate against increased greenhouse gas (GHG) emissions, and provide opportunities for at-risk populations, have been increasingly more pronounced (DFID, 2017; UN, 2017). These conversations have led to a growing focus on developing nations to provide additional measures for intervention and response efforts for marginalized communities while not limiting human and economic growth opportunities. The Kyoto Protocol, an international treaty adopted in 1997 and instituted in 2005, under the United Nations Framework Convention on Climate Change (UNFCCC), was established to help prevent the onset of climate change by reducing GHGs. The Kyoto Protocol looked to developed countries to reduce GHG emissions. However, it was also crucial for developing nations, as it not only deemed that they bear less of the responsibility for the accumulated GHG burden from past activities but also recognized their need for social and economic development together with their need to curtail GHGs, and how these two commitments might interact, which became known as 'common but differentiated responsibilities' (CBDR) (Rajan, 1997; Almer & Winkler, 2017). Furthermore, in 2015, the global community signed The Paris Agreement to deal with mitigation, adaptation, and the financial efforts associated with climate change, cultivating a more collaborative and cooperative effort between states. Fifteen years after the Kyoto Protocol, and almost five years after the Paris Climate Agreement, steps are still underway, with international participants continually pushing to reduce GHG emissions through policy and projects in the hope of meeting the global effort to contain warming to below 2 degrees Celsius (IPCC, 2007; Bhatt et al., 2018).

India is a diverse nation faced with many of the challenges found in developing parts of the world: cultivating health and education, sanitation, employment, and clean drinking water (DFID,

2017). Notably, India became the 80th country to participate in the second commitment period of the Kyoto Protocol and is one of a handful of countries on track to meet its climate pledges under the Paris Agreements—seemingly determined to make its mark as a frontrunner in renewable energy and sustainable development (Bhatt et al., 2018). In 2014, before the Paris Accord, India announced its plan to increase renewable energy to 175 GW by 2022, which was four times its output at the time, and claimed renewable energy would contribute around 20 percent of their total electricity generation (CEA, 2018). Since then, the target has been increased to 227 GW by 2022, putting India in the top five for countries investing in the renewable energy sector, sitting fourth behind China, U.S.A, and Japan, with funding rising from $600m in 2018 to $800m in 2019 (BNEF, 2020). Furthermore, India also committed to reducing the emissions intensity of its 2005 levels of GDP by 33 to 35 percent by 2030 (Gupta, 2018). India's goal of increasing renewable energy production and improving emissions intensity is considered by many to be ambitious, opening a debate around whether they are currently in a position to meet, or surpass, these targets (Sadath & Acharya, 2017; Dubash & Gnosh, 2019; den Elzen et al., 2019).

With mounting pressures from the global community for climate action taking shape through advocacy and awareness worldwide, India is in a position to capitalize on this momentum and use it to propel their political and socio-economic goals (Gnosh, 2015). However, as with many developing nations attempting to balance mitigation efforts and sustainable development, climate action can become more of a concern than a priority. India is a country with a growing economy and a rising energy demand, yet a large portion of its population still struggles with 'energy poverty,' or insufficient access to electricity and other forms of energy (Torero, 2015). With roughly 70 million residents of India living in extreme poverty, and another 300 million without access to electricity, India is struggling to balance environmental sustainability efforts

with its socio-economic responsibilities, as it is still heavily reliant on non-renewables for its energy production capacities and development initiatives (Molyneaux et al., 2016; Malakar, 2018). Plagued with staggering levels of poverty and pollution, India has found itself in a situation where its climate policies are being influenced and shaped by internal priorities such as energy access, energy security, and uneven development across the country (Malakar & Mishra, 2017; Raju et al., 2017).

This paper will explore these themes and will be organized as follows: the first section introduces the research problem followed by the research question and significance of the study; the second section describes the current academic and grey literature on the state of India's climate and socio-economic efforts; and the third section presents a summary of India's actions and policy initiatives to tackle these intentions and outlines of how their behavior either helps combat these obstacles of climate change and sustainable development or contributes to them.

Research Problem

Considering there are around 70 million residents of India that fall under extreme poverty, there are mounting pressures, both nationally and internationally, to increase economic growth alongside rapid poverty eradication to improve adaptation efforts for those at risk, as they are increasingly more vulnerable to climate change (Malakar & Mishra, 2017). These pressures have fostered new ambitious policy initiatives and projects to be proposed to expand the reach of electrification to promote socio-economic growth while also trying to limit the environmental impacts from non-renewable energy sources. To achieve this, local Governments in India are proposing decentralized solutions, such as mini- or micro-grids, as an alternative to connecting communities located far from central grid infrastructure (Srivastava & Rehman, 2006). India

provides a classic example of the developmental challenges faced by more extensive, developing nations: balancing continued economic growth that supports a diverse population while trying to reduce (or at least contain) GHG emissions and other climate change concerns. Although seemingly conflicting in the short term, this balancing act of instilling a new political economy of sustainable development is paramount for continued long-term human advancement.

Research Question

What evidence is there that India has made progress towards their stated policy objectives to advance energy security and align environmental and socio-economic development through decentralized electrification solutions, and how has this been done?

Significance of the Study

As our world becomes more interconnected and intertwined through technology and circumstance, so too should our ways of approaching development. There should no longer be a focus on single-point policy measures or individualized initiatives when a more holistic, multi-faceted approach could be more beneficial in dealing with global issues that simultaneously impact both our planet and our populations (Stephenson et al., 2013; Sreenivas & Gambhir, 2019). The environment has been a significant issue over the last few decades and continues to become one of the critical public and political concerns of our time (Hansen, 2011; Zhang & Liu, 2012). With an increasing population, more and more countries face congruent environmental issues stemming from a growing demand for resources and industrial expansion (Rai & Rai, 2013). Developing countries require economic growth, as it provides many of the fundamental opportunities needed for progress; although, this progress is contingent on various other factors, such as the policy that drives it and the mechanisms used to enhance its impact (Lopez, 2010). Evidence and predictions

show that climate changes are accelerating and that these changes can significantly influence food and agriculture production, temperature and rainfall, weather events, health, and nutrition (Rai & Rai, 2013). Unfortunately, the most dramatic impacts of climate change are in the developing world, due to insufficient adaptive capacity, exposure, and a heavy reliance on climate-sensitive sectors, which results in profound socio-economic impacts, either directly or indirectly (Stern, 2006; IPCC, 2007; Cline, 2007; Tyler, 2010; Zhang & Liu, 2012). The increased use of fossil fuels throughout the developing world has raised severe environmental concerns concerning the acceleration of climate change (Bierbaum & Zoellick, 2009; Raju et al., 2017). Currently, India stands as a significant contributor of GHG emissions, as their electricity generation is largely based on non-renewable fossil fuels like oil, gas, and coal (Sathaye et al., 2006).

India is a vast and diverse country with varying landscapes and a rich cultural history. Comprising of 28 states and eight union territories, India has the second-largest population and the most populous democracy in the world—with a large portion of India's population living in rural areas, developmental policies specifically designed for these communities have been an essential component of political strategy and planning (Chindarkar, 2017). According to Sreenivas and Gambhir (2019), India's four major energy sectors are industrial, residential, agricultural, and transportation, which make up roughly 90 percent of all energy consumption in the country. Of the four, residential electricity consumption has been rising significantly in the last few years, more so than in other sectors. In turn, significant efforts have been put into the development and electrification of rural areas to improve quality of life at the household level, healthcare, education, and maximize agricultural and industrial efforts (Khandker et al., 2013). As each state handles its issues and security, different approaches and varying tactics have resulted in an attempt to tackle these development issues, primarily with 'energy poverty.'

Energy poverty is typically defined as insufficient access to electricity and other forms of energy and is an issue that affects more than a billion people around the world (Torero, 2015). The International Energy Agency (IEA) states that energy poverty comprises of a reliance on traditional biomass fuels (wood, coal, dung) and a lack of access to electricity (IEA, 2016). More recently, the United Nations and the United Kingdom's Department for International Development have broadened definitions of energy poverty to encompass multiple indicators—as poverty is typically viewed as a lack of income and is not often considered for its other dimensions such as health, education and living conditions (DFID, 2017; UN, 2017). The energy poverty discourse has been primarily focused on the interrelation between access to electricity and socio-economic growth, as a reliable source of energy is considered by many scholars as the most crucial link to improved economic development and quality of life (Kirubi et al., 2009; Halff et al., 2014; Chakravorty, 2014; Yadav et al., 2019). The concept of energy poverty is considered to be a result of financial, social and technical circumstances, unfair or regressive pricing structures, subsidies for energy technologies, poorly designed or targeted energy efficiency policies, or limited transmission infrastructure (Kirubi et al., 2009; Barnes et al., 2011; Halff et al., 2014). One of the major developmental concerns associated with a lack of electricity is a lack of power in residential homes and insufficient energy for industry and businesses (Ghosh, 2015).

As previously stated, there are around 300 million Indian residents without electricity access, which will eventually lead to increasing demand for energy access and energy production around the country (Chakravorty et al., 2014). In April 2018, according to the World Economic Forum's Global Competitiveness Report, the government of India, led by President Narendra Modi, announced 100 percent rural electrification—meaning that all villages were either connected through the convectional grid or a decentralized generation system. President Modi

promised to bring 'power to all' that helped garner support by the many marginalized communities in India left in the dark, and eventually cemented his seat as the president in 2014 (D'Cunha, 2018). In 2015, the Modi government released a plan to electrify the entire country within 1000 days, which meant that basic infrastructure would be installed, electricity would be provided for public services, and at least 10 percent of households in areas without power would now have access (Agrawal et al., 2020). This plan was eventually accomplished and deemed a 'success story.' However, there are still questions surrounding the quality and affordability of this 'access' to electricity, its utility for poorer households, and how this power will be generated as more and more people look to benefit from it (Kumar, 2018; Tripathi, 2019).

This situation in India highlights an interesting divide between policy and performance in developing countries and illustrates how the mechanisms that make up a particular development scheme can often be overlooked in pursuit of progress—creating a divide between the means and the motive. With a heavy reliance on non-renewable resources for energy production, this increase in demand across India, and the developing world, creates environmental concerns due to the risk of increased emission levels (Molyneaux et al., 2016). Consequently, as India looks to address those t living without access to reliable energy while meeting commitments through the Paris Agreement and their own NDCs, more emphasis will be required on alternative methods of providing energy access—limiting GHG emissions by adopting distribution generation technologies based on renewable energy sources (Gnosh, 2015).

Tracing India's early negotiations in International and national forums and reviewing policies such as the *Rural Electricity Supply Technology Mission* (REST) and *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY), it could be argued that India has clearly articulated a policy position that aligns with the balancing of climate action and socio-economic needs.

Furthermore, this study will explore specific case studies in Uttar Pradesh, India, where decentralized solutions, such as rural electrification projects, were implemented to meet these demands and the particular conditions that enabled their success or failure.

Theoretical Framework

This research aims to investigate the intersection between socio-economic development and environmental sustainability through policy and programs in rural India, such as decentralized electrification projects. To accomplish this, a Research Synthesis was conducted, primarily through the collection and categorization of information from secondary sources related to the subject. These provided a summary of the current findings and helped identify gaps in the literature that may not have been addressed, for which this research might hopefully contribute in a useful and meaningful way.

Literature Review

This review comprises three central literature bodies: the inter-linkage of climate and development policy for emerging economies, India's national climate and development action, and India's policy implementation and challenges. These categories will be followed by a summary and case study illustrating these issues and how they relate to India's approaches. The following sections will provide a more comprehensive comparative policy analysis of India's strategies that have contributed to their current position on this inter-linkage between environmental sustainability and socio-economic growth. These will outline India's motives and commitments from early international forums to a more focused understanding of the nationally based projects and policy measures implemented in recent years.

Inter-linkage of climate and development policy for emerging economies.

Climate change is considered one of the most threatening and challenging environmental issues of today and has far-reaching implications on oceans, weather systems, food sources, and human health. A specific result of climate change, and one that has gained significant scrutiny, has been rising temperatures. A warming planet has the effect of making weather more extreme, with more intense storms and more prolonged and more recurrent droughts, which impact agriculture, animal migration, and water supplies (WMO, 2019). Further, climate change can have a considerable impact on people's health by acutely creating an environment with increased smog and pollution, leading to asthma, heart disease, and cancer (SoE, 2017; Caniglia et al., 2020). Since the pre-industrialized era, studies show that the Earth's climate has changed dramatically, with evidence indicating that a majority of the warming detected over the last 50 years, roughly 0.1 °C every decade, is mostly due to human activity (Sathaye et al., 2006). This consistent rise in global temperature is expected to further impact ecosystems and the livelihoods that make them up, primarily threatening developing countries, as they struggle with internal displacement through disasters and conflict (Jiankun et al., 2012; Stephenson et al., 2013).

The terms 'sustainable development', 'environmental justice,' and 'social ecology' have become increasingly popular in recent times, being used by the masses and media alike as more attention is aimed at global health. These terms and concerns are not new by any means and are most notably traced back to the Stockholm Conference in 1972—a UN conference on the environment, designed to discuss issues surrounding sustainability—and the Stockholm Declaration and Action Plan for the Human Environment, which outlined measures needed to ensure proper management of the environment (UN, 1973). Faced with more pronounced environmental concerns during this period, the global community witnessed the first collective

effort to address problems like depleting resources and ecological degradation (Mauss & Berg, 1972). Further measures were addressed as the World Commission on Environment and Development (WCED) released its 1987 Brundtland Commissions Report, a more unified effort to address these mounting trepidations. The report famously explained 'sustainable development' as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p.24). The Brundtland report highlighted some reasonably significant risks associated with the planets prevailing trajectory and sparked further unification and global involvement, which was put front-and-center in the 1992 Rio Earth Summit (Egelston, 2013; Borowy, 2014). This UN summit helped cement a more focused effort for sustainable development by adopting Agenda 21, which put forth more practical and pronounced mitigation measures. As discussions progressed and plans started to take shape, quantified targets for action were not fully established until the United Nations Millennium Summit in 2000, which brought together 189 countries to declare their support and commitment in addressing more sustainable efforts with issues from extreme poverty and education, to environmental sustainability (Basu & Shankar, 2015). In 2002, the World Summit on Sustainable Development, held in Johannesburg, looked to expand the global sustainability efforts by including a more comprehensive approach to development by considering social and economic aspects to advance a well-rounded approach to global care (Egelston, 2013). These efforts have led to more cumulative discussions surrounding economic, social, and environmental phenomena in both developed and developing countries.

Compared to more developed, industrialized nations, India has produced relatively little in terms of overall emission levels responsible for the effects of climate change, yet has indeed started to see its consequences (Dubach & Ghosh, 2019). The center for Science and Environment (CSE), a research and advocacy think tank out of New Delhi, releases an annual State of India's

Environment report, which has identified that India is warming faster than the rest of the world. They have recognized that every year since 1995, temperatures have risen in parts of the country, documenting the warmest years ever recorded, leading to a growing prevalence of droughts and evidence of declining yields, which are predicted to only accelerate if temperatures continue to rise (SoE, 2017). Pollution, namely air and water pollution, is rampant throughout the country, with the last decade providing stark examples by way of lakes being on fire and thick smog blanketing cities where air quality indexes reach the limits of the measurement tools used to measure it (Abraham, 2018). Although severe in India's case, these examples are common in developing parts of the world, where the focus is typically more so on poverty than pollution (Ürge-Vorsatz & Herrero, 2012).

Development has been recognized in India as a principal element in policy creation since the middle of the 20th century—consistently meant to target equity and poverty alleviation (Chopra, 2017). However, during this time in India, there was little to no mention of environmental conversation or the need for environmental policy, let alone any attention paid to climate change (Jorgensen, 2020). As a growing economy, India was more concerned with not hampering advancement and capitalizing from the 'top-down' development approach through technology and funds than its long-term environmental trajectory (Chopra, 2017). Policies and Acts in India continued to evolve during the year's post-independence, with the Planning Commission instituted in 1951 responsible for developing Five-Year Plans, which were centralized and integrated national economic programs meant to guide policy (Jorgensen, 2020). The first of these Five-Year Plans were introduced alongside the commission's inception, with a heavy focus on economic and social change within areas like inequality of income and inequality of opportunity, and was the first policy plan that outlined this idea of 'inter-linkage' between national interests, where actions

were being undertaken simultaneously through multi-faceted policy initiatives and projects (Srivastava & Rehman, 2006; Chopra, 2017; Ciecierska-Holmes, 2020). All this to say, India is no stranger to national policy programs aimed at local development, and as a review of past international meetings will show, India has also been part of the global conversations surrounding sustainable development for nearly three decades.

India's road to sustainable development, along with many other developing nations, began on the international stage through conferences held to address global concerns. As International discussions on environmental issues started to take root in Stockholm in 1972, it wasn't until 1990, during the Conference of Select Developing Countries on Global Environment Issues, that India began to take more of a participatory role in the negotiations and generated support from other developing countries on what the future of climate action should look like between the developed and developing world (Sengupta, 2019). Conversations continued again at the 1992 Rio negotiations, which marked the beginning of economic reform in India. From here, India considered a more balanced approach—leading to the concept of 'sustainable development' officially recognized in 1995 through four supreme court judgments that pushed the need to balance environmental protection and socio-economic development moving forward, which will be explored in the following chapter (Basu & Shankar, 2015). These international conferences were a critical turning point for India, and events that garnered much attention, as a large portion of the rural population at that time, and their livelihoods, were reliant on sectors heavily influenced by climate and resource management (Sathye et al., 2006). It was in Rio that India claimed its strong support for poverty eradication and socio-economic development as a 'priority of developing countries', whereby the ability of developing countries to be successful in meeting their

targets would rely on the ability of developed countries to fulfill their commitments in finance and technology transfer (UNFCCC, 1992, p.8).

India continues to participate in global negotiations concerning climate change and the proposed strategies to combat global warming and has recently become more engaged in the effort by declaring international commitments under the Paris Agreement. India announced their role in tackling climate change by making three commitments in its intended Nationally Declared Contributions: first, to reduce the GHG emissions intensity of its GDP by 33-35% below 2005 levels; second, to achieve 40% of installed electricity capacity to be renewable or nuclear by 2030; and third, to create an additional carbon sink of 2.5 to 3 billion tonnes of Co2 by 2030 (Bhatt et al., 2018). Dubash and Ghosh (2019) identify how India started with a relatively low bar when it came time to articulate climate policy under their Nationally Declared Contributions through the Paris agreement, providing them the opportunity to set their social and economic goals better to align with their climate and development priorities.

India's national climate and development action.

India has made significant progress in the international realm through its work and discussions from the Rio Earth Summit to the Paris Agreements, but these pledges did not lend themselves to substantial local changes at home and could be seen as merely bargaining statements in the face of international negotiations (Sreenivas & Gambhir, 2019). When looking to enact change that is both population lifting and long-lasting, it is only through national and local policy measures that real progress can be made.

Environmentalism made its first appearance on India's political agenda after the first United Nations Conference on the Human Environment in 1972, where the subject of sustainability was

put front-and-center at a global scale. Here conversations around pollution, soil erosion, water, air quality, and the environment inspired the Indian government to rethink their approach to environmental demands and pushed them to consider new ways of addressing the environment while concurrently protecting economic growth (Agrawal & Yokozuka, 2002). These conversations led India to pass the Environmental Protection Act of 1986 to protect and improve the environment and an all-encompassing framework for central and state authorities to coordinate environmental sustainability activities and preserve and enhance the human environment (Srivastava & Rehman, 2006).

In the early 1990s, the term 'sustainable development' was beginning to be more thoroughly interpreted in India's constitution, primarily due to Supreme Court decisions that required a more comprehensive and multi-faceted approach, as India's economy was seeing growth through industrialization, which resulted in adverse impacts on the environment (Basu & Shankar, 2015). Before this, India's judiciary failed to show a steady approach to balancing two competing interests—conservation and development. During this transitional period, the Supreme Court played a significant role in constructing the doctrine of sustainable development, most notably in *Vellore Citizen Welfare Forum vs. Union of India* of 1991. Here, the process of 'sustainable development' was considered relevant within the polluter pays principle under Article 31 of India's Constitution, as public interest in industry's environmental implications was becoming more pronounced (Basu & Shankar, 2015). This case marked a critical moment in Indian's Constitutional evolution, as it marked the moment when the impacts of industry and development, and the effects they have on the environment and human well-being, were legally identified as being inter-linked. *Vellore Citizen Welfare Forum vs. Union of India's* decision meant that any new project or policy

would be looked at through a kind of bifocal lens that would begin to consider more extensive, long-term implications to development.

Another prominent Supreme Court decision was the *Narmada Bachao Andolan vs. Union of India* case that was brought to the courts to discuss the research and understanding of potential environmental impacts associated with development projects and the importance of alleviation measures being included in project implementation to reduce the environmental damage that might come as a result of large scale development projects (Basu & Shankar, 2015). Two other cases were also crucial for India concerning this balancing act between economic, environmental, and social development. The *T.N. Godavaraman Thirumulpad vs. Union of India* case and the *Indian Council of Enviro-Legal Action vs. Union of India* case, which led to the Supreme Court declaring that "the necessity to preserve ecology and environment should not hamper economic and other developments", which swung the pendulum back toward the center as there was concern that too much environmental regulation could hinder much-needed development projects required to promote growth in other areas (Santhakumar, 2003, p.507). These four court cases present a snapshot of India's process in recognizing sustainable development as an integral part of balancing environmental protection and development in India and the difficulties therein. These four judgments helped bridge the gap between these two seemingly opposing themes and identified development needs as critical for growth. Although it may be perceived as somewhat inconsistent, it can be viewed as an essential step to addressing both concerns—balancing both development and environment through the lens of sustainable development.

These Supreme Court Decisions further lend themselves to the Nationally Determined Contributions (NDCs) India pledged, as greater focus was placed on this symmetry between development and environment and the regulations to support them. India's NDCs are targeted at

mitigation and adaptation efforts meant to provide economic growth opportunities while simultaneously looking to reduce their GDP's emissions intensity by 33-35 percent by 2030. These markers are partly achievable due to their pledge to achieve a 40 percent cumulative installed electricity capacity from non-fossil fuel-based energy sources by 2030. Although India's 2022 targets are seen as being ambitious, there has been tremendous progress made in increasing the use of renewable energy in development projects (Agrawal, 2017). The shift in India's approach to adopting 'co-benefits' in their climate mitigation strategies was embodied in their 2008 National Action Plan of Climate Change (NAPCC), which helped create synergy between their national goals and state goals—addressing socio-economic development while still adhering to their international agreements (Chandel et al., 2016). National and state-level policies before the NAPCC, like the Electricity Act in 2003 and the Tariff Policy in 2006, were critical in this advancement, and together with technology sharing and private sector engagement allowed for an increase in renewable energy usage (Chandel et al., 2016; Ciecierska-Holmes, 2020).

India's NAPCC was a significant landmark for the country, as it helped pave the way for national climate policy and a climate framework that would set a standard for all plans and programs. The NAPCC established a policy that looked to encapsulate climate policy objectives consistent with its development goals through what was deem as 'co-benefits,' where development objectives and climate change can be simultaneously addressed. The plan was made up of eight missions, essential factors in their sustainable development strategy. These missions were geared toward solar energy, enhanced energy efficiency, sustainable habitat, conserving water, sustaining the Himalayan ecosystem, creating a "Green India," sustainable agriculture, and establishing a strong foundation for climate change (NAPCC, 2008). This plan worked alongside India's National Development Plan to better align with the goal of applying national policy with 'co-benefits' and a

focus on achieving a balance between three pillars: economic, social, and environmental (Chandel et al., 2016; SyamRoy, 2017).

The three main goals from India's National Development Plan that best align with their push for poverty alleviation, climate action, and socio-economic progress are Goal 1: End poverty in all its forms everywhere; Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; and Goal 17: Revitalize the global partnership for sustainable development (SyamRoy, 2017). Furthermore, India developed its Sustainable Development Plan, which was very much similar to the global Sustainable Development Goals established by the United Nations General Assembly in 2015, as they plan to universalize access to essential services, boost employment-intensive manufacturing segments and work toward international cooperation in the pursuit of climate change mitigation (UN, 2017). India also enacted a Three-Year Action Agenda between 2017 and 2020 that committed to minimizing the emissions intensity of GDP and creating an additional carbon sink. These national policy measures better aligned India to address the multi-faceted problems of poverty and pollution that were plaguing a large portion of their population; however, some of the significant problems plaguing these and future initiatives are resources, reliability, and funding, which will be examined in the next section.

India’s policy implementation and challenges.

As India's economy continues to accelerate, having grown 7.4 percent in 2018 alone, there will inevitably be an increase in demand for energy access and availability (IMF, 2018). With India looking to help mitigate GHG emission levels by shifting to more renewable energy options, there are doubts about how soon this shift can take place given the rate of growth and the specific technical and regulatory challenges associated with renewables, and the financial burden that goes

with them (Tongia, 2015; Dubash & Ghosh, 2019). With India's target of reaching 223 GW of renewable energy by 2022, questions are surrounding how these projects will be funded and if this could interfere with their progress. Sreenivas and Gambhir (2019) highlight the vital role of electricity distribution companies (DISCOMS) in the relationship between the electricity sector and its consumers. While there is a push to create infrastructure for those households without electricity, and further finance renewable energy projects, there exists an information and funding gap as DISCOMS are already dealing with economic losses through subsidized power programs and technical and commercial losses, creating additional barriers in their ability to supply the appropriate funding to further electrify rural parts of India (Sreekumar et al., 2019). These financial restraints are challenging to overcome for emerging economies and require alternative financing instruments to make up the difference.

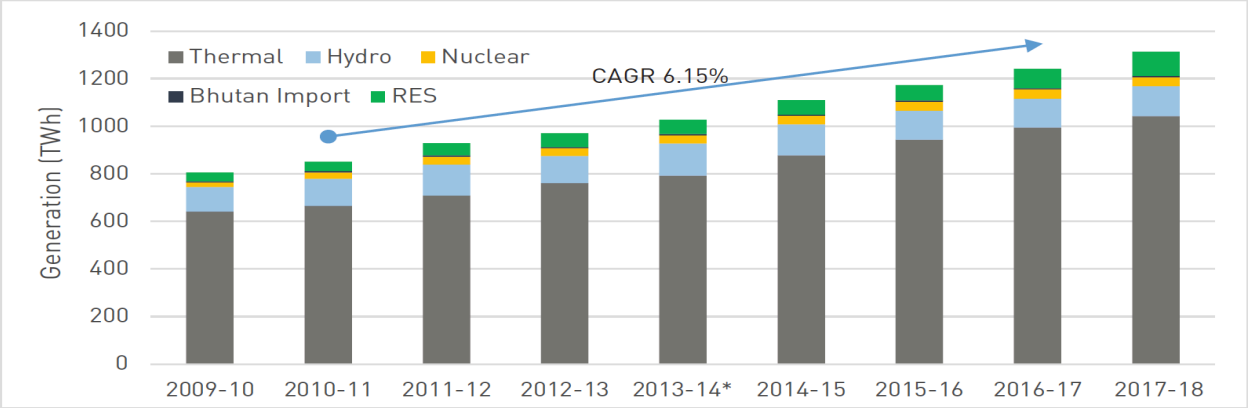
Rahman and Baranyi (2018), in their article Beyond Binaries: constructing new development partnerships with middle-income countries, discuss how the landscape is changing in global development with greater access to financial opportunities now available outside of the traditional donor aid system previously seen in developing countries. New financing mechanisms are being realized through a combination of public and private investments—such as foreign direct investment and national and international bonds (Rahman & Baranyi, 2018; Weber & Saravade, 2020). As India is now considered an LMIC, it is no longer viewed 'in need' of development aid and assistance, but more so as capable of addressing issues internally by financing their development with little to no financial support provided, which is complicated as MICs house the largest number of people living in extreme poverty. Rahman and Baranyi (2018) further highlight that OECD aid should part with the traditional structure of development aid, through financial support systems, and move toward 'issue and region-based solutions' where community

participation could help customize support and strengthen regional ties to aid, further enhancing projects and policy that address poverty (p.253). Rahman and Baranyi (2018) explain that funding for low-emission climate initiatives could be more reliably propelled through public-private partnerships (PPPs) or foreign private sector investors, where there could exist a more collaborative approach that would better promote the needs of emerging markets. Even with an increase in interest from the private sector, high levels of risk, marginal expected returns on investment, and inconsistent public policy have deterred many private sector investors from getting involved in rural electrification projects in developing countries (Jacobson, 2007). As technology improves and costs decrease, we may begin to see more actors from the private sector participating in these activities, but this will require consistent policy measures and adequate technologies.

As mentioned, a reoccurring problem in rural development is a lack of capital, which can dramatically delay advancement in electrification activities, causing emphasis to be placed on development aid or private sector participation to fill the gap (Dugoua et al., 2017). As an alternative to costly grid expansion, some states in India have proposed decentralized solutions, such as mini- or micro-grids, as an alternative to connecting communities located far from central grid infrastructure (Willams et al., 2015). Molyneaux, Wagner, and Foster's (2016) article Rural electrification in India: Galilee Basin coal versus decentralized renewable energy microgrids seeks to compare the investment costs required to build infrastructure that will fuel large, centralized power stations and networks in rural India with the costs of building decentralized micro-grids using locally sourced renewable energy. Molyneaux, Wagner and Foster's (2016) findings show that decentralized renewable energy systems are more cost-effective, environmentally friendly, and provide more readily available low-power energy sources and opportunities to rural

communities—although, they are typically a less efficient means of providing rural communities with adequate amounts of electricity to power large scale services.

The main challenge for India when it comes to sustainable development is its ability to manage development goals and resource requirements. A significant roadblock on India's path to a greener future is its coal generation, growing steadily with rising energy demands (Tongia, 2015). The following chart shows India's electricity generation by source, indicating a steady increase in the use of thermal and renewable energy sources since 2009, with all other sources remaining relatively stable.



India's Electricity Generation by source
Source: Central Electricity Authority (CEA) Monthly Reports Executive Summaries, 2012-18

Coal is a major part of India's current energy system, making up 60% of its existing 350-gigawatt grid (Dugoua et al., 2017). As we can see from the chart, thermal energy, which includes all fossil fuels (primarily made up of coal), has continued to rise each year between 2009 and 2017 at a rate of about 12.67 percent, over twice the rate of energy demand, which only grew an estimated 6.15 percent, leading to a 'power surplus' in the country (Tongia, 2015). This surplus has caused many coal power plant's 'plant load factors' to fall and in some cases as much as 13 percent, which is an indication that the plant is not being utilized at its optimal capacity, which can lead to increased

costs for both distribution companies (DISCOMS) and consumers. Although the reduced application of coal plants is positive when considering India's NDCs to reduce GHG emissions intensity, developing countries need to be careful not to limit these plants too much without first making up the difference with reliable energy sources (Molyneaux et al., 2016).

Tongia (2015) discusses the potential for a 20-25 percent rise in energy demand in India by 2022 and how this level of growth puts the energy sector in a precarious position where they cannot wholly begin to phase out all thermal power sources without first finding a way to replace them reliably. Coal plants don't allow for short-term shutdowns, as it can create cost implications and damage to the plants that can take hours to restart if a problem does occur (Yadoo & Cruickshank, 2012). Furthermore, depending on the coal plant's age, lowering the output won't just cause wear and tear but might also reduce the thermal efficiency, increasing sulfur oxide and nitrogen oxide emissions when operational. This strategy of "flexing" by coal plants, whereby they can operate with flexibility, lowering output or shutting down for periods, can be incredibly expensive for companies, even with compensation initiatives put in place (Tongia, 2015).

Considering energy generation from coal-based plants, it is relatively effective at providing sufficient energy supplies to a growing economy, even if it isn't the most environmentally efficient—capable of being used on demand and dispatched according to market needs (Yadoo & Cruickshank, 2012). The government of India, in an effort to curtail further coal production levels, implemented more rigorous emission standards and environmental regulations, raising the price per kWh to make the industry less attractive, and in turn, attempt to move the market toward more renewable energy production (Sethi, 2017; Sreenivas & Gambhir, 2019). Currently, the significant costs associated with expanding the renewable energy sector in India will likely come from energy storage, where power supply and demand are equal at any given moment, or else they could be

faced with curtailment issues, which could mean a loss in economic and energy efficiency (Guta et al., 2017). It is likely that as technology in the renewable energy sector improves, costs will continually decrease, allowing developing nations to reduce their heavy reliance on non-renewable energy sources; conversely, even as India looks to limit their emission levels, they are at odds with the fact that the majority of their energy generation is through non-renewable energy sources and a large portion of its population is without electricity.

The issue of a 'lack of energy' in India is not easily remedied, where households can just simply be connected to a new or existing grid, but requires ingenuity and innovation to meet the needs of those without access to electricity (Malakar, 2018). India is in a position where they are experiencing the ramifications of climate change with an unequal share in the consumption of the world's resources to date, but are likely to contribute a large percentage of future emissions as their industries continue to grow (Malakar, 2018). As India transitions from an agrarian-based economy to more of an industrial-based one, it will require more resources and more energy from its existing thermal energy plants during a period when these metrics are meant to decrease (Sadath & Acharya, 2017). Although seemingly problematic, could this developmental delay in India's transition to a more environmentally sustainable future work in their favour, as it could provide opportunities to learn from past mistakes and access newfound, innovative pathways that could help provide them with the knowledge and tools to become a trendsetter for sustainability? Perhaps the pace of coal phase-out and whether India can do so without burdening ordinary citizens and electricity consumers will be critical determinants of their energy future and will be further explored in the following section.

Summary

To analyze the review of the literature and India's policy pathways, this section will look to summarize these findings through electrification policy and projects in rural India to better respond to the research question: What evidence is there that India has made progress towards their stated policy objectives to advance energy security and align environmental and socio-economic development through decentralized electrification solutions, and how has this been done? We can see that India has made significant progress through international and national policy objectives, but how do these align with advancing energy security and improving environmental and socio-economic development?

As part of India's NDCs of limiting emission levels and their goal of providing 'electricity for all' through their SDGs, electrification projects were being proposed throughout the country. The Government of India launched various rural electrification schemes to achieve 100% rural electrification, as REPs were established as a vital alternative to expensive power grid expansion, and for its specific impacts on environmental and human health in both urban and rural areas (Singh, 1991). One reason for this is that extending the national grid network is a timely and arduous undertaking, even though it can provide many advantages (economic, technical, and social) to urban and rural areas situated close to the grid system (Singh, 1991). Dugoua et al. (2017) explain that one significant benefit to grid-based electrification is that costs are generally cheaper, and consumers have a stronger connection that will produce a higher quality of energy than most small-scale alternatives. Although, this is very much dependent on the reliability and availability of resources and the maintenance and mechanical integrity of the grid—as many developing countries struggle with providing a reliable service, with users experiencing constant power cuts or brownouts, which can hamper economic development (Kirubi et al., 2009).

Micro-, mini-, or off-grid electricity generation is often seen as an alternative, as it takes place within a confined geographic space where the distribution, storage, and consumption is localized and operates at lower loads and voltages (Kirubi et al., 2009). These are primarily established to provide low levels of electricity for household use or for small businesses and vary in installed capacity on the source of energy—whether its fossil fuel, biofuel or fuel cells, or renewable energy sources such as micro-hydro dams, solar PV, biomass combustion, or wind turbines (Yadoo & Cruickshank, 2012). These off-grid renewable energy options are typically thought of as being expensive, unreliable and limited in how they can benefit rural communities compared to diesel generators; however, this is type of thinking is becoming less and less frequent as new tactics and technologies emerge— technologies such as biogas digesters, biomass gasifiers, and micro-hydro plants that are cheap alternatives to diesel generators (Owen et al., 2010; Yadoo & Cruickshank, 2012).

The Rural Electrification Corporation (REC) of India helped develop various schemes to establish REPs around India, primarily focusing on rural communities outside of the reach of the established grid. Agrawal, Kumar & Rao (2020) investigated rural electrification in India and identified multiple schemes that helped India establish a strong foundation on which to build on concerning decentralized energy systems. The following is a brief description of more pertinent schemes. *The Minimum Needs Program* (MNP) was introduced in the late 1970s and was one of the earlier projects that looked to invest in rural communities with low levels of electrification to promote education and infrastructure needs while also addressing environmental issues. About a decade after MNP, the *Kutir Jyoti Program* (KJP) was launched to inject more focus on providing single-point connections to rural households. The *Accelerated Rural Electrification Program* (AREP) was launched in 2002 as a means for the government to give states assistance through

subsidized interest payments to help promote issuance and performance. *The Rural Electricity Supply Technology Mission* (REST) was launched in 2002 to electrify all villages by 2012. One of the main differences between REST and previous schemes was that REST looked to decentralized energy generation through renewables and could be seen as India's first successful electrification effort that combined environmental with socio-economic development. This scheme marked an essential shift for India as it pushed them to review their current and legal institutional framework and financial capacity toward new technological solutions, and may have acted as the catalyst for environmental reform through India's Supreme court (Basu & Shankar, 2015; Agrawal et al., 2020).

The most recent and still active scheme, *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY), was launched in 2015 and designed to provide continuous power supply to rural India. This scheme is most notable for its role in the 2018 announcement of reaching 100% rural electrification through the completion of an off-grid and micro-grid distribution network, an increase in agriculture productivity, increase employment in small/medium enterprises, improvement in health and education, as well as benefits to social welfare through newly electrified public services (Agrawal et al., 2020). One of the major takeaways from these schemes is that renewable energy development has been relatively useful in creating opportunities for economic and environmental co-benefits at the state level, primarily in rural areas, and has opened the door for more substantial changes in policy through review and reform.

As highlighted here, there are actions and policy measures that can bring development gains while bringing climate gains. For India, a new political pathway has revealed itself, providing an opportunity to meet two demands with a seemingly singular focus—sustainability. The 2008 NAPCC and India's 2009 National Action Plan articulates this: that India can grow in a way that

is less reliant on fossil fuels and more conducive to healthy living. These changes can allow people and places to survive and thrive with more sustainable growth, which is the overarching goal from a developmental perspective and can lead to fewer emissions from industry and fewer emissions from local pollutions. However, India is in a very precarious situation where they carry the burden of being a developing nation with a large number of impoverished people who require developmental needs and at least some level of resource-intensive action while also looking to take the lead in renewable markets and technology in the developing world. The following case study will illustrate how India has attempted to meet these needs through decentralized electrification projects.

Case Study

The case of rural electrification and renewable energy in India is both controversial and complicated. Energy poverty affects more than 300 million people in India alone, and many believe poverty reduction can only be achieved if a wide range of productive and welfare-enhancing uses of electricity is established (Kirubi et al., 2009; Halff et al., 2014; Chakravorty, 2014; Yadav et al., 2019). The 2019 Voluntary National Review Report in India claims that the installed capacity in non-fossil-fuel sectors has grown by 51.3 percent and more than doubled in the renewable energy sector, as India continues to expand its renewable energy capacity to 227 GW, as per their NDCs. Rural electrification projects are viewed as an opportunity to achieve co-benefits between both these streams of policy development, not only through the implementation of decentralized energy systems but also under consistent policy measures and financial considerations.

To explore these decentralized energy systems and their impacts on both human health and the environment, we will look at the implementation of electrification projects in Uttar Pradesh, India. This case study will allow for a more policy-driven analysis and provide some quantitative and qualitative data that should deliver more information on the impacts of rural electrification projects and the progress, achievements, and challenges faced in their development. Further, this study will provide significant insight into the socio-economic impact and overall significance of rural electrification projects on people's lives and livelihoods at the community and household-level—helping explore the benefits and challenges of rural electrification projects and the potential for decentralized electricity in India, and the developing world.

In 2015, the Rockefeller Foundation started a $75 million rural electrification project to provide energy for India's most marginalized communities. The Smart Power for Rural Development (SPRD) project delivers decentralized, renewable-energy mini-grids to poor and powerless communities in hopes of enhancing the daily activities of those who need it most. A case study conducted by Agrawal et al. (2020) looked at 91 villages across 19 districts in Uttar Pradesh and Bihar, consisting of 1,000 households and 320 micro-enterprises. Uttar Pradesh is India's most populated state and is found in the country's northern region. A state with a similar landmass to the United Kingdom, and an energy program heavily reliant on coal-based grid systems, Uttar Pradesh has struggled with energy poverty, with roughly only 55 percent of households having access to electricity in 2017 and the inability to provide reliable energy supply to rural areas outside the reach of the current infrastructure (Yadav et al., 2019). Like many other states in India, even when access to energy is available through existing infrastructure, there can be an issue with reliability and affordability (Chandran, 2017). A reoccurring problem within India, and rural electrification efforts worldwide, is system capacity and these communities' ability

to pay, as many rural communities in developing nations fall under the poverty line. Decentralized energy technologies are considered an economical and feasible solution in many rural communities to manage many of these types of imbalances and meet particular goals, namely addressing energy poverty; supplying efficient and effective electricity that benefited consumers; and providing clean energy alternatives that meet development needs (Dugoua et al., 2017).

The renewable energy mini-grid projects through SPRD in Uttar Pradesh were geared toward customers who fell on the lower to medium level socio-economic status. According to data collected by Agrawal et al. (2020), 33 percent of households connected through SPRD relied primarily on seasonal and susceptible livelihood sources, such as self-employed or labor-intensive jobs, and 36 percent worked in the agriculture sector. One of the significant benefits of implementing these decentralized mini-grids is the ability to transition households and businesses away from potentially harmful and polluting sources of fuel like kerosene and diesel, or traditional biomass fuels (Willams et al., 2015). These small victories can have large impacts when it comes to environmental sustainability and per capita GDP.

Another important element of the quantitative analysis of SPRD was what the energy was used for and how the participants viewed the service. Agrawal et al. (2020) concluded that the most frequently reported uses of electricity were for lights, charging cell phones, and using the television. It was identified that some smaller appliances were also used by households, such as electric hot plates and irons, but that SPRD participants believed one of the significant benefits that came from these mini-grid connections was the ability to provide security lighting in the town center and power for public services and small businesses (Agrawal et al., 2020). In addition to enhancing security and services, data from this study showed that household electricity consumption also helped facilitate trade and commerce and improve school productivity.

The findings show that the introduction of electricity to rural communities, similar to the case in Uttar Pradesh, can provide an efficient source of lighting for households, helps establish and strengthen social networks through television and communication, and helps generate additional productivity and income opportunities for households (Agrawal et al., 2020). These small successes provide other services for participants in the short-term by improving quality of life and convenience, but may not meet their needs in the future or allow for significant changes in their community. A study by Jacobson (2007) studying household electricity use from a micro-grid solar system in rural Kenya showed that the primary household use of the low-level electricity is not necessarily contributing to economically productive or educational activities, but that rural electrification can help in poverty reduction only if a range of formative and non-productive uses of electricity is established. The productive services of electricity may improve living standards, but for more comprehensive benefits for the local economy, infrastructure, communication, and access to markets through more substantial infrastructure investments are needed (Jacobson, 2007). Renewable energy mini-grids can provide policymakers and rural development practitioners with a means of combating poverty, mitigating against increased GHG emissions, and improving adaptive capacity to climate change. However, they may not serve the long-term purposes needed for significant change. If a community is close enough to an existing grid network that provides reliable power to both its urban and rural customers, grid extension may be preferable for more beneficial results of electrification, but this does not lend itself to long-term environmental improvements (Jacobson, 2007; Agrawal et al., 2020).

Conclusion

We can see that India's approach to development and climate change issues have continued to change, pushed by a precarious global climate and a growing interest by civil society at large. India can now point out that it is decreasing energy intensity with the introduction of renewable energy, but does this allow for the adaptation and mitigation efforts required for socio-economic development? Within India's climate change policy measures there was a constant theme around sustainable development and growth, which may seem at odds with its goal of limiting emissions intensity as per its NDCs depending on the means of providing socio-economic stimuli, as coal is still the cheapest source of electricity in India and is projected to be a main source of fuel moving, as identified in the literature (Dugoua et al., 2017; Tongia, 2015). Adaptation and mitigation efforts are used to address this disconnect through policy measures such as *Rural Electricity Supply Technology Mission* (REST) and *Deen Dayal Upadhyaya Gram Jyoti Yojana* (DDUGJY) (Basu & Shankar, 2015; Agrawal et al., 2020), but how does this relate to socio-economic development?

Jacobson (2007) and Agrawal et al. (2020) discuss how these decentralized electricity projects provide access to energy for marginalized communities, but it is often not sufficient for any large-scale usage. Perhaps, it could be more productive for long-term development to focus on low-carbon growth and socio-economic development as individual entities. Gnosh (2010) discusses how efforts geared toward low-carbon growth in the short-term could potentially cause decreases in national income as a greater focus would be applied on meeting targets, rather than a gradual transition to low-carbon energy sources. The SPRD case study demonstrates that off-grid options can sustainably provide rural communities with access to electricity and potentially help India limit their emissions, but further research needs to be done to identify how these energy sources impact long-term socio-economic development in communities. Research on community-

based management of decentralized energy projects could help identify opportunities for support systems and training and potential employment opportunities for local members who would be better able to meet system needs, collect tariffs and identify any problems that might occur. Actively involving the community from a project's early stages is likely to raise users' level of interest, buy-in, and appreciation of the electrification system (Scoones, 2009). Ribot (2011) looks at adaptation and the tendency for agents to focus on response rather than the causes for these rural vulnerabilities. By providing rural 'at-risk' communities with access to additional energy sources, it provides them with a greater ability to cope with changing climates, reducing their vulnerability, and improving their livelihoods. Furthermore, Grove (2014) sees adaptation as giving more power to the actors and can be seen as a 'short-term' action which may be necessary, given the problem, as larger issues are not always easy to tackle and can take time and funding. Although it is essential to consider the root causes of these significant issues, as adaptation efforts and small-scale solutions can directly impact communities in the short-term, this does not always help deliver long-term environmental efforts.

As India continues to work toward meeting its social, economic, and environmental responsibilities, there is a constant struggle to maintain a balance between these areas, as each brings its challenges and opportunities for growth. Climate change has put India in a precarious situation where they must continue to provide access and opportunity for their population while looking to meet its NDCs and limit its emission levels. At this point, India's international agreements are beyond perceptions but more about putting diplomatic, political, and financial efforts into moving the country forward. With technological and financial help, India has every opportunity to change their development pathways to be cleaner, greener, and eventually more effective with regard to their local and global pollution levels. India's focus should be on

development that improves local environmental quality and the quality of life of those who live in its cities, and if improvements in climate are a result, all the better. Moving toward more renewable energy sources gives India the opportunity to contribute to poverty reduction, climate change mitigation, and improved resilience—moving toward a greener future, and, in turn, a cleaner world.

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