International Journal of Humanities and Social Science Research
www.socialsciencejournal.in
ISSN: 2455-2070
Received: 10-12-2021, Accepted: 26-12-2021, Published: 10-01-2022
Volume 8, Issue 1, 2022, Page No. 1-6

Clean energy transition in India: A geopolitics analysis

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Abstract
Climate change has affected the world's energy system. Over the years, the world has used fossil fuels (Oil, Coal, and Gas) for its energy requirements, which has resulted in global warming. Now the world is shifting to renewable energy sources as a practical solution to tackle climate change. Economies like India will definitely benefit from Energy Transition, and the use of Renewable energy resources will help India recover from its energy crisis and curb its rising level of CO2 emissions. The shifting of energy sources will allow it to deepen its global geopolitical impact. This article has shown how Climate change mitigation policies and energy security objectives are setting down the energy system of India. Also, the paper will discuss the economic, climate, and geopolitical impact of the energy transition for India.

Keywords: climate change, energy security, energy transition, geopolitics, renewable energy, sustainable development

Introduction

India is expected to become the world's most populous nation and projected to be the third-largest economy, contributing $500 billion to the global economy by 2030. In given time, almost 80 per cent populous will be in the middle class, which would further stress on the energy resources (WEF 2021). Plenty of reason could be counted for increasing the energy demand of the country: growing industrialisation, expanding urbanisation, and governments' effort of reducing poverty in turn leading to rising standards of living etc.

Focusing on India's energy system, the government's key objectives include energy security and independence, affordable energy, and greater sustainability (NITI Aayog 2017). Along with these objectives, SDG goal seventh, 'access and availability of clean energy for all' is on the list of India to be achieved by 2030. Out of the mentioned goals, one has been effectively achieved of reaching almost 100 per cent household electrification (Saubhagya 2021). While the others including energy security and independence, and greenhouse gas (GHG) emission continues to remain a challenge for the Indian government and its policymakers.

It is imperative to briefly understand the aforementioned energy insecurity challenges. Since 1990, India has been 80 per cent relying on the three fossil fuels (Coal, Oil, and Biomass) to meet its energy demand (IEA 2021). Unfortunately, domestic energy resources couldn't meet the energy demand and therefore increasing demand-supply gap pushed the country towards increased import of fossil fuels. This heavy reliance on fossil fuel resources has opened the vulnerability gate of price volatility, instability, and burden on the trade balance.

This, in turn, has resulted in India being a major global GHG emitter. In the light of amplified domestic and international pressures, India is considering changing its energy resources, keeping in mind its climate responsibility.

To address these challenges, renewable energy resources are being explored as an intelligent solution. Over the last decades, the world has been dependent for its energy needs on fossil fuels, but now a change in the global energy system could be observed. The world is now moving from fossil fuel resources to clean energy resources. The key factors behind this energy transition is cost competitiveness, operational efficiency, and global investment particularly in solar Photo Voltaic (PV) and wind energy (WEF 2021). To meet the increasing current and future energy demand and to curb its growing emissions, the Asian giant is also shifting towards sustainable energy use.

The changing pattern of energy resources propels India in two ways; First, economic growth powered by renewable energy enables the economic engine to be sustainable, reducing GHG emissions at the same time. Secondly, the transition of the economy to clean energy allows India to overcome its energy insecurity.

Keeping in mind the closer alignment between energy security and renewable energy policies, the objective of this study is to analyse the energy transition in India. This paper focuses on the rapid deployment of renewable energy along with India's energy security and decarbonisation targets. The study also assesses the long-term geopolitical impact of energy transition in India.

The following paper presents the study's methodological framework, followed by a brief discussion on the geopolitical implication of energy transition. Further, the paper reviews the enabling factors for the energy transition and its geopolitical advantage for India; Lastly, the paper concludes by delving into some recommendations.

Methodology

This study has a combination of literature surveys to understand the objectives listed in the introduction section. Relevant policy documents, programs, and laws related to climate change and energy security in India are examined, to identify facilitators and barriers at the policy level dealing with the deployment of renewable energy. Relevant indicators (such as energy demand and supply gap, import dependency, energy import bill) have been drawn from the literature review on energy security, which are undertaken

by multilateral institutions, academic organizations, and individual researchers. These indicators have been used to assess energy security levels and their impact on the energy system in India.

The factors that shaped the growth of clean energy and the country's energy policies are also analyzed from climate change and energy security perspective, to understand the geopolitics of clean energy transition. Notably, after ratifying the Paris Agreement on climate change, it is crucial to understand the INDCs commitment that India often underlines in its energy diplomacy. It is also essential to analyze the progress of these commitments to achieve energy security and universal energy access and to reach the 2 °C stabilization global goal underlined in these commitments.

Energy Transition and its geopolitical implications

Development activities fuelled by burning fossil fuels, deforestation, industrialisation, and transport have released GHG emissions (mainly CO2) that have been stored in the atmosphere. Since 1750, fossil fuel combustion has been responsible for about 2/3rd of anthropogenic CO2 emissions (Solomon 2007). In the study, Charles David Keeling also finds that anthropogenic activities affect global atmospheric chemical composition (Keeling 1960). His research on atmospheric CO2 concentration shows that CO2 emission from fossil fuel combustion rose by 3.4 per cent from 1959 to 1971 (Charles D. Keeling 1976). Similarly, Intergovernmental Panel on Climate Change (IPCC's) 4th assessment report on climate change observes that the composition of CO2 in the atmosphere increased to 379 ppm in 2005 compared to 280 ppm in the pre-industrial era (IPCC 2007).

Sadly, this is the harsh reality that the earth has been warming due to GHG emissions since the Industrial Revolution. As a result, the average earth temperature is continuously increasing. Between 1880 to 2015, the average earth temperature rose by 0.9 percent (Rebecca M. Henderson 2018). IPCC noticed that the increasing CO2 emission would continue to change the atmospheric system throughout the twenty-first century (UNFCCC 2006) [47].

Climate change as a global issue got highlighted in state policies in the 1970s (Saryal 2015) [39]. After this, climate change mitigation actions as a future policy gained attention in the international conferences and agreements started from Rio in 1992 then Kyoto Protocol in 1997, and most recently in Paris in the year 2015. The main objective of these agreements was basically to reduce the amount of CO2 emission. Hence, these policy frameworks are strongly noted to reduce the use of fossil fuels. As an outcome of these policies, using Renewable resources turned out to be the best alternative to fossil fuels solving the climate change issue (Stevens 2019).

In this paper, the notion of 'Energy Transition' is understood as a 'shift from fossil fuels to renewable energy.' In the late 1950s, petroleum resources became the main source of interaction between various nations resulting in energy geopolitics (Roman Vakulchuk 2020). In recent years, the world has seen a fundamental change in the global energy scenario. Fossil fuels are losing their importance as economies are switching their primary source of energy (Stevens 2019). The reasons behind this transition include; lesser cost of renewables, to reduce pollution and climate change due to fossil fuels, to match renewable energy targets by different nations, technological innovation (IRENA 2019).

The new narrative of energy geopolitics is underpinned by the idea that countries will gain or lose geopolitical advantages as a consequence of the energy transition (Overland, *et al*. 2019). For years, fossil fuels (Oil and Gas) have shaped the geopolitical map, but now renewables will tailor the allocation of power, political and economic relations between states and geopolitical instability. In the emerging new energy geopolitical narrative, India is looking to gain its advantages.

Enabling Factors for Energy Transition in India

1. GHG emission due to use of Fossil fuel

Since the year 1990, India's CO2 emission has been gradually increasing. Table 1 shows that from 1990 to 2019, India's global CO2 emission increased from 530.12 Mt (Metric tons) to 2309.06 Mt CO2 (IEA 2019). This has put India as the 3rd largest CO2 emitter (Fleming 2019).

Table 1: Total CO2 emission By India, 1990-2019

Year	CO2 emissions
1990	530.12
1995	704.34
2000	889.83
2005	1074.99
2010	1572.14
2015	2036.88
2019	2309.06

Source: IEA, 2020

India's Total Primary Energy Supply (TPES) largely depends on the use of Coal and Oil; in 2017, Coal accounted for 44 per cent of TPES, and oil met 25 per cent. From 2007 to 2017, India's TPES increased by 55 per cent, major share of which came from Coal and Oil (IEA 2020). In India, Coal and oil have remained a major source of CO2 emission as the burning of coal and oil for energy demand is highly associated with environmental costs and emission of a large amount of CO2. In 1990 Coal contributed 365 Mt CO2 emission, which increased to 572 Mt in 2000, and 1628 Mt in 2018. In the year 1990 use of oil emitted 151 Mt CO2, which increased by 595 Mt in 2018 (IEA 2020)

Table 2: CO2 Emission by Energy Source, India (1990-2018)

Year	Coal	Oil	Natural gas
1990	365	151	14
1995	477	201	26
2000	572	277	41
2005	710	309	56
2010	1089	408	75
2015	1447	525	63
2018	1628	595	83

Source: IEA, 2020

However, India has also made significant progress to moderate its GHG emission. Over the past decade, India's emission intensity compared to its gross domestic product (GDP) has declined more than 20 per cent. Also, Compared to the world's 4.4 tonnes per capita emission, India's per capita emission is well below 1.6 tonnes (IEA 2020) [6, 12, 14]

International Renewable Energy Agency's (IRENA) study REmap (Renewable Energy Road Map) 2030 emphasized on the role of renewable energy. It is noted that if the

international community could double the Renewable Energy share in the total energy mix, it would help reduce 8.6 gigatons of CO2 emission. Along with the energy efficiency measures, this would play a significant role in keeping the temperature below 2°C by 2030 (IRENA 2016).

2. Renewable Energy Targets

For India, using renewable energy could achieve multiple objectives: energy security, energy efficiency, de-carbonization, and sustainability among others. The country has given an important place to renewable energy in its national policies and international commitments. This is why India has focused on ambitious renewable energy targets over the years.

The country has committed itself firmly to multilateral negotiations under UNFCC. It committed to reduce the emission intensity of GDP by 20-25 per cent against the 2005 level by 2020. And it is a matter of satisfaction and a firm commitment that by 2012, the country's emission intensity had fallen by 17 per cent (UNEP 2014).

In 2015 at COP 21, in its submitted Intended Nationally Determined Contribution (INDC) in Paris Accord, India strongly committed to take actions on the energy sector including a reduction in emission intensity of GDP by 33-35 per cent against 2005 levels. India also committed towards generating 40 per cent electricity from renewable resources (NITI Aayog 2015).

For the commitments stated in the Paris Accord, In the year 2018, the country has set a target to deploy 175 Gigawatt (GW) of renewable energy installed capacity by the year 2022, which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power, and 5 GW from small hydro-power (PIB 2018).

In 2019, at the United Nations Climate Summit, Prime Minister Shri Narendra Modi announced an increased ambition to promote renewable energy by 450 GW without indicating a time frame. Therefore, India in 2021's climate summit set a target of 450 GW by 2030 (Ministry of External Affairs 2021).

3. Renewable energy Cost

Improving technologies, economies of scale, competitive supply chain, and growing developer experiences make renewable energy generation technologies the most cost-effective alternative to electricity generation. Hard to believe that between 2010 to 2019, due to the fall in module prices resulting in reduced production costs, electricity from utility-scale solar photovoltaics (PV) decreased by 82 per cent. Also, the production cost of onshore and offshore wind plants came down by 39 per cent and 29 per cent respectively because of the reduction in Turbine Prices. These developments have made renewable power technologies the least-cost option for new power generation capacity (IRENA 2020).

In the last decade, India's Levelized Cost of Electricity (LCOE) declined by 85 percent. The country has the most competitive installation cost for utility-scale solar PV. Since 2010, installation cost for wind plants has also fallen by 23 percent. All these cost reductions are making India the most competitive market in renewable energy.(IRENA 2020).

Energy Transition and Geopolitical Implications for India

Considering the energy security and energy scenario in India, some of the disadvantages of using fossil fuels have been mentioned in this section followed by the merits of energy transition for India.

One of the disadvantages relying on fossil fuels is the import dependency of India. Though, India is the 3rd largest coal-producing country, its domestic supply is insufficient to meet its energy demand. Hence, its high degree of import dependency generates price volatility, costs and risks.(Obja Borah Hazarika 2019). It is expected that the coal demand would increase to 2854 Million Metric Tons (MMT) by 2031, and dependency on coal import is expected to rise to about 78 per cent by 2031 (TERI 2008). Also, increasing domestic oil demand has further increased India's oil import dependency. It could be confirmed by the facts that in 2017 India's import bill for crude oil was USD 88 billion, which increased by 27 per cent in 2018 to USD 112 billion (IEA 2020) [6, 12, 14].

Table 3: Coal import, India 2003-2019, Units ktoe

Year	2000	2005	2010	2015	2018
Import	14802	26062	70544	117536	123528

Source: IEA, 2020

Table 4: Crude oil import, India 2003-2019, Units kt

year	2000	2005	2010	2015	2019
Import	74097	99409	163595	202850	226955

Source: IEA, 2020

Noting the heavy reliance of the countries on fossil fuels, IRENA in its study finds that import-dependent nations are highly exposed to currency fluctuations and fuel prices, adversely affecting their trade balance sheet (IRENA 2019). India, too, faced a substantial economic burden during the geopolitical crisis in the Persian Gulf. The Organisation of Petroleum Exporting Countries (OPEC) increased oil prices overnight which made India suffer with a import bill of one billion dollars (Sunjoy and Lydia 2018). Again, volatile prices adversely affected the Indian economy when oil prices increased to USD 147 in 2008 from just USD 28 in 2003 (Janardhanan 2017). However, oil price falls too but India does not have that much facilities to avail the advantages of this favourable situation. In April/May 2020, when the oil price fell, India could manage to fill its strategic reserve by mere approximately INR 500 crore (PIB 2021).

Additionally, fossil fuel importing countries are also vulnerable to supply disruption risks by political instability, terrorist attacks, or armed conflicts in energy-exporting countries (IRENA 2019). Noting the fact that India too imports massive oil demand; any geopolitical disruption in the external supply route or exporting nations would inevitably drastically impact the Indian economy (Janardhanan 2017).

Despite the challenges of being a heavy oil importer, India has augmented its preparedness during any emergency oil shortage situation. The Government has constructed crude oil reserve facilities as a buffer to deal with any problem of supply chain disruption due to external reasons. However, these reserves are not enough to meet India's massive energy demand. If we look at the capacity of strategic reserves of India, under the phase-1 of Strategic Petroleum Reserve (SPR) program, India's current strategic reserve capacity is about 5.33 MMT reserves for about 10 days only. Even after completing Phase-2, an additional 6.5

MMT reserve capacity could only meet 22 days of India's crude oil requirement (Ministry of Petroleum and Natural Gas 2019). However, looking at the expected growth of oil consumption, the existing capacities of strategic reserves may cover only 4 days of net imports by 2040 (IEA 2020) [6, 12, 14]. Aforementioned challenges of being reliant on fossil fuels would be solved if India promptly changes its energy pathway towards renewable resources.

Focusing on these energy security challenges, The Integrated Energy Policy undertaken by the Government of India (GoI), focuses on three critical dimensions; 'Affordable, reliable, and sustainable energy for all', 'energy should be available at all times', 'energy should be shocks and disruptions free' (Planning Commission 2006). Moving on the energy transition pathway will give India more freedom to quickly achieve these targets.

In a renewable energy economy, India's current dependence on fossil fuel imports could be overcome as the development of renewable energy sources are indigenous and distributed at several places. They have low costs of generation which could help India to increase its energy security by diversifying its existing energy basket, reducing its import dependency, and mitigating fuel price volatility (Sargsyan, *et al*. 2011). Hence, by using renewable sources India would gain the strategic and economic benefits.

Towards achieving energy transition, energy policies in India in recent years, have been designed to develop alternative sources of energy, namely solar, and wind energy (IEA 2020) [6, 12, 14]. While undertaking these policies along with its international commitment to a healthy planet and its INDC pledge under the Paris Accord, India is emerging as a global leader in renewable energy. It is confirmed by the below rankings and numbers. In total installed renewable energy capacity, India ranked 5th. Also, in wind power and solar power, it secured 4th and 5th position respectively in 2018 (PIB 2018).

Looking at the overall growth of renewables in 2017, the total supply of India's renewable energy was around 200 MTOE (Million Tonnes of Oil Equivalent), which accounted for 23 per cent of TPES (IEA 2020) [6, 12, 14]. By the end of November 2019, out of 84 GW grid-connected renewable electricity capacity, 32.5 GW emerged from solar PV and around 37 GW from onshore wind and small hydro (IEA 2020) [6, 12, 14].

Specifically, if we look at the growth trajectory of renewables by source, wind. It is the second top source of electricity generation, accounting for 6211 GW of electricity in 2005, which later increased to 19657 GW in 2010 and 44856 GW in 2016. Further, electricity generation from solar energy accounted for just 3 MW in 2005, which significantly increased to 10478 GW in 2015, and later to 14130 GW in 2016 (IEA 2019).

Hence, these developments in Renewable energy resources has helped India to top the renewable energy production and installed capacity. This indeed would help India to gain strategic, economic, and environmental benefits in the coming time.

Conclusion

This paper argues that the global energy transition driven by renewable energy would significantly affect the geopolitical situation, currently built majorly on the foundation of fossil fuels. The dominance of India will grow in the global energy system because it has diversified its economy towards renewable technologies and invested heavily in the renewable sector to take a competitive advantage. Further, the transition in energy will create opportunities to strengthen energy security and dependence. It would further help promote job creation and enhance sustainable development of the poor, remote population by providing off-grid electrification leading to sustainable economic growth. Along with these benefits, energy transformation will also push the world in the right direction, that is, to keep the temperature below 2 °C which will address the issue of global warming and will combat climate change.

The study recommends an integrated approach to link household energy policies with national energy strategies. As India is the most competitive economy in renewable energy, the low-cost advantage must reach and benefit the targeted rural and urban beneficiaries.

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