“A Study on Renewable Energy and Its Impact on Coal Import”

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By

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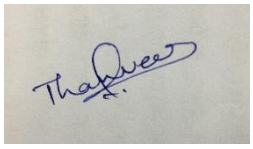
DECLARATION

I, **MUHAMMED THANVEER KP (Reg. No. 2103304014),** student of School of Maritime Management, Indian Maritime University –Chennai Campus, hereby declare that this project report titled **"A Study on Renewable Energy and Its Impact on Coal Import"** submitted in partial fulfilment of the requirement for the degree of Master of Business Administration in Port and Shipping Management is my original work carried under the guidance of my project guide. It has not formed the basis for the award of any Degree/Diploma of any University/Institution. The information submitted is true and original to the best of my knowledge.



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ABSTRACT

The shift towards renewable energy has been gaining momentum worldwide due to concerns about climate change and the negative environmental impacts associated with fossil fuels. As a result, the energy industry is undergoing a transition towards cleaner and more sustainable energy sources, which has the potential to significantly impact the demand for coal imports. This study aims to examine the impact of renewable energy on coal imports, with a particular focus on India. The study analyses the trends in coal imports and renewable energy production in India and other countries, and identifies the drivers and barriers to renewable energy adoption. The findings suggest that the increasing production of renewable energy in India, particularly for solar and wind energy, is a positive development in the country's efforts to transition towards cleaner and more sustainable energy sources. However, the study also highlights the challenges associated with reducing the dependence on coal imports, particularly in countries heavily reliant on coal for their energy needs. The study concludes by discussing policy implications for governments and businesses seeking to accelerate the transition towards renewable energy and reduce the environmental impacts of fossil fuels.

TABLE OF CONTENTS

Contents

CHAPTER 1 1

INTRODUCTION 1

1 INTRODUCTION 2

1.1. DEFINITION AND MEANING 3

1.2. OBJECTIVE OF THE STUDY 5

1.3 SCOPE OF THE STUDY 5

1.4 RESEARCH METHADOLOGY 5

1.5 LIMITATION 5

CHAPTER 2 6

LITERATURE REVIEW 6

CHAPTER 3 16

INDUSTRY PROFILE 16

3.1 COAL INDUSTRY AN OVERVIEW 17

3.2 RENEWABLE ENERGY AND ITS IMPORTANCE 17

3.3 COAL GLOBAL TRADE 19

3.4 EFFECT OF RENEWABLE ENERGY ON COAL IMPORT TO INDIA 19

3.5 POLICIES AND INCENTIVES FOR PROMOTING RENEWABLE ENERGY ADOPTION 20

3.6 IMPACT OF RENEWABLE ENERGY ON THE ELECTRICITY MARKET AND PRICING. 21

3.7 ANALYSIS OF THE RELATIONSHIP BETWEEN RENEWABLE ENERGY ADOPTION AND COAL IMPORT REDUCTION IN DIFFERENT REGIONS. 22

3.8 CURRENT STATE OF RENEWABLE ENERGY ADOPTION IN DIFFERENT COUNTRIES AND REGIONS. 23

3.9 CHALLENGES AND BARRIERS TO RENEWABLE ENERGY ADOPTION 25

3.10 POTENTIAL FUTURE DEVELOPMENTS IN RENEWABLE ENERGY 26

CHAPTER 4 28

ANALYSIS AND INTERPRETATION 28

4.1 DISTRIBUTION OF COAL IMPORTED INTO INDIA IN 2021 29

4.2 RENEWABLE ENERGY MARKET SIZE WORLD WIDE 2021, WITH A FORECAST FOR 2022 TO 2030(IN BILLION U.S. DOLLARS) 31

4.3 IMPORT OF COAL TO INDIA 33

4.4 RENEWABLE ENERGY PRODUCTION – INDIA 35

4.5 USE OF COAL BY VARIOUS INDUSRTIES 37

4.6 COMPARISON ON POWER GENERATION USING COAL AND RENEWABLE ENERGY 39

CHAPTER 5 41

FINDINGS, SUGGESTIONS AND CONCLUSION 41
5.1 FINDINGS 42
5.2 SUGGESTIONS 43
5.3 CONCLUSION 44

LIST OF TABLES

Table 1 DISTRIBUTION OF COAL IMPORTED INTO INDIA IN 2021 29
Table 2 FORECAST OF RENEWABLE ENERGY PRODUCTION 2022 TO 2030 31
Table 3 IMPORT OF COAL IN INDIA 33
Table 4 RENEWABLE ENERGY PRODUCTION – INDIA 35
Table 5 USE OF COAL BY VARIOUS INDUSRTIES 37
Table 6 POWER GENERATION USING COAL AND RENEWABLE ENERGY 39

TABLE OF FIGURES

Figure 1 PERCENTAGE OF COAL IMPORT 29
Figure 2 FORECAST OF RENEWABLE ENERGY PRODUCTION 32
Figure 3 IMPORT OF COAL IN INDIA 34
Figure 4 RENEWABLE ENERGY PRODUCTION - INDIA 36
Figure 5 USE OF COAL BY VARIOUS INDUSRTIES 38
Figure 6 POWER GENERATION USING COAL AND RENEWABLE ENERGY 39

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

The shift towards renewable energy sources has gained significant momentum in recent years due to concerns about climate change and the negative environmental impacts of fossil fuels. As renewable energy becomes increasingly affordable and accessible, many countries are turning to these sources to reduce their carbon footprint and promote sustainable development. This trend is having a significant impact on the traditional energy source of coal, which has been the primary source of energy production for many countries for decades.It seeks to investigate the effects of the growing use of renewable energy sources on the global coal trade. The study aims to understand how the shift towards renewable energy sources is impacting the demand for coal imports, the economic and environmental implications of reduced coal imports, and the policy interventions that can facilitate the transition to renewable energy sources.

Coal is a vital source of energy for many countries worldwide, particularly in developing countries. Coal-fired power plants provide cheap and reliable electricity, and coal mining is an important source of employment and revenue for many communities. However, coal also has significant environmental impacts, including air pollution, greenhouse gas emissions, and land degradation.

Renewable energy sources, such as solar, wind, hydro, geothermal, and biomass, offer a cleaner and more sustainable alternative to coal. These sources do not produce greenhouse gas emissions or air pollution and have a lower environmental impact than coal mining. Moreover, renewable energy sources have become increasingly affordable and accessible, particularly solar and wind energy, which have reached grid parity in many countries, meaning they are as cheap or cheaper than coal-fired power generation. The growing demand for renewable energy sources is impacting the global coal trade in several ways. The shift towards renewable energy sources is reducing the demand for coal imports, particularly in developed countries that have implemented policies to promote renewable energy. This is having a significant impact on coal-exporting countries, particularly in Asia, where coal has been a significant source of revenue.

Reduced demand for coal imports has economic and environmental implications. On the one hand, reduced demand for coal imports can lead to job losses and economic decline in coal-exporting countries. On the other hand, reduced coal consumption can have positive environmental impacts, including reductions in greenhouse gas emissions and air pollution. The potential economic and environmental impacts of reduced coal imports. The study can

analyze data on energy consumption and production, conduct interviews with experts in the energy industry, and examine case studies of regions or countries that have successfully transitioned from coal to renewable energy sources.

Policy interventions can also facilitate the transition from coal to renewable energy sources. Governments can provide subsidies and tax incentives for renewable energy sources and energy efficiency measures, as well as regulations that promote renewable energy adoption. These policies can help create new economic opportunities in renewable energy industries, which can help offset the economic impact of reduced coal imports.

It seeks to investigate the effects of the growing use of renewable energy sources on the global coal trade. The study aims to understand the economic and environmental implications of reduced coal imports and identify policy interventions that can facilitate the transition to renewable energy sources. While there are challenges associated with reduced coal imports, the benefits of renewable energy sources are significant, both in terms of reducing environmental impacts and creating new economic opportunities.

1.1. DEFINITION AND MEANING

An investigation into the effects of the increasing use of renewable energy sources on the global coal trade. The study aims to assess how the shift towards renewable energy is affecting the demand for coal imports, the economic and environmental implications of reduced coal imports, and the policy interventions that can facilitate the transition to renewable energy sources. Renewable energy sources, such as solar, wind, hydro, geothermal, and biomass, offer a cleaner and more sustainable alternative to fossil fuels like coal. These sources do not produce greenhouse gas emissions or air pollution and have a lower environmental impact than coal mining. Moreover, renewable energy sources have become increasingly affordable and accessible, particularly solar and wind energy, which have reached grid parity in many countries, meaning they are as cheap or cheaper than coal-fired power generation.

The growing demand for renewable energy sources is impacting the global coal trade in several ways. The shift towards renewable energy sources is reducing the demand for coal imports, particularly in developed countries that have implemented policies to promote renewable energy. This is having a significant impact on coal-exporting countries, particularly in Asia, where coal has been a significant source of revenue. Reduced demand for coal imports has

economic and environmental implications. On the one hand, reduced demand for coal imports can lead to job losses and economic decline in coal-exporting countries. On the other hand, reduced coal consumption can have positive environmental impacts, including reductions in greenhouse gas emissions and air pollution.

It seeks to investigate the potential economic and environmental impacts of reduced coal imports. The study can analyze data on energy consumption and production, conduct interviews with experts in the energy industry, and examine case studies of regions or countries that have successfully transitioned from coal to renewable energy sources.

The study can assess the economic impacts of the shift towards renewable energy sources on coal-dependent regions, including changes in employment and economic growth. It can also analyze the environmental benefits of renewable energy sources compared to coal, such as reductions in greenhouse gas emissions and air pollution. The study can also identify the challenges associated with the adoption of renewable energy sources, such as intermittency and the need for energy storage, and explore potential solutions to these challenges.Policy interventions can also facilitate the transition from coal to renewable energy sources. Governments can provide subsidies and tax incentives for renewable energy sources and energy efficiency measures, as well as regulations that promote renewable energy adoption. These policies can help create new economic opportunities in renewable energy industries, which can help offset the economic impact of reduced coal imports.

An analysis of how the world's coal commerce is affected by the rising usage of renewable energy sources. The study's objectives are to comprehend the economic and environmental effects of decreased coal imports and to propose potential policy changes that could hasten the switch to renewable energy sources. Understanding how this transition will affect the world's energy system is crucial since renewable energy sources have considerable advantages in terms of minimising environmental effects and generating new economic opportunities.

1.2. OBJECTIVE OF THE STUDY

1. To analyse the impact of renewable energy on coal import.
2. To identify the economic benefits of renewable energy.
3. To study the environmental impacts of renewable energy.

1.3 SCOPE OF THE STUDY

- Details regarding the impact on coal import due to renewable energy.
- To understand the effect renewable energy has on the environment.
- Understand the data relating to coal import to India.

1.4 RESEARCH METHADOLOGY

Secondary data is used for the completion of the project as various news articles and journals have been collected and studied.

1.5 LIMITATION

- Study is conducted on secondary data it's not reliable.
- Primary data about study could not be collected due to time constraints.

CHAPTER 2

LITERATURE REVIEW

1. In India, using renewable energy is primarily done to advance economic growth, increase energy security, increase access to electricity, and slow down climate change. By using sustainable energy and guaranteeing that all residents have access to cost-effective, dependable, sustainable, and contemporary energy, sustainable development is made feasible. India is becoming one of the top leaders in the most lucrative markets for renewable energy in the world because to strong government support and the increasingly favourable economic environment. The government has created liberal laws, programmes, and an atmosphere to entice foreign investment and quickly advance the nation in the renewable energy sector. Over the coming years, it is projected that the domestic employment situation in the renewable energy sector will improve significantly. This essay seeks to outline important developments in renewable energy in India, including prospects, projections, electricity generation, obstacles, and potential for investment and employment. The numerous challenges that the renewable energy business is up against have been identified in this review. Policymakers, innovators, project developers, investors, industries, related stakeholders and departments, researchers, and scientists will all benefit from the advice based on the review's findings.(Charles Rajesh Kumar & Majid, 2020)
2. A substantial portion of the population, the majority of whom reside in rural regions, India faces a significant difficulty in providing access to sufficient, affordable, and clean sources of energy, especially electricity generation. The majority of India's thermal power plants that produce electricity use coal as fuel. As a result, we can better appreciate the significance of the non-renewable or finite resource coal and its steadily rising usage. Since the two are related, as the world's energy needs have grown, so too has fossil fuel exploitation. Coal is one of the most popular and widely used fossil fuels, according to fossil fuels. Additionally, it serves as the Indian subcontinent's main energy source. Coal harvesting is a difficult task because it can lead to many issues for the labourers, including death. It is not only a risky profession, but it also has a negative effect on the environment. Since coal is a finite resource, it should be properly conserved. Coal has a substantial market share in the production of electricity. However, because coal is a finite resource that can only be used for a short period of time, we must discover a quick replacement for coal and its applications. Both hydropower and nuclear power facilities are excellent choices.(Akhai & Mishra, 2013)
3. In the fight against climate change, energy security and sustainability are without a doubt the top priorities. A replacement for fossil fuels must be developed, even though

a call for 100% green and renewable energy at this time appears to be impractical given the significant financial costs and weak energy infrastructure. In comparison to other fossil fuels like coal, bitumen, and diesel, natural gas, a naturally occurring fossil gas, is a cleaner alternative as a source of energy. Due to its competitiveness with other fossil fuels like coal and its capacity to facilitate the integration of renewables, natural gas is the best option for a sustainable transition to renewable energy in every nation on the planet. Natural gas is abundant in the ASEAN region, which suggests that it is a suitable primary energy source for the transition to short- and medium-term sustainable renewable energy sources. Additionally, natural gas can be produced using a variety of techniques and renewable energy sources. Natural gas power plants' flexibility makes it possible to incorporate sporadic renewable energy sources like solar and wind.(Mohammad et al., 2021)

4. Numerous articles indicate coal is more expensive than renewable energy (RE). Two cost curves, one rising for coal and the other lowering for RE, particularly solar, are frequently displayed in newspapers. At some time, they get to a "grid parity" intersection, where they cross. Whether this has already occurred or is about to do so is a another question. It is doubtful that coal disappears after a simple crossover, therefore this framing misses the important factors at play. Even before taking into account extra difficulties of contracting, technical limitations like ramping capacities, and frameworks for who will pay for the transition, the reality needs to take time of day, location, and share of RE into account. The straightforward assertion that RE is already less expensive hides system-level costs as well as the disproportionate impact on particular states, generators, and stakeholders. The portfolio strategy, with both playing a role in the near future, is suggested as having higher planning value in this paper's alternative comparison model for RE and coal.(RAHUL TONGIA, 2018)
5. The only fossil fuel that may effectively serve as a transitional energy source as one shifts from an economy based on petroleum and natural gas to one based on non-depletable or renewable energy sources is coal. In the industrialised nations of the world, coal extraction has needed constant technological advancements in order to remain competitive with other energy sources. Among its many useful applications are the production of electricity, the production of steel and cement, and the heating of industrial processes. Despite the long-term significance of using oil and gas, coal will continue to be a key component of the global energy supply.(Balat, 2007)

6. Renewable energy is the limitless energy produced by continuous regeneration and includes wind, solar, geothermal, and tidal power. The ability to obtain renewable energy without harming the environment is one of its key benefits. It has been discovered that renewable energy sources can provide answers to the environmental issues that humanity is now facing. India has a large population, which increases its need for energy. One of the primary methods to satisfy this attribute is renewable energy. Today, 37% of India's energy consumption comes from renewable sources. The goal of this essay is to discuss the potential for renewable energy in the United States.(Ravichandran et al., 2022)
7. This essay aims to analyse the management of India's renewable energy resources, which serve as an alternative to conventional energy sources. It aims to concentrate energy from programmes in India that promote renewable energy awareness as well as grid-interactive renewable energy power and off-grid/distributed renewable energy power. The methodology of the data is based on secondary data published by the Ministry of Renewable Energy Resources in India for the years 2001–2002 to 2012–2013, and it makes use of statistical techniques like mean, compound growth rate, percentage, and standard deviation with graphical representation. The study's key finding was that while wind energy generates more power, solar energy and waste-to-energy are more reliable sources of energy. When compared to off-grid renewable energy, the power energy produced by grid-interactive renewable energy sources is higher. In conclusion, renewable energy sources are superior to conventional energy sources because they can be used in a variety of ways, including power generation, cooling, cooking, pumping, heating, etc. Conventional energy sources are also bad for the environment because they produce insufficient energy. Therefore, alternative energy sources are used to safeguard the environment, benefit customers, address the issue of electricity generation and promote economic growth and development.(Mahendrakumar, 2013)
8. India has pledged to reduce emissions with the aim of increasing the generation of renewable energy to 175 GW by 2022. Rapidly expanding the use of solar and wind energy will be necessary to meet this goal, along with addressing the associated issues of funding needs, environmental implications, and power system integration. Instead, than building new infrastructure within natural habitats or regions of intensive agriculture, developing energy on lands degraded by human activity will lessen cumulative effects and land use disputes. We calculated that converted lands across

India have a potential capacity of 1789 GW, which is more than ten times the expectations for 2022. Nevertheless, a sizable amount of land will be required to achieve India's 2022 renewable energy target, with estimates ranging from 55,000 to 125,000 km2, or nearly the size of Himachal Pradesh or Chhattisgarh, respectively. Approximately 6700-11,900 km2 of forest land and 24,100-55,700 km2 of agricultural land could be affected if renewable energy is promoted with the sole intention of maximising resource potential. Public support for renewable energy could be increased by subsidies and incentive programmes that encourage the deployment of low-impact renewable energy sources and set mitigation obligations that boost prices for projects that have an impact on the environment.(Kiesecker et al., 2020)

9. Does a nation's level of financial capital have an impact on its capacity to implement energy transitions? The significance of financial capital for changes in the use of each energy type is examined in this research using data for up to 137 countries for the years 1998 to 2013. I discover that financial capital facilitates the switch to more expensive energy sources. Financial resources help high-income nations make the switch from fossil fuels to contemporary renewable energy sources, particularly wind energy. Greater percentages of wind energy are supported by both domestic private debt securities and private financing from banks. Financial capital helps lower-income nations transition from biomass to fossil fuel energy sources like coal. I also discover that nations with higher financial capital stocks are more inclined to switch to more expensive power producing systems.(Best, 2017)
10. Energy is crucial for a region's or country's economic and social growth. However, the primary contributor to air pollution and climate change is the usage of fossil fuels. Global concern has been raised over the threat to sustainability posed by greenhouse gas emissions and the erosion of the natural resource base (such as the oil crisis, fuelwood scarcity, etc.). For a region to develop sustainably, energy efficiency improvements and the decoupling of economic growth from energy use, particularly of fossil fuels, are crucial. On the one hand, the energy sector is a component of the economy, and on the other, it is made up of components that interact with one another, such as the energy supply and demand. These two relationships are incredibly intricate. Each and every business activity needs energy. Energy resources are necessary for both end consumption and intermediate production. Consequently, the nation's energy system affects economic development. In turn, economic considerations like capital costs, energy pricing, etc. affect how technologies are implemented or how the energy

system is improved. Additionally, the flow of energy from source as primary energy to service as useable energy is a component of the demand-supply balances. Technologies are involved at each level of the energy flow with varying conversion efficiency and losses.(Dr T V Ramachandra, 2020)

11. Fossil fuel consumption has major negative effects on the economy and ecology, including high fossil fuel subsidies, high carbon emissions, and high energy demand. New approaches are required in order to produce sustainable solutions that are largely independent from the usage of fossil fuels in the current economic climate. The growth of renewable energy is yet hampered by numerous obstacles. According to the research, economic, policy and legal, and technical impediments to renewable energy are the biggest ones. This research conducted a literature review to ascertain the motivations for switching from conventional energy to renewable energy and to identify the impediments to the growth of renewable power generation.(Kabel & Bassim, 2020)
12. Decarbonization of electrical power networks must be completed while preventing recurrent blackouts, given the severe repercussions of climate change and the war in Ukraine. This effort is supported by an in-depth knowledge of the effectiveness and dependability of various power sources. We need to find a straightforward and effective method of presenting the energy transition's important indicators because it affects several socioeconomic sectors. The capacity factor (CF) is a quantitative indicator of both the effectiveness and expenses of a power producing system. Since 2000, solar PV and wind power have experienced an accelerated growth that has improved the dependability of their CFs. One may immediately determine the nominal capacity needed to replace the current fossil fuel mix for electricity generation or growth to satisfy future demand by knowing the long-term average CFs of various electricity sources. Although CFs are simply calculated, they are based on actual performance rather than modelling or wishful thinking. According to the current average CFs, installing 4 W of solar PV or 2 W of wind power is required to replace 1 W of fossil fuel energy producing capacity. It is need to add 8.8 W of solar PV or 4.3 W of wind power to the current energy mix.(Bolson et al., 2022)
13. In a dynamic environment, the theory for picking the best intervals for an asset rejuvenation/replacement sequence is established. R/R optimum timings for asset rejuvenation and then replacement are established for both deterministic and stochastic models. Comparative statics results show how significantly different the parameters are

from pure replacement and R/R policies in terms of the ideal length of cycles. The interplay of the relative costs between the early non-rejuvenation and rejuvenation periods is what causes these variations in the comparative statics results. According to the methodology used to arrive at these conclusions, the ideal moment to renew the asset is determined by the proportionate difference in expenses between each stage.(Wetzstein & Michael, 2017)

14. Using new datasets for renewable energy, this study examines the technological and financial aspects of an expedited energy transition in 2050. The analysis shows that energy efficiency and renewable energy technologies are the key components of such transformation, and their synergies are also significant. Such a transformation is supported by advantageous economics, widely accessible resources, scalable technology, and major socioeconomic advantages. Two-thirds of the world's energy needs can be met by renewable energy, and these sources will also make up the majority of the greenhouse gas emissions reductions required between now and 2050 to keep the average global surface temperature increase below 2 °C. In order to mobilise the required six-fold acceleration of renewables growth, it will be necessary to make changes to the enabling policy and regulatory frameworks. The biggest growth is anticipated for wind and solar PV technologies, which will be accompanied by high levels of energy efficiency. However, new technology and innovation are necessary to assure the eventual abolition of carbon dioxide emissions, particularly for the manufacturing and transportation sectors, which are usually disregarded in the global discussion. Emerging infrastructure challenges like charging infrastructure and other sector coupling implications require more focus.(Gielen et al., 2019)
15. Production of renewable energy is required to stop climate change and stop the concomitant loss of biodiversity. However, developing the necessary infrastructure and technologies will lead to an increase in the production of several metals, posing new mining risks to biodiversity. Here, we map mining regions and evaluate how closely they are located to important locations for biodiversity conservation. 50 million km2 of the Earth's land surface could be affected by mining; 8% of the area is protected, 7% is a key biodiversity area, and 16% is still unexplored wilderness. The majority of mining areas (82%) target the resources required for the generation of renewable energy, and regions that overlap with Protected Areas and Remaining Wilderness have a higher density of mines than the overlapping mining areas that target other materials (our measure of threat severity). As more mines target resources for the creation of

renewable energy, the hazards to biodiversity from mining will grow. Without careful planning, these new threats to biodiversity may outweigh those prevented by the mitigation of climate change.(Sonter et al., 2020)

16. In the world, India has been a leader in the adoption of renewable energy as part of its energy transformation. By August 2022, installed renewable energy capacity—including huge hydro—had increased from a few megawatts (MW) in 2010. The government of India's aspirational goals for renewable energy, along with the corresponding framework for policy and reform, have been a significant driver of the sector's growth. The change has also led to a rejection of coal generating capacity, with additions reaching an all-time low in FY2021/22. Over 606GW of coal-fired power projects have been scrapped or shelved, and 15.6GW have been withdrawn in India between 2010 and 2022. Despite this, the demand for electricity across the nation has been expanding quickly, creating a number of challenges for the renewable energy sector. Due to these reasons, the government is reconsidering the use of thermal power as a remedy for any impending power shortages.(Buckley, 2022)
17. In order to address challenges like climate change and air pollution as well as the growing need for electricity in the country, the Indian government is advocating policies that seek to increase the usage of renewable energy sources and decrease the percentage of coal-fired power generation. By 2030, it has set a goal of implementing 510 GW of solar-focused renewable energy power output. Additionally, it intends to lower CO2 emissions per unit of GDP from 2005 levels by 33% to 35%. The following issues must be resolved in order to accomplish these goals: the privatisation of state-owned retail and distribution companies (DISCOMs) with significant deficits; transmission and distribution losses of over 20%; flaws in the transmission infrastructure tying consumption and production areas together; and grid stabilisation.(Asia, 2021)
18. Based on the current quality of domestic coal, it has been estimated by the Integrated Energy Policy of Planning Commission of India (in August 2006) that India would require a massive coal availability level of over 2 billion tons/annum to achieve the country's target power generation capacity of 8 lakh MW by 2031–2022. India produced 638.05 (Provisional) million tonnes of coal in 2015–16, placing it as the third-largest coal producer in the world. With 199.88 Mt (Provisional) imported during 2015–16, it is also the fourth biggest importer of coal. Under the 'business as usual scenario' and roughly 185 Mt under the 'optimistic scenario,' the import requirement is projected to be 265 Mt by 2016–17. India has had to depend on such heavy imports which have

grown over time due to the continuously expanding demand for coal and the availability of less indigenous and low-quality coal. And it has been predicted that this disparity will expand even more as a result of the booming demand from the infrastructure and heavy investment sectors. In this light, this article will examine historical import patterns of coal into India and how they have complimented domestic coal production to close the supply-demand imbalance for coal in the nation.(Kirtiraj Lahiri, 2016)

19. India's main energy mix and changes in consumption and production are examined in order to determine the causes of these changes and their likely effects on the country's economy and emissions. Energy consumption increased significantly between 1980 and 2013, driven by rising GDP growth rates and shifting economic structures, but with no visible impact on the primary energy mix, which remained mostly stable and was dominated by coal and oil. India's primary energy consumption per person is still low compared to global standards despite growth in energy consumption. The main elements that will affect the rise of India's energy demand are industrialization, urbanisation, and the energy mix. India's primary energy consumption is anticipated to increase faster than China's in the future. Even if gas and renewable energy sources will take some of coal's market share, coal will still dominate the energy mix. India's energy and emission intensities have decreased over time, however this is primarily because of increased energy efficiency rather than a shift in the country's energy mix. Gains from higher shares of more energy- and carbon-efficient fuels are likely to remain small if the energy mix stays the same. Significantly for India, domestic production has lagged in keeping up with the rise in energy consumption, and imports are anticipated to keep rising, adding to the macroeconomic load. To comprehend their effects on the energy policy environment, improvements in energy and carbon intensity, import dependency, and domestic production, a higher GDP growth path and a green growth path are investigated.(Kaushik Deb, 2016)
20. The goal of this essay is to examine the development of steam power plants and renewable energy sources through investment. With secondary data from the report of the Ministry of Energy and Mineral Resources and the Electricity Supply Business Plan, this study employs a descriptive quantitative methodology. According to the study's findings, neither overall renewable energy capacity nor investment in renewable energy increased noticeably or briefly. The capacity of all coal-fired power plants, the amount of electricity consumed, and the amount of coal sold for electricity production all increased dramatically. According to the findings of earlier experiments, the researchers

came to the following conclusions: The total capacity of renewable energy did not greatly rise; The capacity of all coal-fired power plants dramatically increased; Sales of coal for the production of power increased greatly; the national electrical energy consumption increased significantly; Investment in renewable energy has not considerably grown.(Pranadipa & Sulton, 2022)

CHAPTER 3

INDUSTRY PROFILE

3.1 COAL INDUSTRY AN OVERVIEW

The coal industry is a sector of the economy that is focused on the mining, processing, and distribution of coal. Coal is a fossil fuel that is primarily used to generate electricity and heat, and it is also used in industrial processes such as steel and cement production. The coal industry has been a significant contributor to the global economy for many years, providing a reliable and affordable source of energy. However, in recent years, the industry has faced several challenges, including environmental concerns about greenhouse gas emissions and the increasing competitiveness of renewable energy sources.

Despite these challenges, the coal industry continues to play a vital role in many countries' economies, particularly in developing countries where coal is still the primary source of energy. Coal production and consumption remain high in countries like China, India, and the United States. There are several types of coal, including anthracite, bituminous, and lignite, with different energy contents and properties. Coal is typically mined from underground or surface mines and then transported to processing plants where it is cleaned, crushed, and sorted before being transported to power plants or industrial users. The coal industry remains an important part of the global energy mix, but it is facing increasing pressure to transition to cleaner energy sources and reduce its environmental impact.

3.2 RENEWABLE ENERGY AND ITS IMPORTANCE

Renewable energy has become an increasingly important topic in recent years due to concerns over climate change, energy security, and economic development. Renewable energy refers to energy sources that are naturally replenished and can be used continuously without depleting their resources. Some examples of renewable energy sources include solar, wind, hydropower, geothermal, and biomass. Renewable energy sources offer several benefits compared to non-renewable energy sources such as coal, oil, and natural gas. One of the most significant benefits of renewable energy is that it produces little to no greenhouse gas emissions or other pollutants that contribute to climate change and air pollution. By reducing our reliance on fossil fuels and transitioning to renewable energy, we can significantly reduce the negative impacts of climate change and air pollution on human health and the environment.

Renewable energy sources also offer significant economic benefits. The development of renewable energy industries can create new jobs and stimulate economic growth. In addition, renewable energy sources can provide long-term price stability and lower energy costs over

time. This can help to reduce energy poverty and increase energy access, particularly in underdeveloped regions where conventional energy sources may not be available or feasible. Renewable energy is also important for energy security. Many countries rely on imported fossil fuels to meet their energy needs, which can make them vulnerable to supply disruptions, price fluctuations, and geopolitical tensions. In contrast, renewable energy sources are often domestically sourced, reducing reliance on foreign sources of energy and improving energy security.

Sustainability is another key benefit of renewable energy sources. Renewable energy sources are sustainable and have the potential to meet the world's energy needs without depleting finite resources or causing environmental harm. In contrast, fossil fuels are finite resources that will eventually run out, and their extraction and use can have significant environmental impacts, including air and water pollution, habitat destruction, and climate change. Despite the benefits of renewable energy, there are still challenges that need to be addressed. One of the biggest challenges is the intermittency of renewable energy sources such as solar and wind. Unlike fossil fuels, renewable energy sources are not always available, and energy storage technologies are still in the early stages of development. This can create challenges for grid stability and energy management.

Another challenge is the upfront cost of renewable energy infrastructure. Although the cost of renewable energy has been declining in recent years, it is still more expensive than fossil fuels in many regions. This can make it challenging for some countries and communities to adopt renewable energy sources, particularly in areas with limited financial resources.

Renewable energy is becoming increasingly important in addressing the challenges of climate change, energy security, and economic development. Renewable energy sources offer several benefits compared to non-renewable energy sources, including reduced greenhouse gas emissions, economic benefits, energy security, sustainability, and increased energy access. However, challenges such as intermittency and upfront costs still need to be addressed to ensure the widespread adoption of renewable energy sources.

3.3 COAL GLOBAL TRADE

Coal is a widely traded commodity around the world, with countries importing and exporting it for various purposes. The global coal trade is dominated by a few key players, primarily Australia, Indonesia, Russia, and the United States. These countries account for the majority of the world's coal exports, while countries like China and India are the largest importers. The global coal trade is driven by a variety of factors, including demand for energy, industrial production, and transportation. Coal is used to generate electricity in power plants and is also used in various industrial processes, such as steel production. As a result, countries that have a high demand for energy and industrial products are significant importers of coal.

Australia is the world's largest coal exporter, accounting for around 37% of global coal exports in 2020. The country exports mainly to Japan, China, and South Korea. Indonesia is the second-largest exporter of coal, with China and India being the largest importers. Russia is the third-largest exporter, with the majority of its coal going to European countries like Germany and Turkey. The United States is the fourth-largest exporter of coal, with significant exports going to countries in Asia and Europe. In recent years, the global coal trade has been affected by various factors, including the growing shift towards renewable energy sources and the increasing environmental concerns about coal. Several countries, including China and India, have announced plans to reduce their coal imports and phase out coal-fired power plants. This shift in energy policy could have significant implications for the global coal trade in the coming years.

Despite the challenges facing the coal industry, the global coal trade is expected to continue in the coming years, driven by demand from developing countries and industrial production. However, the industry will likely face increasing pressure to reduce its environmental impact and transition to cleaner energy sources in the future.

3.4 EFFECT OF RENEWABLE ENERGY ON COAL IMPORT TO INDIA

Renewable energy sources such as solar, wind, and hydro power are becoming increasingly important in India's energy mix, and their growth is expected to have a significant impact on the country's coal imports. India has set a target to achieve 175 gigawatts (GW) of renewable energy capacity by 2022, which includes 100 GW of solar energy, 60 GW of wind energy, 10 GW of bio-energy, and 5 GW of small hydropower. This would represent a significant shift away from fossil fuels, including coal. The growth of renewable energy in India is expected to

reduce the country's dependence on coal imports in several ways. First, renewable energy sources can provide a more cost-effective alternative to coal, particularly in remote and rural areas that are not connected to the grid. Second, renewable energy can reduce the demand for electricity generated by coal-fired power plants, reducing the need for coal imports. Finally, as India's renewable energy sector grows, it is likely to create new jobs and economic opportunities, reducing the country's reliance on coal for employment and economic growth.

India's government has already taken several steps to promote renewable energy, including offering subsidies and incentives for renewable energy projects, creating a renewable energy fund, and launching a national solar mission. However, there are still several challenges to overcome, including the intermittency of renewable energy sources and the need for a robust transmission and distribution network to support renewable energy deployment. The growth of renewable energy in India is expected to have a significant impact on the country's coal imports, reducing the demand for coal and promoting cleaner, more sustainable energy sources. While there are still challenges to overcome, India's ambitious renewable energy targets and supportive government policies are likely to drive the continued growth of the renewable energy sector in the coming years.

3.5 POLICIES AND INCENTIVES FOR PROMOTING RENEWABLE ENERGY ADOPTION

Policies and incentives are essential tools for promoting renewable energy adoption and accelerating the transition to a low-carbon economy. The most common policies and incentives for promoting renewable energy adoption include feed-in tariffs, tax credits, renewable portfolio standards, and net metering. Feed-in tariffs (FITs) are a policy mechanism that guarantees a fixed rate for electricity generated from renewable energy sources. FITs provide a stable and long-term revenue stream for renewable energy projects, which reduces the financial risk associated with developing these projects. FITs are typically designed to encourage the development of small-scale renewable energy projects by offering a higher tariff rate for small installations. This helps to create a level playing field for small and large-scale renewable energy projects. Tax credits are another policy tool used to promote renewable energy adoption. Tax credits reduce the cost of renewable energy projects by allowing project developers to deduct a portion of their investment from their tax liability. Tax credits can be used to promote a range of renewable energy technologies, including solar, wind, geothermal,

and biomass. Tax credits can be structured to provide an incentive for new installations, or they can be used to support existing projects.

Renewable portfolio standards (RPS) are policies that require a certain percentage of electricity to come from renewable energy sources. RPS policies are typically set at the state level and can vary from state to state. RPS policies provide a clear market signal to developers and utilities, which encourages the development of renewable energy projects. RPS policies can be designed to provide flexibility for utilities to meet the renewable energy targets through the use of renewable energy credits (RECs) or other mechanisms.Net metering policies allow consumers who generate their own electricity from renewable sources to sell excess electricity back to the grid. Net metering policies provide a financial incentive for consumers to invest in renewable energy projects by reducing their energy bills and providing a revenue stream for excess electricity generated. Net metering policies are currently in place in many states, and they have been successful in promoting the development of small-scale renewable energy projects.

Policies and incentives are crucial for promoting renewable energy adoption and reducing our dependence on fossil fuels. Feed-in tariffs, tax credits, renewable portfolio standards, and net metering are just a few of the policies and incentives that can be used to promote renewable energy adoption. By implementing these policies and incentives, we can accelerate the transition to a low-carbon economy and reduce the impacts of climate change.

3.6 IMPACT OF RENEWABLE ENERGY ON THE ELECTRICITY MARKET AND PRICING.

Renewable energy sources such as wind, solar, and hydro power have been gaining increasing attention as a sustainable and clean alternative to traditional fossil fuel-based energy sources. As the world becomes more aware of the environmental and health impacts of burning fossil fuels, renewable energy has become an attractive option to reduce carbon emissions and combat climate change. The growing use of renewable energy sources is having a significant impact on the electricity market and pricing, with both positive and negative effects.One of the most significant impacts of renewable energy on the electricity market is the reduction in the marginal cost of electricity. Unlike fossil fuels, renewable energy sources are essentially free once the infrastructure is in place. This means that once a wind turbine or solar panel is

installed, the cost of generating electricity is very low. This has resulted in a reduction in the wholesale price of electricity, which benefits consumers by reducing the cost of electricity bills.

Another positive impact of renewable energy on the electricity market is the increase in competition. As more renewable energy sources come online, traditional fossil fuel-based power plants are facing increasing competition. This has led to a decrease in the market share of fossil fuel-based electricity providers, which is pushing them to invest in renewable energy sources to remain competitive. However, there are also some negative impacts of renewable energy on the electricity market and pricing. One of the main challenges is the intermittency of renewable energy sources. Wind and solar power are dependent on weather conditions, which can lead to fluctuations in energy supply. This can create challenges for grid operators, who need to maintain a balance between supply and demand. To compensate for the intermittency, energy storage solutions like batteries or pumped hydro storage are needed, which can increase the cost of renewable energy.

Moreover, renewable energy sources require significant investment in infrastructure, such as building wind turbines and solar panels. This can lead to higher upfront costs, which can put a strain on the finances of energy companies. Governments may provide incentives to encourage investment in renewable energy, but these incentives can also increase the cost of electricity for consumers.Renewable energy is having a significant impact on the electricity market and pricing, with both positive and negative effects. The reduction in the marginal cost of electricity and the increase in competition are positive outcomes, while the intermittency of renewable energy and high upfront costs are challenges that need to be addressed. It is clear that renewable energy will play an increasingly important role in the future of electricity markets, and it is important to carefully consider the impacts on pricing and infrastructure as this transition takes place.

3.7 ANALYSIS OF THE RELATIONSHIP BETWEEN RENEWABLE ENERGY ADOPTION AND COAL IMPORT REDUCTION IN DIFFERENT REGIONS.

Renewable energy adoption and coal import reduction are closely linked, as countries that adopt more renewable energy sources tend to decrease their reliance on coal imports. The relationship between the two varies depending on a variety of factors, such as government policies, availability of renewable resources, and energy infrastructure.

Europe is a region that has seen a significant reduction in coal imports as it has increased its adoption of renewable energy. Countries like Germany and Denmark have invested heavily in wind and solar power, which has allowed them to reduce their reliance on coal imports. This has been achieved through policies such as feed-in tariffs and renewable portfolio standards, which incentivize the adoption of renewable energy sources.

In Asia, China has become a leader in renewable energy adoption, with the country investing heavily in wind and solar power. This has allowed China to reduce its reliance on coal imports, which has been a major source of air pollution in the country. However, some countries in the region, such as India and Vietnam, are still heavily reliant on coal imports and have been slower to adopt renewable energy sources due to infrastructure challenges.

In the United States, the relationship between renewable energy adoption and coal import reduction is more complicated. While the country has seen a significant increase in renewable energy adoption in recent years, it has also increased its domestic production of natural gas, which has allowed it to reduce its reliance on coal imports. Additionally, some states have implemented policies to support the adoption of renewable energy sources, while others have focused on increasing domestic energy production.

The relationship between renewable energy adoption and coal import reduction is complex and varies depending on a variety of factors. While increasing the adoption of renewable energy sources is a key strategy for reducing reliance on coal imports, it is important to consider the unique circumstances of each region and country in order to develop effective policies and strategies for reducing coal imports and promoting renewable energy adoption.

3.8 CURRENT STATE OF RENEWABLE ENERGY ADOPTION IN DIFFERENT COUNTRIES AND REGIONS.

Renewable energy adoption is gaining momentum globally, with many countries and regions transitioning from fossil fuels to cleaner sources of energy. However, the current state of renewable energy adoption varies greatly across different countries and regions, with some leading the way in the transition to clean energy, while others continue to rely heavily on fossil fuels.

Europe: Europe has been a leader in renewable energy adoption, with some countries, such as Denmark and Germany, obtaining a significant percentage of their electricity from wind and

solar power. The European Union has set a target of achieving 32% renewable energy by 2030, and several countries, including Spain and Italy, have announced plans to phase out coal by 2025. In addition, Europe has been making significant investments in offshore wind energy, with the United Kingdom, Germany, and Denmark leading the way.

China: China is the world's largest investor in renewable energy, with the country investing heavily in wind and solar power in recent years. China has set a target of achieving 35% renewable energy by 2030, and has already surpassed its 2020 target. However, the country still relies heavily on coal, which is a major source of air pollution. To address this, the Chinese government has implemented policies to reduce coal consumption and has been promoting the use of electric vehicles.

United States: The United States has seen a significant increase in renewable energy adoption in recent years, with wind and solar power becoming more competitive with traditional fossil fuels. However, the country still relies heavily on fossil fuels, and the federal government has been criticized for its lack of action on climate change. Despite this, many states have implemented their own renewable energy targets, with California aiming to achieve 100% renewable energy by 2045.

India: India has set an ambitious target of achieving 175 GW of renewable energy by 2022, and has made significant progress in increasing its solar and wind capacity. The country has also been promoting the use of electric vehicles, with plans to have only electric cars on its roads by 2030. However, the country still relies heavily on coal, and the transition to clean energy has been slowed by infrastructure challenges and bureaucratic hurdles.

Africa: Renewable energy adoption in Africa is still in its early stages, but several countries, including South Africa and Kenya, have made significant investments in wind and solar power. The potential for renewable energy in Africa is significant, as the continent has abundant solar and wind resources. However, the lack of infrastructure and funding has been a barrier to renewable energy adoption in many African countries.

Latin America: Latin America has been making significant investments in renewable energy, with countries such as Brazil, Chile, and Mexico leading the way. Brazil has a goal of achieving 45% renewable energy by 2030, while Chile has already surpassed its 2025 target for renewable energy adoption. In addition, many Latin American countries are investing in hydropower, which is a significant source of renewable energy in the region.

Overall, while renewable energy adoption is increasing in many countries and regions, there is still a long way to go to fully transition to clean energy. Policymakers and investors must continue to prioritize renewable energy development in order to address the urgent challenge of climate change. In addition, the transition to clean energy must be equitable, with efforts made to ensure that all communities have access to clean energy and benefit from the transition.

3.9 CHALLENGES AND BARRIERS TO RENEWABLE ENERGY ADOPTION

Renewable energy is a key solution to addressing the environmental and economic challenges associated with fossil fuel dependence. However, its widespread adoption faces several challenges and barriers that need to be overcome. Some of the key challenges and barriers to renewable energy adoption include intermittency, infrastructure, energy storage, and financing.

Intermittency is one of the biggest challenges facing renewable energy adoption. Unlike fossil fuels, renewable energy sources such as wind and solar are not always available, and their availability is often unpredictable. This makes it difficult to match supply and demand, and could lead to instability in the energy grid. To overcome this challenge, renewable energy technologies need to be coupled with energy storage systems that can store excess energy and release it when needed. Infrastructure is another challenge that hinders renewable energy adoption. Many renewable energy sources, such as wind and solar, are often located in remote areas that are far from population centers. This requires significant investment in transmission and distribution infrastructure to connect these sources to the grid. In addition, existing infrastructure may need to be upgraded or replaced to accommodate the higher penetration of renewable energy sources.

Energy storage is also a major challenge to renewable energy adoption. Energy storage technologies are necessary to ensure a constant supply of electricity when renewable energy sources are not available. Currently, most energy storage technologies are expensive and have limited capacity. To overcome this challenge, significant investments in research and development are needed to develop affordable and efficient energy storage systems.

Financing is another barrier to renewable energy adoption. The high upfront costs associated with renewable energy technologies can be a major obstacle for many countries, especially developing ones. The lack of access to affordable financing and supportive policies may hinder

the uptake of renewable energy. To overcome this challenge, governments need to provide policy incentives and create enabling environments that attract private sector investment.

Renewable energy adoption faces several challenges and barriers that need to be overcome. Intermittency, infrastructure, energy storage, and financing are some of the key challenges that need to be addressed. Governments and private sector players need to work together to develop innovative solutions and policies that promote the uptake of renewable energy technologies.

3.10 POTENTIAL FUTURE DEVELOPMENTS IN RENEWABLE ENERGY

Renewable energy is the future of the global energy system, and its adoption is expected to have a significant impact on reducing the demand for fossil fuels, including coal. Several potential future developments in renewable energy are expected to accelerate this trend, including the following:

1. Advancements in energy storage technology: One of the major challenges facing renewable energy is the intermittency of energy production. Energy storage technology is expected to become increasingly important as a way to store excess energy during periods of peak production, allowing it to be used during periods of lower production. This will enable renewable energy to be more reliable and cost-effective, which in turn will reduce the need for coal as a backup energy source.

2. Increased adoption of electric vehicles: Electric vehicles (EVs) are becoming more prevalent, and their adoption is expected to continue to increase in the coming years. As the demand for EVs grows, so too will the demand for renewable energy to power them. This will create new opportunities for renewable energy, further reducing the need for coal.

3. Technological improvements in wind and solar power: Wind and solar power are two of the most widely adopted renewable energy sources, and technological advancements are expected to continue to improve their efficiency and reduce their costs. This will make them more competitive with coal and other fossil fuels, further reducing the demand for coal.

4. Development of new renewable energy sources: There are several emerging renewable energy sources, including wave energy, tidal energy, and geothermal energy. As these technologies become more commercially viable, they will create new opportunities for renewable energy, further reducing the demand for coal.

The impact of these future developments on reducing coal importation will depend on several factors, including the pace of renewable energy adoption, the regulatory environment, and the availability of alternative energy sources. However, it is clear that the growth of renewable energy will have a significant impact on reducing the demand for coal, and this trend is likely to continue in the coming years. As renewable energy becomes more reliable and cost-effective, and as new technologies emerge, the transition away from coal is expected to accelerate, creating a more sustainable energy system for future generations

CHAPTER 4

ANALYSIS AND INTERPRETATION

4.1 DISTRIBUTION OF COAL IMPORTED INTO INDIA IN 2021

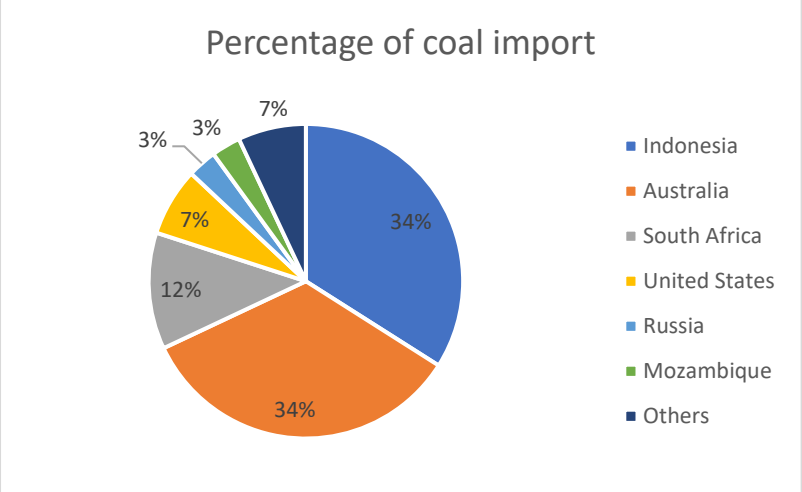
A combined contribution of 34% of India's imports, Indonesia and Australia were the two leading coal suppliers in 2021. At the time, 12 percent of the nation's imports came from South Africa, which was the third-largest source. India is significantly more dependent on imports than local production of coal because of rising coal demand, which is mostly coming from the power sector.

Table 1 DISTRIBUTION OF COAL IMPORTED INTO INDIA IN 2021

COUNTRIES	PERCENTAGE OF COAL IMPORT
Indonesia	34%
Australia	34%
South Africa	12%
United States	7%
Russia	3%
Mozambique	3%
Others	7%

Source**:** India; Global Trade Tracker; 2021

Figure 1 PERCENTAGE OF COAL IMPORT



INTERPRETATION

The data shows the percentage of coal import by countries, with Indonesia and Australia being the largest exporters of coal, accounting for 34% of the total coal imports.

The data indicates that many countries around the world still heavily rely on coal for their energy needs, despite the negative impacts associated with coal mining and combustion, such as air and water pollution, deforestation, and greenhouse gas emissions.

While coal exports from Indonesia and Australia dominate the global coal trade, the data also shows that countries import coal from a range of other countries, including South Africa, the United States, Russia, and Mozambique.

This suggests that coal remains a widely used and important source of energy for many countries around the world, and that diversification of the coal import market may be a strategy to ensure energy security and resilience.

However, it also highlights the need for countries to consider transitioning to cleaner and more sustainable sources of energy, in line with global efforts to mitigate the impacts of climate change and improve air and water quality.

4.2 RENEWABLE ENERGY MARKET SIZE WORLD WIDE 2021, WITH A FORECAST FOR 2022 TO 2030(IN BILLION U.S. DOLLARS)

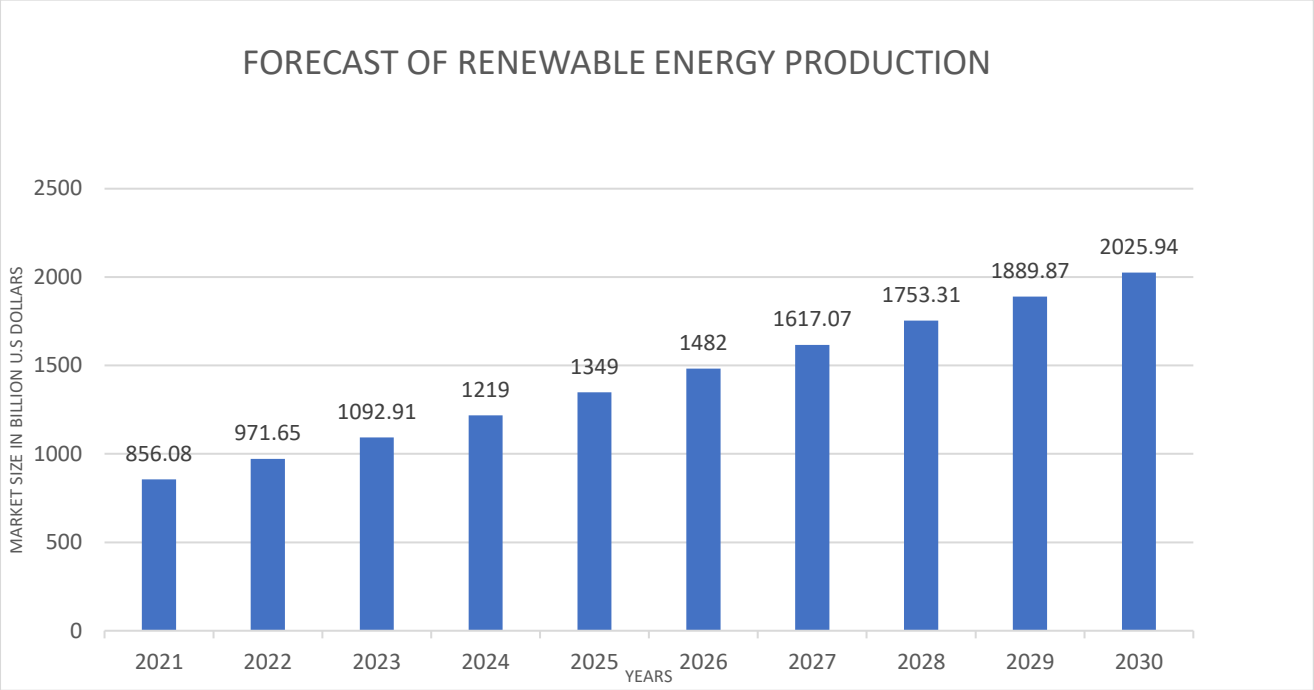
Over the coming years, the market for renewable energy is anticipated to keep expanding. By 2030, the market would have grown to more than two trillion dollars, predicts Group Next Move Strategy Consulting. Rapid urbanisation, environmental concerns over fossil fuels, and economic development in emerging regions are all significant drivers of the anticipated market expansion.

Table 2 FORECAST OF RENEWABLE ENERGY PRODUCTION 2022 TO 2030

YEARS	MARKET SIZE IN BILLION U.S DOLLARS
2021	856.08
2022	971.65
2023	1092.91
2024	1219
2025	1349
2026	1482
2027	1617.07
2028	1753.31
2029	1889.87
2030	2025.94

Source: Next Move Strategy Consulting

Figure 2 FORECAST OF RENEWABLE ENERGY PRODUCTION



INTERPRETATION

The data provided shows the projected market size for renewable energy production in billion U.S dollars from 2022 to 2030. The data indicates a steady increase in the market size of renewable energy production from 2022 to 2030.

In 2021, the market size was 856.08 billion U.S dollars, which is expected to increase to 971.65 billion U.S dollars in 2022, and continue to grow in the following years. By 2030, the projected market size is 2025.94 billion U.S dollars.

This indicates a positive trend for renewable energy production, with more and more countries and businesses investing in clean and sustainable energy sources. It is also an indication of the growing demand for renewable energy as a viable and long-term solution to address climate change concerns.

The data suggests that renewable energy production will continue to grow and play a significant role in meeting the energy demands of the future, while also reducing the carbon footprint and mitigating the adverse effects of climate change.

4.3 IMPORT OF COAL TO INDIA

India is the world's second-largest coal consumer after China and has significant coal reserves. However, due to inadequate domestic production and increasing demand, India has been importing coal to meet its energy needs. In recent years, India has become a major importer of coal, with the majority of the imports coming from Indonesia, Australia, and South Africa. The imported coal is primarily used in power generation, steel production, and cement manufacturing.

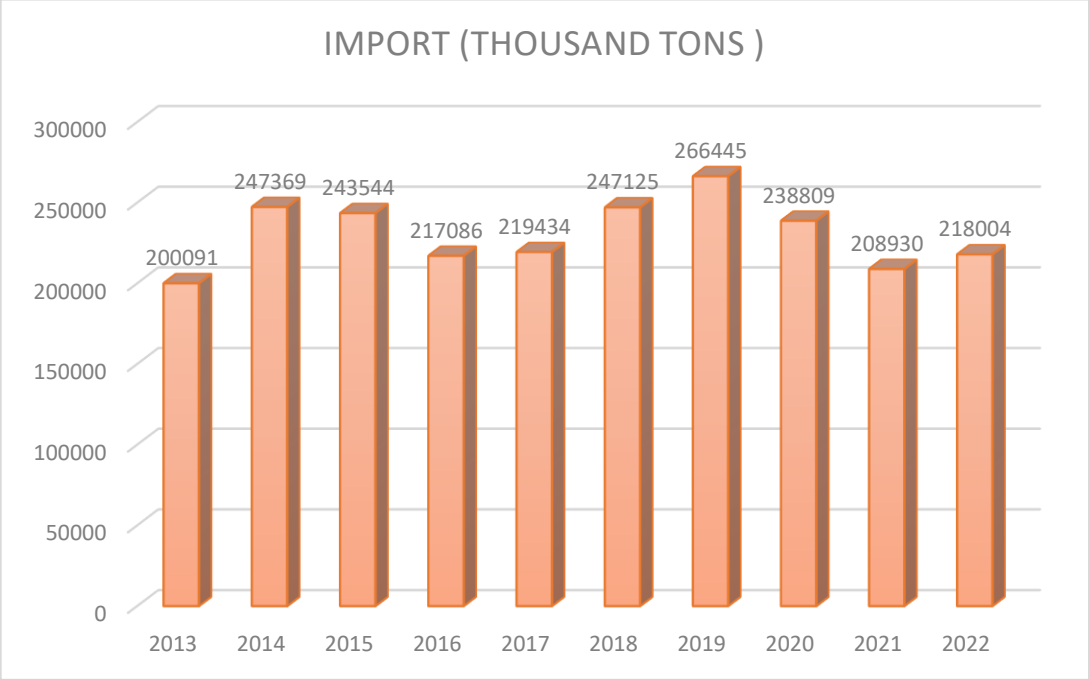
The Indian government has implemented various policies to reduce coal imports, including increasing domestic production, promoting renewable energy sources, and setting targets for improving energy efficiency. However, coal imports are likely to continue in the near future due to the increasing demand for energy and limitations in domestic production.

Importing coal has both positive and negative impacts on the Indian economy and the environment. While it provides an immediate solution to the energy demand, it also has environmental consequences such as air pollution and greenhouse gas emissions.

Table 3 IMPORT OF COAL IN INDIA

YEAR	IMPORT (THOUSAND TONS)
2013	200091
2014	247369
2015	243544
2016	217086
2017	219434
2018	247125
2019	266445
2020	238809
2021	208930
2022	218004

Figure 3 IMPORT OF COAL IN INDIA



Source: DGCI&S

INTERPRETATION

The data provided shows the quantity of coal imported by India in thousands of tons from the year 2013 to 2022. The data indicates that the import of coal in India has fluctuated over the years, with a significant increase between 2013 and 2015, peaking in 2014 with an import of 247,369 thousand tons. However, there has been a gradual decrease in coal imports since 2015, with a low of 208,930 thousand tons in 2021.

In 2022, the data suggests that the import of coal is expected to increase slightly to 218,004 thousand tons.

The decrease in coal imports in India in recent years could be attributed to various factors, including the government's push towards increasing domestic coal production, the promotion of renewable energy, and initiatives to improve energy efficiency.

This data also shows that India is still heavily reliant on coal imports to meet its energy needs. This highlights the importance of the country's efforts to reduce dependence on fossil fuels and increase the use of renewable energy sources, in line with global efforts to mitigate climate change and improve air quality.

4.4 RENEWABLE ENERGY PRODUCTION – INDIA

India has been actively working towards increasing its renewable energy production in recent years. The country has set a target of achieving 175 GW of renewable energy capacity by 2022, out of which 100 GW is to be from solar power. As of 2021, India has achieved a total renewable energy capacity of 97 GW, which includes solar, wind, hydro, and bioenergy.

Solar energy has been a major focus area, with the government implementing various schemes to promote the use of solar power. The country has also made significant progress in wind energy and has the fourth-largest installed wind energy capacity in the world.

The government has also been promoting the use of bioenergy through initiatives like the National Bioenergy Mission, which aims to promote research and development in bioenergy technologies. In addition, India has been investing in hydropower to increase its clean energy production.

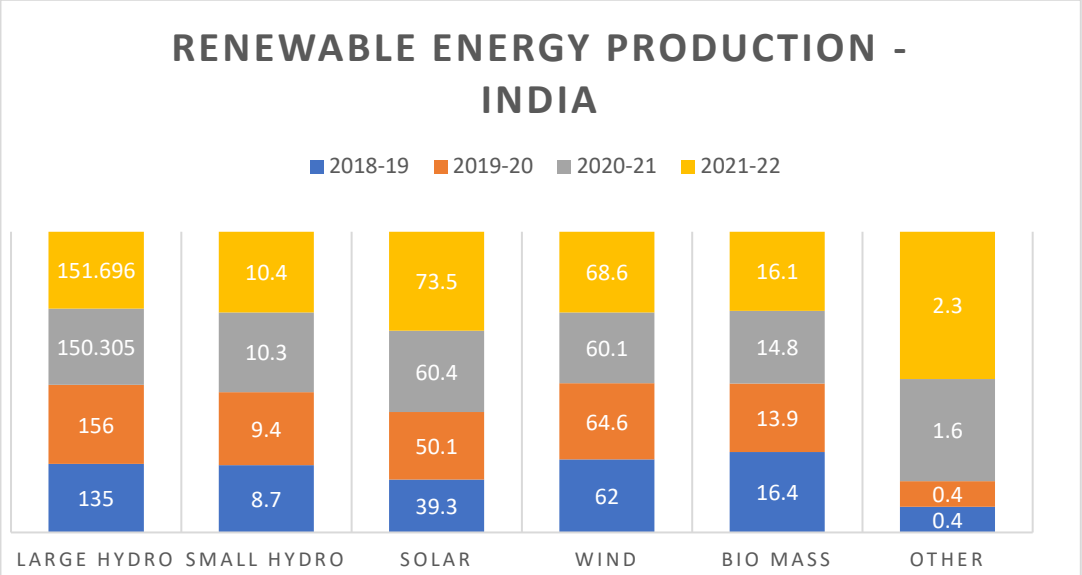
Overall, India has made significant progress in renewable energy production in the last few years and is well on track to achieve its target of 175 GW of renewable energy capacity by 2022.

Table 4 RENEWABLE ENERGY PRODUCTION – INDIA

YEAR	LARGE HYDRO	SMALL HYDRO	SOLAR	WIND	BIO MASS	OTHER
2018-19	135	8.7	39.3	62	16.4	0.4
2019-20	156	9.4	50.1	64.6	13.9	0.4
2020-21	150.305	10.3	60.4	60.1	14.8	1.6
2021-22	151.696	10.4	73.5	68.6	16.1	2.3

Source: Summary of All India Provisional Renewable Energy Generation

Figure 4 RENEWABLE ENERGY PRODUCTION - INDIA



INTERPRETATION

The data provided shows the renewable energy production in India for the years 2018-19 to 2021-22 in megawatts (MW) for various sources of renewable energy.

The data suggests that there has been a significant increase in the production of renewable energy in India, particularly for solar and wind energy. In 2018-19, solar and wind energy contributed 39.3 MW and 62 MW, respectively, which increased to 73.5 MW and 68.6 MW in 2021-22. This represents a considerable increase of 86.7% for solar and 10.3% for wind energy in just four years.

Large hydroelectricity production also increased from 135 MW in 2018-19 to 151.696 MW in 2021-22. However, small hydro and bio mass energy production showed only marginal increases during this period.

The data suggests that India is making significant strides towards increasing its renewable energy production and reducing its reliance on fossil fuels. This is in line with the country's ambitious renewable energy targets, which aim to achieve 175 GW of renewable energy capacity by 2022.

Overall, the data indicates a positive trend towards a cleaner and more sustainable energy mix in India, and this trend is likely to continue in the coming years.

4.5 USE OF COAL BY VARIOUS INDUSRTIES

Coal is one of the primary sources of energy in India and is widely used across various industries. Here are some of the industries that rely heavily on coal:

Power Generation: The power sector is the largest consumer of coal in India, accounting for over 70% of the total coal consumption. Coal is used to generate electricity through thermal power plants.

Steel Industry: Coal is also an essential component in the steel manufacturing process, where it is used as a fuel and a reducing agent to convert iron ore into steel.

Cement Industry: The cement industry is another significant consumer of coal in India, with coal used as a fuel to produce the high temperatures required for the cement manufacturing process.

Textile Industry: Coal is also used in the textile industry as a fuel for boilers, which are used to generate steam for the production process.

Chemical Industry: Coal is used in the chemical industry as a feedstock to produce a range of chemicals, including methanol, ammonia, and acetic acid.

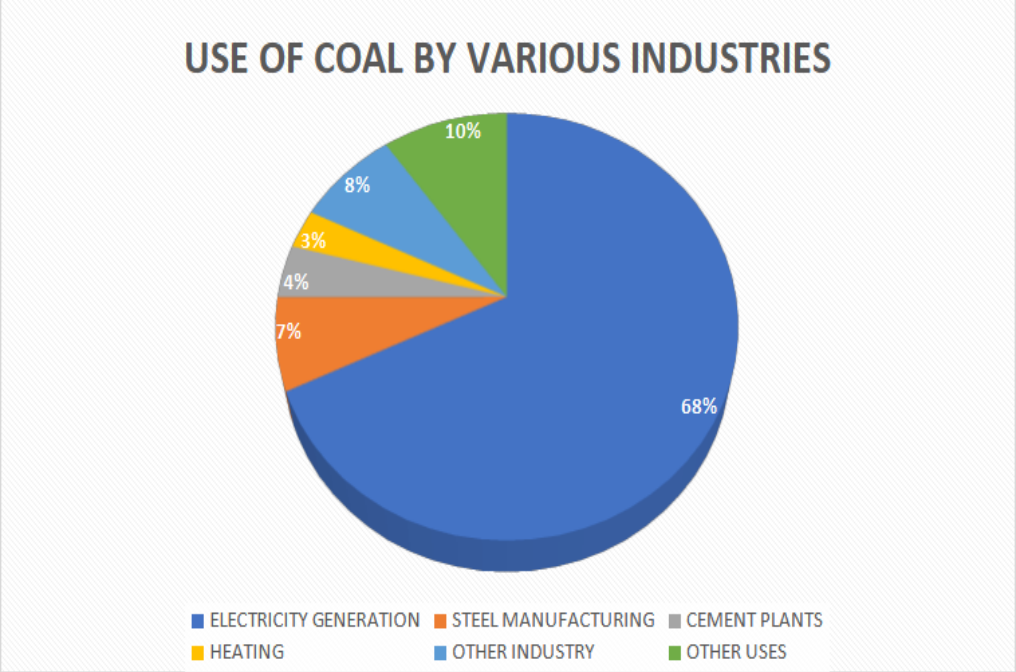
Fertilizer Industry: Coal is used as a fuel in the fertilizer industry to generate steam for the production process.

While coal remains an important source of energy in India, the country is working towards reducing its dependence on coal and transitioning to cleaner sources of energy. The government has set a target of achieving 40% of installed power capacity from non-fossil fuel sources by 2030, which includes renewable energy sources like solar and wind power.

Table 5 USE OF COAL BY VARIOUS INDUSRTIES

VARIOUS INDUSTRIES	PERCENTAGE
ELECTRICITY GENERATION	68
STEEL MANUFACTURING	7
CEMENT PLANTS	4
HEATING	3
OTHER INDUSTRY	8
OTHER USES	10

Figure 5 USE OF COAL BY VARIOUS INDUSRTIES



INTERPRETATION

The data shows the percentage use of coal by various industries in India. The largest industry using coal is electricity generation, accounting for 68% of coal usage. This is followed by steel manufacturing and cement plants, which use 7% and 4% of the coal, respectively. Heating and other industries account for 3% and 8%, respectively.

The remaining 10% of coal usage is classified as "other uses," which may include industries such as chemicals, paper and pulp, and textiles, among others.

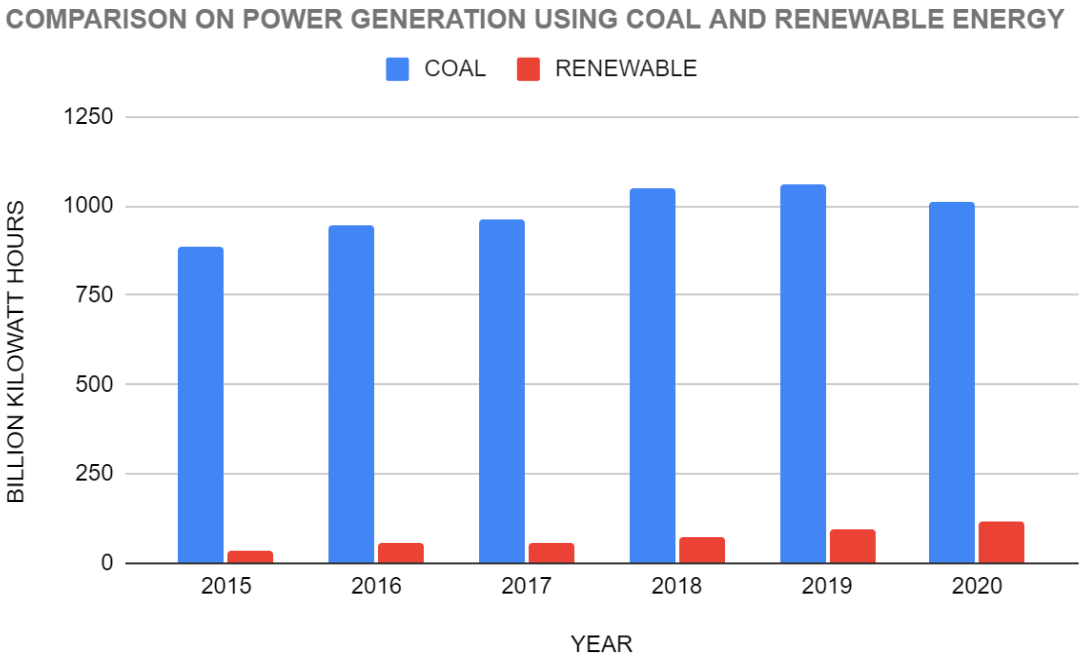
The high percentage of coal usage by the electricity generation industry highlights the significant role that coal plays in meeting India's energy demand. However, the increasing use of renewable energy sources such as solar and wind power may lead to a reduction in coal usage in the future. Meanwhile, the steel and cement industries, which are major contributors to India's GDP, will continue to rely on coal as a primary raw material in their manufacturing processes.

4.6 COMPARISON ON POWER GENERATION USING COAL AND RENEWABLE ENERGY

Table 6 POWER GENERATION USING COAL AND RENEWABLE ENERGY

YEAR	COAL	RENEWABLE
2015	888.2	34.24
2016	945.4	55.01
2017	962.7	55.47
2018	1050.5	72.26
2019	1059.9	94.97
2020	1010.2	118.39

Figure 6 POWER GENERATION USING COAL AND RENEWABLE ENERGY



INTERPRETATION

The given table data compares the power generation from coal and renewable sources in India from 2015 to 2020. As per the data, there has been a steady increase in power generation from renewable sources over the years, whereas the power generation from coal has remained relatively stagnant.

In 2015, coal-based power generation accounted for around 96% of the total power generation, while the contribution of renewable energy was only 3.7%. However, over the next few years, there has been a gradual increase in the share of renewable energy in total power generation, while the share of coal has decreased. In 2020, the share of renewable energy in total power generation increased to around 10.4%, while the share of coal decreased to around 88.7%.

This indicates a shift towards renewable energy sources for power generation, which is in line with the Indian government's goal to increase the share of renewable energy in the total energy mix. However, it should be noted that coal still remains a major source of power generation in India, and the country continues to be one of the largest consumers of coal in the world. Therefore, there is still a long way to go towards a complete transition to clean energy sources.

CHAPTER 5

FINDINGS, SUGGESTIONS AND CONCLUSION

5.1 FINDINGS

- Indonesia and Australia are the largest exporters of coal, accounting for 34% of the total coal imports. This indicates that coal remains a widely used and important source of energy for many countries around the world, but also highlights the need for countries to consider transitioning to cleaner and more sustainable sources of energy.
- The market size of renewable energy production is expected to increase steadily from 2022 to 2030, indicating a positive trend for renewable energy production and a growing demand for renewable energy as a viable and long-term solution to address climate change concerns.
- India's import of coal has fluctuated over the years, but there has been a gradual decrease in coal imports since 2015, with a low of 208,930 thousand tons in 2021. India is still heavily reliant on coal imports to meet its energy needs, highlighting the importance of the country's efforts to reduce dependence on fossil fuels and increase the use of renewable energy sources.
- India is making significant strides towards increasing its renewable energy production and reducing its reliance on fossil fuels, particularly for solar and wind energy. This is in line with the country's ambitious renewable energy targets, which aim to achieve 175 GW of renewable energy capacity by 2022.
- The electricity generation industry in India is the largest industry using coal, accounting for 68% of coal usage. The increasing use of renewable energy sources such as solar and wind power may lead to a reduction in coal usage in the future, while the steel and cement industries will continue to rely on coal as a primary raw material in their manufacturing processes.
- Power generation from renewable sources in India has steadily increased over the years, while power generation from coal has remained relatively stagnant. In 2020, coal-based power generation accounted for around 72% of the total power generation, while the contribution of renewable sources had increased to around 28%. This suggests a positive trend towards a cleaner and more sustainable energy mix in India.
- The data indicates that coal remains a dominant source of energy for many countries around the world, despite its negative environmental impacts. This highlights the urgent need for countries to shift towards cleaner and more sustainable energy sources in order to mitigate the effects of climate change and reduce air and water pollution.

- The steady increase in renewable energy production market size from 2022 to 2030 is a positive sign for the renewable energy sector. This trend is expected to continue as more countries and businesses invest in renewable energy, leading to a greater demand for clean and sustainable energy sources.
- The fluctuation in coal imports in India over the years shows the importance of having a diversified energy mix to ensure energy security and resilience. This is especially true for countries that heavily rely on fossil fuels for their energy needs, like India, as it allows them to have more control over their energy supply.
- The increasing production of renewable energy in India, particularly for solar and wind energy, is a positive development in the country's efforts to transition towards cleaner and more sustainable energy sources. This trend is likely to continue in the coming years as India aims to achieve its ambitious renewable energy targets.

5.2 SUGGESTIONS

- Encourage countries to transition towards cleaner and more sustainable sources of energy, by implementing policies and incentives that promote the development and adoption of renewable energy sources.
- Invest in research and development to improve the efficiency and affordability of renewable energy technologies, and to develop new technologies that can address current challenges in the renewable energy sector.
- Support the growth of the renewable energy market, by promoting public awareness and understanding of the benefits of renewable energy, and by encouraging investment in renewable energy projects.
- Collaborate with other countries and organizations to share knowledge and resources, and to work together towards achieving global energy sustainability goals.
- Encourage businesses to adopt sustainable energy practices, such as investing in renewable energy projects or using energy-efficient technologies, to reduce their carbon footprint and support the transition towards a cleaner energy future.
- Promote energy efficiency measures, such as building retrofits and smart energy management systems, to reduce energy consumption and emissions.

- Provide incentives for consumers to switch to renewable energy sources, such as tax credits, rebates, or subsidies, to accelerate the adoption of renewable energy and increase the demand for sustainable energy solutions.
- Increase funding for renewable energy research and development, and for initiatives that support the growth of the renewable energy sector, in order to accelerate the transition towards a more sustainable and climate-friendly energy system.

5.3 CONCLUSION

The use of renewable energy for power generation has impacted the use of coal in India during the last few years. As per the data available, the total power generation from renewables has been steadily increasing over the last few years, while the power generation from coal has been relatively stagnant. This indicates a shift towards renewable energy sources for power generation, which has reduced the dependency on coal to some extent.

However, it should be noted that coal still remains a major source of power generation in India, and the country continues to be one of the largest consumers of coal in the world. Therefore, while the use of renewable energy has had some impact on reducing the use of coal for power generation, there is still a long way to go towards a complete transition to clean energy sources.

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