

**A CRITICAL ANALYSIS OF CRUDE OIL AND ITS  
ALTERNATIVE ENERGY SOURCES:  
IMPACT ON INDIAN ECONOMY**

कच्चे तेल और इसके वैकल्पिक ऊर्जा स्रोतों का एक महत्वपूर्ण विश्लेषण:  
भारतीय अर्थव्यवस्था पर प्रभाव

**A  
Thesis**

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**2024**

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**DATE: -**

**PONMANY JOSEPH DAVID**

## **PREFACE**

Critically understanding the over dependence of crude oil imports, looking at the ill effects of use of crude oil, understanding how we can improve domestic production of crude oil & natural resources, at the same time looking at alternative energy source to fulfil the requirements of our country in a cleaner & sustainable manner.

The primary objective was to critically analyse the all the drawback our nation has because of the overdependence on imports of crude oil, like Trade deficits, Inflation, Currency Depreciation, Fiscal Deficit, Energy security risk, Impact on balance of payments, Impact on industrial growth, environmental concerns & logistics issues

Second objective is to look at improving our domestic crude oil & natural gas production, like incentivizing exploration & research, bringing regulatory reforms, public & private partnerships, bring international technology & infrastructure structure development

Continuation of the second objective is looking at alternative & sustainable sources of energy, like Solar energy, Wind energy, Hydropower energy, Biomass energy, Geothermal energy, Ocean energy & Nuclear Energy

Programs and Initiatives: First understanding the background of the current situation, where I tried to understand the current situation, like what is crude oil, how it is formed, how it is extracted, the cost of extraction, who controls the crude oil prices, how is crude oil traded, how is crude oil transported & finally its impact on the Indian economy.

Understanding domestic crude oil industry, who controls the crude oil industry, how many PSU are there in India, what are the major initiatives taken by these countries & what are the other things the government & these PSU's can do to improve the current situation.

Understanding the growth of Solar Power Energy, understanding the initiatives taken by the ISA, how India plays an important role in the ISA, How India is planning to totally move from fossil fuel consumption to clean sustainable form of energy.

Understanding the other sources of clean & sustainable energy sources & understand how to make required developments in those areas.

Total five Hypotheses statements was created & was checked in the research conducted to find out whether the Null Hypothesis would prove right or the alternative hypothesis would prove right.

Conducting research by preparing a questionnaire, and connecting to people of different cities, different gender, different age groups, different work experience & different earning capacity people, to tell their views on the above given points.

Once the research was conducted the research data was then collected, analysed & statistical data was created & discussed. Major findings are given after the research, major recommendations are also give based on the research & findings. Also the limitations of the research are displayed, so as to understand if an extensive research is needed in the future what has to be done.

**Key Words** – Crude Oil, Imports, Economy of India, Alternative Energy sources, Solar Power, Affordable power, Solar Mining Grids & International Alliance, Hydropower Energy, Wind Energy, Nuclear Energy, Bio fuel Energy, International Solar Alliance, Electric Vehicles, Solar Panels & Indian PSU's

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# CHAPTER – I

## INTRODUCTION



## **1.1 Research Background**

Why heavy dependency on Crude Oil Imports is a big problem to our Economy?

About Crude Oil.

Crude oil is regarded as an influential natural resource in the economy worldwide. In most countries, the import of crude oil is treated as a major economic issue. It is identified that fluctuation in the price of crude oil also becoming an emerging topic worldwide. Oil exporting countries take the opportunity for the purpose of considering their economic power. It is observed that fluctuation in the pricing of crude oil not only affected importing and exporting oil to other countries. In the year 2020, the prices of crude oil decreased drastically. Due to the continuous spread of the coronavirus, demand from consumers declined and directly influenced the economy's growth (Baisane, 2023).

It is considered that crude oil prices keep changing in the global markets, as it depends on various factors such as geo-political situation, policies of crude oil producing countries, and demand and supply in the market. It is observed that the Indian Basket of crude oil averaged \$23 per barrel at the time of dismantling of APM in the year 2002 March. In addition to this, the average price of crude oil in India during 2014-15 to 2019-2020 was recorded at \$84.16/ bbl, \$47.56/bbl, 56.43/bbl, 69.88bbl and \$60.47bbl (Baisane, 2023). The price of crude oil in India fell below \$20 per barrel in April 2020 as the lockdown resulted in a historic dip in transportation fuel demand in the country. In the month of June, in India refiners imported 2.17 million barrels per day from Russia crude which also accounted for 45 percent of total imports in India. It is evaluated that in India average import of Russian oil in the month of June was higher compared with a peak season as in May. Russia is considered the biggest source of crude oil in New Delhi (Sharma, 2023).

India is regarded as the third largest oil consumer & importer after US and China. It is identified that oil is the largest source of the country's energy supply after coal and is considered the largest in terms of final consumption (Times of India, 2023). Oil demand in the market increasing rapidly. In India, the oil and gas segment is the sixth core industry and most traded commodity. It is determined that oil has both attributes commodity and financial. A rise in the price of oil increases firms operating cost

which further lead to depressed prices of stock treated as a financial asset. For India, crude oil financial attribute is significant and operating. It is estimated by the Reserve Bank of India (RBI) that 10 percent above the baseline of USD 100 per barrel for prices of crude oil globally (Times of India, 2023).

It is determined that oil prices always haunted the economy of India. Costs of an oil shock tend in messing up macroeconomic variables in India. Prices of oil started moving into uncomfortable zones. It is observed that the prices of crude doubled and there has been huge volatility in the prices of oil. Moreover, the prices of energy and fuel cascading affect prices pushing up costs at different stages of production (Ray & Pal, 2023). Increasing oil prices drop subsequently due to higher inflation rates. For controlling the rising inflation rate, the government absorbs the increase in international crude prices by the reduction in taxes on diesel and petrol. Crude oil is irreplaceable in the international economy as the prices of crude oil are volatile considering option pricing, portfolio allocation, and the creation of strategies (Liang et al., 2020).

It is evaluated that oil and gas energy's main alternative sources are solar power, ethanol, wind power, and nuclear power. In the international energy markets, fossil fuels are considered the most adopted energy source by industries. In the modern era, industries are shifted toward sustainability and adopting green business practices (Ross, 2022). It is identified that fossil fuels mainly comprise of energy sources through oil, propane, coal, and natural gas. It is evaluated that at the year-end of 2020, in the US there are 94 operating nuclear power reactors which provided an estimation of 20% of all domestic electrical output (Ross, 2022). Other countries are having a large amount of nuclear energy. It is identified that France is the best example as it uses the world's highest nuclear power and generates 70% of the electricity from it.

Underutilization of Resources in India.

Furthermore, it is analyzed that India is considered as the largest oil reserve situated in Western offshore with 37% and 27% in Assam. In the deployment of PSUs used in the deployment, regulation, and management of oil and using its power sector are ONGC, Oil India, and IOC. In the Indian power sector, oil is mainly used to generate electricity. It is the second largest source of electricity generation in India. It is

identified that the oil and gas industry contribute around 34.4% of the primary consumption of energy and fuels (Sharma, 2023). In India, oil is used by different industries and is considered an important material for the power sector. It is used in kerosene, fuel for vehicles, and LPG. Indian government allowed 100% FDI in the projects for oil.

It is determined that in economically developing countries such as India, different factors affected the demand for resources for social development, generation of income, and serious issues of health which arise because of the use of fuelwood and charcoal. India is treated as a tropical country, which is having an abundance of solar energy. The geographical regions allow in a large amount of radiation from the sun throughout the year (Raina & Sinha, 2019). In addition to this, photovoltaic solar and other renewable energy sources, are also plenty; the Ministry of Non-conventional Energy Sources was changed to the Ministry of New and Renewable Energy (MNRE). For the promotion of R&D in the sector of photovoltaics government set up a commission for Additional Sources of Energy in the Science and Technology department (Raina & Sinha, 2019).

### **Origin of Crude Oil**

Crude oil is mainly comprised of thick black liquid obtained from the ground through oil rigs. The nickname of crude oil is black gold and is considered as naturally occurring fossil fuel as it comes from dead organisms. It is determined that crude oil is made from a mixture of hydrocarbons including carbon atoms and hydrogen. It mainly exists in the form of liquid in underground reservoirs by having tiny spaces within sedimentary rocks. It is found near the oil sands surface (Howden, 2023). It is also found concerning saline water and natural gas. It is also known as petroleum because it comprises both refined as well unrefined petroleum products. It is a non-renewable energy source that cannot be replaced easily. Crude oil is mainly formed from the remains of dead organisms including algae and zooplankton which existed million years ago in the environment. Based on the recent data received from IEA an average of 100 million barrels of oil were produced in the year 2018 worldwide. It involves 32 million barrels of crude oil only and 68 million barrels of crude oil received from non-conventional sources. It is observed top oil-producing countries are mainly responsible for half of the production of crude oil (Howden, 2023).

In the current fiscal year, India is set to cross the \$100 billion mark in importing oil. Already, \$94.3 billion was spent in the first ten months. By the end of the financial year, the total import of oil is expected to touch \$105-110 billion. India with 1.4 billion people in the country, imports around 84% of crude oil needs. With increasing prices, imports, and declining production of domestic oil. In India, the demand for total gas was one-fourth, and import was also done to a larger extent. In the Indian economy, there is growing demand for oil. 84% of crude oil is imported into India and it further rises after a year passes (Groww, 2023). Compared with demand in the country there is a deficiency in the production of crude oil at the domestic level. With respect to this, the government is taking measures to reduce the high price of oil because of the huge amount of imports—the total amount spent on imports expecting to be \$110 billion (Groww, 2023).

It identified that crude oil is considered a vital fuel resource that is obtained through sedimentary rocks of marine origin. It is treated as a naturally occurring product of petrol containing hydrocarbon and other organic compounds. Sedimentary rocks did not contain crude oil and were mainly found in the tertiary period. In the tertiary period, the formation process of crude oil began. In different forms of flora and fauna marine life was abundant (Iassite, 2023). For oil formation, conditions were favorable and as time progressed this underwent chemical changes because of heat and pressure which also resulted in the crude oil formation and natural gas after millions of years. There are two types of oilfields comprises of on-shore and off-shore. It is identified that on-shore oil fields in India are situated in the Brahmaputra valley, the Gujarat coast, and the Barmer area of Rajasthan. While offshore oil fields in India were located on the western coast and eastern coast oilfields (Iassite, 2023).

It is evaluated that the oil and gas segment is mainly responsible for the emission of greenhouse gases. Emissions arise considering the transportation, processing, extraction, and distribution of fuel and combustion in different applications such as heat, transportation, and energy. It is determined that international seaborne transportation of crude oil takes place mainly on tankers with annual seaborne crude flows of an estimated 12 billion barrels (Greene et al., 2020). Taking into account, the carbon footprints of crude oil from the international distribution sector utilizing a dataset at the micro level having more than 28,000 individual shipments for

estimating emission of carbon. Carbon emission at the country level for importers and exporters considering the size of the vessel (Greene et al., 2020).

Crude oil mainly comprises a complex mixture involving hydrocarbons. There is a difference in the composition and traits of crude oil which vary based on its origin. It also involves saturates, resins, aromatic and asphaltenes. The saturates with hydrocarbon have 20 carbon chains known as paraffin wax. The temperature of crude oil decreases along with considering the production line in the crude oil production system. This situation causes flow-in assurance issues and the shutdown of pipelines (Zamri & Husin, 2023). Here, the major challenge associated with wax and paraffin and deposition mainly occurs in the inner walls of transportation and production. In some situations, the deposition of wax caused the formation of plugging at the time of treatment of stimulation. The process of wax deposition mainly reduces the internal diameter of tubular, perforations, pump strings, pipelines, and rods. The production and transportation costs increased because of the handling problem of wax deposition. It creates issues in regions in which the temperature is low seasonally (Zamri & Husin, 2023).

It is determined that crude oil prices are mainly driven by supply. The Organization of the Petroleum Exporting Countries (OPEC), which controls 60% of worldwide oil commerce and 40% of the world's crude oil production, in particular, sets production targets to control supply. It is observed that production is reduced by OPEC targets of production, and prices of crude oil tend to rise. Oil prices are also affected by changes in the production by largest producer named as OPEC. In early 2023 April, an announcement was done with respect to the addition of production of oil cuts down by 1.16 million barrels per day. This attempt in stabilizing and supports the markets of oil during the recession. Oil prices have fallen by \$70 in the year 2022 April compared with \$139 in March 2022 (Emran, 2023). Falling in the price of crude oil is also driven by turmoil in the banking sector. It is identified that a reduction in production is considered a reliable method for the purpose of restoring prices.

Further, India is looking for bringing diversification in the sources of crude oil and considering a purchase of oil from Canada, Guyana, Colombia, and Brazil. Presently, the country looking towards Guyana, Gabon, Colombia, and Canada. It is observed

that countries like Gabon, Colombia, and Brazil supply crude oil to India as the quantity is not significant and India is looking for increasing imports from these countries. From the data received from the Ministry of Commerce India imported crude oil worth \$722.54 from Brazil in April-July in the year 2022. The oil supplied by Colombia was worth \$717.40 million. Similarly, considering Guyana supplied \$106.06 million in crude oil. On the other side, countries like Colombia, Brazil, and Gabon accounted for contributing 1.27%, 1.13%, and 0.16% of imports of oil made by India in the financial year 2023 (Baruah, 2023).

It is identified that after Iraq Russia become the largest source of crude oil. Till February, India's total crude oil imports were around 2% which mainly comes from Russia. Contracts in India stand at around 66.5 million barrels based on the data received from Kpler. Since the beginning of the Ukraine war, it is spotted that Russia has been spotted as the war began in Western countries with sanctions on the country. Refineries in India are eager for supplies of Russian oil reported major aspects from Rosneft and Bloomberg. Importing India helps in fulfilling 85% of the requirements of oil. In the year ending the country spent \$119.2 billion in the previous year (Verma, 2023).

Moreover, it is determined that economies faced several implications for foreign and domestic investors impacted by shocks in the oil market. Over the last two decades, there has been abundant literature that provides knowledge regarding the interconnection between the stock market and oil. On the contrary, some studies depicted that responses of stock markets to oil mainly depend on the net positioning of the country in the global market. It is observed oil markets represent the alternative destination for most investors and financial institutions with respect to the correlation between traditional assets and prices of oil (Youssef & Mokni, 2019). Studies also claim that prices of oil shocks affected the stock markets considering macroeconomic variables including economic growth and inflation. Rising in the prices of oil is expected in having a positive influence on oil-exporting countries as the income of the country will increase. A rise in income is expected to rise in expenditure which creates greater unemployment and productivity. Prices of oil increase positively influencing responses towards stock markets (Youssef & Mokni, 2019).

**Critical Analysis of Crude Oil Imports & its overdependence**

Numerous economic, environmental, as well as technological factors are causing significant changes in the world's energy landscape. An exhaustible fossil fuel called crude oil has long been the main energy source for the global economy. However, due to its inherent drawbacks and unfavorable effects on the environment, research into alternative energy sources has increased. In the context of the Indian economy, this critical analysis seeks to explore the function of crude oil and alternative energy sources. The nation's energy security and economic stability face significant challenges as a result of its heavy reliance on foreign oil sources. Volatile oil prices, which have fluctuated significantly over time, can strain the Indian economy by increasing its current account deficit, causing instability in fiscal balances, and limiting long-term growth prospects (Kuehl et al., 2021).

Burning fossil fuels including crude oil has negative environmental effects that are a growing source of concern worldwide. Significant amounts of greenhouse gases (GHGs), primarily carbon dioxide (CO<sub>2</sub>), are released into the atmosphere during the burning of fossil fuels. These emissions contribute to climate change and global warming, which has negative effects like sea level rise, extreme weather, and ecological disruptions. India, one of the biggest CO<sub>2</sub> emitters in the world, is under increasing pressure to reduce its carbon footprint and switch to cleaner and renewable energy sources.

The investigation and production of elective energy sources have sped up all around the world in light of these issues. Sun-based power, wind power, hydropower, biofuels, and geothermal energy are instances of environmentally friendly power advances that can be utilized to enhance energy portfolios, cut ozone-harming substance discharges, and further develop energy security. The meaning of moving to a cleaner and more maintainable energy blend has likewise been recognized by India. The country has defined aggressive objectives, expecting to reach 450 GW of environmentally friendly power limit by 2030, to build the extent of environmentally friendly power in its all-out energy utilization.

While switching to alternative energy sources has many benefits, there are also many significant drawbacks. In order to ensure a dependable and uninterrupted power



supply, for example, the nature of renewable energy necessitates the development of strong energy storage systems and grid infrastructure (Bhuvaneshwari et al., 2019). Economic obstacles include the high upfront costs connected with installing renewable energy sources and the requirement for ongoing technological advancements.

This analysis aims to offer useful insights into the opportunities, challenges, and trade-offs associated with the transition away from crude oil by critically analyzing the existing literature, data, and expert opinions. Ultimately, this research lays the groundwork for wise policy choices and strategic planning in the energy sector by deepening our understanding of how crude oil and alternative energy sources affect the Indian economy.

The analysis of crude oil and alternative energy sources is influenced by the geopolitical environment in addition to economic and environmental factors. Because of the geographic concentration of crude oil reserves, there are frequent geopolitical tensions and conflicts over who controls and has access to these valuable resources. India's reliance on imported crude oil puts it at risk of supply interruptions brought on by geopolitical unrest or armed conflicts in areas where oil is produced (Hoang et al., 2021). The Indian economy may suffer greatly as a result of these disruptions, which may also result in higher energy costs, lower industrial productivity, and a decline in overall economic growth.

India has the chance to lessen its reliance on foreign oil and improve its energy security by switching to alternative energy sources. India can lessen the risks posed by geopolitical unrest and changes in the world oil markets by diversifying its energy mix and encouraging renewable energy sources. The vulnerability to external shocks can be decreased by developing domestic renewable energy sources, which can offer a more reliable and sustainable energy supply.

Also, the use of alternative energy sources may encourage job growth and economic expansion. New job opportunities are provided by the renewable energy industry, which also includes infrastructure manufacturing, installation, and maintenance. India can support the development of domestic industries and produce a skilled workforce that meets the requirements of the developing energy sector by investing in renewable

energy projects. The advancement of renewable energy technologies can also advance technological innovation, R&D, and research, establishing India as a leader in the transition to clean energy on a global scale.

The switch to alternative energy sources is not without difficulties, though. The high up-front costs related to renewable energy infrastructure are one of the major obstacles. Although the cost of renewable technologies like solar cells along with wind turbines has significantly dropped recently, significant initial investments are still needed for large-scale renewable energy projects. Government incentives, subsidies, and public-private partnerships are just a few of the financing tools that can help with the transition and make renewable energy more economically viable.

Another significant problem for alternative energy sources is intermittency (Gajjar et al., 2019). Renewable energy production is influenced by weather patterns and other natural variations, in contrast to fossil fuels, which offer a consistent and predictable energy supply. For instance, the use of solar and wind power depends on the sun's rays and the direction of the wind. Energy storage technologies and grid infrastructure must be created to balance the erratic nature of renewable energy sources in order to guarantee a steady electricity supply. Advances in technology to store energy, like batteries, pumped hydro storage, and other new solutions, are crucial for overcoming this challenge.

The existing infrastructure and expertise built around the fossil fuel industry also present obstacles to the transition. The fossil fuel sector has extensive supply chains, refining facilities, and distribution networks that have been established over decades. Shifting towards alternative energy sources requires significant investments in infrastructure upgrades and the retraining of workers to adapt to new technologies and processes. Additionally, the potential displacement of workers in traditional energy sectors may necessitate the implementation of social safety nets and reemployment programs to mitigate any negative impacts on affected communities.

The pursuit of alternative energy sources aligns with India's commitment to sustainable development and climate change mitigation. The country has taken significant steps to promote renewable energy, including policy initiatives, regulatory frameworks, and financial incentives. The government has taken a target to produce

450 GW of renewable energy & taking steps in transitioning toward a cleaner and more sustainable energy future (Quitow et al., 2021).

The critical analysis of crude oil and alternative energy sources in the context of the Indian economy reveals both challenges and opportunities. The heavy dependence on imported crude oil exposes India to economic vulnerabilities and geopolitical risks. Transitioning towards alternative energy sources, such as renewable energy, offers the potential for enhanced energy security, reduced greenhouse gas emissions, and economic growth. However, the high upfront costs, intermittency, and the need to transform existing infrastructure pose significant challenges. By carefully navigating these challenges and leveraging the available opportunities, India can strive towards a sustainable and resilient energy future.

To successfully transition to alternative energy sources, a multi-faceted approach is necessary. Policymakers need to implement supportive regulatory frameworks, provide incentives for renewable energy investments, and streamline the approval processes for renewable energy projects. The joint effort between the public authority, confidential area, and global accomplices is essential for sharing accepted procedures, innovation moves, and drawing in interest in the environmentally friendly power area.

In order to promote innovation in renewable energy technology, storage systems for energy, & grid integration, efforts to conduct research and development should also be stepped up. Interests in scholastic coordinated efforts and research organizations can advance mechanical turn of events and address the specialized issues connected with the arrangement of sustainable power sources (Majid, 2020).

Promoting energy conservation, the use of renewable energy sources, and energy efficiency at the individual and community levels requires public awareness and education campaigns. Encouragement of sustainable practices and behavioral shifts can result in significant energy savings and lower overall energy demand.

Also, international collaboration and cooperation are essential in addressing the global issues related to the energy transition. The development, as well as application of sustainable energy technologies, can be accelerated by the international sharing of best practices, information, and resources. Countries have the chance to work together

on solar energy projects through platforms like the International Solar Alliance (ISA), which encourages international cooperation in renewable energy.

It is critical to think about the social and economic effects of the energy transition as India sets out on its path to a future powered by sustainable energy sources. A just transition should be prioritized in policies, and this includes social safety nets, retraining programs, and job creation, as well as taking into account the needs of the affected communities. India can navigate the complexities of the energy transition and maximize the potential benefits for its citizens by giving inclusive growth and sustainable development priority.

Because of the assessment of raw petroleum and elective energy sources according to the Indian economy, obviously embracing sustainable power sources, enhancing the energy blend, and decreasing dependence on imported raw petroleum is pivotal. Although there are obstacles like high upfront costs, unpredictability, and the need for infrastructure transformation, there are also significant opportunities for increased energy security, economic growth, and climate change mitigation. India can pave the way for a sustainable and prosperous energy future by taking a comprehensive approach that includes policy support, technological innovation, public awareness, and international cooperation.

The social and health impacts of crude oil and alternative energy sources should be taken into account during a critical analysis along with the economic, environmental, and geopolitical factors. Local communities, particularly those close to oil refineries, pipelines, or drilling sites, may suffer negative effects as a result of the extraction, transportation, and combustion of crude oil. These areas frequently experience environmental pollution, such as contaminated air and water, which can have a negative impact on health (Rynska, 2022). These health risks can be reduced, and communities' general well-being can be enhanced, by the move towards cleaner and renewable energy sources.

Economics impact such as Trade deficits & balance of payments also becomes an issue with the economy of our country, because of huge amount of imports of crude oil from the international markets the trade deficit is always in negative even if we are exporting enough of other goods, this still makes it look as if we are not exporting

enough & the entire economy is dependent on imports only. Even the fluctuation of prices in the international markets, as OPEC controls the prices of crude oil in the international markets, the average cost of production of one barrel of crude oil is about in the range of \$20 to \$30 but still the prices go all the way up to \$110 sometimes & sometimes it is a bit ok with the prices coming low to \$60. But this fluctuation causes a lot of financial instability in our economy as it is difficult to plan the amount of FOREX reserves to be maintained. So all together the prices & the fluctuation in prices creates huge issues in the Trade balance & the balance of payments.

Since the entire crude oil cargo has to be bought from Middle east countries & other countries there is a lot of cost on transportation, this increases the cost of the final product, in turn increasing the cost of every product in our country as each product has to be moved from the producer to the consumer. Since the dependency is on petrol & diesel vehicles and not on EV vehicles the cost is added to the final product & the final consumers of the product have to pay the price for the monopoly OPEC has on the international crude oil prices.

Maintaining FOREX reserves is another major issue due to over dependence of international crude oil as the payments have to be made in dollars to procure the crude oil, this also brings us to the next problem that is the fluctuation in the currency prices, because if Indian currency becomes weaker then we have to pay more & more of Indian rupees to procure US dollars, during the time of independence 1USD to INR was 7 Rupees now it has become approx. 83 INR, look at the amount of increase in the currency fluctuation, this is also causing a lot of issue & load on the Indian financial economy.

As the cost in the international markets for the crude oil becomes more & more to keep the local prices of petrol & diesel the government has to reduce prices to the end customer by reducing the taxes levied on these products. This causes impact on the revenue of the government, because of which the government's social causes towards the people of the country cannot be achieved to the expected levels. These additional expenses also cause the government to lose on new investment opportunities where the government could invest this money given as a subsidy & earn interest from that money.

**Economic Impact**

Energy Import Bill and Trade Balance: India's energy needs are largely met by importing crude oil, making it susceptible to changes in the price of oil on a global scale. High oil prices increase the cost of importing energy, which has an effect on the nation's trade balance and foreign exchange reserves. Businesses in a variety of industries face uncertainties due to the fluctuating price of oil, which has an impact on investment choices, inflation rates, and overall economic stability.

**Fiscal Balances:**

Fiscal Balances are directly impacted by oil prices, particularly in an oil-importing nation like India. Oil prices have an impact on the government's spending on oil subsidies and tax receipts from the oil industry. Fluctuating oil prices can disrupt fiscal planning, leading to challenges in maintaining fiscal deficits and meeting development goals.

**Energy Security:**

The heavy reliance on imported crude oil poses significant challenges to India's energy security. Geopolitical tensions and conflicts in oil-producing regions can disrupt oil supplies, leading to supply shortages and price volatility. Diversifying the energy mix by incorporating alternative energy sources can enhance energy security, reduce dependence on foreign oil, and mitigate geopolitical risks.

**Environmental Impact****Climate Change Mitigation:**

The burning of fossil fuels, including crude oil, contributes to greenhouse gas emissions, exacerbating climate change. India, as a part to international agreements like the Paris Agreement, has committed to reducing its carbon footprint and transitioning towards a low-carbon economy (Kassem et al., 2020). By promoting alternative energy sources that emit fewer greenhouse gases, India can contribute to global efforts to mitigate climate change.

**Air Pollution and Health Impacts:**

The combustion of crude oil releases pollutants into the air, leading to air pollution and associated health risks. India has been grappling with severe air pollution levels in major cities, causing respiratory illnesses, cardiovascular diseases, and other health issues. Transitioning to cleaner and renewable energy sources can help improve air quality, reduce pollution-related health risks, and lower healthcare costs.

**Alternative Energy Sources**

The global energy landscape is undergoing a profound transformation as countries around the world recognize the pressing need to address the challenges of climate change, environmental degradation, and energy security. Central to this shift is the critical analysis of the impact of crude oil and alternative energy sources on the Indian economy. India's economy has long relied on crude oil as its main energy source because it is a finite fossil fuel. However, its drawbacks and detrimental effects on the environment have spurred research into and use of alternative energy sources (Pareek et al., 2020). This thorough analysis aims to assess the economic, environmental, and social effects of crude oil dependence as well as the potential advantages and difficulties connected with India's move towards alternative energy sources.

The Indian economy has historically been significantly shaped by crude oil. India's import bill increases in response to an increase in oil prices, widening the trade deficit and taxing foreign exchange reserves. Due to the nation's heavy reliance on imported crude oil—which supplies more than 80% of its oil needs—these effects are especially pronounced. Additionally, the erratic nature of oil prices makes it difficult to plan for the future of the economy and breeds uncertainty for companies operating in a variety of industries, including manufacturing, transportation, and agriculture. The Indian economy is greatly impacted by the environmental effects of crude oil consumption. Carbon dioxide (CO<sub>2</sub>) and other greenhouse gases (GHGs) are released into the atmosphere during the burning of fossil fuels, including crude oil, which contributes to climate change and global warming. India, one of the major contributors to global CO<sub>2</sub> emissions, is under increasing pressure to reduce its carbon footprint and switch to cleaner, more sustainable energy sources. Extreme weather events and rising sea levels can cause ecological disruptions, health effects, and economic losses if environmental concerns are not addressed.



The examination and reception of elective energy sources present likely solutions for lessening the dangers to the economy and climate welcomed by reliance on raw petroleum. A cleaner, more reasonable energy future is guaranteed by sustainable power innovations like sun-oriented power, wind power, hydropower, biofuels, and geothermal energy. India has put forth aggressive objectives to build the extent of environmentally friendly power in its energy blend since it perceives the significance of doing the change to sustainable power sources. By 2030, the country desires to have 450 GW of environmentally friendly power limit introduced, delineating its devotion to feasible development and environmental change moderation.

Alternative energy sources have a wide-ranging and intricate effect on the Indian economy. The potential decrease in oil imports and increased energy security are two important benefits. India's exposure to price volatility and geopolitical risks can be reduced by decreasing its reliance on imported crude oil and increasing its share of renewable energy. As a result, there may be more economic stability, fewer trade imbalances, and better financial health. Adopting alternative energy sources can also encourage economic expansion and job creation. The manufacturing, installation, as well as upkeep of renewable energy facilities, are examples of domestic industries that can benefit from the renewable energy sector (Sultana et al., 2021). India can promote technological advancement, strengthen its research & development capabilities, and draw both domestic & foreign investment by funding renewable energy projects. Particularly in rural areas, where decentralized renewable energy solutions can provide access to electricity and help alleviate poverty and promote inclusive development, the growth of the renewable energy sector may create employment opportunities.

The move to alternative energy sources has the potential to support sustainable growth and tackle social issues in India. It is essential for socio-economic development, including advancements in healthcare, education, and agriculture, to get dependable and energy at lower cost. By bridging the energy access gap and empowering communities, alternative energy sources like off-grid solar systems and mini-grids can deliver electricity to isolated and underserved areas. This can then have a domino effect on healthcare, education, and employment opportunities, reducing poverty and improving quality of life. The transition away from crude oil towards alternative



energy sources is not without difficulties, though. The initial investment needed for renewable energy infrastructure is a major barrier. Despite recent reductions in the price of renewable technologies, significant upfront capital is still needed for large-scale installations. To facilitate the adoption of renewable energy technologies and draw investments from the private sector, it is necessary to develop financial mechanisms like government incentives, subsidies, and advantageous financing options.

Another significant issue with alternative energy sources is intermittent. Renewable energy production is influenced by weather patterns and other natural variations, in contrast to fossil fuels, which offer a consistent and predictable energy supply. Due to the intermittent nature of renewable energy, smart grid infrastructure and energy storage systems must be developed in order to guarantee a steady and dependable power supply. For this problem to be solved and the grid integration of renewable energy, technological advancements in storing energy, like batteries, pumped hydro storage, and new solutions like hydrogen, are essential. Furthermore, the infrastructure and human resources already in place in the fossil fuel industry must be carefully taken into account as we switch to alternative energy sources (Cloutier et al., 2020). The fossil fuel industry has developed extensive distribution networks, refining facilities, and supply chains over many years. The transition to renewable energy sources necessitates both infrastructure redesign and worker retraining to accommodate cutting-edge procedures and technologies. In order to minimize any negative effects on impacted communities, it is crucial to develop strategies that facilitate a just transition for workers in the fossil fuel sector by offering reemployment opportunities and social safety nets.

To sum up, the effects of crude oil and other forms of energy on the Indian economy are complicated and multifaceted. India is subject to economic vulnerabilities, geopolitical risks, and environmental difficulties as a result of its heavy reliance on imported crude oil. However, the use of alternative energy sources, like renewable energy, has the potential to increase energy security, have a smaller negative impact on the environment, and promote inclusive economic growth. A comprehensive strategy that incorporates policy support, technological innovation, financial mechanisms, and social considerations is needed to make the switch to renewable

energy sources. India can create the conditions for a prosperous, resilient, and sustainable energy future by skillfully managing the challenges and utilizing the opportunities. For the purpose of guiding policy choices, strategic planning, and fostering the transition to a cleaner and more sustainable energy system, a critical analysis of how crude oil and alternative energy sources affect the Indian economy is essential.

An important area of research as the world struggles to address issues like global warming, and energy scarcity; sustainable development is the effect of crude oil along with other forms of energy on the Indian economy. For a very long time, India's main energy source was crude oil, a limited fossil fuel that was used to run businesses, transport systems, and homes. However, the drawbacks and unfavorable effects of using crude oil have prompted research into and use of alternative energy sources. This thorough analysis aims to assess the economic, environmental, social, and technological effects of crude oil dependence as well as the potential advantages and difficulties of switching the Indian economy over to alternative energy sources (Chabhadiya et al., 2021).

### **Social Impact**

#### **Energy Access:**

A significant portion of India's population still lacks access to reliable and affordable energy. Alternative energy sources, like energy not through the main grid, or smaller grids or roof top solar systems , can provide electricity to remote and underserved areas, bridging the energy access gap. Access to energy empowers communities, enabling them to improve their living conditions, access education and healthcare services, and engage in income-generating activities.

#### **Employment and Economic Opportunities:**

The transition to alternative energy sources can generate employment opportunities and contribute to economic growth. The renewable energy sector requires skilled labor for the manufacturing, installation, and maintenance of renewable energy infrastructure. Investments in renewable energy projects can stimulate job creation and support the growth of domestic industries, fostering technological innovation and research and development (Watari et al., 2019).

## **Technological Impact**

### **Technological new adoptions:**

The adoption of alternative energy sources necessitates technological innovation to improve the efficiency, reliability, and affordability of renewable energy technologies. Research and development efforts in the renewable energy sector can drive technological advancements, leading to breakthroughs in energy storage, grid integration, and renewable energy technologies. These advancements can further enhance the competitiveness and viability of alternative energy sources in the Indian market.

### **Synergies with Other Sectors:**

Alternative energy sources can have synergistic effects on other sectors of the economy. For instance, bioenergy derived from agricultural waste or dedicated energy crops can provide a renewable source of energy while promoting agricultural productivity and rural livelihoods. The adoption of renewable energy-powered electric vehicles can help the transportation sector become less reliant on fossil fuels, resulting in lower emissions and better air quality.

The economic, environmental, social, and technological aspects of the impact of crude oil & alternative energy sources on the Indian economy are all interconnected & complex issues. India is subject to economic vulnerabilities, geopolitical risks, & environmental difficulties as a result of its heavy reliance on imported crude oil. Alternative energy use, however, may bring about advantages like increased energy security, decreased greenhouse gas emissions, improved air quality, more job opportunities, as well as inclusive economic growth (Majid, 2020).

A comprehensive strategy is needed to transition to alternative energy sources successfully. This entails putting in place beneficial laws and regulations, encouraging the advancement of new renewable energy technologies, easing access to funding and investment, and educating people about the advantages of renewable energy. The difficulties of the transition must also be addressed, including the high initial costs of renewable energy infrastructure, the erratic nature of renewable energy sources, and the necessity of reorganizing the workforce and existing infrastructure.

India may prepare the way for an environmentally friendly, resilient, and successful energy future by successfully controlling the effects of crude oil & welcoming alternative energy sources. Policymakers, researchers, and stakeholders can use the critical analysis of the effects of crude oil & renewable energy sources on the Indian economy in order to create strategies, make well-informed decisions, and advance the nation's transition to a more ecologically friendly & sustainable energy system.

### **Policy Implications**

#### **Policy Support:**

The move to renewable energy sources is greatly aided by governmental regulations and policies. Feed-in tariffs, renewable purchase responsibilities, tax breaks, & grants are examples of supportive policies that can encourage investment in energy-efficient projects & foster the expansion of the renewable energy industry. For the market for sustainable energy to attract private sector investments & promote innovation, clear & consistent policies that offer long-term certainty & stability are crucial.

#### **Infrastructure Development:**

Infrastructure development is crucial for the switch to alternative energy sources. This covers the construction of energy storage facilities, networks for distribution as well as transmission, & power plants using renewable energy sources. To ensure the successful integration of energy from renewable sources into the current power system, policymakers should prioritize investments in grid infrastructure and smart grids. Additionally, the creation of a strong charging infrastructure for electric vehicles is essential to support the wide-scale uptake of environmentally friendly transportation (Rynska, 2022).

#### **Research and Development:**

Interests in innovative work (Research and development) are fundamental for driving mechanical advancement in the sustainable power area. State-run administrations ought to designate assets for Research and development programs pointed toward working on the productivity and cost-adequacy of sustainable power innovations. Cooperation between the scholarly world, research foundations, and the confidential area can encourage development, speed up innovation headways, and advance the commercialization of sustainable power arrangements.

**International Collaboration:**

International cooperation and collaboration play a significant role in addressing the global challenges associated with the energy transition. Sharing best practices, knowledge, and resources among nations can accelerate the development and deployment of renewable energy technologies. Platforms such as the International Solar Alliance (ISA) provide an opportunity for countries to collaborate on solar energy projects, share expertise, and promote global renewable energy cooperation. India should actively engage in international partnerships to leverage global expertise, attract foreign investments, and promote the exchange of technology and knowledge.

The impact of crude oil and alternative energy sources on the Indian economy encompasses economic, environmental, social, and technological dimensions. The heavy dependence on imported crude oil exposes India to economic vulnerabilities, geopolitical risks, and environmental challenges. The utilization of elective energy sources, in any case, presents critical opportunities for expanded energy security, diminished ozone-harming substance emanations, further developed air quality, and comprehensive monetary development.

An exhaustive methodology that incorporates steady strategies, interests in Research and development, foundation improvement, and global participation is expected to do the change to elective energy sources. The production of a strong strategy climate that empowers interest in environmentally friendly power undertakings and offers long-haul security ought to be a first concern for policymakers. To ensure a productive and reliable stock of sustainable power, framework improvement is fundamental, including network mix and energy stockpiling. For mechanical advancement to happen and for environmentally friendly power innovations to turn out to be more productive and practical, innovative work speculations are pivotal. International cooperation can also quicken the energy transition by promoting knowledge exchange, attracting investments, and sharing best practices (Quitow et al., 2021).

India may prepare the way for an environmentally friendly, resilient, & prosperous energy future by effectively managing the effects of crude oil as well as embracing alternative energy sources. For policymakers, researchers, and participants, the critical analysis of the effects of crude oil & alternative energy sources on the Indian

economy offers priceless insights. It assists in the creation of strategies, informs decision-making processes, and directs the nation's transition to a more sustainable and clean energy system. India can overcome the obstacles and take advantage of the opportunities presented by the energy transition with concerted efforts and strategic planning, ultimately promoting sustainable development and a greener future.

## **1.2 Research Problem**

The present research aims in providing knowledge related to the influence of overdependence on crude oil imports and its alternative energy sources on the Indian economy. It seeks in highlighting the economic impact of India's dependency on crude oil along with including the effect on inflation and trade deficit. In addition to this, the study emphasizes analyzing the benefits and issues linked with shifting to alternative energy sources such as renewable energy. Information related to alternative energy resources is not identified properly by the researchers so there is a need to carry out the present research to see how Indian Economy is impacted by the crude Oil markets

## **1.3 Aim and Objectives**

The study's main aim is to analyze the influence of crude oil and its alternative energy sources on the Indian economy.

### **Objectives**

RO1 to critically analyze the impact of over dependence Crude Oil Imports on our national economy

RO2 To compare and analyze alternative sources of energy & reduce dependency on international crude oil imports

## **1.4 Contribution of the Study**

The research emphasizes contributing to providing an understanding of the influence of over dependence of crude oil imports along with alternative energy sources on the economy of India. It provides a critical analysis of economic consequences considering India's over dependence on crude oil along with highlighting challenges with respect to inflation and trade deficit. It contributes to providing knowledge associated with the origin of crude oil and its importance for the Indian economy.

Additionally, it contributes to identifying alternative energy sources with respect to crude oil affecting the economy of India.

### **1.5 Thesis structure**

**Introduction:** - In the first chapter of the thesis background of the research will be provided along with the aim and objectives of the research. Further, the problem statement will be discussed considering the contribution of the study.

**Literature review:** - This chapter involves various themes which will be discussed by considering existing literature on the basis of the topic selected. The theoretical framework will be taken into consideration and aligned with the research topic.

**Research Methodology:** - The chapter provides various methods and techniques for the completion of the study. Different techniques will be involved such as research approach, research design, research philosophy, and data analysis method.

**Data analysis and interpretation:** - Statistical analysis will be done concerning the formulation of graphs and tables. Further, interpretation will be discussed based on the tables and graphs provided.

**Results and Discussion:** - In this chapter, results gained from the statistical analysis will be discussed here.

**Conclusion and recommendation:** - In the last chapter, short summary of the overall research will be discussed. Moreover, suggestions will be provided based on the issues identified in the research.

# CHAPTER – II

## REVIEW OF LITERATURE





## **2.1 Introduction**

Crude oil has long been a critical component of modern economies, acting as the foundation of global energy consumption. Within this context, the Indian economy has grown as a robust and quickly developing entity that is significantly reliant on crude oil as a critical energy source to power its industries, transportation networks, and overall development trajectory. Nonetheless, this reliance on crude oil creates a slew of intrinsic vulnerabilities, including price volatility, geopolitical complexities, and pressing environmental imperatives. In response to these issues, there has been a distinct trend toward the exploration of alternative energy sources, to minimize risks and encourage long-term economic growth (Henriques, 2008).

The Indian economy's vulnerability to swings in global crude oil prices highlights a significant vulnerability. This element requires careful examination because rapid oil price fluctuations can undermine the nation's fiscal equilibrium, resulting in trade imbalances and inflationary pressures. A thorough examination of historical trends in crude oil prices and their consequences for the Indian economy will provide essential insight into the extent to which oil price shocks can have a significant impact on economic growth, capital investment, and overall fiscal resilience (Demirbas, 2009).

The complicated relationship between global crude oil markets and geopolitical factors necessitates close examination. India's reliance on oil imports, in particular, makes it vulnerable to a range of geopolitical risks, including supply interruptions caused by international conflicts, sanctions, and multidimensional diplomatic problems. This component of the study will analyze India's efforts to diversify energy sources, reducing its susceptibility to the intricate tapestry of geopolitical concerns (Barnwal, 2005).

Beyond economic and geopolitical considerations, the environmental consequences of crude oil usage need cautious exploration. This entails investigating the environmental cost of crude oil extraction, transportation, and combustion, which has far-reaching ramifications for India's air quality, public health, and ecological integrity. An investigation of the potential and viability of renewable energy sources, which are emerging as critical alternatives capable of resolving pressing environmental imperatives while also satisfying India's energy appetite, is central to this examination (Agarwal, 2007).

Technology is a driving force behind the movement from traditional fossil fuels and toward renewable sources of energy. This section of the literature review will outline the current contours of technological innovation in the renewable energy sector, focusing on India's efforts to increase renewable energy capacity through strategic investments in solar, wind, and other green technologies. Furthermore, the discussion will highlight the associated obstacles and untapped opportunities that come with incorporating renewable energy resources into India's energy mix (Boutabba, 2014).

In conclusion, the current literature review embarks on a careful investigation of the subtle interplay between crude oil and its renewable alternatives, emphasizing the aggregate consequences for the Indian economy. This scholarly endeavor aspires to contribute substantively to the existing body of knowledge by critically dissecting the economic, geopolitical, environmental, and technological facets, thereby advancing a nuanced understanding of the opportunities and challenges that underpin India's endeavor to achieve energy security, sustainable growth, and environmental stewardship.

## **2.2 Overview of Crude Oil**

Crude oil, also known as "black gold," is a non-renewable hydrocarbon resource that has molded the modern world economy. Crude oil is a finite resource recovered from geological reserves beneath the Earth's surface. It is composed of complex organic compounds created from the remains of ancient marine life. The nature of this dense and viscous liquid varies from light and sweet crude to heavy and sour variations. Crude oil is a complex and valuable hydrocarbon resource that is the result of geological processes that have lasted millions of years. This fossil fuel is created by the breakdown of organic materials, primarily old marine plants, and animals, that have been subjected to heat and pressure throughout geological time. As a result, crude oil occurs beneath the Earth's surface in distinct geological formations and reservoirs, making it a limited and non-renewable resource (Ong, 2011).

Crude oil has a very complex makeup, with different types and grades exhibiting distinct features. Light crude oil is lower in density and viscosity, whereas crude oil that is heavy is denser and more viscous. Furthermore, crude oil is classed as sweet or sour based on its sulfur content, with sweet crude having lower sulfur levels and sour crude having greater sulfur levels. Crude oil extraction entails drilling wells into oil

reserves and using various methods to get the oil to the surface. Once extracted, crude oil goes through refining procedures to be converted into usable products. The crude oil is separated into different components based on their boiling points in these processes, resulting in the manufacture of gasoline, diesel, jet fuel, heating oil, and numerous petrochemical feedstocks (Su, 2021).

Crude oil's significance extends beyond its role as a key energy source. It is a precursor for a wide range of goods, including petrochemicals, polymers, lubricants, and a plethora of industrial inputs. As a result, crude oil is critical to powering transportation systems, driving manufacturing processes, and strengthening global economic development (Sultan, 2020).

### **2.2.1 Uses of Crude Oil**

Crude oil's complex relevance extends beyond its role as a traditional energy source. Its uses are many, encompassing energy production, industrial manufacturing, and technological growth, and thereby underpin the basis of modern society. The deliberate utilization of this hydrocarbon resource demonstrates its critical function as an essential engine of economic and societal evolution (Salim, 2012).

**Energy Generating and Transportation:** The most important of crude oil's numerous applications is its contribution to energy generating and transportation networks. Refined derivatives, such as gasoline, diesel, and jet fuel, are the lifeblood of transportation networks, powering everything from automobiles to airplanes. These fuels' sophisticated combustion processes accelerate locomotion, exemplifying crude oil's prowess as a worldwide transportation enabler. Furthermore, crude oil-derived fuels are indispensable in powering electric generators, hence assisting in the electrification of society and enterprises alike.

**Petrochemical Industry and Manufacturing:** The versatile derivatives of crude oil form the foundation of the petrochemical industry, allowing for the synthesis of a diverse range of components required for modern living. Petrochemical feedstocks derived from crude oil are used to make polymers, plastics, synthetic fibers, and a wide range of industrial chemicals. This catalytic role drives industrial manufacturing throughout sectors, resulting in the manufacture of consumer products, packaging materials, pharmaceuticals, and a plethora of commodities that support modern living standards.

**Industrial Inputs and Lubricants:** Crude oil, in both its unrefined and refined forms, provides a variety of industrial inputs required for the smooth operation of machinery and industrial processes. Lubricating lubricants generated from crude oil reduces friction and wear within machinery, improving operational efficiency and extending the life of the machinery. Furthermore, asphalt, a crude oil derivative, is a cornerstone of road building, ensuring the durability and functionality of transportation infrastructure.

**Technological Advancements:** Crude oil has an important influence on technological progress. Petrochemicals derived from crude oil help to produce cutting-edge materials that enable technological developments ranging from electronics to medical equipment. Plastics and specialty materials made from crude oil-derived chemicals are at the heart of the advancement of electronics, telecommunications, and a wide range of modern technological devices.

Crude oil uses appear as a tapestry woven with intricate threads, each contributing to the fabric of modern communities and economies. The energy it produces powers transportation networks and electrification, while its derivatives are critical components of industrial manufacture, petrochemical innovation, and technological advancement. The strategic use of crude oil's numerous applications demonstrates humanity's ability to harness nature's resources to power progress and raise living standards. Aside from its critical responsibilities in energy, manufacturing, and transportation, crude oil has a wide range of applications that rely on its distinct qualities (Boutabba, 2014).

Crude oil-derived jet fuel, with its high energy density and temperature stability, is essential in the aviation sector for powering commercial and military aircraft worldwide, permitting long-distance air travel and military operations. Meanwhile, crude oil-based products play an important role in heating and cooling systems, with oil furnaces providing heating solutions and crude oil serving as a foundational component in various air conditioning systems, ensuring efficient temperature control in residential, commercial, and industrial settings (Ahmad, 2011).

Certain power plants use crude oil as a primary or secondary fuel source for electricity generation, especially in areas where alternative energy sources are scarce. Because of

its flammable nature, crude oil is a desirable resource for powering these facilities. Crude oil is a critical precursor in the synthesis of a wide range of compounds, including solvents, synthetic rubber, resins, and dyes, in the chemical industry. These compounds are used in a variety of industries, including textiles and pharmaceuticals (Singh, 2010).

The printing business uses crude oil derivatives to make inks and toners, which are used to make newspapers, periodicals, packaging materials, and other printed media. Furthermore, crude oil-derived chemicals are widely included in cosmetics and personal care products (such as moisturizers) and serving as core components for several beauty and skincare formulas. Crude oil byproducts, such as fertilizers and insecticides, play important roles in agriculture. Fertilizers supply important nutrients to crops, increasing agricultural productivity, while pesticides protect crops from pests and diseases (Panwar, 2011).

Beyond its use in asphalt for road building, crude oil has an impact on the construction industry. It serves as the foundation for materials such as roofing shingles, sealants, and insulation, all of which improve building durability and energy efficiency. Crude oil derivatives are critical components in the synthesis of active pharmaceutical ingredients (APIs) and medication formulations in the pharmaceutical industry. This contributes to the pharmaceutical industry's ability to distribute pharmaceuticals and medical supplies (Gaurav, 2017).

The numerous applications of crude oil include the manufacture of candles and wax goods, where paraffin wax, a byproduct of crude oil refining, is an important element noted for its clean-burning features. Finally, in the world of sporting equipment, crude oil derivatives are used to improve the performance and durability of products such as tennis balls, golf balls, and athletic shoes (Kumar, 2011).

To summarize, the utility of crude oil is extensive, permeating a wide range of sectors and industries. Its distinct qualities make operations easier, improve product quality, and aid in technological developments. These numerous applications highlight crude oil's significance as a vital resource that has a major impact on modern society and its economy.

### **2.2.2 Studies Relating to Crude Oil and Its Uses**

The scientific investigation of crude oil and its numerous applications is a vibrant and dynamic subject of research that crosses disciplines and ideologies. Researchers, academics, and specialists from various fields come together to unravel the complicated tapestry of crude oil's functions, ramifications, and trajectories within global socioeconomic contexts. This scholarly project encompasses a multidimensional investigation that includes economic studies, geopolitical assessments, environmental assessments, and technical improvements (Asif, 2007).

**Economic Analyses:** Economists have begun an analytical adventure to comprehend the complicated connection between crude oil dynamics and macroeconomic landscapes. The complex relationship between shifting crude oil prices and its effects on national economies, trade balances, and inflationary pressures is the subject of research. These efforts include econometric modeling, time-series analysis, and empirical assessments, which result in deep insights into the intricate ways in which oil price volatility affects economic indicators and policy formulations (Jebaraj, 2006).

**Geopolitical Insights:** The geopolitical intricacies buried in crude oil trading and consumption constitute an enticing topic of investigation. Scholars from the fields of international relations and political science examine the geopolitical consequences of global crude oil supply chains, identifying the deep links between energy security, international crises, and diplomatic negotiations. Researchers navigate the maze of international power dynamics through rigorous analysis, revealing the strategic maneuvers used by nations to safeguard their energy interests, and showing the complex interplay between geopolitics and global energy dynamics (Kumar, 2021).

**Environmental Assessments:** Environmental scientists conduct in-depth examinations of the environmental impact of crude oil production, transportation, and combustion. Carbon emissions, air pollutants, and environmental deterioration caused by crude oil-related operations are being studied. These inquiries highlight the need for sustainable energy transitions and green technologies, emphasizing the importance of adopting renewable alternatives. In turn, environmental economists quantify the externalities

associated with crude oil consumption, underlining the economic rationale for shifting to cleaner and more sustainable energy sources (Kumar, 2010).

**Technological Advancements:** In the field of technological innovation, engineers and materials scientists explore the frontiers of refining and extraction technologies. Novel approaches for increasing extraction efficiency while reducing environmental impact are being studied. Furthermore, researchers investigate advances in petrochemical refinement, catalysis, and downstream processing, supporting the creation of high-performance materials and processes that adhere to the principles of sustainability and efficiency (Bajpai, 2006).

The extensive exploration of crude oil and its various applications demonstrates the complex importance of this finite hydrocarbon resource in modern cultures and economies. Crude oil pervades every aspect of modern life, from its essential position as an energy source powering transportation systems and electrical generation to its deep impact on industrial manufacturing, technological innovation, and geopolitical dynamics. This comprehensive viewpoint emphasizes the inherent connections between energy, economics, politics, the environment, and technology in the context of crude oil (Omri, 2014).

Scholars and researchers from a variety of fields have tirelessly delved into this complicated terrain, enhancing academic discourse with a plethora of ideas and discoveries. Economists have methodically examined the economic effects of crude oil price variations, revealing light on the far-reaching ramifications for national economies and global trade dynamics. The complicated web of international connections and power conflicts woven within crude oil trading has been unraveled by geopolitical specialists, demonstrating how energy security and diplomatic talks intersect. Environmental experts have emphasized the environmental consequences of crude oil usage, highlighting the critical need for sustainable energy alternatives to counteract climate change and ecological damage. Simultaneously, technicians and engineers have propelled innovation in crude oil extraction, refining, and petrochemical processes, to increase efficiency and lower the environmental imprint of crude oil-related operations (Shafiee, 2009).



To summarize, the collection of literature dedicated to crude oil and its applications is a complex mosaic of knowledge that spans disciplines and weaves together numerous perspectives. This collaborative scholarly effort sheds light on the diverse nature of crude oil's impact on society, emphasizes the importance of sustainability in energy transitions, and informs policy decisions as they navigate the complicated terrain of global energy dynamics. As nations cope with the difficulties and opportunities that crude oil presents, this rich tapestry of study remains a vital resource for crafting a more sustainable and resilient future. The literature on crude oil and its applications emerges as a vigorous confluence of interdisciplinary inquiry. This scholarly discourse, which has been expanded by economists, political scientists, environmental experts, and technologists, weaves a comprehensive tapestry of understanding that crosses disciplinary boundaries. The academic community as a whole strives to illuminate the intricate features of crude oil's influence in influencing economies, geopolitics, environments, and technology landscapes through rigorous analysis and empirical research (Pao, 2013).

### **2.3 Importance of Crude Oil in the Global Energy Landscape**

Crude oil's importance in the global energy landscape goes beyond mere prominence; it is a critical cornerstone, substantially influencing the dynamics of modern civilization's growth and the trajectory of energy systems everywhere. This section draws on existing literature to show the critical significance of crude oil in the global energy matrix, anchoring this argument in the rich tapestry of scholarly debate surrounding its multidimensional position in the global energy matrix. Crude oil is a critical commodity for the world economy since it is the primary source of energy production and a feedstock for a variety of products, including fuels and plastics. Supply and demand, geopolitics, environmental concerns, and economic situations all have an impact on crude oil prices. Due to the Covid-19 epidemic, crude oil demand fell by 8.8% in 2020 but is predicted to rise by 6% in 2021. China is the only big economy where oil demand in 2020 will be higher than in 2019 (Nyga-Łukaszewska, 2020).

**Fulfilling Energy Demand:** A thorough grasp of crude oil's significance begins with its critical position as a key source of energy. Existing literature emphasizes that crude oil is an indispensable fuel, meeting a significant amount of the world's energy needs.



It is widely used in a variety of industries, most notably as a fuel for transportation, energy generation, and different industrial activities. Crude oil's high energy density and transportability make it an efficient and versatile energy source, supporting the worldwide mobility and industrialization required by modern societies (Atabani, 2012).

**Economic Implications:** Extensive scholarly study helps to clarify the far-reaching economic ramifications of crude oil in the global energy landscape. The literature emphasizes how crude oil price changes have a significant impact on national economies, trade balances, inflation rates, and fiscal stability. The economic dependency of nations on crude oil imports and exports is a recurring issue, stressing the role of crude oil as a determinant of global economic stability and growth trajectories (Saboori, 2013).

**Geopolitical Complexities:** According to academic research, the importance of crude oil in the global energy landscape is intricately tied to complicated geopolitical issues. The study focuses on how access to crude oil resources and control over supply chains have historically been key components of international politics and conflicts. The geopolitical literature vividly depicts states' strategic posturing and diplomatic talks to protect their energy interests, highlighting the essential role that crude oil plays in influencing global politics and diplomacy (Bilgen, 2014).

**Energy Security and Vulnerabilities:** The issue of energy security is important in arguments about the relevance of crude oil. Scholars have carefully examined the vulnerabilities that nations suffer as a result of their reliance on crude oil imports, highlighting the possible risks posed by supply disruptions, geopolitical conflicts, and market volatility. Existing research emphasizes the compelling need for energy source diversification and effective policies for sustainable energy transitions, providing a blueprint for improving energy security and mitigating vulnerabilities (Yergin, 2006).

**Environmental Implications and Alternatives:** Crude oil's vital role in the global energy landscape is crucially supported by its varied environmental implications. A considerable amount of scholarly research investigates its impact in greenhouse gas emissions, air pollution, and changes in the climate. Simultaneously, scholars examine renewable energy options and energy transition plans within this discourse,

emphasizing the importance of lowering reliance on crude oil to solve critical environmental challenges. This body of literature connects energy, environmental sustainability, and the evolution of the global energy landscape (Rahman, 2020).

**Technological Innovation and Future Prospects:** The global energy landscape is inextricably linked to technological innovation, a topic that has received a lot of attention in the literature. Numerous studies investigate the creation of more efficient and environmentally friendly energy technologies, providing insights into technology's revolutionary potential in transforming the future of energy. Advances in renewable energy sources, energy storage, and efficiency improvements are painstakingly analyzed within this scientific subject, highlighting the constant quest for innovation that is expected to reshape the contours of the global energy landscape (Narayan, 2007).

**Technological Advances' Effects:** Technological innovations are transforming the crude oil sector at an unprecedented rate, and the topic is gaining traction in academic circles. The study of the revolutionary effects of digitalization, automation, and artificial intelligence on every aspect of the crude oil sector, from exploration and extraction to refining and distribution, is underway. These technological advancements have the potential to improve operational efficiency, minimize environmental impacts, and reshape the industry's operational landscape, creating an exciting field of academic research at the crossroads of energy and technology (Jayanthakumaran, 2012).

**Global Energy Policy:** Scholarly analysis is required for the intricate web of global energy governance, with a special focus on crude oil. Literature on the role of international organizations, agreements, and institutions in regulating and coordinating the global oil market is available. Furthermore, it looks into the power exerted by major oil-producing countries, clarifying their impact on global energy geopolitics and supply dynamics. These investigations provide vital insights into the complex systems and power structures that underpin the global energy landscape (Khan, 2009).

**Access to Energy and Equity:** The significance of crude oil extends to issues of energy access and equity, both of which have received significant scholarly study.

Literature highlights worldwide energy access discrepancies, indicating that certain regions and underprivileged groups continue to lack reliable access to modern energy services. The role of crude oil in worsening or reducing these gaps is investigated, as are evaluations of how energy policies, technology, and international collaboration might contribute to greater equity in energy provision, addressing crucial social and developmental concerns (Atabani, 2013).

Exploration and resource depletion: The discovery and depletion of crude oil resources are still being studied in depth by academics. Scholars investigate the worldwide crude oil reserves, focusing on the difficulties connected with finding and extracting new deposits, particularly in increasingly remote and difficult environments. Deep-sea drilling and unconventional oil extraction processes like hydraulic fracturing (fracking) have ushered in a new age in oil exploration. This research not only investigates the sustainability and longevity of crude oil as a primary energy source but also highlights the complexity of resource management in a dynamic energy landscape (Höök, 2013).

Transition to a Sustainable Energy System: Energy transition and sustainability are increasingly significant issues in today's scholastic scene. Scholars are focusing more on the importance of lowering carbon emissions and combating climate change. The crucial role of crude oil as a large contributor to greenhouse gas emissions heightens the necessity of moving to cleaner and more sustainable energy sources. The literature in this field digs into the complexities of policy frameworks, technology advancements, and renewable energy deployment tactics. These studies provide important insights into the worldwide quest to decarbonize the energy landscape and reduce environmental impacts, demonstrating the academic community's dedication to building a more sustainable energy future (Ghosh, 2010).

Oil firms control the price of crude oil, which means they have a lot of sway over the global economy, and weaker countries can easily lose control of their economies. Countries that produce oil for other countries have significant political power since they can effectively 'shut off' other countries' crude oil supplies in the event of a political disagreement. Political unrest, wars create major impact on the supply of crude oil, secondly due to war the damage it does to the source of crude oil, spilling oil into the environment also causes a lot of damage to the environment, if the

spilling happens in water it effects the aquatic life, if the crude oil is spilled on the land it spoils the plant life, it causes a lot of damage to the environment, use of alternative like fossil fuel is also not a good solution as it emits more carbon dioxide. Oil refineries and oil-fired power plants consume a lot of land, destroying potential wildlife habitats and ruining the landscape. However, this dilemma applies to every industrial site and is not limited to the oil business (Suganthi, 2012).

In conclusion, the breadth of scholarly research on the subject highlights the undeniable relevance of crude oil in the global energy landscape. It is an economic fulcrum, a geopolitical pivot, a focal point for energy security considerations, and a key player in environmental discourse and technological innovation. This scholarly discourse's synthesis leaves an indelible stamp, highlighting crude oil's ongoing relevance in determining the trajectory of modern societies and economies and anchoring the complicated web of interconnections within the global energy arena. The academic debate on the role of crude oil in the global energy landscape is a fluid and ever-changing area. In addition to its traditional duties, the literature is today grappling with the imperatives of sustainability, resource exploration, energy access, governance, and the far-reaching consequences of technological breakthroughs. These aspects, taken together, contribute to a thorough understanding of the delicate interplay between crude oil and the complex energy dynamics that constitute our modern world (Pata, 2018).

There are multiple writeup in literature about the impact of overdependence on crude oil imports such as, “Oil Shock Vulnerability and Impact on India’s Balance of Payments” by Shankar Acharya, where he mentions about the historical prices of crude oil, structure of imports, macroeconomic implications of the oil price volatility, trade deficits & foreign exchange revenue. “Impact of Oil Prices On Indian Economy” by N.R. Bhanumurthi and Rajesh Kumar, shows similar studies about the impact of crude oil prices. “Crude Oil Price Volatility and its Impact on Indian Economy” by Deepak Kumar and J.K. Sharma also speaks about the cost that get absorbed into the Indian production system, increases the COP of every single product produces & consumed in India by its final consumers. This dumping of final cost affects the lives of every single Indian in our country in multiple ways.

## **2.4 Alternative Energy Sources**

**Solar Energy:** As a classic example of renewable energy, solar energy is obtained from the sun's radiant energy. This energy is primarily harvested using photovoltaic (PV) cells and solar thermal systems. PV cells turn sunlight directly into electricity, whereas solar thermal systems heat a fluid, which is subsequently utilized to generate energy. India has enormous solar potential, particularly in areas with plenty of sunlight. The ambitious Jawaharlal Nehru National Solar Mission of the government has promoted solar energy generation and permitted tremendous expansion in this industry.

**Wind Energy:** Wind energy is produced by using the kinetic energy of moving air with wind turbines. India's diversified geography, which includes coastal regions and mountainous terrain, makes it ideal for wind power generation. Wind energy makes a substantial contribution to the country's renewable energy capacity and is constantly expanding. The Indian government's Wind Power Program intends to boost wind energy output and integrate it seamlessly into the national grid.

**Hydropower:** Hydropower is a well-known source of renewable energy that uses the energy of flowing or falling water to generate electricity. India has a large number of hydroelectric power plants, which are critical in satisfying energy demands and guaranteeing system stability. Hydropower is a baseload renewable energy source because of its dependability and continuous power delivery.

**Biomass Energy:** Biomass energy is produced from organic resources such as wood, agricultural wastes, and municipal garbage. The vast agricultural sector of India provides tremendous resources for biomass energy production. Biomass can be utilized for a variety of applications, including heating, power generation, and biofuel production. Sustainable biomass management strategies are critical for preserving biomass's carbon neutrality and environmental benefits.

**Geothermal Energy:** Geothermal energy uses the Earth's inherent heat to generate electricity or offer direct heating by extracting steam or hot water from geothermal reservoirs. India has tremendous geothermal potential, particularly in areas such as the Himalayas and selected geothermal hotspots. This energy source is both stable and emits little carbon dioxide.

**Tidal and Wave Energy:** Tidal and wave energy systems use the kinetic energy of ocean tides and waves to generate electricity. While India has a long coastline, tidal and wave energy production is still in its early phases. These novel solutions hold the most promise in coastal areas with strong tidal currents and predictable wave patterns.

**Nuclear Energy:** Nuclear energy uses regulated nuclear reactions to generate heat, which is then turned into electricity. India has a significant nuclear power capacity and intends to enhance its nuclear energy portfolio. However, issues including safety, nuclear waste management, and international non-proliferation treaties remain important considerations.

**Hydrogen Energy:** Hydrogen energy is a versatile and clean energy carrier that is mostly created by the electrolysis of water. It can be utilized as a transportation, heating, and industrial process fuel. India is investigating hydrogen as a viable solution to decarbonize several sectors, despite issues with production efficiency, storage, and the development of distribution infrastructure.

**Biofuels:** Biofuels are fuel in form of liquid or gas generated from organic resources, such as ethanol and biodiesel. These biofuels have the potential to be environmentally benign substitutes for traditional fossil fuels, notably in the transportation and heating sectors. India has established goals for blending biofuels with conventional fuels to promote their use and sustainability.

**Ocean Thermal Energy Conversion (OTEC):** OTEC generates energy by exploiting the temperature difference between warm surface water and the chilly deep water. While still considered a developing technology, OTEC has great potential, especially in tropical climates with a substantial temperature difference. Ongoing research and development activities attempt to more effectively exploit this potential energy source.

Finally, India's search for alternative energy sources indicates the country's dedication to sustainability, energy security, and carbon reduction. A diverse energy portfolio that includes solar, wind, hydropower, biomass, geothermal, and developing technologies such as tidal, wave, hydrogen, and OTEC can dramatically reduce the environmental effect of traditional fossil fuels while supporting economic growth and increasing energy access. Continued research, investment, and governmental support

are required to fully realize the potential of these alternative energy sources in India. This strategic strategy not only strengthens energy resilience but also adds to India's worldwide leadership in the transition to a more sustainable energy future (Dresselhaus, 2001).

## **2.5 Influence of Crude Oil and Alternative Energy Sources on the Indian Economy**

The impact of crude oil and alternative energy sources on the Indian economy is critical in terms of India's pursuit of energy security, economic growth, and environmental sustainability. As a rapidly developing country with a growing population and industrial base, India's energy demands have increased, necessitating a heavy reliance on conventional fossil fuels, particularly crude oil. This dependency has far-reaching consequences for the country's economic stability, balance of payments, and environmental footprint. Simultaneously, India has begun a dramatic path toward incorporating alternative energy sources into its energy mix, motivated by the imperatives of lowering greenhouse gas emissions, improving energy security, and encouraging economic diversification. This paradigm shift includes research into renewable energy sources such as solar, wind, and biomass, as well as efforts to improve energy efficiency. In this complex and dynamic ecosystem, a critical examination of the interactions between crude oil and alternative energy sources is essential for understanding their aggregate impact on the Indian economy. This investigation goes into the complexities of energy usage, policy dynamics, and economic implications, finally shedding light on the critical role of energy transitions in setting India's future economic trajectory (Naylor, 2007).

### **2.5.1 Impact of Crude Oil on the Indian Economy**

As a crucial global commodity, crude oil has a considerable impact on the Indian economy. The supply and price of crude oil are inextricably linked to India's economic growth and development. Crude oil has a wide-ranging impact on the Indian economy, with consequences for energy security, fiscal management, inflation, and trade balances (Baffes, 2015).

**Energy Security and Import Dependency:** India's energy needs are primarily reliant on crude oil imports, putting it vulnerable to global oil price changes. The country



imports a large amount of its crude oil, especially from the Middle East. As a result, disruptions in global oil supplies or price increases in oil can endanger India's energy security. The research emphasizes the danger created by this substantial import dependency and the necessity for energy mix diversification.

**Current Account Deficit and Exchange Rate Volatility:** In academic research, the impact of crude oil on India's current account deficit is widely documented. When crude oil prices rise, the import bill rises, especially since India imports the majority of its crude oil. This phenomenon strains the trade balance and exacerbates the current account deficit. Furthermore, a growing current account deficit might cause currency instability, affecting the value of the Indian rupee. Scholars have investigated the relationship between oil prices, trade imbalances, and exchange rate changes.

**Inflationary Pressures:** The literature emphasizes the link between rising crude oil prices and rising inflation in India. Because crude oil is a critical component in transportation and manufacturing operations, rising oil prices result in greater operational expenses for enterprises. These extra costs are frequently passed on to customers as higher prices for goods and services. This contributes to inflationary pressures and has an impact on the population's purchasing power. (Hall,2014)

**Fiscal Management and Subsidy Burden:** Historically, the Indian government has subsidized petroleum products to protect consumers from the full impact of rising oil costs. The fiscal burden associated with these subsidies, on the other hand, has been the topic of academic investigation. Subsidies on petroleum products strain government finances, diverting money that could be dedicated to important public services and infrastructure development, according to the literature. Scholars investigate fiscal management difficulties and policy alternatives.

**Environmental Implications:** While extant research is mostly economic, it also emphasizes the environmental costs connected with crude oil usage. The combustion of fossil fuels, especially crude oil, contributes to air pollution and the production of greenhouse gases. These environmental externalities have consequences for public health, infrastructure damage, and the economy as a whole. Academics have investigated the economic repercussions of environmental deterioration caused by crude oil use.



To summarize, the impact of crude oil on the Indian economy is varied and extensive. It includes concerns about energy security, fiscal management issues, inflationary pressures, and environmental effects. In a worldwide climate of shifting oil prices, the Indian government faces the difficult issue of combining energy needs with economic stability and environmental sustainability. Understanding these factors is critical for policymakers, economists, and researchers seeking to improve India's resilience to crude oil price changes and promote long-term economic stability (Nyga-Lukaszewska, 2020).

### **2.5.2 Effect of Alternative Energy Sources on the Indian Economy**

In India, the growth of alternative energy sources is altering the energy landscape and influencing the economy. The addition of alternative energy sources to India's energy mix has had substantial economic consequences.

**Reduced Import Dependence and Improved Energy Security:** Alternative energy sources, particularly solar and wind power, have been critical in lowering India's dependency on crude oil imports. According to the research, this diversification has increased India's energy security by reducing its sensitivity to swings in global oil prices. As the country progresses toward greater energy independence, its vulnerability to external economic shocks decreases.

**Job Creation and Economic Growth:** Alternative energy infrastructure development and deployment have emerged as significant sources of job creation. Academic studies highlight the job prospects created by the renewable energy sector in production, installation, and maintenance. This sectoral expansion helps not only to job creation but also to overall economic growth, particularly in rural areas.

**Technological Advancements and Innovation:** Academic research has revealed how investments in alternative energy have fueled technical breakthroughs and creativity in India. The renewable energy sector has been a hub for R&D activity, leading in the development of cutting-edge technologies and innovative solutions. Such developments boost India's worldwide competitiveness in the renewable energy market and open the door to economic partnership.

**Environmental and health benefits:** The adoption of alternative energy sources has significant environmental and health benefits as emphasized by scholarly literature.

These sources contribute to enhanced public health and lower healthcare costs by lowering greenhouse gas emissions and reducing air pollution. A healthier population has significant economic repercussions that go beyond immediate environmental issues.

**Economic Policy Implications:** Economic policy implications of alternative energy adoption in India are frequently studied. According to studies, government policies such as subsidies, incentives, and renewable purchasing obligations have played an important role in promoting the rapid rise of renewable energy installations. These regulations are intended to foster investment in renewable energy and the development of the industry (Sehrawat, 2015).

Finally, alternative energy sources have far-reaching and positive ramifications for the Indian economy. These sources minimize import dependency, create jobs, promote technology developments, give environmental advantages, and have important policy ramifications. Understanding the economic dynamics and policy concerns around alternative energy is critical as India continues its journey toward a more sustainable and diverse energy mix. Academics, policymakers, and industry stakeholders all play critical roles in creating the future of India's energy landscape, assuring long-term economic growth and environmental sustainability (Zambrano-Monserrate, 2018).

## **2.6 Indian Energy Sector**

The Indian energy sector is critical to the country's economic development, providing energy to a rapidly growing population and expanding industrial base. It includes a wide range of energy sources, infrastructure, and policy measures aiming at guaranteeing energy security, access, and sustainability.

The energy landscape of India is characterized by a diversified mix of conventional and renewable sources. Coal has historically played a significant role in powering the nation, particularly in electricity generation. However, a noteworthy shift is already taking place as India shifts toward cleaner and more sustainable energy options. In addition to coal, India uses a variety of different renewable energy sources, such as natural gas, oil, hydroelectric power, nuclear energy, solar power, wind energy, biomass, and others. This diversification reflects the country's desire to reduce its carbon footprint and promote a more sustainable energy future. Electricity generation

is a critical component of India's energy economy, enabling economic growth and rising living standards. This sector includes a varied array of energy sources, such as thermal power provided by coal, natural gas, and oil, hydroelectric power, nuclear power, and the rapidly growing renewable energy industry. India has set aggressive renewable energy capacity objectives to diversify its energy mix and reduce greenhouse gas emissions. Solar and wind power investments and capacity expansions have been particularly impressive, establishing India as a global leader in renewable energy producer (Banerjee, 2010).

Providing widespread access to electricity is a central element of India's energy policy. The Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) is an important project that aims to electrify every family in the country. While significant progress has been made, issues with last-mile connectivity and grid reliability linger, particularly in remote and underserved areas. Bridging these inequalities is still critical to ensuring equitable access to energy for all populations. India's energy consumption has been steadily increasing, driven by robust economic expansion and rising urbanization. Energy-intensive industries such as manufacturing and transportation play critical roles in driving this rising demand. As a result, tackling the energy-security-environment nexus has become increasingly important, necessitating substantial investments in infrastructure development and the pursuit of sustainable energy solutions (Demirbas, 2009).

The renewable energy sector in India is experiencing revolutionary growth, attracting both domestic and global investment. The country has set lofty ambitions for renewable energy generation, including a historic aim of 175 GW by 2022 and a more audacious goal of 450 GW by 2030. Solar and wind energy projects have dominated this boom, significantly increasing India's renewable energy capacity. This not only meets environmental goals but also offers economic opportunities and places India as a global leader in renewable energy. India has implemented a comprehensive set of energy efficiency measures in response to rising energy demand. Programs such as the Perform, Achieve, and Trade (PAT) scheme, Standards & Labeling, and the UJALA scheme are critical in encouraging energy efficiency across a wide range of industries. These programs attempt to improve total energy performance by

optimizing energy use, reducing waste, and improving overall energy performance, therefore contributing to India's energy sustainability goals (Ayoub, 2012).

While India's energy sector has made significant development, it is not without obstacles. Disparities in energy availability, air pollution, greenhouse gas emissions, and the urgent need for significant infrastructure expenditures all pose challenging challenges. However, these difficulties also present the potential for innovation, job creation, and long-term growth, notably in the rapidly growing fields of renewable energy and energy efficiency. To navigate this volatile landscape, cautious policy development, technology innovation, and long-term investing practices are required. India's energy sector's trajectory is inextricably related to government policies and regulatory frameworks. The Ministries of Power and New and Renewable Energy (MNRE), as well as regulatory bodies like the Central Electricity Regulatory Commission (CERC), play critical roles in defining the sector's development and implementation. Policy stability, incentives, and well-crafted regulatory frameworks are critical for attracting investments, promoting innovation, and assuring long-term sectoral growth (Lund, 2007).

India actively participates in worldwide energy collaborations, building ties with global organizations, governments, and agencies. These collaborations are strategic, with the goal of facilitating technology transfer, attracting investments, and promoting information dissemination. Such collaborative efforts strengthen India's position on the global energy scene, promote sustainable development, and lay the groundwork for long-term progress. Finally, the Indian energy sector is fast expanding to suit the country's growing energy needs while also addressing environmental issues. India's focus on renewable energy, energy efficiency, and universal energy access demonstrates the country's commitment to a more sustainable and resilient energy future. Policy support, investment, technology improvements, and international cooperation will all be required to ensure the sector's continuing growth and major contributions to India's economic development (Van der Kroon, 2013).

### **2.6.1 Growth of the Energy Sector in India**

In recent years, India's energy industry has experienced substantial expansion and transition, owing to a mix of factors such as economic development, energy policy

reforms, and a shift toward cleaner and more sustainable energy sources. We offer an analytical perspective on this growth here:

**Diversification of Energy Sources:** Diversification of energy sources in India is a strategic strategy to improve energy security as well as a response to environmental concerns. India's reliance on imported coal and oil made it vulnerable to global price changes and supply interruptions. The transition to renewables, natural gas, and nuclear power is intended to mitigate these vulnerabilities, ensure a steady energy supply, and reduce exposure to global market volatility (Koh, 2008).

**Rapid Expansion of Renewable Energy:** A combination of factors, including dropping costs, favorable government regulations, and increased awareness of the environmental impact of fossil fuels, has brought the rapid expansion of renewable energy in India. Large investments have been made in India's solar and wind sectors, resulting in large capacity expansions. Renewable energy expansion not only addresses environmental concerns but also generates economic opportunity by supporting a thriving renewable energy industry.

**Technological developments:** Technological developments have been critical to the expansion of the energy sector. Improved solar cell efficiency, for example, and the development of improved wind turbine designs have made renewable energy sources more cost-effective and reliable. Energy storage technologies have also progressed, addressing the intermittent nature of renewables and making them more reliable sources of energy.

**Policy and Regulatory Support:** The Indian government's policy support demonstrates its commitment to the expansion of the energy sector. Initiatives such as the National Solar Mission and the implementation of competitive bidding in the renewable energy sector have offered a clear development path. Regulatory changes and initiatives to make doing business easier have drawn investments and created a more favorable climate for energy projects.

**Challenges and Opportunities:** While the energy business is expanding rapidly, it is not without challenges. Among the problems that must be addressed include grid integration of intermittent renewable sources, balancing energy supply and demand, and updating old power infrastructure. These issues, however, provide opportunities

for innovation and investment in smart grid technology, energy storage solutions, and demand-side control.

**Sustainable Development Goals (SDGs):** The expansion of India's energy sector is intimately related to the Sustainable Development Goals (SDGs). India's top objective is to achieve SDG 7, which calls for universal access to affordable, dependable, sustainable, and modern energy. Expansion of renewable energy and increased electrification of rural regions both contribute greatly to this goal.

**Foreign Cooperation and Investments:** The expansion in the Indian energy sector has prompted foreign cooperation and investment. Collaborations with countries and organizations, such as the International Solar Alliance (ISA), have aided in the transfer of technology and capacity building. Foreign direct investments (FDI) in India's energy industry have increased steadily, bolstering India's status as a global energy player.

Finally, the rise of India's energy sector is characterized by a strategy move toward sustainability, diversification, and resilience. Renewable energy expansion, fueled by technology improvements and regulatory backing, has not only addressed environmental issues but also created economic possibilities and improved energy security. While obstacles exist, they are viewed as opportunities for greater innovation and growth, putting India on a path toward a more sustainable and energy-secure future. Policy commitments that stimulate investment, research, and international cooperation will be critical in sustaining and boosting prosperity in the future years (Cherubini, 2010).

## **2.7 Research Gap**

The impact of over dependency crude oil imports and alternative energy sources on the Indian economy is an important subject of research that has received a lot of attention in the literature. A thorough examination, however, exposes significant research gaps that require correction. These gaps, discovered through a study of existing literature, serve as a foundation for additional exploration and investigation.

**An In-Depth Look at Alternative Energy Transition:** While previous research has thoroughly addressed the effects of India's excessive reliance on crude oil and its economic ramifications, there is a significant gap in providing an in-depth study of

India's ongoing transition from conventional fossil fuels to alternative energy sources. A more in-depth examination of the policies, methods, and issues connected with this transformation is required. Understanding the transition dynamics is critical for informed policymaking and economic planning.

**Quantitative Analysis of Economic Impacts:** The literature frequently provides qualitative insights into how fluctuations in crude oil prices and import dependency influence India's economy. However, there is a study gap in terms of quantitative analyses of these elements' economic influence. Such analyses should take into account variables such as GDP growth, trade imbalances, fiscal balance, and job creation. A quantitative approach will provide a more complete understanding of the economic implications of India's energy decisions.

**Integration of Environmental and Economic Aspects:** While some studies discuss the environmental benefits of alternative energy sources, there is a research gap in assessing the economic and environmental trade-offs of switching to cleaner energy options. This entails conducting a detailed evaluation of the possible cost savings, employment creation, and emission reductions connected with the use of alternative energy sources. An integrated economic and environmental analysis is required for a comprehensive understanding of the transition's ramifications.

**Regional and Sectoral Analysis:** The influence of crude oil and alternative energy sources varies greatly throughout India's regions and sectors. There is a research gap in capturing the subtle effects on agriculture, industry, services, and various states or regions of the country through region-specific and sector-specific analysis. Recognizing regional and sectoral differences is critical for targeting policy actions and allocating resources.

**Long-Term Sustainability:** The majority of available research focuses on the short to medium-term effects. However, there is a study void in assessing India's energy choices' long-term sustainability. This includes a consideration of their impact on energy security, resource availability, and India's compliance with global climate targets. Understanding the long-term consequences is critical for maintaining a sustainable energy future.

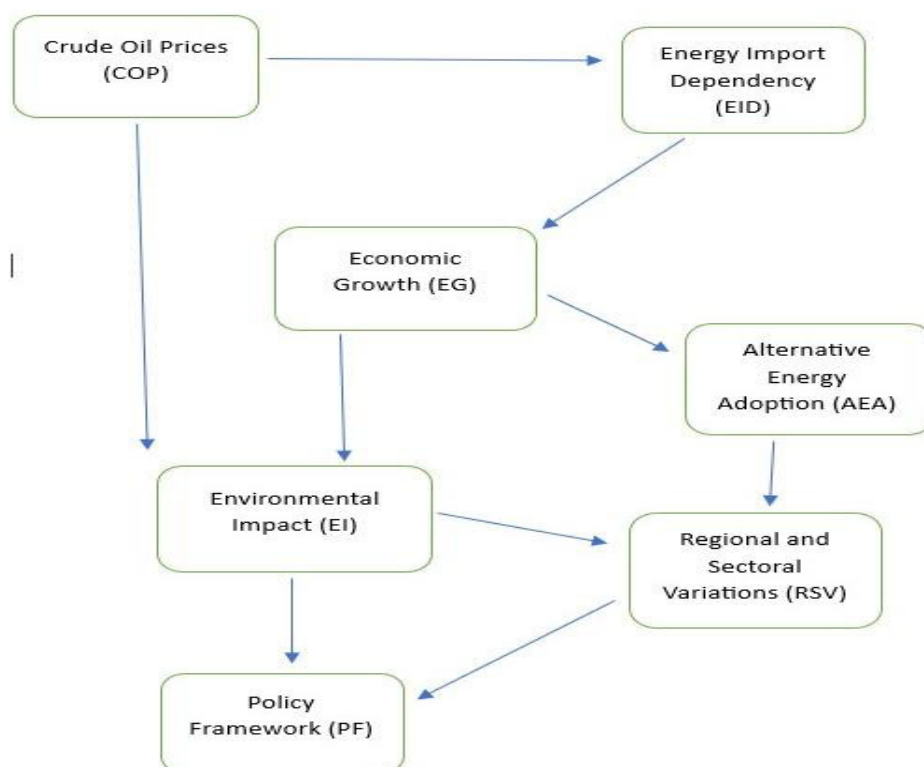


**Policy review and suggestions:** While several studies outline present energy policies in India, more in-depth policy review and evidence-based suggestions are needed. A careful assessment of present policies, as well as the identification of prospective policy reforms, is required to guide effective energy policy decisions.

**International Comparisons:** Comparing India's path to alternative energy adoption to those of other countries that have had substantial energy transformations might provide interesting insights. Comparisons of this type might highlight excellent practices, problems, and potential lessons for India's energy strategy. International comparisons can improve scholarly debate and aid in evidence-based policymaking.

To summarize, filling these research gaps is essential for furthering scholarly understanding of the interplay between crude oil and alternate energy sources, as well as their impact on the Indian economy. Filling these gaps will improve academic rigor while also providing vital insights for policymakers, economists, and stakeholders interested in India's energy and economic future (Sinha, 2018).

## 2.7 Conceptual framework



**Fig. 2.1 : Impact of crude-oil prices on energy import in India**



The above diagram (**Figure 2.1**) shows how the prices of crude oil can impact how much energy India needs to import, which can affect how well the economy is doing and also have consequences for the environment. To make things better, India can adopt cleaner energy sources, but this also depends on government policies and can vary from place to place.

# CHAPTER – III

## RESEARCH METHODOLOGY



**Objectives**

RO1 To critically analyze the impact of over dependence Crude Oil Imports on our national economy

RO2 To compare and analyze alternative sources of energy & reduce dependency on international crude oil imports

**Hypotheses**

H0: There is no substantial association between Crude Oil Prices and Energy Import Dependence.

H1: Crude Oil Prices and Energy Import Dependency have a substantial link.

H0: Energy Import Dependence has no meaningful impact on Economic Growth.

H1: Energy Import Dependence has a major impact on Economic Growth.

H0: There is no substantial association between Crude Oil Prices and Environmental Impact.

H1: Crude Oil Prices and Environmental Impact have a substantial relationship.

H0: There is no substantial association between Alternative Energy Adoption and Economic Growth.

H1: Alternative Energy Adoption and Economic Growth have a substantial link.

H0: Policy Framework has no substantial impact on Alternative Energy Adoption.

H1: Policy Framework has a substantial impact on Alternative Energy Adoption.

**3.1 Introduction**

The systematic and rigorous framework that underpins the execution of a research project, substantiating its empirical integrity and analytical efficacy, is known as research methodology. Within the scope of this research project, which focuses on conducting a critical analysis of crude oil and its alternative energy sources, as well as their effects on the Indian economy, this chapter serves as a comprehensive introduction to the methodological apparatus used, elucidating its salient significance and providing an early overview of forthcoming content delineations. The procedural structure that encapsulates the methodical orchestration, implementation, and

evaluation of a research study is known as research methodology. It includes various methodological tools, procedures, and operational mechanisms that aid in the systematic capture, analysis, and interpretation of data, all of which work together to ensure the strict fulfillment of research objectives. The research technique serves as the compass navigating the labyrinthine exploration of the complicated interplay between crude oil and alternative energy sources in relation to their impact on the Indian economic environment within the scope of this study. (Yu,2023)

### **Relevance of Research Methodology:**

It Protects the precision and dependability of data obtained by careful methodological choices and provides a thorough and methodical examination of the chosen topic matter. Also, produce well-considered and astute inferences and prescriptive imperatives and maintain the necessary ethical standards and epistemic rigor for scholarly scrutiny. (Ghorashi,2021)

### **Contents of this Chapter:**

- Research Paradigm
- Research Approach
- Research Design
- Data Collection Method
- Population and Sampling
- Data Analysis and Interpretation
- Ethical Consideration

## **3.2 Research Paradigm**

### **1. Positivism**

Positivism is a research paradigm based on actual observation, objectivity, and the conviction that the social world can be investigated using methods comparable to those used in scientific sciences. Positivists place a premium on collecting empirical, measurable evidence through methodical observation and experimentation. These researchers seek objectivity by reducing their impact on the study process, with the goal of producing value-free and unbiased conclusions. It prefers quantitative research methods, statistical analysis, and

the utilization of numerical data to identify patterns, regularities, and causal links. Positivist research aims to produce insights that can be extrapolated to larger populations or contexts. It frequently adopts a deterministic viewpoint, in which events and phenomena are considered as having underlying, predictable causes. (Shang,2022)

## **2. Interpretivism:**

Interpretivism is a study paradigm that seeks to comprehend the social world through the prism of individuals' subjective experiences and meanings. Interpretivists think that people create their own social realities based on their subjective interpretations, values, and beliefs. To delve into the richness of human experiences, interpretivism lays a major focus on qualitative research methods such as interviews, ethnography, and content analysis. Interpretive study takes into account the larger social and cultural environment in which phenomena occur, acknowledging that context impacts individuals' interpretations. The art of interpretation, hermeneutics, is frequently used in interpretative research to unearth the layers of meaning buried in texts, narratives, or symbols. Interpretivists see social processes as multidimensional and holistic, recognizing that they cannot be reduced to simple quantitative quantities. It tends to support relativism, which holds that different persons or organizations may have legitimate but opposing viewpoints. (Yu, 2022)

### **3.2.1 Choosing a Research Paradigm**

Positivism is a research paradigm based on empirical observation, objectivity, and the scientific method. It is a quantitative and deductive approach, with the goal of identifying empirical regularities and causal linkages within the phenomena under inquiry. Positivism maintains that the social environment, including economic institutions, can be investigated objectively, with an emphasis on impartiality and generalizability of conclusions. Because of its suitability for investigating empirical linkages and quantitative features of the research issue, which involves assessing the influence of crude oil and alternative energy sources on the Indian economy, this study takes a positivist method. The study's objectives and research questions are aligned with Positivism's emphasis on objectivity, causation, and generalizability. (Ali,2022)

### **3.2.2 Justification for Adopting Positivism**

Given the complexities of the research topic, positivism's empirical orientation is appropriate. It enables the systematic collection and analysis of quantitative data, allowing for a more structured evaluation of the issue. The emphasis on objectivity in Positivism correlates with the need to reduce researcher prejudice and subjectivity. This is especially important when evaluating economic issues when objectivity and impartiality are essential. The study proposes to investigate the links between crude oil dynamics, alternative energy adoption, and economic effects. The focus of positivism on establishing causal relationships through thorough data analysis is appropriate for this goal. (Murshed,2021)

Positivist research seeks to develop conclusions that can be applied outside of the study's specific setting. Generalizability is critical in the setting of the Indian economy for developing insights with broader application. Positivism's dedication to the scientific process assures rigor in research design and data analysis, boosting the study's credibility and validity. Because economic research frequently applies positivist approaches to examine quantitative data, it has become a well-established paradigm in the sector. (Guo, 2023)

## **3.3 Research Approach**

### **3.3.1 Qualitative Research Approach**

Qualitative research is an exploratory and interpretive research paradigm that uses non-numerical data to understand the complexities of human behavior, experiences, and social phenomena. It emphasizes identifying underlying meanings, contextual variables, and nuances linked with a specific issue. (Razmjoo, 2021)

#### **Characteristics:**

To collect rich, descriptive data, qualitative research includes procedures such as in-depth interviews, focus groups, observations, and content analysis. Qualitative researchers take a subjective approach, attempting to record and understand the different perspectives and experiences of participants. It recognizes the importance of understanding phenomena in their larger social, cultural, and historical settings. Rather than imposing preconceived assumptions, qualitative research frequently employs an inductive method, enabling theories and themes to emerge from the data.

Smaller sample sizes are common in qualitative studies, allowing for a more in-depth examination of certain situations or occurrences. (Akadiri,2022)

### **3.3.2 Quantitative Research Approach:**

In contrast, quantitative research is an empirical research that is based on the collection and analysis of numerical data in order to establish patterns, connections, and causal links between variables. Its systematic, ordered, and objective nature distinguishes it. (Jamil,2022)

#### **Characteristics:**

To collect numerical data, quantitative research uses procedures such as surveys, experiments, and statistical analysis. The core premise of quantitative research is objectivity, which is attained through reducing researcher impact on data and using standardized metrics. Findings from quantitative research may frequently be generalized to wider groups by using appropriate sampling strategies. Hypothesis testing and the study of the statistical significance of correlations are common features of quantitative research. Data in quantitative studies are subjected to rigorous statistical analyses, which include descriptive statistics, inferential statistics, and regression analysis. (Udalov,2021)

### **3.3.3 Justification for Using the Quantitative Method**

Examining the influence of crude oil and alternative energy sources on the Indian economy involves a thorough examination of a plethora of economic indicators, statistical models, and numerical datasets. The quantitative technique is suitable for dealing with this analysis's data-intensive nature. Economic phenomena, particularly those relating to crude oil pricing, energy consumption, and economic indicators, lend themselves well to objective measurement using quantitative data, which aligns with the study's objectivity mandate. (Bekun,2022)

Quantitative approaches provide an ideal platform for investigating causal linkages and empirically evaluating hypotheses, allowing the study to thoroughly analyze the causal links between variables. This method allows for the generation of findings that have greater applicability outside the study's specific temporal and contextual limitations, contributing to the corpus of knowledge on the topic. This approach

encourages methodological uniformity in data collection and analysis, increasing the likelihood that the study's findings will be repeated and validated by other researchers. (Ferrer, 2018)

### **3.4 Research Design**

#### **3.4.1 Descriptive Research Design**

A descriptive research design is a methodical strategy for gathering, summarizing, and presenting data in order to provide a comprehensive description of a specific event or subject. Its major goal is to provide fundamental answers to fundamental concerns concerning the "what" and "how" of a phenomenon.

##### **Characteristics:**

Data collection methods used in descriptive research include surveys, observations, content analysis, and historical research. It promotes objective and factual reporting in order to present an accurate portrayal of the issue under examination. Descriptive research frequently captures data at a particular point in time or over a very short period of time, offering a picture of the phenomena. There is no attempt to demonstrate causal correlations between variables in descriptive research, as opposed to explanatory research. Descriptive statistics are frequently used to summarize and show acquired data. (Muneer,2005)

#### **3.4.2 Exploratory Research Design**

When there is limited prior knowledge, an exploratory research strategy is utilized to get a deeper understanding of a phenomenon or to produce insights. It investigates the underlying variables and processes to answer the "what" and "why" questions.

##### **Characteristics:**

Methods used in exploratory research to acquire data include interviews, focus groups, surveys, and literature reviews. It is open-ended and discovery-oriented, allowing for the formation of hypotheses or theories. Exploratory research frequently employs qualitative data analysis to identify patterns, themes, and new viewpoints. Researchers can adjust the study process in response to new results, making it a flexible and iterative approach. Exploratory research is frequently utilized as a preliminary step before beginning a more formal study. (Wang, 2022)



### **3.4.3 Explanatory Research Design**

The explanatory research design investigates causal linkages between variables in order to understand "why" particular occurrences occur. Its goal is to identify and comprehend the factors that can influence an outcome.

#### **Characteristics:**

Explanatory research often involves the design and testing of hypotheses in order to establish causal links. Controlled experiments or quasi-experimental designs are frequently used to control independent factors and examine their impact on dependent variables. To assess causality, it largely relies on quantitative data analysis, statistical tests, and modeling tools. Explanatory research seeks to provide insights that can be generalized to larger populations or contexts. The fundamental purpose is to demonstrate a cause-and-effect relationship between variables in order to infer causality. (Haseeb, 2019)

The research design used is determined by the study objectives, nature of the research questions, data availability, and stage of the research process. Researchers choose the best design for their study based on their objectives and the level of knowledge required. Each design has various advantages and fulfills distinct functions in the research process. (Liu, 2022)

### **3.4.4 Justification for Using a Descriptive Research Design**

The primary focus of this study is a detailed examination of the influence of crude oil and alternative energy sources on the Indian economy. The descriptive research design is ideal for systematically elucidating economic indicators, trends, and their interrelationships. The core study aims are organically associated with the nature of descriptive research, emphasizing the importance of detailed presentation and summarization of critical economic variables and patterns. Economic data and indicators, which form the foundation of this study, are easily accessible, allowing for full descriptive analysis. Given the plethora of economic data sets and the need for a full overview of the research issue, the descriptive research design is pragmatically possible for this study. Because there is no experimental manipulation in this study, a descriptive research design ensures a non-intrusive approach while allowing for the analysis of genuine economic data. (Li, 2022)

### **3.5 Data Collection Method**

The chosen data collection approach, is quantitative research utilizing a questionnaire, in the context of measuring the impact of crude oil and alternative energy sources on the Indian economy.

#### **Questionnaires are used to collect quantitative data.**

Quantitative research entails the systematic collection of numerical data in order to study patterns, correlations, and trends. Questionnaires are a popular tool for collecting quantitative data, especially when researching the impact of various factors on economic indicators. (Zhang,2021)

#### **Reasons for Using Questionnaires:**

Questionnaires offer a standardized and structured approach to data collection. This assures that all respondents are asked the same set of questions, decreasing the possibility of response bias. The study intends to completely examine the impact of crude oil and alternative energy sources on the Indian economy. Questionnaires allow for the efficient collection of data from a large number of responders. Questionnaire results are intrinsically quantitative, allowing for statistical analysis and hypothesis testing. This is consistent with the quantitative research strategy adopted for the study. By surveying a representative sample of the population, the study can draw conclusions and make assumptions about the Indian economy as a whole, increasing the generalizability of findings. (Sahoo,2022)

#### **Method of Sampling:**

To ensure the representativeness of the study's conclusions, the collecting of quantitative data via questionnaires demands a well-considered sampling technique. The sample procedure is outlined in the following steps: (Sasana, 2017)

- Define the population of interest, which in this case could be Indian residents, enterprises, or specific economic sectors impacted by crude oil and alternate energy sources.
- Create a sample frame, which is a list or source from which you will draw possible respondents. It should include all aspects of the people.

- Determine an acceptable sample size that balances the demand for statistical accuracy with resource restrictions. Consider the margin of error and the confidence level.
- Depending on the characteristics of the population and the study aims, select an appropriate sampling technique, such as random sampling, stratified sampling, or cluster sampling.
- Distribute the questionnaires to the chosen sample, guaranteeing a representative and diverse sample of responders.
- Check the obtained data for accuracy and completeness, and rectify any missing or inconsistent responses.
- Using statistical software, do quantitative data analysis to evaluate relationships and draw conclusions about the influence of crude oil and alternative energy sources on the Indian economy.

### **3.6 Population and Sampling**

#### **3.6.1 Target Population**

**Indian Residents:** This category includes the great majority of people living in India, whose daily lives, economic activities, and livelihoods are heavily influenced by the availability, pricing, and sustainability of energy resources.

**enterprises and Industries:** The Indian economic landscape is dotted with a plethora of industries and enterprises from a variety of sectors, including energy, manufacturing, transportation, agriculture, and more. These organizations are crucial in both consuming and determining energy policies.

**Government and Policymakers:** At both the federal and state levels, political entities, regulatory authorities, and policymakers hold tremendous influence in setting energy policies and economic strategies. Their judgments will have far-reaching consequences for the Indian economy.

**Environmental and Energy Specialists:** A critical portion of our target market consists of researchers, academicians, and specialists specializing in energy and environmental economics. Their insights are critical in comprehending the intricate relationship between energy decisions and economic effects.

### **3.6.2 Sampling Design**

**Sample Frame:** It is critical to create a complete and up-to-date sample frame. This requires methodically curating a list or source from which we will draw possible replies. This framework should include all aspects of the target population.

**Sample Technique:** Choosing an appropriate sample technique is dependent on the study objectives and the unique peculiarities of the Indian setting. Random sampling, stratified sampling, and cluster sampling should all be carefully studied. Random sampling, for example, ensures that all elements of the population have an equal chance of being included.

**Stratification:** Stratification is the process of dividing a target population into meaningful subgroups (strata) based on specified characteristics such as industry sector, geographic region, or economic activity, where applicable and useful. This makes it easier to obtain a more representative sample.

**Determining an ideal Sample Size:** A critical part of our research is determining an ideal sample size. The required confidence level, allowable margin of error, and population variability must all be carefully considered. Larger sample sizes usually result in higher statistical accuracy.

**Sampling Method:** The method used to pick respondents, whether human interviews, internet surveys, telephone surveys, or a combination of these modalities, should be precisely established to ensure consistency and dependability.

### **3.6.3 Sample Size Determination**

The selection of an adequate sample size is a vital task in our research that requires precision and careful consideration. The sample size is determined by factors such as the desired level of confidence, the margin of error tolerance, and the inherent variability in the population. To ensure statistical validity, there are statistical formulas or software tools to calculate the requisite sample size. (Salim,2012)

## **3.7 Data Analysis and Interpretation**

### **3.7.1 Data Analysis Method**

1. Descriptive statistics will be utilized to provide a preliminary summary of the data acquired via the questionnaire approach. This comprises mean (average),

median (middle value), mode (most frequent value), and variability metrics like standard deviation and range. Descriptive statistics will aid in summarizing and presenting essential data aspects. (Qayyum,2021)

2. Based on the sample data, inferential statistics will be used to draw conclusions and make inferences about the larger population. This entails testing hypotheses and estimating metrics like population means and proportions. (Abbasi,2022)
  - Hypothesis testing will be utilized to determine whether or not there are any statistically significant relationships or differences between variables. Hypothesis testing, for example, can assess whether there is a substantial difference in economic indicators between times of high and low crude oil prices.
  - Regression analysis will be used to investigate and quantify the correlations between independent factors (like energy costs) and dependent variables (like economic growth or inflation). Multiple regression analysis can account for a variety of economic aspects.
  - Understanding the strength and direction of correlations between variables can be aided by correlation analysis. It can, for example, analyze the relationship between energy usage and GDP growth. (Wan, 2022)

#### **Interpretation of Results:**

- look for any discernible patterns or trends in the data, such as correlations between energy price swings and economic indicators.
- For hypothesis testing, evaluate the statistical significance of the results. This includes analyzing whether the data-observed associations are likely to hold in the larger population.
- Explain how findings affect the Indian economy, policymakers, enterprises, and other stakeholders. For example, during periods of high oil costs, we may examine the economic benefits of shifting to alternative energy sources.
- Identify the study's shortcomings, such as data limits or assumptions made, and offer the next research topics.

- The research report will offer the findings and interpretation in a clear and orderly manner. Tables, charts, and narratives will be used to effectively communicate the findings.

### **3.8 Ethical Consideration**

#### **1. Informed Consent and Privacy:**

Prior to data collection, all possible respondents will be given clear and complete information about the study's purpose, aims, and how their data will be used. Respondents will be asked for informed consent, and they will have the choice to participate willingly. Participants' consent will be documented, and they will be notified that they may withdraw from the study at any moment without penalty. To protect respondents' privacy, all acquired data will be anonymized. Personal identifiers will be erased, and any potentially identifying data will be converted or aggregated to prevent individual responders from being identified. The researchers will keep all data collected confidential. Only approved members of the research team will have access to this information. (Destek, 2022)

#### **2. Reliability and validity:**

To improve data collecting validity, the study will use well-established research instruments and techniques. Questionnaires and data collection methods will be devised to accurately measure the intended constructs. Pilot testing will also be used by the researchers to refine and validate the survey tools. To improve the research's reliability, the data-gathering process will be standardized, and data will be obtained uniformly from all respondents. Internal consistency can be assessed using statistical tests for reliability, such as Cronbach's alpha for questionnaire questions. (Gozgor, 2016)

#### **3. Data Accuracy:**

Researchers will take great care to guarantee that the data collected is accurate. Data entry and coding methods will be properly carried out, and data cleaning processes will be used to discover and correct problems. The study process will be transparently described in the research report, including data collection, analytic methodologies, and findings. Any limits or potential bias sources will be disclosed. (Bondia, 2016)

# CHAPTER – IV

## DATA ANALYSIS



**Data Collection**

Data was collected using questionnaire, created using google sheets, data was collected from major metros, from people of different age groups, work experience & different income groups, the reason was to check what does these individuals feel about the impact of the questions asked in the questionnaire.

Especially in the areas of unpredictable crude oil prices.

The major reasons for targeting cities was as the questionnaire was online, it was easier to access the targeted audience, next was the use of electricity is more in cities within household, compared to rural India, cities also face the most impact of price hikes, where families live pay check to pay check. Next was the impact of any policy changes by the government is normally seen first in cities, it takes time to these policy changes to reach rural areas, so if there are any policy changes the audience from cities might have already experienced it and might have seen what impact it has had on their spendings & savings, for example most of the EV vehicles are sold in cities, because of the infrastructure it provides for the EV vehicles. Next was the diversity of usage of electricity & other forms of energy in cities are more, like vehicles, residential, commercials, malls, industries etc. Next was the awareness levels in cities are better compared to rural locations. Next was the reliability of the data provided by the audience is more precise. Next was the audience in cities are better educated in comparison to the rural audience. Next was the resources available in cities are better in comparison to the rural areas, looking at all the above points it was decided to get data from city audience for this research purpose.

The goal was to clearly find out whether the Null hypothesis or the alternative hypothesis would be more relevant to each individual & as a group when I collate the data how will the outcome look like.

**Gender**

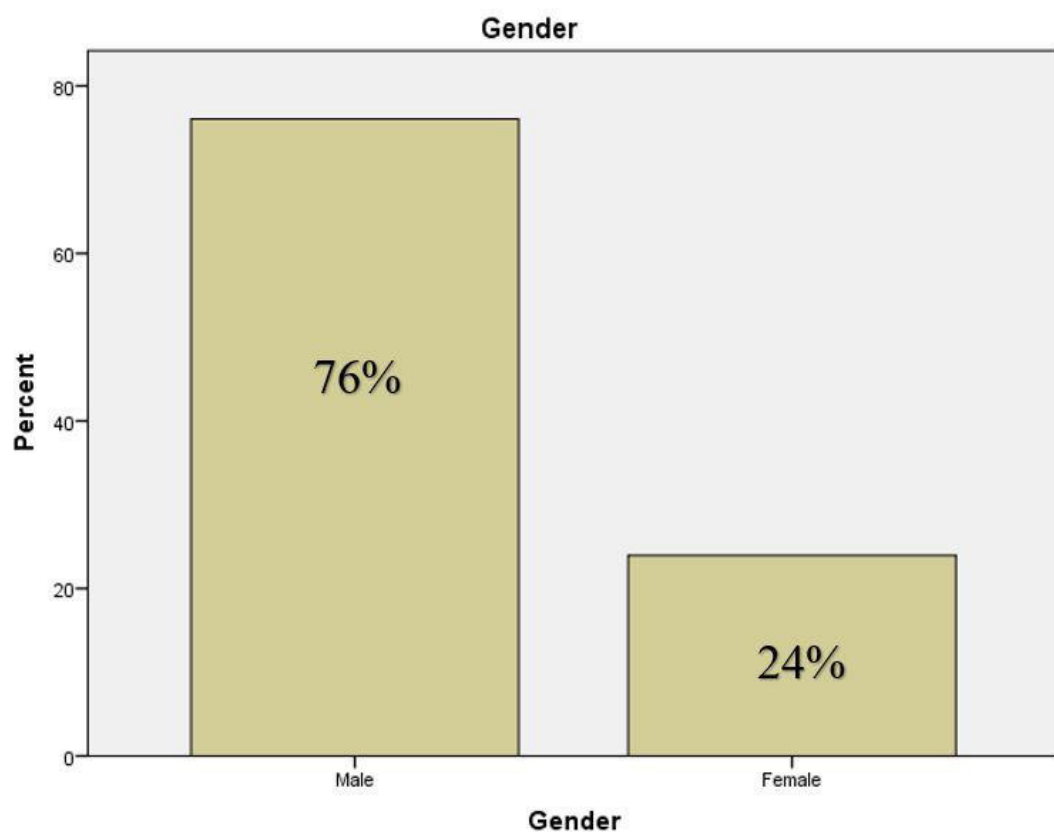
Out of the total 384 participants there are 76% of male respondents and 24% female respondents in the survey.



Bar graph attached below.

**Table 4.1 : Gender**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	292	76.0	76.0	76.0
	Female	92	24.0	24.0	100.0
	<b>Total</b>	<b>384</b>	<b>100.0</b>	<b>100.0</b>	



**Fig. 4.1 : Gender shown percentage of Male & Female**

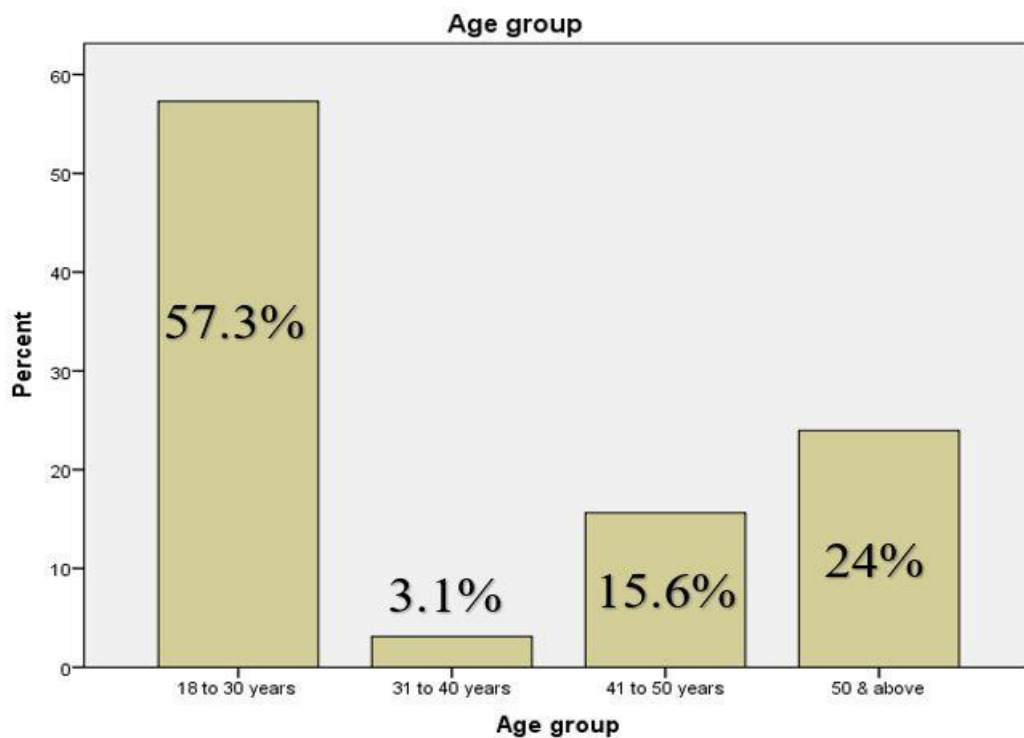
### Age Group

There are 57.3% of respondents around 18- 30 years of age, 3.1% of respondents in the age group of 31- 40 years, 15.6% of respondents 41-50 years and 24% of respondents in the age group of 50 & above.

Bar graph attached below.

**Table 4.2 : Age group**

		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Valid</b>	18 to 30 years	220	57.3	57.3	57.3
	31 to 40 years	12	3.1	3.1	60.4
	41 to 50 years	60	15.6	15.6	76.0
	50 & above	92	24.0	24.0	100.0
	<b>Total</b>	<b>384</b>	<b>100.0</b>	<b>100.0</b>	

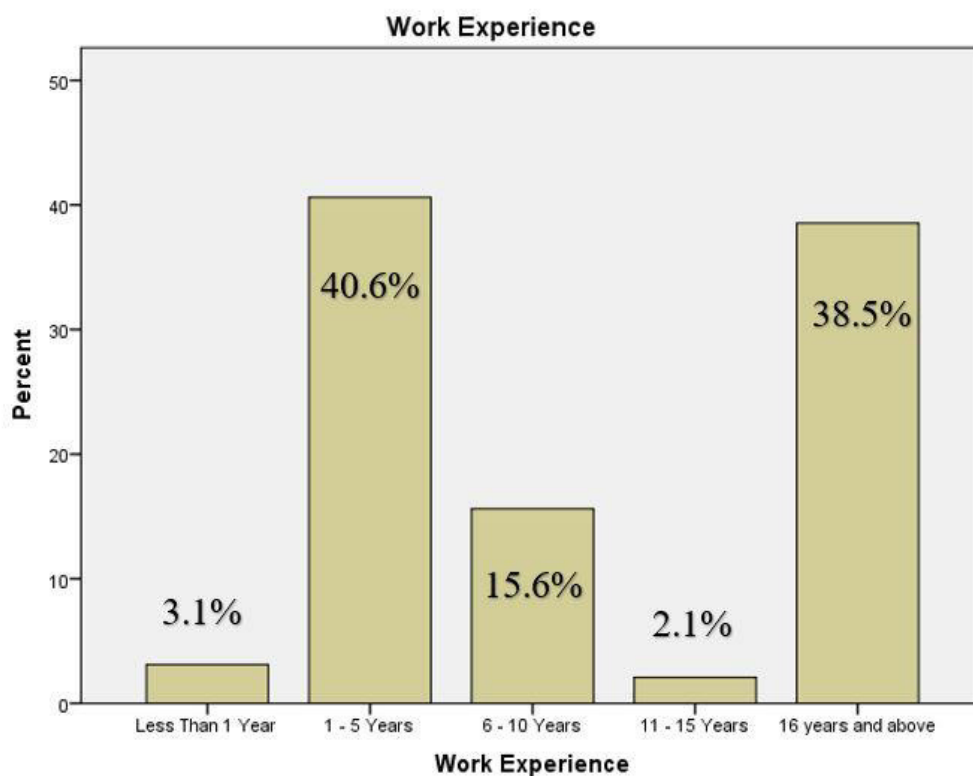
**Fig. 4.2 : Age group**

### Work Experience

There are 3.1% of respondents around Less Than 1 Year of experience, 40.6% of respondents have 1 - 5 Years of experience, 15.6% of respondents 6-10 years of experience, 2.1% of respondents has 11- 15 years of experience and 38.5% of respondents have 16 years and above experience. Bar graph attached below.

**Table 4.3 : Work Experience**

		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Valid</b>	Less Than 1 Year	12	3.1	3.1	3.1
	1 - 5 Years	156	40.6	40.6	43.8
	6 - 10 Years	60	15.6	15.6	59.4
	11 - 15 Years	8	2.1	2.1	61.5
	16 years and above	148	38.5	38.5	100.0
	<b>Total</b>	<b>384</b>	<b>100.0</b>	<b>100.0</b>	

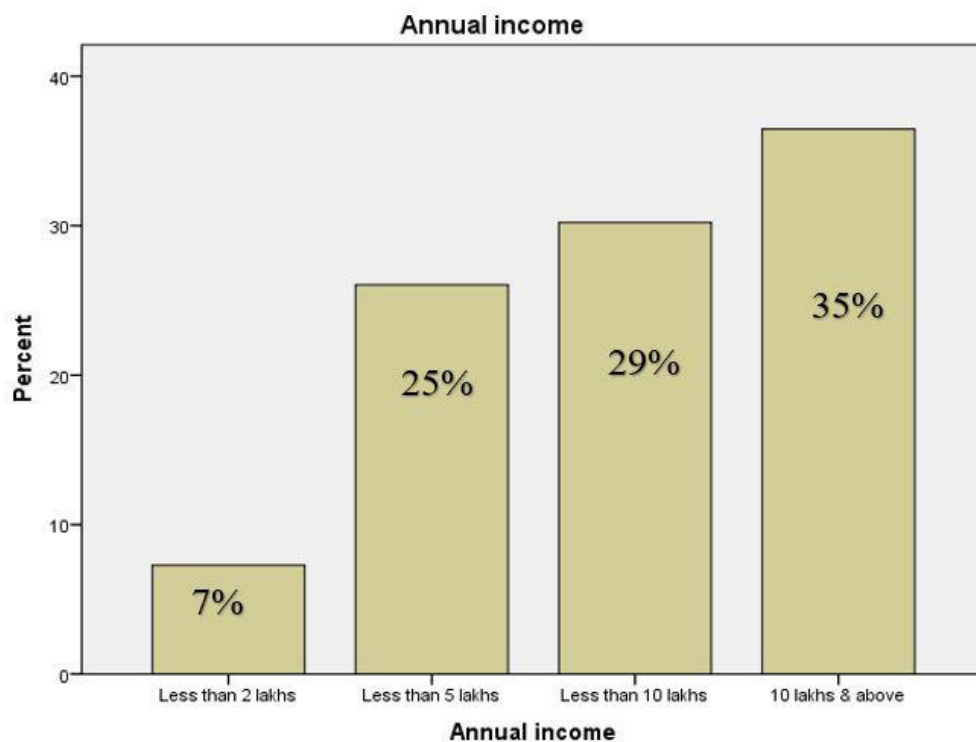
**Fig. 4.3 : Work experience****Annual Income**

There are 7.3% of respondents earning less than 2 lakhs, 26.0% of respondents earning Less than 5 lakhs, 30.2% of respondents earning Less than 10 lakhs, and 36.5% of respondents earning 10 lakhs & above.

Bar graph attached below.

**Table 4.4 : Annual income**

		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Valid</b>	Less than 2 lakhs	28	7.3	7.3	7.3
	Less than 5 lakhs	100	26.0	26.0	33.3
	Less than 10 lakhs	116	30.2	30.2	63.5
	10 lakhs & above	140	36.5	36.5	100.0
	<b>Total</b>	<b>384</b>	<b>100.0</b>	<b>100.0</b>	

**Fig. 4.4 : Annual income**

### Reliability Statistics

Cronbach's Alpha is a reliability test performed in SPSS to assess the internal consistency, or reliability, of a measuring instrument. It is particularly useful when a questionnaire is created with multiple Likert scale items, helping to determine the scale's reliability. The table below presents the reliability statistics for a sample of 384 respondents. With Cronbach's alpha of 0.910, our scale demonstrates good internal consistency for this specific sample.

**4.5 : Reliability Statistics**

<b>Cronbach's Alpha</b>	<b>N of Items</b>
<b>.910</b>	<b>35</b>

**Part B: Crude Oil Price**

We can see that majority of 42.7% respondents have strongly agreed on the statement “I am concerned about the unpredictability of crude oil prices affecting my financial stability due to variations in total expenditure”.

Bar graph attached below:

**Table 4.6 : Survey on crude oil prices**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>	<b>Agree</b>	<b>Strongly Agree</b>
	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>
I think that the government of India has a crucial role in managing and stabilizing crude oil prices which will benefit me.	12.5%	6.2%	21.9%	33.3%	26.0%
I think individuals should actively seek alternative energy sources due to the growing volatility and uncertainty in crude oil prices	8.3%	14.6%	24.0%	24.0%	29.2%
I believe fluctuations in crude oil prices significantly impact the Indian economy and my financial position as well.	20.8%	8.3%	26.0%	17.7%	27.1%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I believe crude oil price changes directly affect my daily expenses and I find it hard to manage monthly expenditures.	22.9%	16.7%	24.0%	21.9%	14.6%
I am concerned about the unpredictability of crude oil prices affecting my financial stability due to variations in total expenditure	12.5%	9.4%	18.8%	16.7%	42.7%

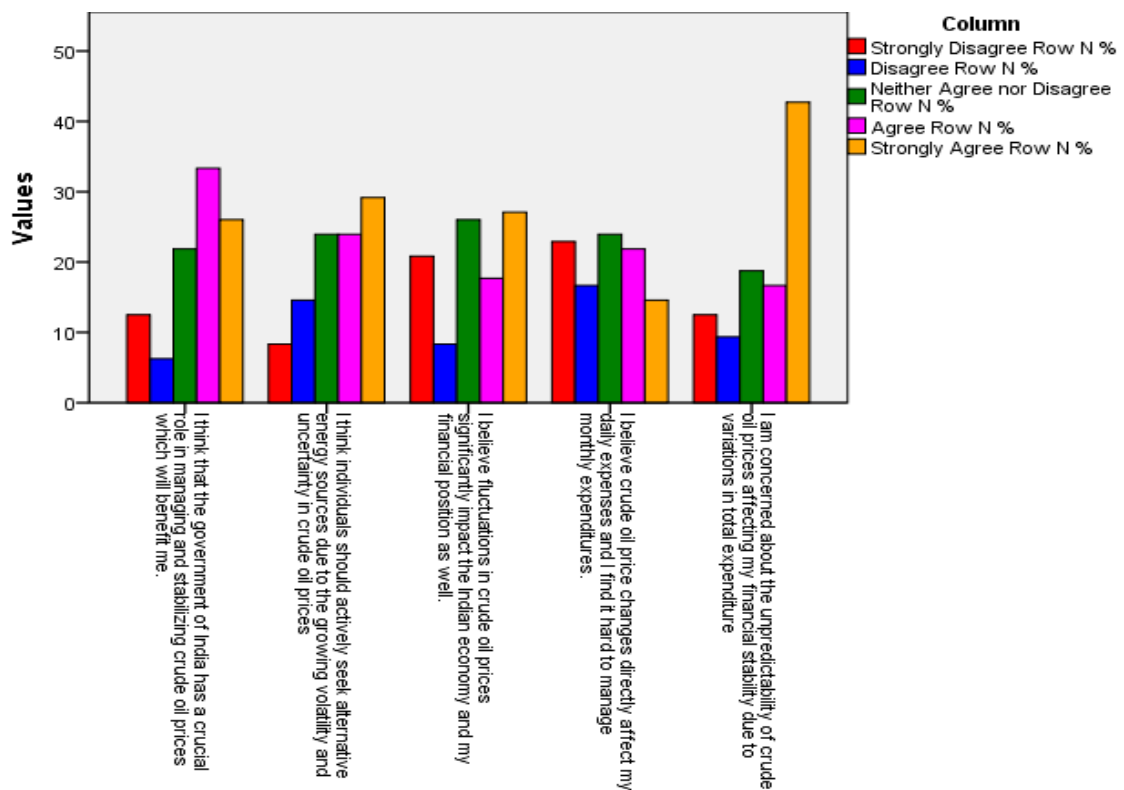


Fig. 4.5 : Crude oil prices

### Part C: Energy Import Dependence

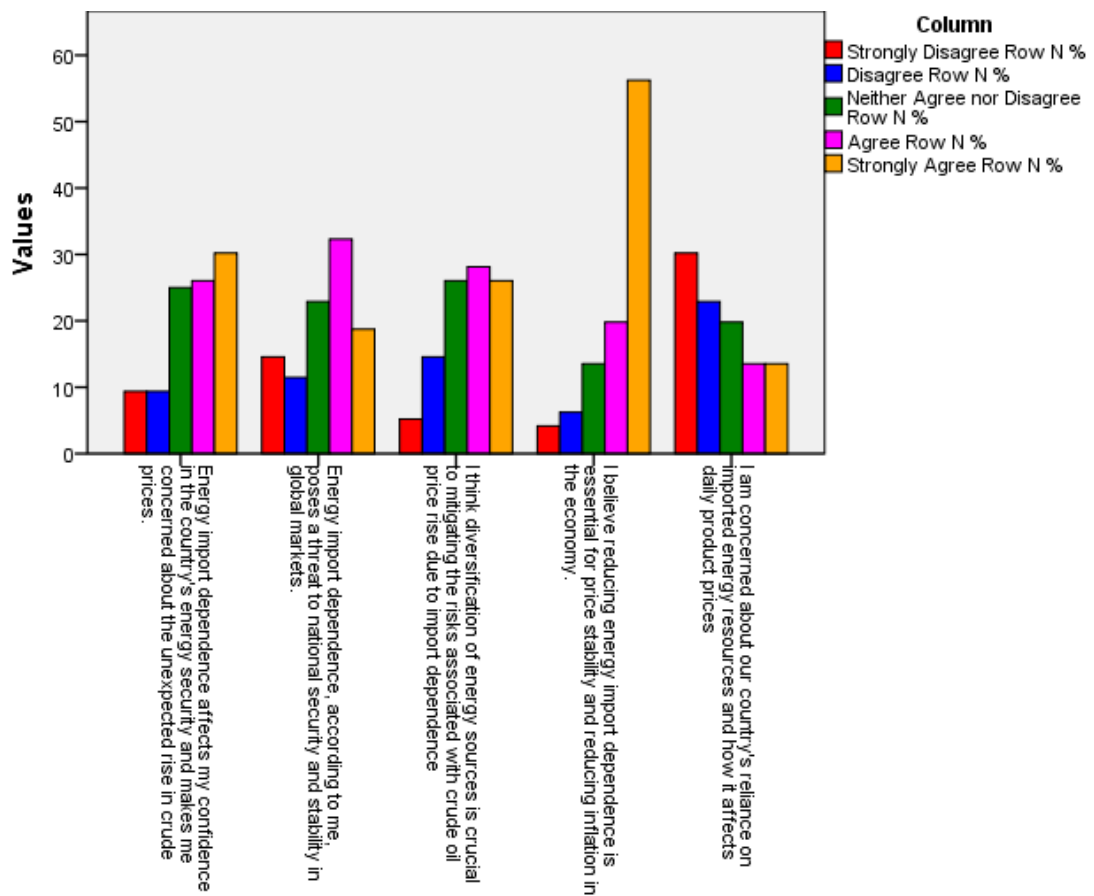
We can see that majority of 56.2% respondents have strongly agreed on the statement “I believe reducing energy import dependence is essential for price stability and reducing inflation in the economy.”.

Bar graph attached below.

**Table 4.7 : Energy import dependence**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>	<b>Agree</b>	<b>Strongly Agree</b>
	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>
Energy import dependence affects my confidence in the country's energy security and makes me concerned about the unexpected rise in crude prices.	9.4%	9.4%	25.0%	26.0%	30.2%
Energy import dependence, according to me, poses a threat to national security and stability in global markets.	14.6%	11.5%	22.9%	32.3%	18.8%
I think diversification of energy sources is crucial to mitigating the risks associated with crude oil price rise due to import dependence	5.2%	14.6%	26.0%	28.1%	26.0%
I believe reducing energy import dependence is essential for price stability and reducing inflation in the economy.	4.2%	6.2%	13.5%	19.8%	56.2%
I am concerned about our	30.2%	22.9%	19.8%	13.5%	13.5%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
country's reliance on imported energy resources and how it affects daily product prices					



**Fig. 4.6 : Energy import dependence**



**Part D: Economic Growth**

We can see that majority of 63.5% respondents have strongly agreed on the statement “According to me, different governmental and environmental policies should be adopted to mitigate the adverse effects of fluctuating crude oil prices.”.

Bar graph attached below.

**Table 4.8 : Economic growth**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>	<b>Agree</b>	<b>Strongly Agree</b>
	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>
According to me, different governmental and environmental policies should be adopted to mitigate the adverse effects of fluctuating crude oil prices.	7.3%	3.1%	8.3%	17.7%	63.5%
According to me, crude oil price volatility hinders long-term economic planning in the country affecting the general population.	7.3%	2.1%	6.2%	28.1%	56.2%
According to me, high crude oil prices negatively impact economic development and my career in the foreseeable future as well.	6.2%	8.3%	9.4%	28.1%	47.9%
I believe stable crude oil prices are necessary for sustained economic growth of India in the foreseeable future.	5.2%	2.1%	12.5%	25.0%	55.2%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I believe there is a direct correlation between crude oil prices and India's economic growth	4.2%	6.2%	9.4%	26.0%	54.2%

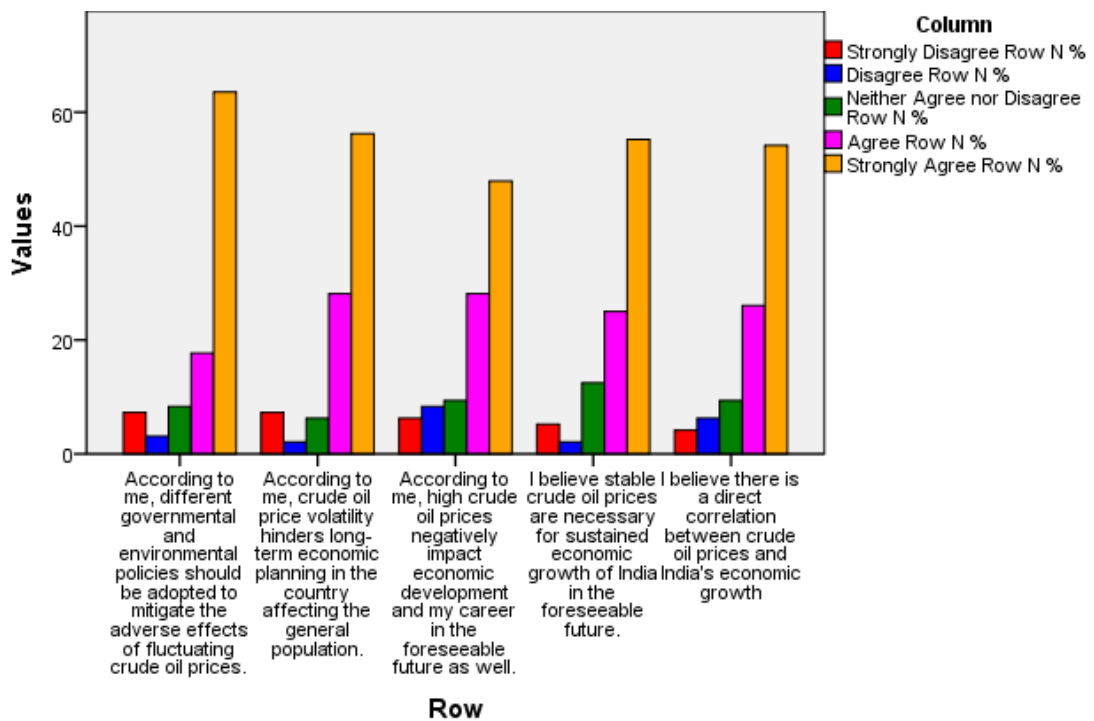


Fig. 4.7 : Economic growth

### Part E: Alternative Energy Adoption

We can see that majority of 60.4% respondents have strongly agreed on the statement “I think different government incentives can encourage individuals to adopt alternative energy solutions”.

Bar graph attached below:

**Table 4.9 : Alternative energy adoption**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>	<b>Agree</b>	<b>Strongly Agree</b>
	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>
I think different government incentives can encourage individuals to adopt alternative energy solutions.	2.1%	4.2%	12.5%	20.8%	60.4%
I support that transitioning to alternative energy sources is an effective way to reduce environmental impact	4.2%	3.1%	10.4%	22.9%	59.4%
I think education and awareness campaigns are necessary to promote the benefits of alternative energy adoption among the masses in India.	5.2%	3.1%	10.4%	21.9%	59.4%
I believe alternative energy technologies are becoming more affordable and accessible for me to use in my daily lives.	5.2%	2.1%	11.5%	26.0%	55.2%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I am optimistic about the potential of alternative energy to replace traditional sources like crude oil in my daily usage pattern.	4.2%	5.2%	8.3%	29.2%	53.1%

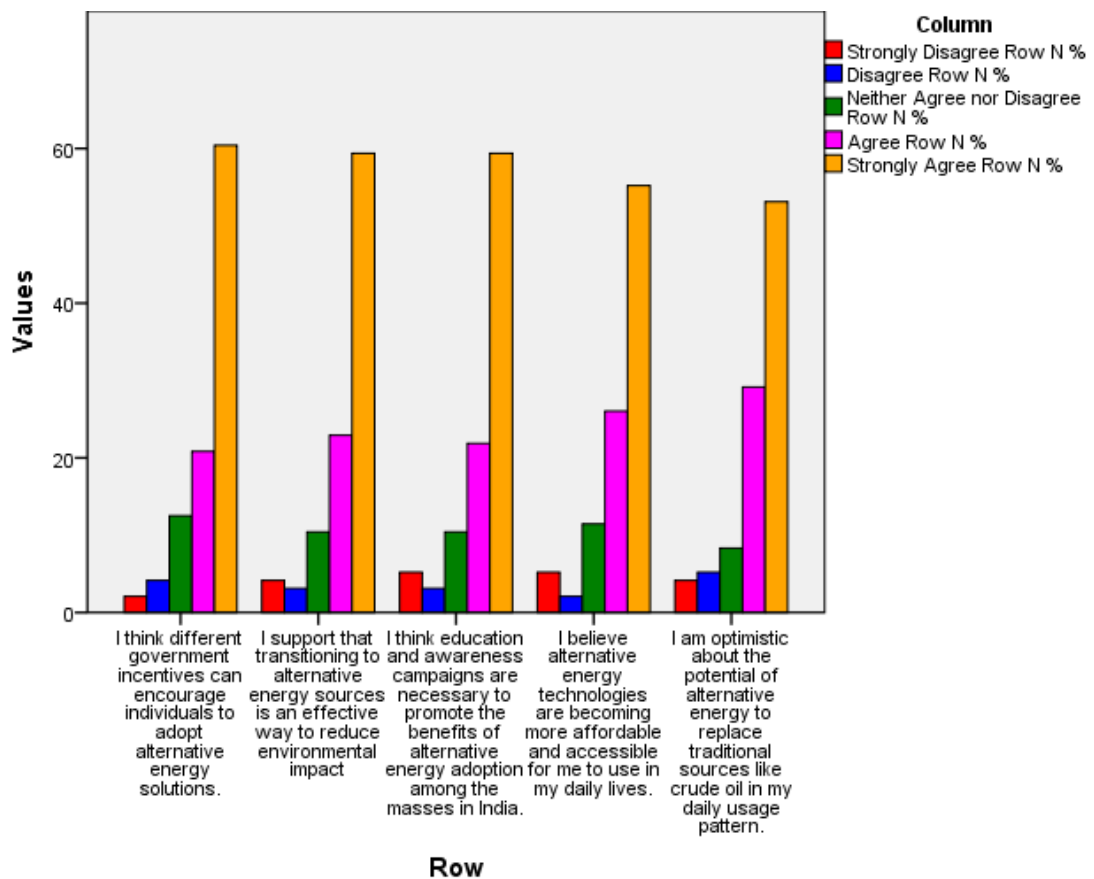


Fig. 4.8 : Alternative energy adoption

### Part F: Environmental Impact

We can see that majority of 64.6% respondents have strongly agreed on the statement “I firmly believe that crude oil consumption contributes significantly to environmental pollution”.

Bar graph attached below.

**Table 4.10 : Environmental impact**

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I believe that the utilization of alternative energy sources is essential to mitigate climate change caused by traditional energy use (crude oil usage).	2.1%	13.5%	19.8%	24.0%	40.6%
I believe mitigation of the environmental impact of crude oil extraction and utilization should be a top priority for the Indian government.	5.2%	4.2%	8.3%	24.0%	58.3%
I feel a personal responsibility to choose energy sources with minimal environmental impact to safeguard nature in India.	4.2%	4.2%	5.2%	30.2%	56.2%
I am concerned about the long-term ecological consequences which can affect the Indian ecosystem due to reliance on crude oil	2.1%	5.2%	11.5%	24.0%	57.3%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I firmly believe that crude oil consumption contributes significantly to environmental pollution.	3.1%	8.3%	9.4%	14.6%	64.6%

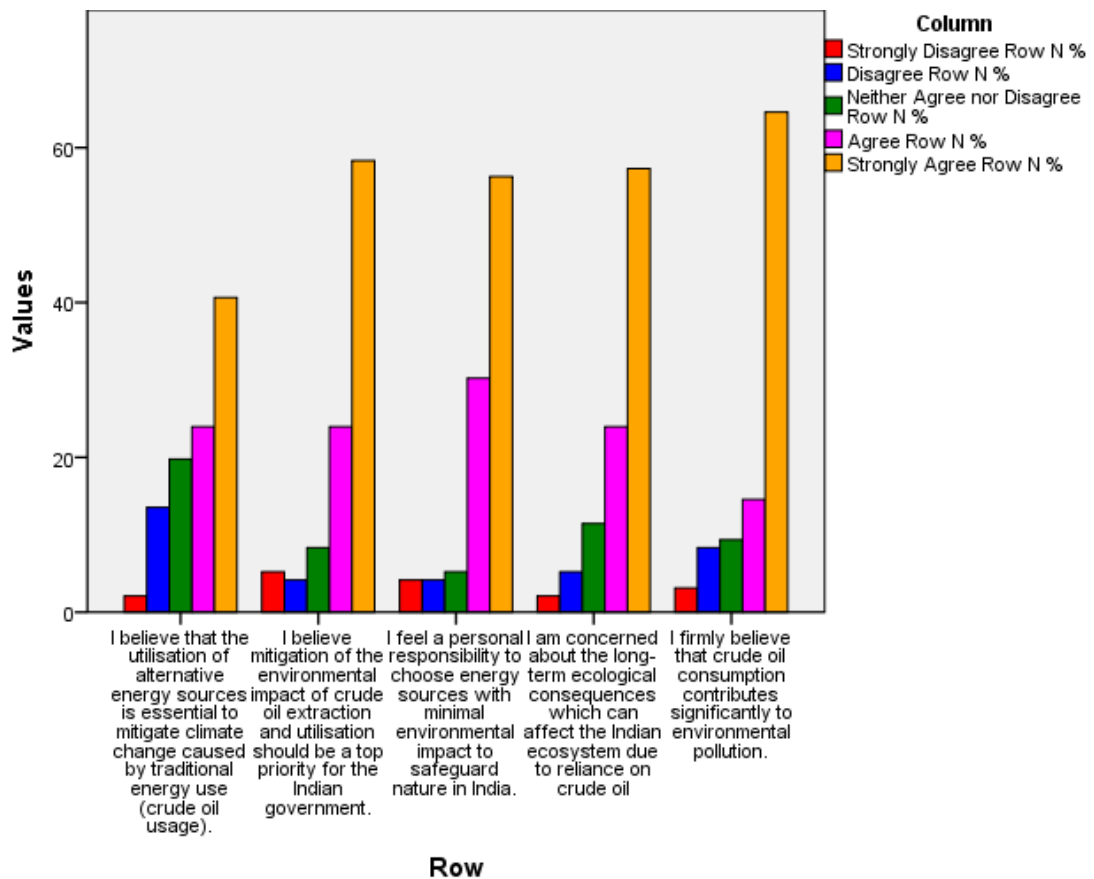


Fig. 4.9 : Environmental impact

### Part H: Regional and Sectoral Variation

We can see that majority of 58.3% respondents have agreed on the statement “According to me, understanding regional and sectoral variations is essential for effective energy planning and policymaking to reduce crude oil consumption”.

Bar graph attached below.

**Table 4.11 : Regional and sectoral variation**

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
According to me, understanding regional and sectoral variations is essential for effective energy planning and policymaking to reduce crude oil consumption.	6.2%	13.5%	4.2%	58.3%	17.7%
I believe the government should implement policies to address disparities in energy prices among different regions	16.7%	20.8%	8.3%	45.8%	8.3%
I think region and sector-specific incentives can play a role in promoting renewable energy adoption in India	13.5%	14.6%	6.2%	53.1%	12.5%
I believe there is a significant impact of regional and geographical price differences on the accessibility of both crude oil and renewable energy	17.7%	21.9%	13.5%	41.7%	5.2%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
I believe there are significant regional variations in crude oil prices across different states in India which impacts individual customers throughout the country.	8.3%	24.0%	13.5%	43.8%	10.4%

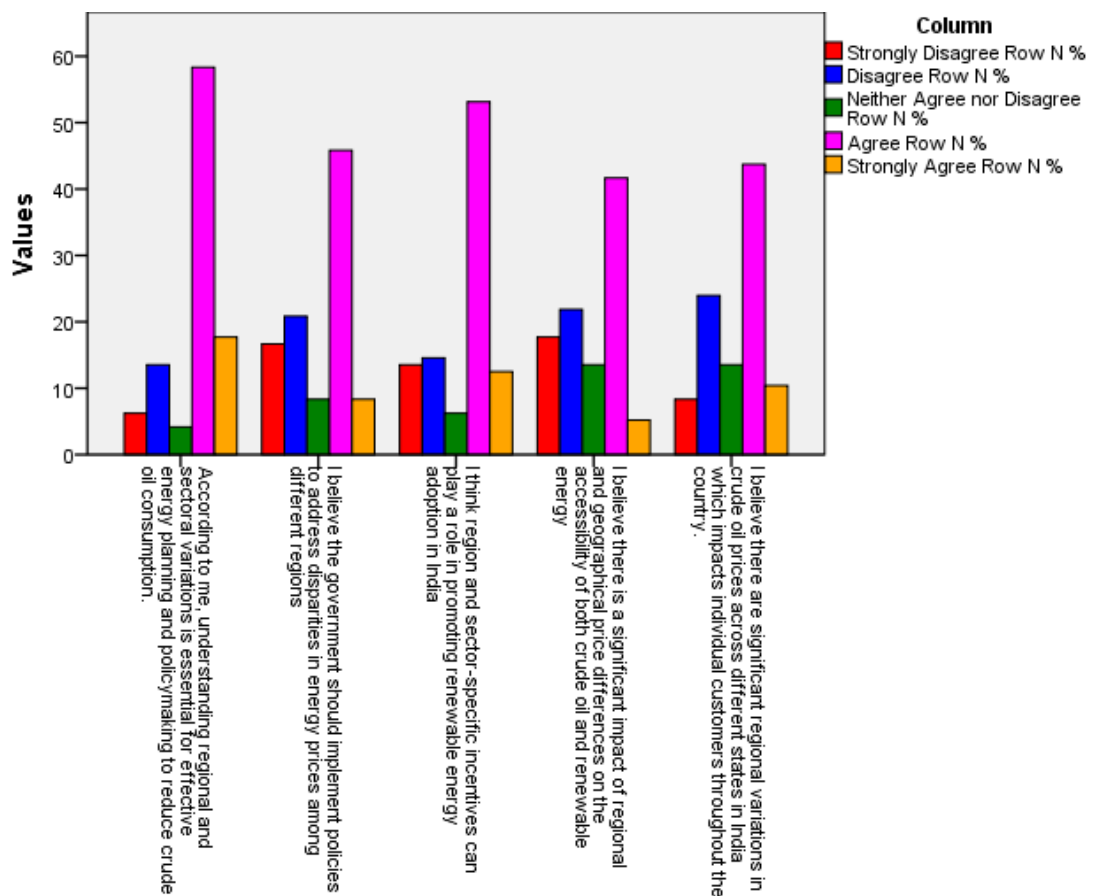


Fig. 4.10 : Regional and sectoral variation



### Part I: Policy Framework

We can see that majority of 59.4% respondents have agreed on the statement “I believe the current policy framework of the Indian government should prioritize investments in renewable energy infrastructure”.

Bar graph attached below.

**Table 4.12 : Policy framework**

	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neither Agree nor Disagree</b>	<b>Agree</b>	<b>Strongly Agree</b>
	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>	<b>Row N %</b>
Evaluating and revising policies regularly is essential to ensure their continued effectiveness in reducing crude oil consumption and improving renewable energy usage.	7.3%	28.1%	15.6%	41.7%	7.3%
I believe the current policy framework of the Indian government should prioritize investments in renewable energy infrastructure	8.3%	5.2%	5.2%	59.4%	21.9%
According to me, there is a need for more stringent regulations to limit the use of crude oil and promote green alternatives.	17.7%	13.5%	12.5%	46.9%	9.4%
I am optimistic about the potential impact of existing policies in reducing the	15.6%	20.8%	18.8%	33.3%	11.5%

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	Row N %	Row N %	Row N %	Row N %	Row N %
country's reliance on crude oil in the foreseeable future.					
I think the current policy framework effectively encourages the use of renewable energy in India.	6.2%	11.5%	5.2%	54.2%	22.9%

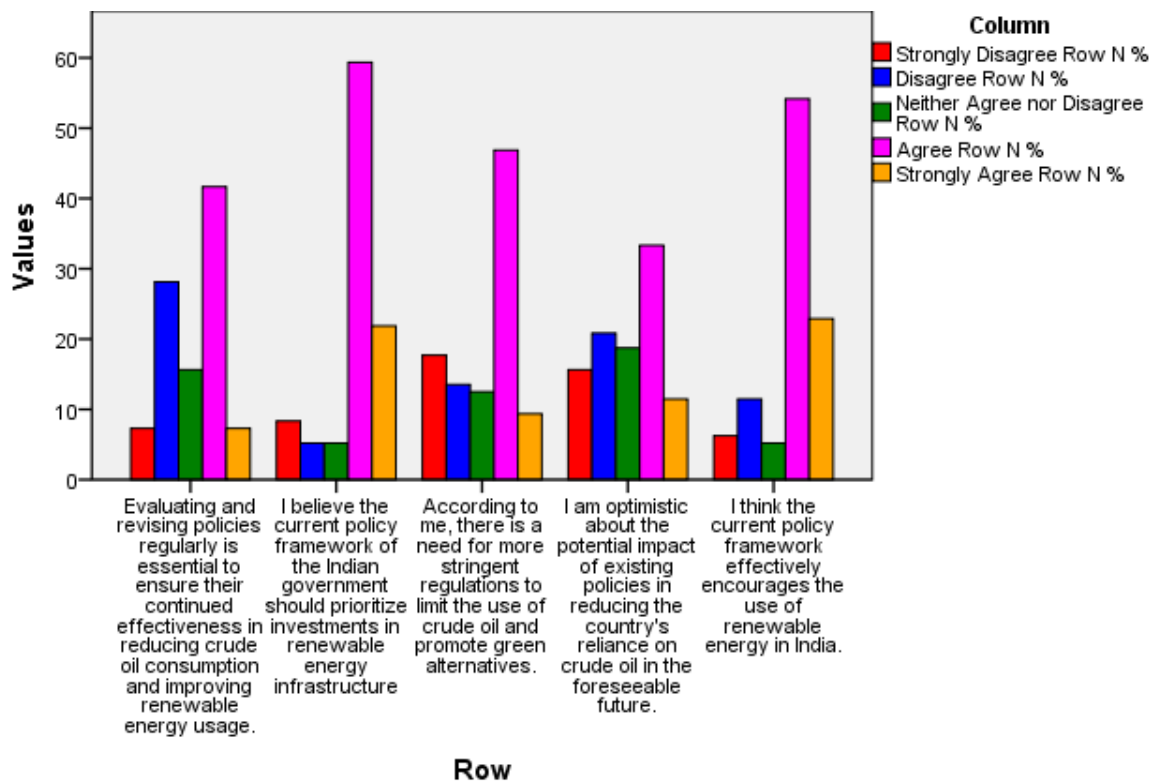


Fig. 4.11 : Policy framework

### Hypothesis Testing

**H0: There is no substantial association between Crude Oil Prices and Energy Import Dependence.**

**H1: Crude Oil Prices and Energy Import Dependency have a substantial link.**

We have applied correlation analysis to prove the above hypothesis.

From the below results we can see that there is positive (.556), significant ( $p\text{-value} = 0.000 < 0.050$ ) association between the variables.

Therefore, we can accept the alternative hypothesis that *Crude Oil Prices and Energy Import Dependency have a substantial link.*

**Table 4.13 : Correlations**

		Crude oil prices	Energy import dependency
Crude oil prices	Pearson Correlation	1	.556**
	Sig. (2-tailed)		.000
	N	96	96
Energy import dependency	Pearson Correlation	.556**	1
	Sig. (2-tailed)	.000	
	N	96	96
**. Correlation is significant at the 0.01 level (2-tailed).			

H0: Energy Import Dependence has no meaningful impact on Economic Growth.

H1: Energy Import Dependence has a major impact on Economic Growth.

We have applied regression analysis to prove the above hypothesis.

From the model summary table, the column “R” represents degree of association between the variables. Here there is 52.2% degree of effect on economic growth through energy import dependency.

**Table 4.14 : Model summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.522 <sup>a</sup>	.273	.265	.88660

a. Predictors: (Constant), Energy import dependency

The “ANOVA” table shows the level of significance, here the p-value is .000 < 0.050 level of significance.

**Table 4.15 : ANOVA table**

	Model	Sum of Squares	df	Mean Square	F	Sig.
1.	Regression	27.747	1	27.747	35.299	.000 <sup>b</sup>
	Residual	73.889	94	.786		
	Total	101.636	95			

a. Dependent Variable: Economic growth

b. Predictors: (Constant), Energy import dependency

Therefore, based on the above test results we can accept the alternative hypothesis that **Energy Import Dependence has a major impact on Economic Growth.**

**H0: There is no substantial association between Crude Oil Prices and Environmental Impact.**

**H1: Crude Oil Prices and Environmental Impact have a substantial relationship.**

We have applied correlation analysis to prove the above hypothesis.

From the below results we can see that there is positive (.508), significant (p-value = 0.000 < 0.050) association between the variables.

Therefore, we can accept the alternative hypothesis that **Crude Oil Prices and Environmental Impact have a substantial relationship**

**Table 4.16 : Correlations**

		Crude oil prices	Environmental impact
Crude oil prices	Pearson Correlation	1	.508**
	Sig. (2-tailed)		.000
	N	96	96
Environmental impact	Pearson Correlation	.508**	1
	Sig. (2-tailed)	.000	
	N	96	96
<b>**.</b> Correlation is significant at the 0.01 level (2-tailed).			

**H0:** There is no substantial association between Alternative Energy Adoption and Economic Growth.

**H1:** Alternative Energy Adoption and Economic Growth have a substantial link.

We have applied correlation analysis to prove the above hypothesis.

From the below results we can see that there is positive (.856), significant ( $p\text{-value} = 0.000 < 0.050$ ) association between the variables.

Therefore, we can accept the alternative hypothesis that **Alternative Energy Adoption and Economic Growth have a substantial link.**

**Table 4.17 : Correlations**

		Alternative energy adoption	Economic growth
Alternative energy adoption	Pearson Correlation	1	.856**
	Sig. (2-tailed)		.000
	N	96	96
Economic growth	Pearson Correlation	.856**	1
	Sig. (2-tailed)	.000	
	N	96	96
<b>**.</b> Correlation is significant at the 0.01 level (2-tailed).			

**H0: Policy Framework has no substantial impact on Alternative Energy Adoption.**

**H1: Policy Framework has a substantial impact on Alternative Energy Adoption.**

We have conducted regression analysis to prove the above hypothesis.

From the model summary table, in the “R” column, we can see that there is around 87.7% degree of correlation between the variables. There is 87.7% impact on alternative energy adoption through policy framework.

### Model Summary

**Table 4.18 : Model summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.877 <sup>a</sup>	.769	.766	.472

a. Predictors: (Constant), Policy framework

The “ANOVA” table, gives the significant output of the regression run.

As the p-value is .000 < 0.05 level of significance, we can accept the alternative hypothesis that **Policy Framework has a substantial impact on Alternative Energy Adoption.**

**Table 4.19 : ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	69.573	1	69.573	312.657	.000 <sup>b</sup>
	Residual	20.917	94	.223		
	Total	90.490	95			

a. Dependent Variable: Alternative energy adoption

b. Predictors: (Constant), Policy framework

# CHAPTER – V

## RESULT AND DISCUSSION



### 5.1 Introduction

This chapter will provide an extensive discussion of insights which have been derived from statistical analysis as highlighted in the chapter below. The primary aim behind such extensive analysis is to derive meaningful insights from the result and compare it with work conducted by prior scholars in order to understand the current situation and interest from different viewpoints. The subsequent section will cover a discussion of the results derived through hypothesis testing and then a comparison of the results. This discussion will form the major aspect of the subsequent chapter where recommendations will be provided to address the challenge which is being considered in this study.

### 5.2 Discussion on Statistical Data

**Hypothesis 1:** This hypothesis was developed to examine the relationship between crude oil prices in a country and energy import dependence. Correlation analysis was conducted to examine the hypothesis in which a positive correlation (0.556) and P-value of 0.000 was noted which suggests there is a significant relationship between crude oil price as well as import dependence for energy.

Any variation in crude oil price has been noted to have a significant impact on import levels for economies which are net importers of crude oil products in the economy as also asserted in the study conducted by Yao et al., (2023). This study is based on the logical aspects which took into account the ratio of total crude oil improvement when compared to the GDP of the economy. The closer the relationship, the more significant impact has been considered of any change in price on the import level. It should be noted higher prices are expected to show negligible deviation in import level when there is a price rise. In case of a price fall, each industry and the economy is considered to act rationally and start acquiring more reserves which may again lead to a price rise. Thus, the ratio of oil consumption to GDP is a major criterion influencing price as well as total import level. The study conducted by Wang & Su (2021) should also be considered who established the conditional aspect and noted that the government acting on behalf of the economy (taking into consideration demand by all industries and reserve level), may take decisions each quarter regarding the need to acquire or continue with current oil reserves. Here, the government is



considered as a price establisher but the role of government is limited to price rise in the global market. The government may still have reserves in a quarter but may increase the price to buy more reserves in subsequent quarters. Hence, though this model established time conditions, the model does not price changes that can be made by the government and actual influence may be faced on a daily level based on how the domestic market reacts. Thus, this study established the relationship between the domestic and international oil markets even when the government makes periodic adjustments owing to the need to pay higher in the foreseeable future. A significant theme which has been noted across the discussion is the role of reserves which has not been directly considered in this empirical study, but such reserve impact on the entire economy has been noted in the study conducted by Anser et al., (2020). Reserves here have been defined in a simpler manner as the total volume of crude oil which an economy has currently. Such oil will be utilised for consumption and hence government need to maintain a balance between consumption and usage. Therefore, the government of an energy-import-dependent economy acts as a price establisher making an active attempt to mitigate direct price shock. However, the government need to slowly transfer prices. Here, it has been asserted that in case of lack of government intervention, such price will be decided freely and shock will be felt across a shorter timeframe (or on a daily basis). Thus, the government acts to delay the impact but may not be able to completely mitigate it in the case of a long-term perspective. The actual situation in the global economy is several countries are net exporters of oil products as well though such countries will always be smaller than oil-importing economies. Liu et al., (2020) noted in the study the presence of such diverse exporters who all may charge different prices. In the current situation, the price is decided by such countries coming together as a group, but here each country is considered a price establisher. In such a scenario, each country may try to shift to a similar price in order to collectively enjoy benefits and gradually shift to a collective approach. Thus, the current study noted price deviation in a longer timeframe may be much lower with a defined percentage range. In such a case, energy importing economy may face only nominal loss or gain nominal amount due to a change in partner and thus negligible impact will be visible affirming the relationship we noted even with diverse exporters.

**Hypothesis 2:** Subsequently, this hypothesis was developed to examine the relationship between energy import dependence and the economic growth of the country. Such has been tested with the aid of regression analysis and ANOVA table. The strength of the relationship was noted to be 0.522 (or 52.2%) and a P-value of 0.000 was noted suggesting energy import dependence has a major impact on the economic growth of the country.

Energy imports have been noted to have a significant influence on economic growth and such has also been established based on a macroeconomic model as evident from the study conducted by Adewuyi & Awodumi (2020). In this study, a comprehensive macroeconomic model has been noted which stated that crude oil consumption is related to different industries which has been noted to lead to positive growth in output per sector or the proportion of GDP which is contributed by that sector. Any change in crude oil price is noted to influence business process and hence output from that sector thus proportion of GDP will also be influenced, and hence economic growth as well. Improve dependence makes it harder for the country to establish prices rather it needs to accept higher prices in the market which can lead to a negative impact on output level in different sectors, and thus lead to a negative influence on economic growth. In this aspect, the relationship which has been observed by Sarigül & Apak (2022) should also be considered who noted that such a relationship between energy consumption and economic growth of the country is felt in a longer timeframe and such is not significant in a shorter time frame. When energy consumption of energy-importing economies is taken into consideration, then a direct relationship can be established between import and consumption and thus may be connected here to establish a relationship between energy import and economic growth in the longer timeframe. The logical framework of the actual situation in which crude oil demand can be met by utilizing existing supply country may have in storage. Over a longer timeframe, if higher prices are sustained, the economy may have no choice but to purchase at higher prices leading to a reduction in energy consumption and hence influence may be felt on economic growth. Moreover, the study which has been conducted by Murshed et al., (2020) should also be considered in which the relationship between energy import dependence and economic growth has been established but at the same time, such has been compared by dividing the

economy into three sectors namely agriculture, industry, and service segment. The industrial segment is noted to have a direct influence but on the other hand, influence is also noted in the agriculture and service segment due to the need to utilize different equipment which needs crude oil products. Thus, the influence has been noted across different segments but at the same time, each segment will have a proportional influence. Energy import dependence is thus noted to firstly influence the industrial segment of an economy and then agriculture and service-based, thus collectively influencing the economic growth of the region. Another logical model has been established in the study conducted by Gibbi & Khan (2023) who also asserted the existence of a relationship between energy import dependence and economic growth. This study considered the aspect of economic expansion which is termed as an increase in total output by any sector and requires more energy consumption despite the role of innovation and making the business process more efficient and less energy-intensive. The need for additional fuel consumption may be lower but such would still be positive. An increase in price and energy import dependence may make such expansion tough. This logical model is considered more relevant as such has been noted to suit in case of a fall in price in which different industries might engage in more consumption of energy and thus showcase an increase in economic growth.

**Hypothesis 3:** This hypothesis examined the relationship between crude oil prices as well as environmental impact, which was examined with the aid of correlation analysis. A positive correlation was noted with a strength of 0.508 and a P-value of 0.000, which suggests that there is a significant relationship between crude oil prices as well as environmental impact.

The influence of prices of crude oil and environmental impact has also been covered in the study which has been conducted by Yadav et al., (2020). A significant observation has been provided in the prior study which noted that the economy which has been dependent on crude oil cannot achieve socioeconomic goals of sustainability or environmental goals due to the higher level of carbon footprint which is generated daily from the consumption of fossil fuels. Regarding the price of fuel, it has been noted that a significant increase may decrease a certain proportion of domestic oil consumption and consumption in each sector for different activities, but still, there will be a significant carbon footprint from continuous usage which will still have an

impact on the environmental footprint. The current study has also analyzed the aspect of renewable energy and noted such in the current timeframe and even in the foreseeable future, may not be possible to completely eradicate the environmental impact as existing infrastructure promotes the usage of crude oil. Further, the study which has been conducted by Ani et al., (2020) has also affirmed the relationship which noted it to primarily stay significant owing to the large use case which is noted regarding the consumption of oil. Additionally, here the scholars also explored different aspects in terms of damage to the environment which consists of not only carbon oxide generation but also of other pollutants like nitrates and sulfates, which may stay longer in the air than regular carbon oxides and hence may cause negative damage to environment based on prior energy consumption trends. This argument hence established the notion that oil prices, when lower, may witness higher levels of consumption which has been established to lead to higher levels of pollutants and thus may cause significant damage to the environment even if the prices go higher in the foreseeable future. Thus, this established the crucial aspect of price and consumption volatility and such needs to be reviewed across a longer timeframe than daily volatility. When considering the influence of crude oil price and the environment, an extensive study which has been conducted by Agbalagba et al., (2021) should also be considered, in which it noted environmental impact is diverse and needs to be considered from the aspect of soil, water, and air. Volatility in crude oil prices can lead to changes in consumption but such changes will not be stationary rather the impact will be felt in different proportions in different sectors and both personal as well as commercial use, thus environmental impact on different attributes (soil, water and air) which has been covered above will be a different and overall significant impact on the environment may be noted. Division of environmental impact on different aspects aids in understanding how price change may lead to usage change which may lead to change in impact across different aspects but impact will still be significant. In this aspect, the study conducted by Hassanshahian et al., (2020) should also be reviewed which noted that considering crude oil price as a singular variable for influence on environmental impact may be harder as the economy depends not only on the consumption of direct crude oil but also different crude oil-related products. At the same time, the economy has extensive infrastructure which involves

refining as well as distribution aspects. Further, oil in existing storage might be used to meet sudden price deviation. In such a complex scenario the influence on the environment due to oil consumption will remain the same unless there is a significant price rise and continuance across a longer timeframe, in which case, an earlier study of the impact on different attributes of soil, water, and air becomes relevant hence asserting crude oil price to have a significant impact on the environment.

**Hypothesis 4:** Similar to another hypothesis, here the relationship between alternative energy adoption as well as economic growth was examined. This was done with the aid of correlation analysis. A positive correlation value was noted with a value of 0.856 and a P-value of 0.000, which established that an alternative hypothesis can be accepted to establish that the economic growth of the country can be linked to adoption of alternative energy sources

Renewable energy has been noted here to have a significant impact on the economic growth of the country. A risk-based model which included both economic and financial aspects has been adopted in the study conducted by Wang et al., (2022) was asserted that earlier adoption of renewable energy will come with significant costs of engaging both in public awareness and development of traditional energy systems in such a manner that it suits the requirement in the utilization of renewable energy. In such instances, the impact will be negative as such will require extensive investment which might have been invested in another sector for economic growth. However, the study has asserted that once such a threshold (investment required for utilization) is crossed, a positive net is expected of renewable energy adoption on the economic growth of the country. The current study does not consider the threshold but even when considering the threshold, overall influence is positive over a longer timeframe. Similarly result has also been noted in the study conducted by Shahbaz et al., (2020) who asserted positive impact was witnessed in 58% of 38 countries of which data was collected from 1990 to 2018. Two aspects need to be considered, firstly the latter study did not take into account new advancements since 2018 and secondly, significant influence is still noted. The current study has extended this and established a positive relationship between renewable energy adoption and the economic growth of India. Further, this study has combined such economic growth as well as environmental aspects and connects the results which have been derived in this

hypothesis with the influence of crude oil on energy import dependence as well as environmental impact. Thus, this study connects each aspect establishing the significant influence of renewable energy adoption on economic growth and such develop on the logical inference that infrastructure for renewable energy must have grown from 2018 to the current timeframe. While analyzing the relationship between growth and adoption of renewable energy, the study conducted by Oliveira & Moutinho (2021) should also be considered who noted the influence of renewable energy adoption on economic growth has been witnessed in all countries except less developed economies. Through logical analysis, India currently can be considered as a developing economy which is making active investments in both the development of renewable energy sources and utilization of such energy across different sectors and personal consumption as well. This leads to affirmation of the argument presented by prior scholars of relationship being evident in developing economies which has been established through empirical analysis. For less developed economies, the latter study considered the need for technology and loans, which is considered crucial and has been discussed as a factor which can negatively influence energy adoption in the short-term, but still such is considered an essential investment if the long-term benefit is being considered. A long-term empirical relationship has also been noted between economic growth as well as the adoption of renewable energy as evident from the result which has been established in the study conducted by Kasperowicz et al., (2020). Thus, one major inference which becomes clear from the analysis of different studies which are based on different regions is the relationship becomes visible as well as significant only in the longer timeframe. In a shorter timeframe, significant deviation may be noted which may be both positive as well as negative based on existing energy infrastructure, crude oil price, and macroeconomic situation. On a longer timeframe, a positive relationship is noted in which the economy is considered to take a rational decision which will promote the growth of renewable energy resources and develop adequate facilities to ensure such energy can be used by diverse sectors. Therefore, from logical analysis, this is expected to contribute to positive economic growth

**Hypothesis 5:** This hypothesis was developed to examine the relationship between policy framework and alternative energy adoption. Regression analysis and ANOVA

table analysis were conducted. Regression analysis established the strength of the relationship as 0.877 or 87.7%. ANOVA table analysis noted a P-value of 0.000, which suggests that an alternative hypothesis can be adopted or there is a relationship between policy framework and alternative energy adoption.

The influence of legal policies has been also noted in the logical framework which has been conducted in the study by Olujobi et al., (2023). Here, the two aspects were considered which the government might think regarding energy regulation, firstly ensuring energy security in the economy from price fluctuations and secondly, meeting environmental and sustainability targets. For both of these, a legal policy is considered as a prerequisite as such would establish the need for taking action to promote renewable energy consumption and at the same time, ensure each process gets covered in a specific timeframe in case of systematic adoption and transition process. Legal policy establishment is considered a significant aspect which will ensure each stakeholder takes dedicated action. Further, this study does not discuss penalties and fines but rather considers them to be dependent upon specific governments. The current study acknowledges such can have both aspects which can involve both incentives as well as penalties and shall be decided based on the macroeconomic situation of the economy. To add to this, Qurbani & Rafiqi (2022) asserted that different legal regulations and guidelines which are established take into account the environment as a dedicated entity for which all stakeholders must engage in protection. This aspect when established legally is considered a significant change in the policy framework under which citizens of the economy are expected to protect the environment which will lead to the adoption of renewable energy resources. This study also took into account the substance, content, and problem which legal policy aims to address through renewable energy adoption. A clear as well as comprehensive policy is noted to have significant benefits but on the other hand, a policy which has no clear implications or direction may not lead to significant change. Thus, the assertion in the current study is considered valid but requires a strong and dedicated policy which establishes a clear plan. Here, plan clarity is considered in terms of what changes are expected in each industry and energy network and by when each change will be implemented to not disrupt traditional economic activities. Further, Chang et al., (2021) noted legal policies as a significant factor based on the entire energy

ecosystem. The shift from a crude oil economy to an economy which is focused on renewable energy requires significant investment in pipelines and also major changes in technology as well as consumption habits. All of these are expected to be addressed through dedicated legislation, in such a case it has been noted that legal policies can have a significant impact on the adoption of alternative energy sources in the economy. Thus, the current study has noted the influence of legal policies, but the discussion here expands it to the need for systematic and comprehensive policies which cover different aspects, provide subsidies or penalties based on macroeconomic aspects and current needs and establish dedicated targets while also establishing accountability for different stakeholders. Therefore, such regulations are noted to significantly influence the adoption of alternative energy sources across the economy including all sectors and personal usage.



# CHAPTER – VI

## CONCLUSIONS AND RECOMMENDATIONS



## **6.1 Major Findings**

Crude oil has been the fuel for the global and Indian economy for decades and, as such has addressed both personal as well as business needs of different sectors across the country. India, however, remains one of the largest net importers of crude oil in the world, making crude oil an important aspect in which price volatility can have a significant impact on our energy needs and hence the economic growth of the country as well. Recently, the shift has been towards renewable energy sources which aims to address environmental challenges due to the higher carbon footprint generated by fossil fuels and at the same time, also address the volatility faced in the economy due to price deviation of crude oil and our current position as one of the largest net importer in the world. This aspect has been reviewed in the current study which has been analyzed using a quantitative analysis approach in which a questionnaire has been used to collect data and analyzed through SPSS software. A significant influence has been noted both regarding crude oil prices and alternative prices on the economic growth of the country. The influence of crude oil reliability on economic growth has been clearly established and participants also highlighted the need to focus on different alternative energy sources. Additionally, the role of policy framework which can be established by the government and which promotes the utilization of alternative energy has also been noted. To add to this, the current study established a negative impact on both economic growth as well as environment due to crude oil prices, thus establishing the need to focus on alternative energy in the transition to a developed and less volatile economy.

## **6.2 Recommendations:**

The following recommendations have been suggested to reduce the dependence of India on crude oil and increase the utilization of alternative energy sources for reduced dependence on energy growth and improvement in the level of economic growth for the country:

- The government should allocate dedicated funds for the development of solar, hydro, and wind energy sources which can aid in increasing renewable energy availability for the country

- The government should provide incentives like tax breaks, incentives and subsidies for investment and utilization of renewable energy in different sectors and personal consumption by individuals
- Businesses and governments should engage in research and development to develop more efficient and cost-effective sources of renewable energy generation and storage which can make it competitive with traditional energy solutions
- Businesses should focus on the development of effective energy storage and distribution solutions which can aid in addressing the unreliability of energy generation from renewable energy sources.
- The government should provide incentives and encourage electric vehicle adoption in an attempt to reduce dependence on fossil fuel consumption for transportation needs across the country
- Government and business should also invest in the development of public transportation solutions to address the need for private vehicles and reduce total fossil fuel consumption
- Government and businesses should launch informative advertising campaigns with the aim of educating people about the impact of crude oil on the economy and encouraging alternative energy adoption
- The government should encourage businesses to engage in collaboration with international firms in order to develop affordable and efficient renewable energy solutions for utilization across the country
- The government should explore and invest in different bioenergy solutions like biofuel and biogas in an attempt to address the diverse energy needs of different businesses for different business process
- The government should engage in the development of a systematic strategy which aims for the planned phase-out of fossil fuel and the adoption of renewable energy sources across different sectors in India for both commercial and public usage

### **6.3 Limitations**

Certain limitations have been noted which might have an impact on both study reliability as well as validity. Firstly, the current study is based on quantitative data

hence public perception regarding alternative energy adoption, challenges faced, and their expectation regarding the role of government and business have not been taken into consideration. Additionally, the current study is based on viewpoints and reflections from different industries and also accounts for both domestic as well as commercial use. It should be noted that energy consumption and usage of energy are different for each sector, and hence distinct focus on aspects of specific sectors and personal usage of energy might show different results in alternative energy adoption. Finally, the current study is based on the crucial assumption that respondents are aware of crude oil prices and renewable energy prices, which may lead to result deviation in case the price of each aspect changes and people get to know about such aspects which may lead to a change in perception.

#### **6.4 Further Research**

Future scholars shall consider this study as a foundational study and attempt to conduct diverse studies with a narrowed down scope, focusing on the needs of particular industries and particular usage under domestic consumption. Additionally, a qualitative study shall also be conducted in order to analyze subjective views, reflections, and perceptions of government officials as well as businessmen involved in different sectors and make plans to systematically implement renewable energy in the country. Moreover, future scholars shall also conduct an extensive analysis of secondary data to establish trends depicting the influence of energy consumption variance in different sectors based on changes in the price of crude oil. Additionally, future scholars shall focus on establishing different energy production and distribution facilities for pilot study or simulation in order to understand the influence on different sectors. Finally, future scholars shall broaden the framework to also take into consideration different aspects like employment, changes in the GDP of the country, and changes in domestic usage due to the utilization of renewable energy usage in the country.

**Important additional points**

Total consumption of Crude Oil In India	1.75 Billion Barrels for 2023-2024				
Transportation is 40 to 50%	Two-wheeler 20 to 25% (EV is 3%)	Four-wheeler LCV 20 to 25% (EV is 2%)	Four-wheelers HCV 30 to 35%	Airplanes 10 to 15%	Shipping 5 to 10%
45% of 1.75 billion barrels = 787.5 million barrels	Cost per barrel = 70\$ to 90\$	80\$ * 787.5 million \$ = \$ 63 Billion	45% of \$ 63 Billion = % 28.35 billion	\$28.35 billion * 83.50 INR = ₹2,367,083,250,000.00 Indian rupees	(2,36,708 Crores) total imported amount 1,169,000.00 crores
Industry 20 to 25%					
Agriculture 10 to 15%					
Residential & commercial areas 10 to 15%					
Power generation 5 to 10%					
Petrochemical products 5 to 10%					

The distribution of crude oil consumption in India across different sectors can be broken down as follows:

### 1. Transportation Sector

The transportation sector is the largest consumer of crude oil in India. This includes:

- **Road Transport:** Diesel and petrol are the primary fuels, used extensively for vehicles.
- **Aviation:** Jet fuel (ATF) consumption for domestic and international flights.
- **Railways:** Although a significant portion is electrified, diesel locomotives still use a considerable amount of diesel.

### 2. Industrial Sector

This sector includes:

- **Manufacturing:** Use of oil in machinery and as a feedstock for chemicals and plastics.
- **Construction:** Heavy machinery and equipment use diesel.
- **Mining and Quarrying:** Diesel is used in equipment and transport vehicles.

### 3. Agriculture

- **Irrigation Pumps and Machinery:** Diesel is widely used for irrigation pumps and farm machinery.

### 4. Residential and Commercial Sectors

- **LPG (Liquefied Petroleum Gas):** Used for cooking and heating.
- **Kerosene:** Used for cooking and lighting in rural and semi-urban areas.

### 5. Power Generation

- **Electricity Generation:** Oil is used in thermal power plants, although its share is decreasing with the increase in renewable energy sources.

### 6. Petrochemicals

- **Feedstock for Petrochemical Industries:** Crude oil derivatives are used as raw materials in the production of chemicals, fertilizers, and synthetic materials.

### Approximate Distribution

While precise percentages can vary year by year, a general distribution based on typical data would be:

- **Transportation:** 40-50%
- **Industrial:** 20-25%
- **Agriculture:** 10-15%
- **Residential and Commercial:** 10-15%
- **Power Generation:** 5-10%
- **Petrochemicals:** 5-10%

### Additional Notes

1. **Policy Impacts:** Government policies promoting electric vehicles and renewable energy can shift these percentages over time.
2. **Economic Factors:** Economic growth or contraction can affect industrial and transportation fuel consumption.
3. **Technological Advances:** Improvements in fuel efficiency and alternative energy sources can reduce crude oil dependence.

For the most up-to-date and specific data, consulting resources like the Ministry of Petroleum and Natural Gas (MoPNG) in India or reports from the Petroleum Planning and Analysis Cell (PPAC) would be beneficial.

The transportation sector's consumption of crude oil in India can be further detailed by looking at the specific segments: two-wheelers, four-wheelers (including cars, buses, and trucks), airplanes, and shipping. Here's an approximate breakdown:

#### 1. Two-Wheelers

- **Two-wheelers (Motorcycles, Scooters):** These primarily use petrol.
- **Consumption Share:** Approximately 20-25% of the transportation sector's fuel consumption.

#### 2. Four-Wheelers

- **Cars, SUVs, and Light Commercial Vehicles (LCVs):** Predominantly use petrol and diesel.
- **Heavy Commercial Vehicles (Buses, Trucks):** Primarily use diesel.
- **Consumption Share:** Approximately 50-55% of the transportation sector's fuel consumption.
  - **Cars and LCVs:** Around 20-25%
  - **Heavy Commercial Vehicles:** Around 30-35%

### 3. Aeroplanes

- **Aviation (Domestic and International Flights):** Use Aviation Turbine Fuel (ATF).
- **Consumption Share:** Approximately 10-15% of the transportation sector's fuel consumption.

### 4. Shipping

- **Marine Transport (Domestic Shipping, Fishing Vessels, and International Shipping):** Use marine diesel oil and other marine fuels.
- **Consumption Share:** Approximately 5-10% of the transportation sector's fuel consumption.

#### Summary Table

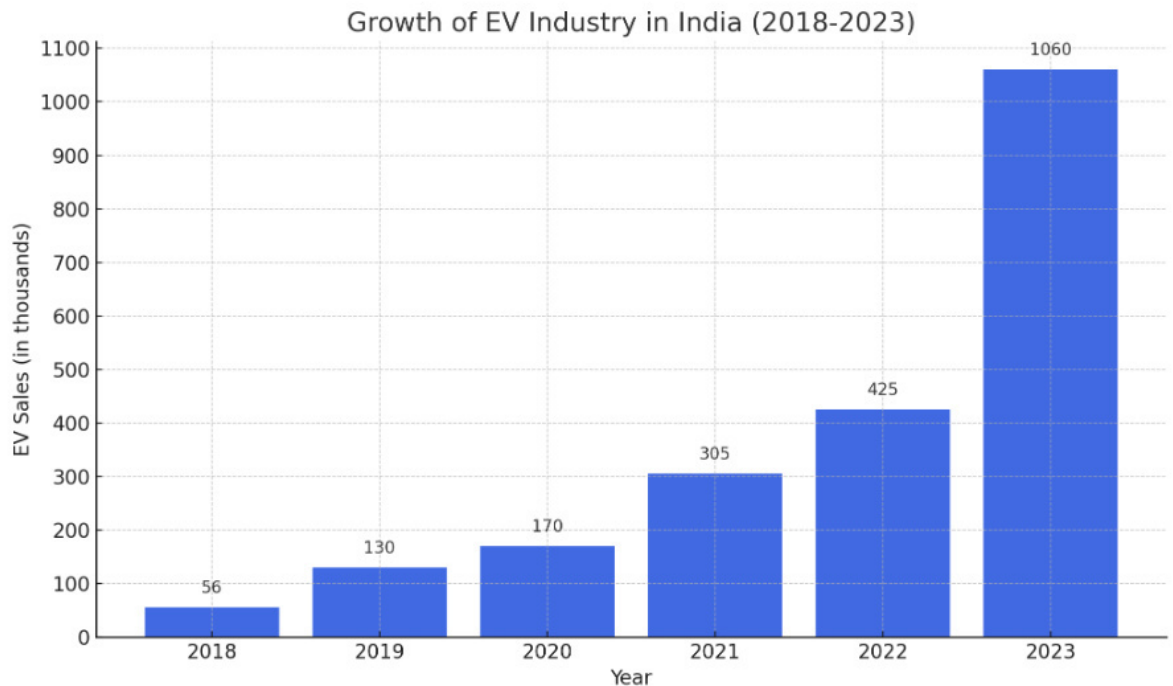
Sector	Fuel Type	Approximate Share (%)
Two-Wheelers	Petrol	20-25
Four-Wheelers	Petrol and Diesel	50-55
Cars and LCVs	Petrol and Diesel	20-25
HCVs	Diesel	30-35
Aeroplanes	Aviation Turbine Fuel	10-15
Shipping	Marine Fuels	5-10

#### Additional Notes

- **Two-Wheelers:** The high number of two-wheelers in India leads to significant petrol consumption.
- **Four-Wheelers:** Heavy commercial vehicles (trucks and buses) consume a major portion of diesel due to long-distance freight and passenger transport.
- **Aviation:** Rapid growth in air travel has been increasing ATF consumption.
- **Shipping:** While smaller in percentage, marine fuel consumption is vital for both domestic and international shipping activities.

These percentages provide a general idea and can vary slightly based on factors such as fuel prices, government policies, and advancements in vehicle technology. For precise and current data, consulting reports from the Ministry of Petroleum and Natural Gas (MoPNG) and the Petroleum Planning and Analysis Cell (PPAC) would be ideal.





The electric vehicle (EV) industry in India has been experiencing significant growth year on year, driven by various factors including government initiatives, increased consumer awareness, and advancements in technology. Here's a summary of the growth trajectory and key drivers:

### **Year-on-Year Growth**

#### **1. Early 2010s to 2018:**

- The EV market in India was relatively nascent, with growth primarily driven by e-rickshaws and two-wheelers.
- Annual growth rates were moderate, influenced by limited infrastructure and high costs of EVs.

#### **2. 2018 to 2020:**

- The launch of the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme and its subsequent iterations provided subsidies and incentives, spurring growth.
- The EV market saw a compound annual growth rate (CAGR) of around 20-25%.

**3. 2020 to 2022:**

- Despite the COVID-19 pandemic, the EV sector showed resilience. Companies like Tata Motors, Mahindra Electric, and new entrants like Ola Electric ramped up production.
- Annual growth rates exceeded 30%, with a significant rise in electric two-wheeler and three-wheeler sales.
- The government's push for cleaner mobility, including a target for 30% of all vehicles on the road to be electric by 2030, fueled investment and consumer interest.

**4. 2023:**

- The EV market in India continued its robust growth, with reports suggesting a nearly 150% increase in EV sales in the first half of 2023 compared to the same period in 2022.
- The total number of EVs sold in 2023 was projected to surpass 1 million units.

**Key Drivers of Growth****1. Government Policies and Incentives:**

- The FAME scheme, GST reductions, and state-level incentives.
- Infrastructure development support, including the establishment of charging stations.

**2. Increasing Consumer Awareness and Demand:**

- Rising awareness about environmental issues and the long-term cost benefits of EVs.
- Enhanced consumer preferences for electric two-wheelers due to lower operating costs.

**3. Technological Advancements:**

- Improvements in battery technology leading to better range and reduced costs.
- Increased investment in R&D by both established automotive companies and startups.

**4. Economic Factors:**

- Rising fuel prices making EVs a more economical option.

- Financial incentives and subsidies reducing the upfront cost disparity between EVs and traditional internal combustion engine (ICE) vehicles.

#### 5. Corporate and Fleet Adoption:

- Large corporations and e-commerce companies adopting EVs for last-mile delivery to reduce carbon footprints.

#### Future Projections

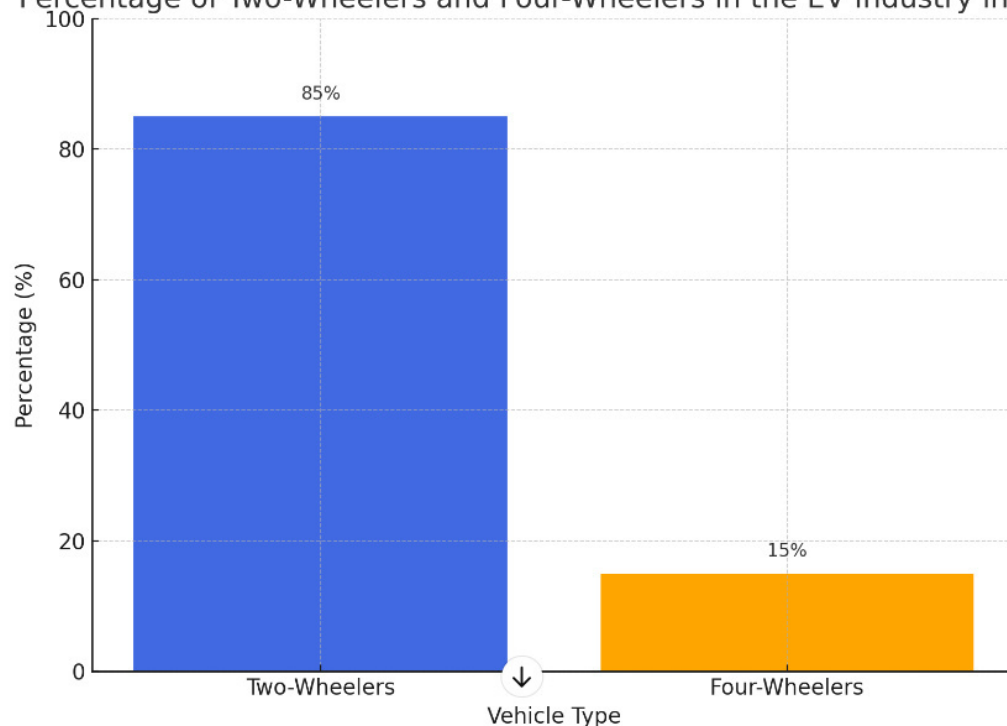
- The Indian EV market is expected to maintain high growth rates, with estimates suggesting that the market could grow at a CAGR of 40-50% over the next decade.
- By 2030, the EV market in India is anticipated to comprise a significant portion of total vehicle sales, with a focus on electric two-wheelers and commercial vehicles.

#### Challenges

- Despite the positive growth outlook, challenges such as inadequate charging infrastructure, high initial costs, and supply chain issues remain.

Continued policy support and investment in infrastructure are crucial to sustaining growth.

Percentage of Two-Wheelers and Four-Wheelers in the EV Industry in India



Here is the bar chart representing the percentage of two-wheelers and four-wheelers within the EV industry in India. As shown, two-wheelers make up the majority of the EV market with 85%, while four-wheelers account for 15%.

As of the most recent data available, the vast majority of two-wheelers in India are powered by petrol. Electric two-wheelers are still a small but growing segment of the market. Here are the approximate percentages:

1. **Petrol-powered two-wheelers:** Around 95-97% of the total two-wheelers in India run on petrol.
2. **Electric two-wheelers:** Approximately 3-5% of the total two-wheelers in India are electric.

As of the most recent data available, the majority of four-wheelers in India are powered by petrol, but there is a noticeable presence of diesel vehicles and a growing segment of electric vehicles (EVs). Here are the approximate percentages:

1. **Petrol-powered four-wheelers:** Around 60-65% of the total four-wheelers in India run on petrol.
2. **Diesel-powered four-wheelers:** Approximately 30-35% of the total four-wheelers run on diesel.
3. **Electric four-wheelers:** Approximately 1-2% of the total four-wheelers in India are electric.

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# QUESTIONNAIRE



## **Questionnaire Development**

### **On**

#### **A CRITICAL ANALYSIS OF CRUDE OIL AND ITS ALTERNATIVE ENERGY SOURCES: IMPACT ON INDIAN ECONOMY**

The main objective of this questionnaire is to get relevant information from different individuals throughout Mumbai region. The Questionnaire given below is a tool that has been chosen for gathering data for the research project titled “**A CRITICAL ANALYSIS OF CRUDE OIL AND ITS ALTERNATIVE ENERGY SOURCES: IMPACT ON INDIAN ECONOMY**”. The respondents are thus requested to respond attentively to all the questions. Please be assured that the information obtained from this questionnaire will be used for research purposes only and will be kept confidential.

1. **Gender**
  - Male
  - Female
  - Others
2. **Age**
  - 18 - 30 Years
  - 31 - 40 Years
  - 41 - 50 Years
  - More Than 51 Years
3. **Years of Working Experience**
  - Less Than 1 Year
  - 1 - 5 Years
  - 6 - 10 Years
  - 11 - 15 Years
4. **Income (Yearly)**
  - 0-1 Lakh
  - 2.5 Lakh - 5 Lakh
  - 5 Lakh - 7.5 Lakh
  - 7.5 Lakh - 10 Lakh
  - 10 Lakh-Others

5. **Department In Which The Respondent Works**

- Production
- Marketing
- Finance
- Human Resource Management
- IT (Information Technology)
- Administration
- Operations Management
- Customer service
- Others (Please Specify \_\_\_\_\_)

**Part B: Current Habits Regarding Crude Oil Consumption**

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. (SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

Statements	SD	D	N	A	SA
I frequently use crude oil-based fuel products to meet my personal and transportation needs.					
I actively participate in carpooling or ridesharing to decrease crude oil consumption while going to work or for personal reasons.					
I actively participate in carpooling or ridesharing to decrease crude oil consumption while going to work or for personal reasons.					
I am conscious of my crude oil consumption and try to minimise it as well as suggest my family members to do so.					
I prefer purchasing or riding on energy-efficient vehicles to reduce my reliance on crude oil.					

**Part C: Current Habits Regarding Renewable Energy Consumption**

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. (SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

Statements	SD	D	N	A	SA
I use renewable energy sources, such as solar or wind, to meet my electricity needs in-house and at work.					
I support government as well as organisation policies that encourage the adoption of renewable energy sources.					
I make an effort to reduce my carbon footprint and promote renewable energy use by actively sharing such practices among family members.					
I have implemented energy-saving practices in my home to promote energy conservation and renewable energy use.					
I am aware of and support the use of renewable energy in my area to reduce dependence on fossil fuels.					

**Part D: Perception Of The Impact Of Crude Oil Import On the Economy**

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. ( SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

Statements	SD	D	N	A	SA
I know that the import of crude oil has a negative impact on our country's economy.					



Statements	SD	D	N	A	SA
I understand that our economy is too reliant on crude oil imports.					
I understand that crude oil import dependence hampers economic growth.					
I understand that crude oil price fluctuations significantly affect our economic stability and can impact the economy.					
I believe our government should reduce our dependence on crude oil imports.					

**Part E: Perception of The Impact Of Renewable Energy Resource Consumption On the Economy**

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. ( D = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

Statements	SD	D	N	A	SA
I understand that the use of renewable energy resources positively impacts our economy.					
I understand that government support for renewable energy initiatives can boost the economy.					
I believe that the transition to renewable energy resources is crucial for long-term economic health.					
I believe that renewable energy consumption reduces our reliance on costly energy imports.					
I believe that the growth of the renewable energy sector is essential for economic sustainability.					

**Part F: Willingness To Shift To Renewable Energy**

On a scale of 1-5, please indicate the degree to which you agree to the statements given below based on your experience. ( SD = Strongly Disagree, D = Disagree, N = Neither Agree nor Disagree, A = Agree, SA = Strongly Agree)

Statements	SD	D	N	A	SA
I am willing to switch to renewable energy sources if they are accessible to me both in-house and at work.					
I would invest in renewable energy technologies for my home if available and affordable within my monthly income.					
I support government incentives to promote the adoption of renewable energy at home and at the workplace.					
I believe in the environmental and economic benefits of shifting to renewable energy and actively refer my friends and family members.					
I am ready to pay a bit more for energy (if suitable within my monthly budget) if it comes from renewable sources					

# PUBLICATIONS



# The Growth of Electric Vehicles in India and Its Challenges

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## Abstract

How use of EV's can reduce imports of crude oil. At the same time tried to see the different challenges we will have over come to achieve the target.

**Keyword:** Electric vehicles, crude oil, reduction of imports, reduced dependence on crude oil, Indian economy, environmental concerns, FAME

## Introduction:

About 45% of crude oil imported in India is used in Public & private transportation in India, if this requirement of crude oil is reduced, then the amount of crude oil needed to be imported in India can be drastically reduced. Crude oil import in India in 2022-23 rose by 9.4% & approx. 232 Million Tons & cost \$158 Billion. Just imagine if Indian government can achieve their below goals, the reduction on crude oil imports can reduce & this will help Indian economy in its Balance of Payments & also make Indian currency a much stronger currency in comparison to the US Dollar.

**Methodology:** By reviewing different articles & giving my views on the same In recent years, the Indian automotive industry has witnessed a significant surge in the adoption of electric vehicles (EVs). With a growing awareness of environmental concerns and a push for sustainable transportation, EVs have gained momentum as a viable alternative to conventional fossil fuel-powered vehicles. However, this transition is not without its challenges.

**Government Initiatives and Policies:** The Indian government has played a crucial role in promoting the growth of electric vehicles. Initiatives such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme have provided financial incentives to buyers and manufacturers of EVs. Additionally, the government has set ambitious targets, aiming for the electrification of a significant portion of the vehicle fleet by 2030.

**100% Electrification of Public Transport:** The government aims to achieve 100% electrification of public transportation, including buses, taxis, and rickshaws, by 2030. This goal involves transitioning existing fleets to electric vehicles and promoting the adoption of EVs for new public transport vehicles.

**40% Electrification of Personal Mobility:** The government aims to electrify 40% of personal mobility vehicles, including two-wheelers, three-wheelers, and cars, by 2030. This target involves incentivizing the

adoption of EVs, encouraging domestic manufacturing, and creating a favourable ecosystem for consumers to switch to electric personal vehicles.

**Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME):** The FAME scheme was launched in 2015 to encourage the adoption of EVs and hybrid vehicles. It provides financial incentives to buyers, manufacturers, and technology developers. Under FAME II, which started in 2019, the focus shifted towards supporting electric buses, two-wheelers, and three-wheelers, along with establishing charging infrastructure.

**EV Subsidies and Incentives:** The government provides various subsidies and incentives to make EVs more affordable. These include reduced GST (Goods and Services Tax) rates, income tax benefits, and exemptions on registration fees and road tax. Additionally, state-level incentives, such as direct cash subsidies and reduced electricity tariffs for charging, are also provided.

**Charging Infrastructure Development:** The government has recognized the need for a robust charging infrastructure to support the growth of EVs. It aims to establish charging stations across the country, including highways and major cities. The National Electric Mobility Mission Plan (NEMMP) envisions the creation of an extensive charging network through public-private partnerships.

**Make in India Campaign:** The Make in India campaign, launched in 2014, focuses on attracting investments and promoting manufacturing within the country. This initiative has led to the establishment of EV manufacturing plants by both domestic and international automakers, thereby boosting the local production of EVs and components.

**National Electric Mobility Mission Plan (NEMMP):** The NEMMP, launched in 2013, aims to achieve national fuel security by promoting electric and hybrid vehicles. It sets ambitious targets for the electrification of vehicles, including public transportation, two-wheelers, three-wheelers, and government fleet vehicles. The plan also emphasizes research and development in battery technology and encourages collaboration with industry stakeholders.

**Infrastructure Development:** One of the primary challenges faced by the EV industry in India is the lack of adequate charging infrastructure. Establishing an extensive and reliable charging network is crucial for widespread EV adoption. Although efforts are being made to set up public charging stations, the pace of development has been relatively slow. Overcoming this challenge requires significant investment in charging infrastructure and collaboration between the government and private stakeholders.

**Charging Infrastructure:** Establishing a robust and widespread charging infrastructure network is essential for the adoption of EVs. This includes the deployment of various types of charging stations, such as:

1. **Public Charging Stations:** These stations should be strategically located in urban areas, highways, commercial hubs, and residential complexes to ensure convenient access for EV users. Fast-charging stations capable of delivering a quick charge should be prioritized.



2. **Workplace Charging:** Encouraging employers to install EV charging stations in office complexes and parking facilities will facilitate charging during working hours and promote EV adoption among employees.
3. **Residential Charging:** Providing EV owners with the option to install charging points at their residences, such as home-based charging stations or shared community charging facilities, is crucial for convenient and overnight charging.

**Grid Upgradation:** The existing electrical grid infrastructure may require upgrades to support the increased electricity demand resulting from the widespread adoption of EVs. Reinforcing the grid capacity, improving distribution networks, and integrating smart grid technologies can ensure stable and efficient power supply for charging infrastructure.

**Battery Swapping Stations:** Battery swapping stations offer an alternative charging method where depleted batteries are replaced with fully charged ones. Implementing a network of battery swapping stations can address concerns related to long charging times and range anxiety, particularly for commercial vehicles.

**Service and Maintenance Facilities:** Establishing a network of service and maintenance facilities specifically equipped to handle EVs is essential. These facilities should have skilled technicians, specialized tools, and diagnostic equipment to cater to the unique requirements of EVs, including battery maintenance and replacement.

**Research and Development Centers:** Promoting the establishment of research and development centers focused on battery technology, charging infrastructure, and EV components will drive innovation and indigenous development. These centers can facilitate advancements in battery performance, energy storage, and charging technologies specific to the Indian context.

**Policy and Regulatory Framework:** A supportive policy and regulatory framework that encourages investment in charging infrastructure is necessary. This includes streamlining permitting processes, providing incentives for private investment, defining technical standards for charging infrastructure, and ensuring interoperability among different charging networks.

**Awareness and Education:** Creating awareness among the general public, potential EV buyers, and key stakeholders about the benefits of EVs and the availability of charging infrastructure is crucial. Educational campaigns, outreach programs, and public-private partnerships can help address misconceptions and promote wider acceptance of EVs.

**Affordability and Range Anxiety:** Affordability remains a significant barrier to EV adoption in India. Electric vehicles are relatively more expensive than their fossil fuel counterparts, primarily due to the high cost of batteries. The availability of affordable EV models with longer ranges is crucial for increasing their appeal to a broader consumer base. Additionally, range anxiety, the fear of running out of charge, continues to be a concern for potential EV buyers. Advancements in battery technology and increasing awareness about the actual driving range of EVs can help address these challenges.

**Battery Manufacturing and Recycling:** The production and disposal of EV batteries pose environmental challenges. Battery manufacturing requires significant resources, including rare earth metals and minerals, which can have adverse ecological impacts. Additionally, proper recycling and disposal of used batteries are essential to minimize their environmental footprint. Developing a robust battery manufacturing and recycling ecosystem is crucial for sustainable growth of the EV industry.

**Production Linked Incentive (PLI) Scheme:** The government introduced the PLI scheme to encourage the domestic manufacturing of advanced battery cells. Under this scheme, financial incentives are provided to eligible companies based on their incremental sales of advanced chemistry cells (ACCs). The scheme aims to attract global battery manufacturers and facilitate the establishment of large-scale battery manufacturing plants in India.

**National Mission on Transformative Mobility and Battery Storage:** The government launched the National Mission on Transformative Mobility and Battery Storage in 2019. This mission aims to drive the adoption of electric mobility and establish robust manufacturing capabilities for EVs and their components, including batteries. It includes initiatives to support battery manufacturing, research and development, and skilling in the sector.

**Battery Storage R&D Initiative:** To boost research and development (R&D) in battery technology, the government has launched the Battery Storage R&D Initiative. This initiative focuses on collaborative R&D projects between industry and academia to develop advanced battery technologies with higher energy density, longer life, and improved safety. It aims to strengthen India's capabilities in battery R&D and innovation.

**Phased Manufacturing Program (PMP):** Under the PMP, the government has introduced incentives to promote the local manufacturing of lithium-ion cells and batteries. This program encourages value addition at different stages of the battery manufacturing process, starting from cell components to complete battery packs. By providing incentives for domestic manufacturing, the government aims to reduce import dependence and enhance the competitiveness of Indian battery manufacturers.

**Setting up Battery Manufacturing Hubs:** The government is actively promoting the establishment of battery manufacturing hubs in the country. These hubs will serve as clusters for battery production, bringing together various stakeholders such as battery manufacturers, component suppliers, research institutions, and supportive infrastructure. These hubs aim to create an ecosystem that fosters collaboration, innovation, and cost-effective battery manufacturing.

**International Collaborations:** The Indian government has been engaging in strategic partnerships and collaborations with other countries to promote battery manufacturing. It has signed agreements with countries like Japan, South Korea, and the United States to facilitate knowledge sharing, technology transfer, and investments in the battery sector.



**Skill Development and Consumer Awareness:** The successful transition to electric mobility requires skilled technicians and engineers who can maintain, repair, and service EVs. Providing adequate training programs to enhance the skill sets of automotive professionals is crucial. Furthermore, raising consumer awareness about the benefits and features of EVs, along with addressing misconceptions, will play a vital role in driving adoption.

The growth of electric vehicles in India holds immense potential for reducing greenhouse gas emissions, improving air quality, reduction of crude oil consumption & imports and enhancing energy security. The government, industry stakeholders, and consumers need to collectively address the challenges of infrastructure development, affordability, range anxiety, battery manufacturing, and consumer awareness. With continued efforts, collaboration, and advancements in technology, India can accelerate the transition towards a sustainable and electric future of transportation.

**Conclusion:** Developing EV infrastructure will help Indian economy to reduce crude oil Imports.

**Acknowledgement:** Google

**References:** Google



# India – Russia Crude Oil Business during Ukraine War

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## Abstract

Did the Indian people benefit or did the government of India & couple of companies benefit from the cheap crude oil deal with Russia, during the war between Ukraine & Russia & in between US sanctions of the Russian crude oil industry.

Introduction: The Ukraine war, which began in 2014, caused significant geopolitical and economic implications around the world. During this period, India strategically turned to Russia as a major supplier of crude oil. This decision proved beneficial for India's energy security and helped mitigate potential disruptions caused by the conflict. This note explores the advantages of India's decision to buy crude oil from Russia during the Ukraine war.

**Keyword:** Crude Oil, Russia, Ukraine, War, India

**Methodology** – By reviewing different articles & giving my views on the same.

During the Ukraine war, the United States imposed sanctions on various sectors of the Russian economy, including its crude oil supply, for several reasons:

- 1) Annexation of Crimea: The sanctions were primarily a response to Russia's annexation of Crimea in 2014. The United States and other Western countries considered this action a violation of international law and a threat to Ukraine's sovereignty. Imposing sanctions on the Russian crude oil sector was one way to exert economic pressure and express disapproval of Russia's actions.
- 2) Support for Separatists: The United States accused Russia of supporting separatist movements in eastern Ukraine, providing them with military equipment and other forms of assistance. By targeting the Russian crude oil sector, the U.S. aimed to restrict Russia's access to international markets and limit its financial resources, making it more difficult for Russia to support the separatist activities.
- 3) Destabilization of Ukraine: The U.S. viewed Russia's involvement in the Ukraine conflict as contributing to the destabilization of the region. By imposing sanctions on the Russian crude oil sector, the U.S. sought to discourage Russia from further aggression and support for armed groups in Ukraine, thereby promoting stability in the region.
- 4) Pressure for Negotiations: The imposition of sanctions was also intended to put pressure on Russia to engage in diplomatic negotiations and find a peaceful resolution to the conflict. The U.S. hoped that by targeting the Russian crude oil sector, which is crucial to its economy, it would incentivize Russia to change its behaviour and work towards a diplomatic solution.

Looking at the situation, India felt it was a great opportunity to get crude oil at a cheaper rate than what was available at the international markets & also India did not have to buy US Dollars from the international markets, which is already devalued drastically in the last few years. India's BoP requires a comprehensive analysis of various economic indicators, trade flows, exchange rates, and other factors. Additionally, the actual use of Ruble as a currency of exchange for crude oil transactions between India and Russia during the Ukraine war helped in its BOP.

Looking at the advantages India went ahead & made the deal with Russia to buy crude oil, some of the other advantages are listed below.

- 1) **Diversification of Energy Sources:** By procuring crude oil from Russia, India diversified its energy sources, reducing its dependence on traditional suppliers in the Middle East. This diversification helped minimize the risk of supply disruptions due to geopolitical tensions in the region. As a result, India's energy security was strengthened, ensuring the smooth functioning of its economy.
- 2) **Stable Supply and Price Stability:** During times of geopolitical instability, securing a stable supply of crude oil at reasonable prices becomes crucial. India's reliance on Russian oil during the Ukraine war provided a steady flow of crude, ensuring continuity in its energy requirements. Moreover, Russia's oil exports to India were not significantly affected by the events in Ukraine, allowing for price stability and shielding India from potential price shocks.
- 3) **Geopolitical Considerations:** Given the Ukraine conflict's implications on global politics, India's decision to buy crude oil from Russia was also driven by geopolitical considerations. India, which maintains friendly relations with both Russia and Ukraine, chose to avoid taking sides in the conflict and maintained neutrality. This approach helped India maintain its diplomatic equilibrium and avoid entanglement in the geopolitical tensions surrounding the war.
- 4) **Strengthened Bilateral Relations:** The increased cooperation in the energy sector between India and Russia during the Ukraine war further strengthened the bilateral relations between the two countries. The trade of crude oil fostered closer economic ties and created opportunities for mutually beneficial partnerships in various sectors beyond energy. The deepening of these ties laid a foundation for broader strategic collaborations between India and Russia.

Selling crude oil to India and receiving Indian Rupees (INR) in return had certain advantages for Russia, although the specific advantages may vary depending on the circumstances and the exchange rate dynamics between the Ruble (RUB) and the INR. Here are some potential advantages for Russia:

- 1) **Diversification of Currency Reserves:** Accepting INR as payment diversifies Russia's currency reserves. Holding a variety of currencies can help mitigate risks associated with fluctuations in the value of a single currency, such as the Ruble. It provides Russia with exposure to a different currency and potentially reduces its dependence on a particular currency, such as the US dollar.
- 2) **Access to Indian Market:** Selling crude oil to India and receiving payment in INR provides Russia with continued access to one of the world's largest and fastest-growing energy markets. India's energy demand is significant, and maintaining a strong presence in this market can be beneficial for Russia's oil exports and revenue generation.
- 3) **Trade and Economic Relations:** Strengthening trade and economic relations with India can lead to broader benefits for Russia. Increased cooperation can foster stronger bilateral ties, potential



investment opportunities, and the development of strategic partnerships in various sectors beyond energy. This can contribute to economic growth and diversification for Russia.

- 4) Hedging Against Exchange Rate Risk: If the Ruble is depreciating against other major currencies, accepting INR payments can potentially act as a hedge against exchange rate risk. If the INR appreciates against the Ruble, Russia could benefit from holding INR-denominated assets, as it would retain value in a stronger currency.

However, it's important to note that the advantages for Russia may also depend on factors such as the stability of the INR, the depth and liquidity of the INR market, the availability of goods and services that Russia imports from India, and the ability to convert INR into other currencies or utilize them effectively in the domestic market.

India's Import of Russian Crude Oil jumped tenfold (BBC) in late 2022, in March 2022, crude oil imported by India, Russian crude oil contributed only 0.2 percent, 1.19 billion Barrels per day, & by October 2022 it became 25 percent, 93.5 billion Barrels per day, (9,35,556 BPD) (ET Energy world) Russia was selling crude Oil to India at a discount of 20\$ to 22\$ per barrel. Russia also became the largest supplier for India. Although the import was done by two private companies Reliance & Nayara Energy, Reliance is an Indian company & Nayara Energy is a Joint Venture, with a Russian Company, Rosneft & Trafigura Group-United Capital Partners, which is a Singapore based company. So, both the partners are foreign companies. Investing funds together & investing in Russian projects. So indirectly Russia gave subsidy to their own Russian company.

Now Reliance & Nayara both were making profits by exporting the finished petroleum products to other countries, so the common people did not get the benefit of the cheap crude oil prices. But the government of India levied Windfall Gain Tax on both the companies & made good income in taxes & the Reliance & Nayara made profits, although the profits were declining, as the taxes went up drastically.

India government diplomatically was safe as the government companies did not buy the Cheap Russian Crude oil & did not have face the heat from OPEC & the US government at the same time benefited by levying the windfall gain tax. Although the common Indian did not benefit out of the whole transaction.

While it is challenging to identify specific individuals or entities that are directly profiting from the deal without more specific information, normal beneficiary if Indian companies would have got the same deal.

- 1) Indian Oil Companies: Indian oil companies, both public and private, that import crude oil from Russia can benefit from the deal. These companies include major players such as Indian Oil Corporation (IOC), Bharat Petroleum Corporation Limited (BPCL), Hindustan Petroleum Corporation Limited (HPCL), and private entities involved in oil trading. The deal provides a reliable source of crude oil for these companies, ensuring a stable supply to meet India's energy demand. But since they were not the importers the effect was not seen.
- 2) Refining Sector: The Indian refining sector, which processes the imported crude oil into various petroleum products, can benefit from the crude oil deal. Refineries in India, both state-owned and private, rely on a consistent supply of crude oil to operate efficiently. The availability of Russian crude oil can contribute to the profitability and smooth functioning of the refining sector. Only for the two companies that is Reliance & Nayara.
- 3) Indian Consumers: The deal can indirectly benefit Indian consumers by helping ensure a stable supply of crude oil, which is crucial for the production of various petroleum products, including fuels such as petrol and diesel. A steady supply of oil can help mitigate price volatility and potential disruptions in the domestic energy market, thereby benefiting Indian consumers. But since the benefit first went to

the government by way of windfall gain tax, but the products produced were exported, so the direct beneficiary were not Indian citizens.

- 4) Indian Economy: A stable and reliable supply of crude oil from Russia can have positive implications for the Indian economy as a whole. It supports various sectors, including transportation, manufacturing, and agriculture, which heavily rely on petroleum products. A consistent supply of crude oil helps sustain economic activities and contributes to overall economic growth. Since the raw material nor the final product were used for Indian consumption, the above benefit was not seen in our Indian economy either.

**Conclusion:**

India's decision to buy crude oil from Russia during the Ukraine war proved advantageous in several ways. It allowed India to diversify its energy sources, ensuring a stable supply and price stability during a period of geopolitical turmoil. Moreover, by maintaining neutrality in the conflict and strengthening bilateral relations with Russia, India navigated the complex geopolitical landscape and safeguarded its own interests. This strategic move showcased the importance of proactive energy diplomacy and highlighted India's commitment to securing its energy requirements in challenging times and maintaining global relations with OPEC, US & Russia.

**Acknowledgement** – Google, ET Energy world, BBC, Study IQ

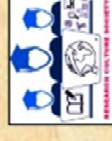
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# A CRITICAL ANALYSIS OF CRUDE OIL AND ITS ALTERNATIVE ENERGY SOURCES: IMPACT ON INDIAN ECONOMY

*by* Ponmany Joseph David

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