



Review Of Methanol Economy Initiative And Its Future Impact On India's Economy

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Abstract

The Methanol Economy Initiative has come up as a viable solution to the energy problems facing India and the need to move away from fossil based energy sources. Methanol, a clean and sustainable fuel, can be produced from coal, natural gas, biomass, and even CO₂. The move seeks to transform India's energy sector to methanol as a viable option in a bid to enhance energy security, cut on carbon emissions and spur economic growth. The transition to methanol-based energy systems will not only help India diversify its energy mix but will also reduce the country's oil imports and save billions of foreign exchange. The project also supports the country's environmental objectives since the combustion of methanol produces less pollutants than the traditional fossil fuels. Also, the methanol economy can help to develop domestic industries such as manufacturing, chemical production, and transportation industries which will create employment opportunities and economic development. However, the following issues have to be solved to fully unlock its potential: the creation of the required infrastructure, the supply of methanol, and safety issues. This paper seeks to discuss the future economic effects of the Methanol Economy Initiative in India with emphasis on energy security, environmental conservation and industrialization. The effectiveness of this campaign can put India at the forefront of the transition to clean energy, which will spur economic change and decrease its emission of greenhouse gases.

Introduction

The Methanol Economy Initiative represents a pivotal shift in India's approach to energy sustainability, economic growth, and environmental conservation. As India faces growing energy demands, coupled with increasing reliance on imported fossil fuels, the need for alternative, cleaner energy solutions has become more pressing. Methanol, a versatile and renewable fuel, offers a promising pathway to address these challenges. It can be produced from a wide array of feedstocks, including natural gas, coal, biomass, and even carbon dioxide, positioning it as a flexible and sustainable energy source. The Indian government, recognizing the potential of methanol, has been promoting its use across various sectors, including transportation, power generation, and industry. Methanol's ability to reduce emissions of harmful pollutants like carbon dioxide, nitrogen oxides, and sulfur oxides aligns with India's commitments to environmental protection and climate change mitigation. Additionally, the adoption of a methanol-based energy system could significantly decrease India's dependence on oil imports, resulting in substantial foreign exchange savings and enhanced energy security. The initiative also holds promise for boosting industrial growth, particularly in the chemical and manufacturing sectors, where methanol serves as a key feedstock. However, the success of this initiative hinges on several critical factors, including the development of robust infrastructure for methanol production, storage, and distribution, as well as ensuring economic viability and addressing safety concerns. This introduction sets the stage for an in-depth exploration of how the Methanol Economy Initiative could transform India's energy landscape, stimulate industrial development, create employment opportunities, and foster long-term economic resilience. As India moves toward cleaner energy solutions, the methanol economy stands as a critical component of the country's broader strategy to meet future energy demands while ensuring environmental sustainability and economic growth.

Need of the Study

This study is necessitated by the increasing energy requirement in India and the country's dependence on imported fossil energy sources. This has been informed by the country's bid to cut down on emissions and meet international climate change agreements thus making the search for other forms of energy crucial. The Methanol Economy Initiative presents a possible solution by presenting a cleaner, sustainable and more cost-effective solution to the conventional fossil fuels. This paper is crucial to assess the possibility and the likely effects of shifting to a methanol-based economy in India. It will look at how methanol can be used to support energy security, lower emissions, and drive economic development in the transportation, electricity, and manufacturing sectors. Additionally, the study looks into the issues that surround the use of methanol including the development of infrastructure, safety issues, and the feasibility of large scale implementation of methanol. Thus, based on the evaluation of the long-term advantages and disadvantages, this research will contribute to the understanding of how the methanol economy can contribute to India's transition to a sustainable energy system. The results will assist policymakers, industry representatives, and

academics in identifying approaches to unlock methanol's capability for decreasing energy reliance and promoting economic stability.

OIL & GAS INDUSTRY IN INDIA

The oil and gas industry is critical to India's economic growth because it accounts for a significant portion of the country's GDP. According to the World Energy Council, India is a significant player in the global energy industry. It is the third-largest oil consumer and fourth-largest LNG importer. Even though the Middle East is India's primary source of goods for economic growth, the country must import to meet its demands because domestic manufacturing cannot keep up with demand. The role of oil and gas in power industries, transportation, and housing has increased in line with the country's urbanisation, industrialisation, and population growth. The Indian oil and gas sector is divided into three parts: upstream, middle, and downstream. The upstream sector consists of exploration and production, which is mainly dominated by state owned players like ONGC and OIL but private players like Reliance Industries and Cairn India also exist in this sector. The midstream segment involves transportation and storage of oil and gas through pipeline networks and downstream segment involves refining, processing and marketing of petroleum products through IOC, BPCL and HPCL. India has been trying to diversify the source of its oil supply by encouraging exploration of the new fields on land as well as sea and at the same time turn towards natural gas as a better option as a fuel. Some of the government's policies include the Discovered Small Fields (DSF) bid round, the Hydrocarbon Exploration and Licensing Policy (HELP), and the Strategic Petroleum Reserve (SPR) program that seeks to increase production and guarantee energy security. Besides, India is developing new LNG regasification plants and terminals, increasing the pipeline length of natural gas, and encouraging the use of CNG in automobiles to meet its energy needs diversely. Oil and gas is still a crucial part of the Indian energy mix, however the country is slowly moving towards a cleaner future and a more diverse energy mix with renewable energy and Natural Gas being the future of the energy mix.

METHANOL ECONOMY IN INDIA

The Methanol Economy in India is a great chance to change the state of the energy sector in the country, decrease the import of the fossil fuels, decrease the CO₂ emissions, and develop a sustainable industrial growth. Methanol can be generated from a number of feedstocks including coal, biomass and carbon dioxide; thus, providing flexibility to India towards achieving energy security. The Indian government has appreciated the use of methanol and has shown efforts to incorporate it in different segments of the Indian economy such as transport, electricity, and manufacturing. Methanol can be used as a blend with petrol and diesel especially in the transportation sector where reduction of emissions is a major concern. It can also be mixed with gasoline to decrease the emission of greenhouse gases and make the air in cities cleaner. Apart from transportation, methanol can be used in industrial boilers, cook stoves and as feedstock for chemicals hence expanding its uses. India's dependence on imported crude oil has a great effect on its forex reserves and energy supply. The Indian government planned to replace oil with methanol as the latter cannot only

help in cutting down oil import bill but also the abundant coal and renewable resources like biomass present in the country can be used for methanol production. This change is in line with India's vision to become Atmanirbhar in energy and to promote circular economy system. However, it is important to note that methanol is used in carbon capture and utilization which can be considered as another environmental benefit of methanol since it helps to fight climate change. However, there are some issues that are associated with the shift to methanol economy, for example the availability of methanol, the storage and distribution of methanol and the issue of safety and viability of methanol economy. Nevertheless, the methanol economy can be a source of employment, a driver for industrialization, and a way to build a cleaner energy future for India. Thus, the transition to the methanol economy can make India one of the leaders in the green energy revolution, improving its energy security and further economic growth.

Literature Review

Vhankade, Prakash (2023) India's economy has grown tremendously since the country attained its independence 75 years ago with a GDP of \$ 2. Crores seven, mostly dependent on agricultural income to being the fifth largest economy of the world with GDP of \$3 trillion. 47 trillion. Major changes for example the economic liberalization policy in 1991 expanded the India market globally enabling industrial development and technology. The new generation IT and services sectors, coupled with the policies such as 'Make in India' and 'Digital India' have fuelled the economic change in India even further. Nevertheless, the future of India's economy does not appear bleak even in the light of the recent COVID-19 pandemic, and the country is set to achieve the \$5 trillion economy that would be a great leap forward in terms of development.

Kwilinski, Aleksy & Oleksii (2023) The countries that make up the European Union (EU) have set themselves the lofty objective of achieving carbon neutrality through the provision of equitable economic growth. In order to do this, it is necessary to construct pertinent incentives and initiatives. In addition, the implementation of such programs and incentives ought to ensure that the goals that have been proclaimed are accomplished. The energy sectors are the primary factors that determine the inclusive growth of the economy. Conventional energy sources, which are primarily coal-based, have a more detrimental effect on the environment and the well-being of people than they do on the economic and social benefits they provide. When it comes to attaining the aims of inclusive economic growth, however, the transition to renewable energy poses new challenges. These challenges include the provision of energy that is both affordable and clean, responsible energy usage, and energy infrastructure. After conducting a study of the theoretical framework, it was discovered that the digitalisation of government could turn out to be an essential tool for addressing the problems that were described before. The purpose of this study is to provide empirical evidence to support the role that green energy plays in attaining inclusive economic growth. The research makes use of the following methodologies: canonical cointegrating regression and fully modified Ordinary Least Square (OLS). Based on the data, it is possible to draw the conclusion that the quality of institutions has a passive influence on inclusive economic growth, and that the digitalisation of government has an impact that is shaped like a U on inclusive economic growth. In this scenario, nations

ought to prioritise the digital transformation of public services and consistently work to improve the quality of their institutions.

Kumar, T & Arunkumar, S & Ajith (2022) The growing wealth of India has resulted in an increase in the number of vehicles available in the country, which has contributed to an increased need for fuel. The transportation sector is in the midst of a number of challenges, including a decreasing supply of fossil fuels, fluctuating prices for crude oil, and increasingly stringent environmental regulations. It is possible that these issues can be resolved by switching to different fuels. Because of the lower level of complexity involved in the production, storage, transportation, and application of biofuels in internal combustion engines in comparison to alternative possibilities, biofuels are currently being investigated in a significant manner. The higher energy density of ethanol, combined with its lesser impact on the environment, makes it a potentially useful alternative fuel. In the past, as part of a strategy to reduce total oil imports, the government of India mandated that petrol contain a mixture of ethanol equal to ten percent. The purpose of this study is to investigate the possibility of using ethanol as an alternative fuel for petrol engines in the Indian environment.

Deka, Tanmay J & Osman (2022) Because of climate change and the fact that fossil fuels cannot be sustained, there is a growing demand for greener energy sources, such as methanol as a fuel. In addition to being one of the most straightforward molecules for the storage of energy, methanol is also utilised in the production of a wide variety of items. Given that methanol may be created from biomass, a great number of nations have the potential to produce and make use of biomethanol sources. The procedures of producing methanol, the technological economy, and the environmental feasibility are discussed in this article. When it comes to the manufacture of biomethanol through gasification, lignocellulosic biomass that contains a high percentage of cellulose and hemicellulose is an excellent candidate. When compared to the combustion of fossil fuels, the combustion of biomethanol lowers emissions of nitrogen oxide by as much as 80 percent, reduces emissions of carbon dioxide by as much as 95 percent, and completely eliminates emissions of sulphur oxide. The qualities of the feedstock, the initial investment, and the location of the plant are the primary factors that determine the cost and output of biomethanol. It is advantageous to utilise biomethanol as a supplemental fuel with diesel, natural gas, and dimethyl ether since it brings about improvements in terms of fuel economy, thermal efficiency, and the decrease of emissions of greenhouse gases.

Xinbao, Zhang & Zhang, Guanghui & Song (2021) Using hydrogen made from renewable energy to turn carbon dioxide (CO₂) into methanol is a good idea because carbon dioxide (CO₂) emissions are hurting the environment and people need more carbon resources to keep growing. A thorough analysis of the situation shows that thermal catalytic CO₂ hydrogenation for making methanol is the most likely method for large-scale industrialisation. The main topics of this review are the biggest problems in making methanol from carbon dioxide (CO₂), as well as the newest developments and what the future holds for this field. The review is based on a thorough technical and economic analysis. As a platform molecule in the energy system, methanol is also looked at in terms of how it is used now and how it might be used in

the future. Finally, this evaluation's goal is to shed light on what should be done next by focussing on the creation of new catalysts, pathways, and tools for changing carbon dioxide into something else.

Nema, Pooja & Dubey (2021) Within the scope of this study, the performance of a reverse flow slinger combustor that was built relatively recently using methanol is investigated. An efficient method of burning methanol in gas turbine engines is the objective of the study that has been carried out with the intention of developing these engines. Because it burns cleanly, is renewable, and is environmentally friendly, methanol is being considered as a potential replacement for fossil fuels in the generation of electricity in the future. Nevertheless, the burning of this fuel in gas turbine engines presents a number of technical obstacles due to the fact that it possesses features that are somewhat distinct from those of traditional hydrocarbon fuels. These properties include a low calorific value and a low viscosity. The innovative combustor that was used in this research has the potential to offer a workable solution for the combustion of methanol in stationary gas turbines. The shape of the combustor makes it easier to preheat the combustion air from the exhaust products on the inside, which improves the flame stability and ignition characteristics, especially when the conditions are lean. An investigation of the performance of the combustor was carried out using methanol, and stable combustion was accomplished at a relatively low fuel–air ratio of 0.022. More than five parts per million (ppm) of nitrogen oxides and one thousand five hundred parts per million (ppm) of carbon monoxide were found to be emitted.

Kumar, Naveen & Tomar (2020) The environment and developing nations' coffers are hit hard by the transportation of crude petroleum caused by the uneven distribution of oil deposits around the globe. Concerns for developing nations include fluctuations in the price of crude oil, sanctions on Iran, and the impact of petroleum-based fuels on climate change. The global energy scenario can be significantly improved by implementing a methanol economy. It is a monocarbon molecule that can be made from many different types of biomass and fossil fuels. In order to produce methanol, scientists are exploring alternative resources to coal and natural gas, which are not renewable. Methanol can be made from the syngas that is released during the gasification of biomass. In addition, an electrochemical process that captures carbon dioxide from power plants and businesses into water and converts it into methanol is another intriguing way to make methanol. Renewable energy sources like wind, solar, hydro, geothermal, etc., can provide the power needed for the process. This approach addresses both the issue of fossil fuel consumption and the problem of industrial carbon emissions. Having a high octane number and flame speed, methanol is ideal for use in petrol engines due to its features. There is a general decrease in engine exhaust emissions since it burns better. In rural places where wood is still a primary fuel source, methanol can also be used as a cooking fuel. One way to power fuel cells is by using methanol, which can be transformed into hydrogen and carbon dioxide on the spot. There is a potential solution for developing nations' fuel needs in the transportation sector, in household cooking, and as a raw material for the synthesis of diverse chemicals: a methanol economy.

Valera, Hardikk & Singh (2020) The transportation sectors of most industrialised nations run on locally sourced fuels, but emerging nations face significant challenges when it comes to producing their own fuels and must rely on imports. Indian efforts to diversify its transport fuel sources, including a range of biofuels, are centred on lowering the country's reliance on foreign suppliers. The coal that is accessible in India has a high ash level and cannot be used to generate electricity. However, it can be converted into methanol through the gasification process, which could power the transportation industry in India. Even though India produces methanol, the country's present output capacity is insufficient to meet the transportation industry's massive demand. Technology is being developed to produce methanol from low-value agricultural residues, municipal solid waste (MSW), and high-ash coal, and the methanol economy initiative is gathering speed thanks to the active engagement of the Government of India (GoI). A spark ignition (SI) engine is a promising application for methanol. The use of methanol in tiny two-wheelers that are supported by carburettors is the focus of this research. Among the vehicles registered in India's road transport sector, more than 70% are two-wheelers. These SI engines, which have tiny capacities (100-150 cc), rely on carburettors to inject fuel. Since most motorcycle engines are already built to run on petrol, a few tweaks will be needed to make them suitable for methanol. In spite of numerous obstacles, India is currently working on a plan to modify its existing SI engines to run on M15, a mixture of 15% v/v methanol and 85% v/v petrol. This paper provides a concise overview of the problems with adapting M15 for use in carburetor-assisted two-wheelers and some potential solutions.

Agarwal, Avinash & Gautam (2019) Eighty percent of the world's energy comes from fossil fuels, with the transportation sector accounting for nearly all of that consumption (95%). The first issue is that oil resources are depleting swiftly. The second issue is that the over use of oil-based fuels pollutes the environment. To develop better fuels, we should investigate biofuels, compressed natural gas (CNG), methanol, and synthetic fuels. These alternative fuels can be utilised in all modes of transportation, including automobiles and aeroplanes. It is now obvious that methanol could be used as an alternate fuel in compression ignition (CI) and spark ignition engines. This book discusses a number of elements of these different fuels. This book discusses a variety of intriguing topics, including the use of methanol in large-bore engines, the qualities of particle pollution from alternative fuel engines, and the use of laser ignition in engines that run on alternative petrol fuels.

Agarwal, Tushar & Singh, Akhilendra & Agarwal, Avinash (2019) Alternative combustion procedures and fuels are needed to stay up with the ever-changing trends in environmental emission standards. One useful idea for India's travel system is to use methanol as a fuel for cars. Methanol, which may be produced from waste carbon sources like high-ash coal, MSW, and low-value agricultural biomass, is one potential substitute for foreign petroleum-based fuels. More octane number, hydrocarbons, and NO_x are released when methanol is burned. In comparison to engines that run on petrol, those that run on methanol make a lot less noise and shaking. Also, the well-to-wheel economy is higher when methanol is used instead of petrol because its better fuel properties make engines more efficient. This paper talks about how hard it is to make an M85 engine retrofitting kit for current electronic fuel injection (EFI) two-wheelers that doesn't

require many structural changes. When an engine has an injection system, the ECU plan mostly controls how the fuel burns. In order to calculate the amount of fuel injected into the cylinder and the time of sparks, this map considers a number of variables, including engine speed, throttle position, intake air temperature, acceleration, altitude, engine temperature, and manifold air pressure. The main topic of this study is how to do theoretical and experimental research on ECU calibration, which is important for how well M85-powered motorcycles work on the road and how easy they are to drive.

Research Problem

The research problem is therefore focused on assessing the applicability of the Methanol Economy Initiative in the restructuring of India's energy sector and its implications on the country's economy. While the global community is increasingly shifting towards alternative sources of energy, India continues to import fossil fuels thus putting a lot of pressure on the economy and the environment. The Methanol Economy Initiative offers a potential answer by using methanol as a flexible, low-emission fuel produced from various and readily available feedstocks including coal, biomass, and carbon dioxide. However, the successful integration of methanol into India's energy mix is not without critical challenges such as the absence of required infrastructure for production, storage, and distribution, and the feasibility of large scale methanol use. Moreover, there are issues of public safety which include toxicity and flammability of methanol that have to be solved. This research aims at finding out whether methanol economy can help India to reduce the dependence on imported oil, reduce emission of greenhouse gases and promote industrialization. It also seeks to determine the viability of methanol as an energy source in different sectors such as transport, electricity and industries. Analyzing the advantages and disadvantages, the study will give the long-term effects of Methanol Economy Initiative on the Indian economy and environment and the strategies that need to be adopted to overcome the limitations to the successful implementation of Methanol Economy Initiative in India.

Conclusion

The Methanol Economy Initiative presents a transformative opportunity for India to address its energy challenges, reduce dependence on imported fossil fuels, and advance towards a more sustainable and environmentally friendly energy future. By leveraging methanol as a cleaner, versatile alternative derived from coal, biomass, and even carbon dioxide, India can significantly diversify its energy sources while enhancing energy security. The initiative aligns with the country's goals of reducing greenhouse gas emissions, promoting clean energy, and improving air quality, particularly in urban areas. Methanol's adoption in transportation, power generation, and industrial sectors offers a viable solution for reducing emissions and contributing to the global fight against climate change. Additionally, the methanol economy has the potential to boost industrial growth, create employment opportunities, and promote innovation within the energy and chemical industries. However, for the initiative to be successful, India must address several key challenges, including the development of adequate infrastructure for methanol production, distribution, and storage, as well as ensuring public safety and managing production costs. Government policies, regulatory frameworks, and public-private partnerships will play a critical role in overcoming

these obstacles. In conclusion, while challenges remain, the Methanol Economy Initiative holds immense potential to drive India's energy transition, support long-term economic growth, and enhance environmental sustainability. With strategic planning, investment, and technological innovation, India can position itself as a global leader in methanol adoption and clean energy, ultimately contributing to a more resilient and sustainable future for both the nation and the world.

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