

# IMPLICATIONS OF TRANSPORTATION FOR SUSTAINABLE ENERGY VIA LIQUID BIOFUELS: A RESEARCH STUDY FOCUSED ON CHINA

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## ABSTRACT

Given that the transportation sector is both an energy provider and a global contributor to greenhouse gas emissions, there is an immediate need for environmentally friendly solutions. The potential of liquid biofuels including bioethanol, biodiesel, and bio-jet fuel to reduce environmental impact on China's transportation network is explored in this paper. With China's economy expanding rapidly and its reliance on fossil fuels being heavily questioned, this research investigates the potential of biofuels to mitigate climate change, boost energy accessibility, and promote sustainable development. Data gathered from 864 respondents was analysed statistically using SPSS. The reliability of the measurement scales was confirmed using factor analysis. There is a statistically significant correlation between transportation habits and ecologically friendly electrical approaches, according to the data. Changing from fossil fuels to biodiesel may help second-world nations in coping with climate change by reducing greenhouse gas emissions. Using biofuels has a lot of disadvantages, such as competition for limited resources, increased prices, and challenges with technology. If technology and regulations were to improve, expansion might happen more quickly. A sustainable transport system may be achieved by enhancing regulations, creating modern technology, and constructing first-rate facilities, as emphasised in the paper. The study concludes that increasing funding for biofuel production would aid China's shift to renewable energy and conservation. These proposals enrich the discussion on renewable energy. A sustainable future and progress towards global climate targets may be within reach, thanks to innovations in liquid biofuels, they say.

**Keywords:** Transportation, Sustainable energy, Biofuels, Fossil fuel, Greenhouse gases.

## 1. INTRODUCTION

Transport accounts for 29% of global energy consumption due to its rapid expansion and critical role in the energy market. Many individuals are worried about pollution in the air and carbon emissions from vehicles since this sector uses so many fossil fuels. Given the present situation of global security and the growing cost of fossil fuels, it is necessary that both wealthy and emerging countries seek long-term sustainable solutions. Liquid biofuels, such as biodiesel, bioethanol, and bio jet fuel, are better than solid biofuels since they do not retain carbon dioxide or other hazardous pollutants. They also have a bigger effect on how environmentally friendly transportation is. There will be an increase from the 4% of vehicle fuel that was liquid biofuel in 2020. In 2014, transport accounted for fourteen percent of total emissions, placing it as the fourth most polluting sector (Tao et al., 2023). The impacts of large cars on air pollution and other pollutants have lately become known as a significant issue. This is due to the rise in the production of carbon dioxide,

which is the primary contributor to the phenomenon of global warming. One school of thought is that if the transportation industry were to significantly reduce the amount of pollution it produces, acid rain and global warming would be significantly reduced. At present, fossil fuels are the source of all of the green power that is utilised by the transportation industry. Many unusual types of alternative fuels, such as solar power, fuel cells, and biofuels, have been proposed as potential solutions for minimising the significant negative effects that the usage of fossil fuels has on the environment. Researchers and politicians are evaluating biofuel as a viable alternative to petrol that has the potential to reduce the amount of pollution that is released into the atmosphere (Jeswani et al., 2020).

## **2. BACKGROUND OF THE STUDY**

The green financial development that China has been experiencing since 2008 has had a significant influence on the use of renewable energy, the infrastructure of transportation, and the green economic growth of this nation. Due to the fact that Chinese governments and politicians have become aware of the adverse effects of climate change and the diminishing availability of fossil fuels, they have been driven to search for alternative solutions. A significant amount of progress has been made in China's transport system and renewable energy sources during the last several years. Not only does China have the largest population of any nation in the world, but it also has the highest amount of carbon dioxide emissions of any country. Through an examination of the Chinese setting, anybody may get valuable information about the potential advantages and difficulties associated with fostering green economic development. China is quickly becoming the world leader in the field of renewable energy (Li et al., 2023). The main sources of energy for the nation have been biomass, water-powered solar, and turbines powered by wind. Some of the government programmes that have aided these attempts to encourage the use of renewable energy sources include pass-through fees, subsidies, and legal frameworks. Using renewable energy technologies has not only made an impact on China's environment, but it has also created new business opportunities. The growth of renewable energy sources has made China's energy security even better. Because of this, the government has been able to cut down on its dependency on imported oil and find other sources of energy. The Chinese government has recognised the need for a transportation infrastructure that is good for the environment and has made steps to encourage the use of other forms of transportation. It is fantastic to witness that more and more people in China are preferring to use electric cars (Ding & Liu, 2023).

## **3. PURPOSE OF THE RESEARCH**

The study's overarching objective is to explore the potential positive and environmentally beneficial outcomes of liquid biofuels on China's transportation infrastructure. Many environmental problems have arisen in China as a result of the country's fast economic growth and reliance on traditional fossil fuels. It also released a great deal of carbon dioxide and other air pollutants. Research on the potential advantages of liquid biofuels like biodiesel and ethanol for the transportation sector in terms of lowering carbon emissions, increasing energy security, and fostering sustainable development is the primary goal of this research. The study's overarching goals are to take stock of biomass fuel production and consumption in China as it is right now, identify the regulatory, economic, and scientific obstacles to widespread adoption, and weigh the pros and cons of widespread deployment in terms of sustainability. In this study, the unique social and economic conditions, energy limitations, farming methods, and technical advances in China

were examined to find out if liquid biofuels could be used instead of gas and diesel. The main goal of the study is to help lawmakers, business leaders, and groups understand how biofuels could be used as a long-term energy source by giving them useful information and policy ideas. The primary purpose is to share China's point of view and the new knowledge that was learnt so that the worldwide conversation about green energy can be better. This means that the country might get closer to having travel infrastructure that is positive for the environment and lasts a long time. The upshots of this investigation should help future studies, investments, and policy choices that aspire to make China environmentally conscious and capable to supply its own energy needs.

#### 4. LITERATURE REVIEW

Although they depend on each other, energy and transportation are completely different from one another and may even be antagonistic at times. Ecological road transport is often defined as a kind of transport that meets society's inherent and essential mobility needs in a way that does not deplete local resources, harm the environment, or both. In addition to this, they claim that it ought to establish a harmonic integration with other social and economic areas. The efficacy of road transport networks in various locations is influenced by a number of factors, including the passage of time, the availability of resources, and the constraints imposed by the environment. It is imperative that the majority of China's major cities give priority to the growth of public transport in order to make automobile travel more ecologically friendly (El-Araby, 2024). So, to minimise the costs to society, the economy, the environment, and the available resources, green road transport energy efficiently meets the energy demands of an ecologically friendly road transport system. Since energy is one of the most basic resource constraints for road transport and many social sectors, it keeps popping up in discussions about resource scarcity. Instead of just supplying enough energy to meet the road transit industry's renewable energy demands, a green highway energy system actively organises and improves transportation-related operations across society to reduce the total social, economic, environmental, and material costs of energy consumption. Biofuels will be able to sidestep the typical obstacles (Cavelius et al., 2023). Many are optimistic that they will help the transportation sector reduce its dependence on oil and the release of climate gases. In addition, the present transportation system can be readily modified to accommodate biofuels. Indeed, biofuels are gaining traction in a number of nations. Several gas stations across the globe now provide modest volumes of bioethanol blends, such as 10% bioethanol in regular petrol, due to their outstanding integration with both components. There are a lot of nations right now that mix biodiesel with conventional diesel. Biofuels have the potential to reduce greenhouse gas emissions while also generating copious amounts of electricity. In several nations, biofuel production has received financial backing from governments. Biofuels may help boost rural development and energy availability in developing nations, which is good news for farmers looking to supplement their income. A lot of money has gone into manufacturing and technical advancement in this sector. Biofuels are quickly becoming the subject of an increasing number of scholarly articles (Al-Breiki & Bicer, 2021).

## 5. RESEARCH QUESTION

- How does transportation influence sustainable energy?

## 6. RESEARCH METHODOLOGY

### 6.1 Research Design

A quantitative research technique was used to carry out the inquiry in this study. SPSS version 25 was used for the analysis of the data. Descriptive statistics were used to make the demographic data more understandable. The study estimated odds ratios (OR) with a 95% confidence interval (CI) to consider the pattern and significance of the relationships. When the p-value is lower than 0.05, the outcomes are considered statistically significant. Quantitative methods are favoured for thorough statistical research and systematic assessments of survey data.

### 6.2 Sampling

A random sampling method was used to precisely reflect the research population. The Rao-soft technique stipulates that a minimum of 857 individuals is required for a valid sample. A total of 948 questionnaires were distributed. Due to inadequate information, 31 of the 895 responses were excluded from the final count. Consequently, the total sample size included 864 valid responses.

### 6.3 Data and Measurement

The study used a random selection strategy to identify respondents, ensuring that each member of the public had an equal chance of participation. Data gathering used bifurcated surveys: (A) fundamental demographics and (B) a 5-point Likert scale considering aspects associated with digital and conventional channels. The usage of the internet and such secondary sources additionally augmented the data collection.

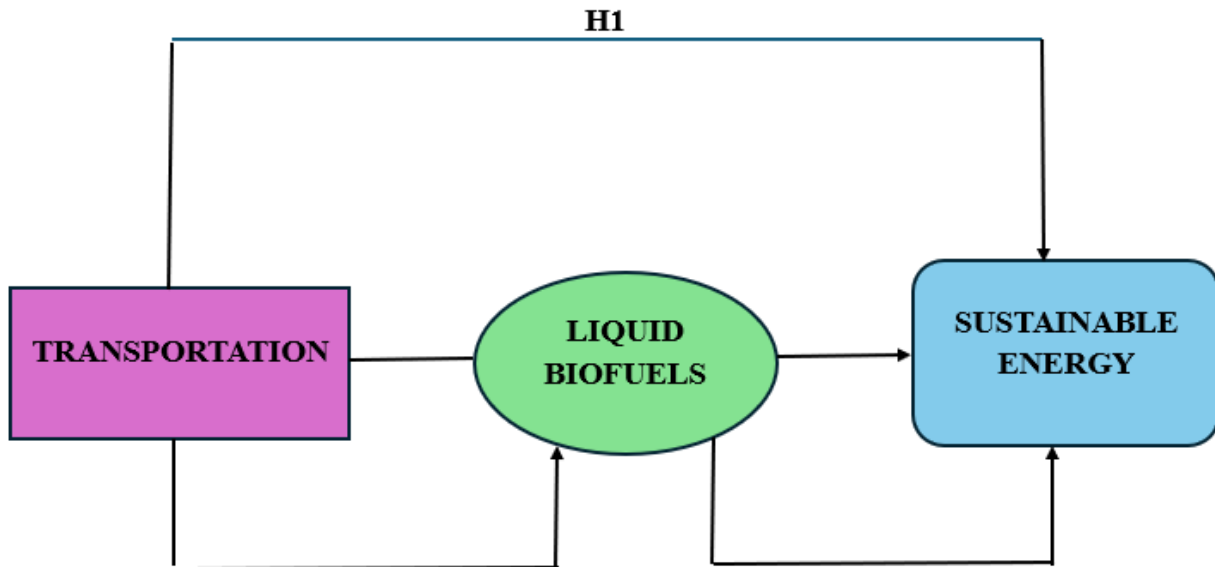
### 6.4 Statistical Software

Using SPSS 25 and MS-Excel, the researchers conducted the statistical analysis.

### 6.5 Statistical Tools

Through the use of a descriptive analysis approach, the essential characteristics of the data were comprehended. The reliability and validity of the measuring scales were examined by factor analysis.

## 7. CONCEPTUAL FRAMEWORK



## 8. RESULT

### • Factor Analysis

Factor analysis (FA) sometimes uses an approach to verify the foundation of a set of measuring items. A common misconception is that hidden factors directly affect the results of the visible ones. A framework-based approach is precision analysis (FA). An essential objective of this research is to measure errors and establish links between observable occurrences and their causes.

If the data lends itself to factor analysis, the Kaiser-Meyer-Olkin (KMO) technique could show it. The investigators check that each component of the model has a sample size to ensure that the overall sample size is sufficient. Results show that several of the components have a common variation. Data with smaller percentages provides better results when using the factor estimates.

The KMO algorithm returns a value between 0 and 1. Testing is necessary if the KMO value is between 0.8 and 1.

With a KMO below 0.6, researchers have identified insufficient sampling and must move promptly to fix the issue. One should think about the general agreement among authors; hence, 0.5 is often selected, and the typical range of values is 0.5 to 0.6.

When the proportion of total connections including partial encounters reaches a statistically significant level, the KMO score becomes close to zero. Important relationships make evaluating components much more difficult.

From 0.050 to 0.059, frequency ranges vary immensely.

- The range of 0.60 to 0.69 is quite adequate.

The median rating ranges between 0.70 and 0.79.

The typical range for point values is 0.80 to 0.89.

When the value is between 0.90 and 1.00, a very unlikely event takes place.

Testing the Appropriateness of the KMO and Bartlett's Sampling Method (Table 1):

Valued at 0.895 on the Kaiser-Meyer-Olkin scale.

The results of Bartlett's test of sphericity are as follows: 3252.968 is the approximate chi-square value; 190 is the degrees of freedom (df); sig = .000.

**Table 1: KMO and Bartlett's Test**

<b>KMO and Bartlett's Test</b>		
<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		.895
<b>Bartlett's Test of Sphericity</b>	<b>Approx. Chi-Square</b>	3252.968
	<b>df</b>	190
	<b>Sig.</b>	.000

The results of Bartlett's sphericity test demonstrated a strong relationship between the matrix architectures. Kaiser-Meyer-Olkin has achieved a sample adequacy level of 0.895. Using Bartlett's sphericity test, the researchers were able to get a p-value of 0.00. Through Bartlett's sphericity analysis, it was shown that the connection matrix was inaccurate.

## ❖ INDEPENDENT VARIABLE

### ● Transportation:

The transport industry was crucial to the rise of international commerce, and society has benefited financially from the enormous investments made in the physical infrastructure of this sector. It is essential to adopt a new definition of transport governance in order to determine the greatest obstacles to the implementation of significant policy changes and to address the shortcomings of decision-making that is fragmented. Within this framework, researchers provide a range of comprehensive methodologies that rely on principles of specialisation development and transition management in order to foster technical innovation as well as new modes of transportation and

commerce. At this point, the issues of diminished carbon emissions and heightened energy conservation have become difficulties on a worldwide scale that everyone must confront (Bruton, 2021). The government financing programmes in China will be affected by the zero-carbon nation green transportation plan that the country is implementing. In addition, this strategy will control the total number of electric scooters and petrol motorcycles, as well as require the issuing and regulation of new motorcycle certificates. Every single one of these components works in conjunction with other components in order to form a system that is not only sophisticated and dynamic but also has an impact on more than just laws; it also has an impact on the lifestyle that is most prevalent in the present day. Prior to the establishment of rules for China that will have an impact on the lives of millions of people, simulations are conducted in order to replicate the behaviour of green transport systems and the consequences of related legislation in a more restricted and closely regulated environment (Simonsen et al., 2024).

## ❖ DEPENDENT VARIABLE

### ● Sustainable Energy:

Sustainable energy comes from renewable sources that will not negatively impact the standard of living for future generations. This includes energy that could be utilised again after it has been used once. Renewable energy sources are a good strategy to fight global warming since they do not produce a lot of greenhouse gases or any at all. Investing in sustainable energy makes the economy stronger by ensuring energy security and minimising dependency on fossil fuels, which are becoming harder to find. This sort of investment also produces jobs that are good for the environment. It is important that people switch to sources of renewable energy as quickly as possible so that people in the future may continue to survive. Everybody need these technologies for creating an economy that is both strong and long-lasting solution (Alper et al., 2020). Despite the fact that a significant number of economies have seen an increase in the percentage of electrical consumption that is generated by renewable energy sources due to the availability of substantial subsidies, conventional energy sources and fossil fuels continue to hold a dominant position among alternatives for electricity production, accounting for approximately 75 percent of the worldwide market share. There are three fundamental technological improvements that are necessary in order for the development of endeavours in the field of sustainable energy to take place. The substitution of renewable energy sources for fossil fuels is an important measure that has to be taken in order to ensure the protection of the natural environment. The sheer volume of carbon emissions that are generated by industrialised nations is the principal factor that necessitates the development of a blueprint for the production of renewable energy (Nastasi et al., 2022).

### ● Relationship between transportation and sustainable energy:

Land usage does not need much consideration from conventional energy production from fossil fuels since these resources are often sourced from under the earth's surface and have very high energy density. An extraction method, such as an oil well, takes up a minimal amount of land. A sustainable energy-producing facility that generates the same amount of energy, on the other hand, covers a much larger area of land. Examples of such installations are wind farms, solar photovoltaic installations, and biomass plantations. The relative land usage of proposed scenarios must be taken into consideration while evaluating them. Hopefully, doing so will show more

advantageous or ideal circumstances, and it will also hopefully put the size of land usage into perspective (Muhammed et al., 2023). In an effort to make the transport sector cleaner and more sustainable, governments of many developed and underdeveloped countries have developed policies, both for customers and manufacturers, in an effort to reduce dependence on fossil fuels and to reduce the harmful emissions that result from the combustion of these fuels in internal combustion (IC) engines. The transportation industry has been less environmentally harmful as a result of the implementation of emission regulations and the use of higher-quality green fuels, which are sustainable energy sources. However, sustainable energies have been a significant breakthrough in the development of environmentally friendly and sustainable forms of transportation. The use of this sort of energy may ensure that there will be reductions in the total amount of carbon dioxide and other dangerous emissions, as well as lessen the heavy dependence on fossil fuels (Shah et al., 2021).

The researcher acquired the hypothesis that follows to assess the effect of transport on sustainable energy in light of the first discussion:

- *“H<sub>0</sub>: There is no significant relationship between transportation and sustainable energy.”*
- *“H<sub>1</sub>: There is a significant relationship between transportation and sustainable energy.”*

**Table 2: H<sub>1</sub> ANOVA Test**

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37921.462	366	5973.492	1094.647	.000
Within Groups	364.573	497	5.457		
Total	48357.720	863			

Considerable results are generated by this study. There is a statistically significant difference with a p-value of .000, which is within the .05 alpha level; the coefficient of determination (F) statistic is 1094.647. Researchers deny the null hypothesis and approve the alternative, *“H<sub>1</sub>: There is a significant relationship between transportation and sustainable energy”* as real.

## 9. DISCUSSION

Using liquid biofuels, the study's findings demonstrated a strong link between transportation and green energy. With a p-value of 0.000, mathematical research was carried out to establish that changes in transport habits might impact the adoption and efficiency of renewable energy sources. This was in line with previous research suggesting that biofuels might significantly reduce emissions of greenhouse gases and provide environmental benefits as a substitute for fossil fuels. Refuelling vehicles with liquid biofuels is one potential solution to the problem of environmental deterioration. In developing countries like China, where car emissions made up a disproportionately considerable portion of the overall emissions, this would be quite useful. Along with technological limitations, the study highlighted the urgent need for regulatory frameworks.

Technological progress and financial incentives were making it more suitable to change to biofuel-powered vehicles. Biofuels may lead the way to sustainable energy sources since they can adapt to the times and new restrictions. The findings also indicated that increasing the use of liquid biofuels and decreasing the use of imported fossil fuels may enhance the energy security. But limited technology, high production costs, and problems with getting resources are all things that everyone has to work on in order for it to reach its full potential. In conclusion, the results supported the idea that governments should provide more money to biofuel research and related laws in order to speed up the adoption of a better transportation system that helps meet global climate objectives. This study's relationship bolsters the assertion that modifications in the transport sector are crucial for achieving broader sustainable energy objectives, especially in the context of increasing environmental apprehensions and worldwide ambitions to combat climate change.

## 10. CONCLUSION

Our in-depth research showed that mobility, particularly in conjunction with liquid biofuels, would play a pivotal role in defining the future of sustainable energy in the years to come. In view of rising energy needs and worldwide environmental concerns, biofuels including plant-based ethanol, bio aviation fuel, and biomass diesel are being considered as viable alternatives to conventional fossil fuels. These fuels were primarily known for their low emissions and the possibility of carbon neutrality. Liquid biomass fuels, which show the crucial connection between travel behaviour and new developments in sustainable energy, are the most influential components of the study's impacts. From this relationship, anybody may imply that biofuels have the potential to increase energy security, decrease CO<sub>2</sub> emissions, and lessen the dependence on petroleum. Countries like China, experiencing rapid economic growth and environmental problems requiring creative solutions, were particularly obligated to do this. Furthermore, this study showed that transport networks might be made more resilient and long-lasting by the implementation of policies that promote the use and expansion of biofuels. The article addressed the topic of how manufacturers and government programmes have made biofuels more accessible and usable by the general public. In the fight against climate change and the depletion of natural resources, this is a huge boon. The research demonstrated that oil-based biofuels have the potential to significantly alter the regulation of green energies—subject to significant technology advancements and governmental permission, of course. Everybody still had not solved all of the supply chain issues or pushed technology to its limits. Biodiesel use in vehicles is compatible with global climate accords. A more stable and long-lasting future may be in store for nations if this helps them achieve energy independence and financial stability.

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