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EDITED BY
Kirsten Heimann,
Flinders University,
Australia

REVIEWED BY
Kit Wayne Chew,
Xiamen University Malaysia,
Malaysia

*CORRESPONDENCE
Jian Gao,
gaojianeor@126.com

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Development of bio-diesel to achieve Sustainable Development Goal 7

Hao Kang[1], Guanghui Li[2] and Jian Gao[3,4]*

[1]College of Engineering, Polytechnic Institute, Hebei Normal University, Shijiazhuang, China, [2]Seventh Oil Production Plant of Changqing Oil Field, PetroChina, Xi'an, China, [3]State Key Laboratory of Enhanced Oil Recovery, PetroChina, Beijing, China, [4]Research Institute of Petroleum Exploration and Development, PetroChina, Beijing, China

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Introduction

The Sustainable Development Goals (SDGs) aim to address the social, economic, and environmental dimensions of development in an integrated manner between 2015 and 2030 and to shift to a sustainable development path. Among these goals, "Sustainable Development Goal 7: ensures access to affordable, reliable, and sustainable modern energy for all" is a common challenge for all countries and concerns everyone. Energy is a common concern around the world today and is at the heart of almost every major challenge and opportunity. Access to energy is essential for all, regardless of occupation, security, climate change, food production, or increasing income and expenditure. Over the past 3 years, the global COVID-19 epidemic, coupled with geopolitical conflicts and other factors, has led to a rise in fossil energy prices, and some countries have returned to the use of fossil energy, affecting energy security. As is known to all, affordability is meaningless if the supply of energy is not stable. Therefore, analysis of the energy production trend is necessary to accurately identify the potential for energy supply.

Under these circumstances, many scholars have performed much research concerning the relationship between fossil energy and sustainable development. According to the principle of judging the bottom line demand for oil and gas, Chen et al. established the bottom line demand category for oil and gas. It is proposed that the rapid growth of China's dependence on foreign oil and gas and energy security should be viewed dialectically, and suggestions for sustainable development are provided for China (Chen et al., 2021). Liu et al. analyzed the impact of the Russia–Ukraine conflict on world energy development. The study believes that the construction of a global energy Internet is a strategic measure to realize the sustainable development of world energy (Liu et al., 2022). Considering the profound impact of the COVID-19 epidemic on the global energy pattern, Kang et al. analyzed the relevant policies issued by various countries in the world. The analysis shows that with the rapid development of renewable energy, the geopolitical influence of traditional oil and gas resource countries will be greatly weakened in the future, and the boundaries between resource countries and consumer countries will be increasingly blurred, thus forming a new "energy geopolitical map" (Kang et al., 2022). Through analysis, Jin et al. pointed out that the comprehensive development mode through the combination of energy, resources, and environment is an effective guarantee

to realize sustainable development, and the key is to solve the problem of coordination between energy utilization and environmental protection. Based on the goal of human sustainable development, the important research direction of engineering thermophysics in the future is finally put forward (Jin et al., 2020). Based on the major challenges of climate change, Huang et al. pointed out that a clean, zero-carbon, safe, and efficient energy system should be built in the future with new energy as the main body, "fossil energy + carbon dioxide capture, utilization, and storage (CCUS)", and nuclear energy as the guarantee (Huang and Xie, 2021).

Fossil energies can cause huge pollution through their combustion process, and the pollutants generated can induce severe environmental problems, such as greenhouse gas emissions, acid rain, and climate change. These environmental problems have a negative impact on the people's health. Therefore, it is necessary that humankind should find new sustainable energies to meet the requirements of ecological balance, social development, and people's health (Huang et al., 2021; Zheng et al., 2021; Pang et al., 2022). In recent years, many scholars and institutes have started to focus on the research and development of bio-fuels. Bio-fuels are sustainable energies with carbon neutrality and can be a good supplement for fossil energies from the perspective of sustainable development (Li and Zhou, 2021; Zhang et al., 2022). Organisms can store solar energy by means of photosynthesis, and huge amounts of biomass energy can be stored in this process. Bio-fuels are mainly composed of biomass, which contains both living and dead biological substances as well as the substances generated in the metabolic process on the Earth. On the one hand, biomass energy is a kind of green carbon energy without pollution, sustainable, low carbon, and degradable, and it can provide heat, motivation, and electricity. On the other hand, it is different from solar energy, hydroelectricity, and wind energy because it has much better properties in storage and transportation. Biological energy is composed of various types of sustainable energies from biomass, including bio-fuels, bio-heat, and bio-motivation. Bio-fuels mainly exist in the form of liquids, and they mainly include bio-gasoline and bio-diesel. Actually, many scholars have carried out a number of studies concerning the application of bio-fuels (Chang et al., 2022; Gong et al., 2022; Zhou et al., 2022). Sutherland et al. reviewed microalgal biotechnology in detail and evaluated the potential for microalgae to achieve SDGs from a totally new perspective. Their studies are of great significance for eliminating the negative effects of the utilization of natural resources and thus helpful for the sustainable development of the world (Sutherland et al., 2021). With the development of science and technology, more and more new types of bio-fuels may arise in the near future.

Based on BP's annual statistical data, this study analyzes the characteristics of the world's bio-fuel production from the year 1990 to 2021 (BP, 2022). The purpose of the study is to establish the development potential of bio-fuels through this analytical method so as to achieve Sustainable Development Goal 7 by effectively increasing the production of bio-fuels.

Production analysis

In order to obtain the development trend of bio-fuels, the production is analyzed and illustrated in many aspects by Figure 1. All the data used in this study were obtained from BP (2022). In Figure 1A, the abscissa stands for the analysis period from the year 1990 to 2021, and the vertical ordinate stands for the production rate. In order to make the value easy for comparison, the vertical ordinate uses the unit of 1,000 barrels of oil equivalent per day. To find out the production change during the past 30 years, the data are analyzed by fuel type.

Figure 1A shows the bio-gasoline production in the world from the year 1990 to 2021. From the curve, it is obvious that the production value increased from 130 to about 1,000 during the past 30 years. The general trend is in an increasing pattern, except for some occasional decreases. During the years 1990–2003, there is almost no increase and production is generally at a steady level. The fastest production increase occurred during the period 2005–2010. Production decreases occurred during the years 1997–2000, 2010–2012, 2015–2016, and 2019–2020. Among them, the last decrease concerning the year 2019–2020 was the largest; some recovery was seen during the years 2020–2021.

In order to obtain more details about the production of bio-fuels, the production ratio toward the total world production from various aspects is calculated and illustrated in Figure 1B: the abscissa stands for the analysis period during the years 1990 to 2021, and the vertical ordinate stands for the percentage calculated. In order to make the value easy for comparison, the vertical ordinate uses numbers by percentage directly.

Figure 1B shows the bio-gasoline ratio to the bio-fuels production in the world from 1990 to 2021. From the curve, it is obvious that the percentage value decreased from 100% to about 57% during the past 30 years. The general trend is in a decreasing pattern except for only two increasing periods. During the years 1990–1994, the ratio was almost nearly 100%, which means that bio-gasoline was the sole fuel type of bio-fuel at that period. The fastest ratio decrease occurred during the period 2003–2021, which means that the production had generally been decreasing at a steady level. The ratio increase occurred only during the years 2014–2015 and 2020–2021. It can be seen from this perspective that the production of bio-diesel has a decisive impact on the increase in bio-fuel production.

To find out more details, new types of figures are plotted based on more data. Figure 1C demonstrates the bio-gasoline production ratio in some major production regions separately from the whole for the years 1990–2021. From the chart, it is obvious that the United States and Brazil own the lion's share in the production of bio-gasoline. The share of the United States has actually been increasing since the years 1990–2011. After 2011,

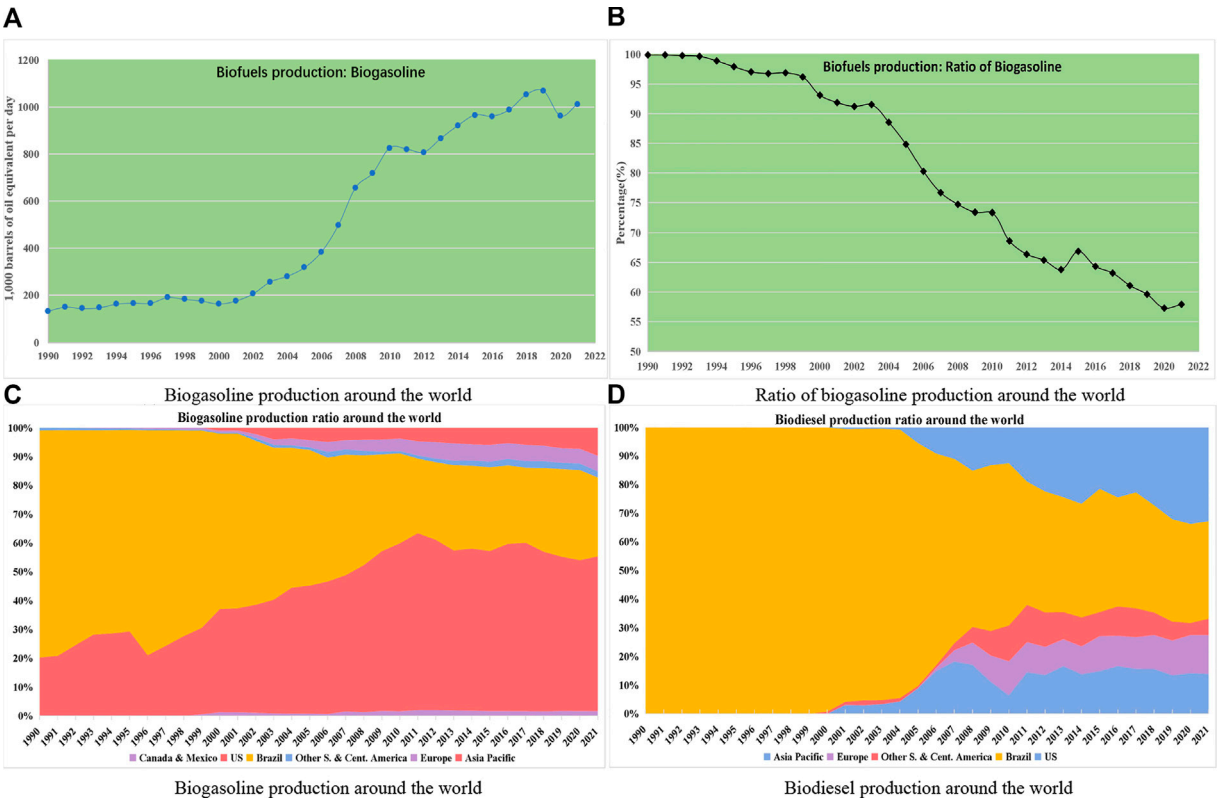

FIGURE 1
Statistical data of bio-fuel production. **(A)** Bio-gasoline production around the world. **(B)** Ratio of bio-gasoline production around the world. **(C)** Biogasoline production ratio by regions around the world. **(D)** Biodiesel production ratio by regions around the world.

there is a slight decrease in this share of the United States. As for Brazil, the share has been decreasing from 1990 until around 2011. After 2011, the share remains relatively the same.

Figure 1D demonstrates the bio-diesel production ratio in some major production regions separately from the whole for years 1990–2021. From the chart, it is obvious that Brazil owns the lion's share in the production of bio-diesel between the years 1990 and 2000. After that, the share of the United States and the share of the Asia-Pacific region gradually increased. With the increasing share of Europe and other South and Central America regions, the share of Brazil has been relatively in a decreasing pattern since the year 2004 until now.

Discussion

Based on the figure and analysis mentioned earlier, characteristics concerning the production of bio-fuels around the world can be obtained as follows:

(1) From Figure 1A, it is clear that the production of bio-gasoline has generally been on an increasing trend. However, judging from the image, the production of bio-diesel has increased much more than that of bio-gasoline, so the ratio of bio-gasoline toward bio-fuels production has actually been in a decreasing pattern.

(2) The fast-increasing trend of bio-diesel production demonstrates that bio-diesel has the biggest potential for future increase in bio-fuels production.

(3) As for the bio-gasoline production ratio shown in Figure 1C, Brazil is in a decreasing pattern and that of the United States is generally in an increasing pattern. In recent 10 years, the ratio of the United States has remained steady and there has even been a small decline in some years. The ratio of the United States to Brazil continuously constitutes the lion's share toward the total production of the world.

(4) Concerning the bio-diesel production ratio in different regions from the years 1990 to 2021, which is clearly demonstrated in Figure 1D, Brazil is in a decreasing pattern and the Asia-Pacific region is generally in an increasing pattern in the recent 20 years. In the recent 15 years, the ratio of the United States has remained steady and there has even been a decline in some years.

The Asia-Pacific region may still have a big potential for bio-diesel production increase in the following years.

In all, to achieve Goal 7 through the development of bio-diesel, the Asia-Pacific region has to continue to focus on the following aspects.

First, such a clear understanding should be established that bio-diesel resources are a prerequisite for the development of bio-diesel. Selecting suitable crops for cultivation is the first step in promoting bio-diesel production. In addition, investigation and evaluation of available land resources should be carried out, and demonstration zones for bio-diesel raw material supply should be planned and constructed to lay a reliable raw material supply foundation for pilot demonstration projects of non-grain fuel ethanol and large-scale development.

Second, the weak industrial foundation of bio-diesel technology in the Asia-Pacific region is also an important factor restricting the large-scale development of bio-diesel. Bio-diesel is still a developing new energy technology, and strengthening the research and development of bio-diesel technology is an important basis for promoting the development of bio-diesel. Based on the current reality, great efforts should be made to study the technology of producing bio-diesel from oil plants. Bio-synthetic diesel technologies should also be given appropriate attention because of the great potential of cellulose reserve resources.

Last but not least, government departments should formulate investment, price, and tax policies conducive to the development of bio-diesel, implement product sales channels, give full play to the leading role of large energy enterprises, widely absorb the participation of social enterprises, and form a complete bio-diesel production, processing, and marketing system.

Conclusion

Through analysis of BP's statistical data based on the criteria of bio-fuel types and production regions, the great potential concerning the development of bio-diesel in the Asia-Pacific region is predicted and confirmed. Furthermore, detailed suggestions are provided to promote bio-diesel production in the Asia-Pacific region. In fact, this study mainly focuses on the policy level to effectively promote the production of bio-fuels as an alternative to traditional energy resources. In order to put the development of bio-diesel into practice, future research is suggested to focus on technological innovation in the production process. This kind of research is conducive to increasing the production of bio-diesel in the world, thereby increasing the proportion of bio-fuels and renewable energy in the total energy supply and ultimately contributing to the achievement of Sustainable Development Goal 7 in 2030.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

Authors GL and JG were employed by the company PetroChina.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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