ISSN: 04532198
Volume 62, Issue 06, January, 2020

Biodiesel Research Progress in Indonesia: Data from Science and Technology Index (Sinta)

Bagiyo Condro Purnomo[1*], Suroto Munahar[1], Zulfikar Bagus Pambuko[1], Hamid Nasrullah[2]

Universitas Muhammadiyah Magelang, Magelang, Indonesia[1]
Politeknik Dharma Patria, Kebumen, Indonesia[1]
*Email: bagiyo_condro@ummgl.ac.id

Abstract— It is undeniable that efforts to provide biofuels are a must for Indonesia for now and in the future. Increasing oil imports not only burden the country's finances, but the massive use of fossil fuels also threatens the environment. Therefore, this article presents an analysis of the provision of research funding by the government on biodiesel. Dada was obtained from SINTA (Indonesian Science and Technology Index), a government-owned science portal. We find there is a fair trend in terms of research funding on biodiesel which allows supporting government targets in the implementation of large scale renewable fuels by 2050. Although, more than 50% of research activities are still concentrated in Java.

Keywords— Biodieel, Research activity, Sinta, Funding trend

1. Introduction

In recent years, issues concerning oil reserves, oil price fluctuations, climate change, and environmental have come to the attention of stakeholders and research institutions [1], [2]. The search for alternative energy to deal with the world energy crisis has also become an agenda in the energy policies of almost all countries. Sustainability of the industrial and transportation sectors by testing and applying renewable fuels continues to be carried out for the substitution of fossil fuels, both by full dedication system (mono fuel) as well as by bi-fuel system or hybrid system [3]–[8].

The use of fossil fuels has many environmental risks from the process of exploration, transportation, production, distribution, and use [9]–[13]. Natural damage in the oil drilling area and cases of oil spills in the Gulf of Mexico are other examples of environmental threats posed by fossil fuels [14]. On the usage side, the increase in air pollution and the concentration of carbon emissions in the atmosphere is also the impact of fossil fuels. Therefore, besides renewable energy from nature (wind, geothermal, waves, solar radiation, micro-hydro, etc.), efforts to produce renewable fuels from plants continue to be carried out, especially in countries with suitable land potential [15].

The transition to 100% renewable energy implementation is a complex process with various technical, political, economic and social challenges. To achieve predetermined success indicators, several strategies must be carried out comprehensively, including increasing energy efficiency, saving primary energy consumption, and finally, the dissemination of variable renewable energy sources (VRES) [16]. In the case of renewable energy from nature (wind, water, waves, etc.) to electricity, energy storage is still a long-term challenge with a large investment. Practices such as Vehicle to Grid (V2G) are a good example to do at this time, where partial storage in vehicle batteries is done [17]. In addition to natural energy-based energy, alternative fuels from plants are likely to be the solution in the next few decades to cover the fossil fuel problem in the industrial and transportation sectors.

In Indonesia, the increase in crude oil imports continues to occur to fulfill domestic energy. Although the numbers fluctuate, the trend line shows an increase from 1980 to 2018. Indonesia's oil production is not sufficient for domestic consumption. Indonesia's imports were reported at 350,800 barrels/day in 2018. This record is up compared to 343,750 barrels/day in 2017, with an average of 223,592 barrels/day from 1980 to 2018. This data reached the highest curve of 401,721 barrels/day th in 2013 [18]. The burden on the government through the APBN is getting heavier if this import trend continues. At present, energy production based on natural power on a large scale is still not possible. Therefore, the development of plant-based alternative fuels is a reasonable solution with potential available domestically.

The palm oil-based biodiesel industry in Indonesia experienced a major expansion in 2018. There are two drivers of this large production, the national expansion of B20 into the non-public transportation sector and huge demand by abroad. Domestic consumption is set for a big increase in the coming years for the transportation and industry sectors. Meanwhile, exports are expected to remain high based on ongoing demand from the EU and China [19]. There are many studies reporting on the potential development of biodiesel in Indonesia and many researchers agree that biodiesel is feasible to be applied as mono fuel or blended fuel for the transportation and industrial sectors, including as fuel for fishing boat engines and agricultural machinery [20]–[25]. In addition, much basic research for property improvement and evaluation of its use in the automotive sector is also being conducted [26]–[31]. This is not only for biodiesel from palm, but also for biodiesel from Indonesia's biodiversity [32]–[38].

The Indonesian biofuel program is a key component of the National Energy Policy (KEN), as regulated in Government regulation 79/2014. KEN is targeting 23% renewable energy use in 2025 and 31% in 2050 nationally [19]. Biofuels are also one of the main topics of the national research agenda. Every year, the government finances biodiesel research projects, both for basic research and applied research. Therefore, this article presents a map of research funding related to biodiesel by the government listed in the Indonesian science and technology index (Sinta) for the 2013-2019 funding period. This report will provide a detailed description of research sub-topics related to biodiesel, funding trends, and maps of research institutions that are concerned with biodiesel.

2. Method

We collected research data on biodiesel from SINTA (Indonesian Science and Technology Index, http://sinta.ristekbrin.go.id/) on the main search menu "source" then to the advanced search menu "researchs". The keywords "biodiesel", "bio-diesel", “biodiesel”, “biodisel” “bio diesel” and "bio-diesel" were applied in this search, as presented in Figure 1. Data was collected on 2 July 2020. There were 467 research titles obtained, and it is the research funded by the Ministry of Research and Technology through research grants has been established in Simlitabmas, a research and community service information management system managed by the Ministry of Research and Technology.

ISSN: 04532198
Volume 62, Issue 06, January, 2020

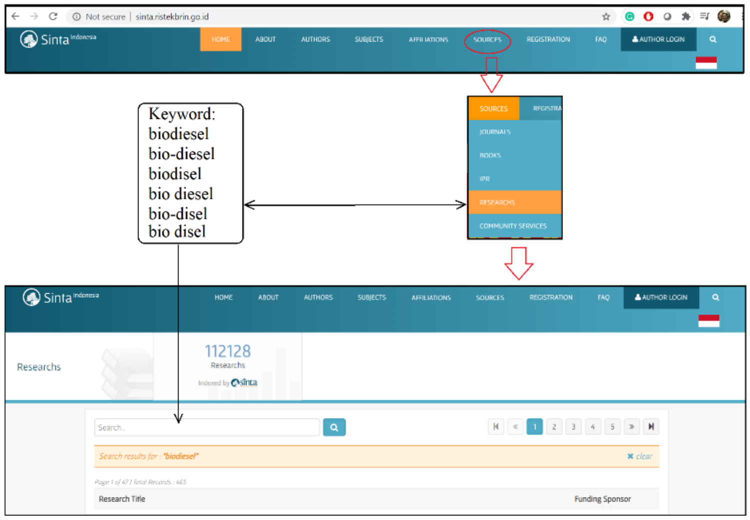

Figure 1. Searching method and data collection

After the data was collected, we classify research based on schemes, research costs, and affiliation of the researchers. This was done to map universities and research institutions in Indonesia that are concerned in biodiesel.

3. Result and Discussion

First, we found that research on biodiesel is evenly distributed in almost all major islands in Indonesia. Of the 467 data processed, they came from 26 provinces in Indonesia (76% of the total 34 provinces). However, 271 research (58%) is still concentrated in Java (East Java, Central Java, West Java, DI Yogyakarta, Banten, and DKI Jakarta). This is normal data because there are more universities and research institutions in Java than in other islands in Indonesia. In fact, of these 271, they are at the top of the overall data, except for DKI Jakarta, as presented in Figure 1.

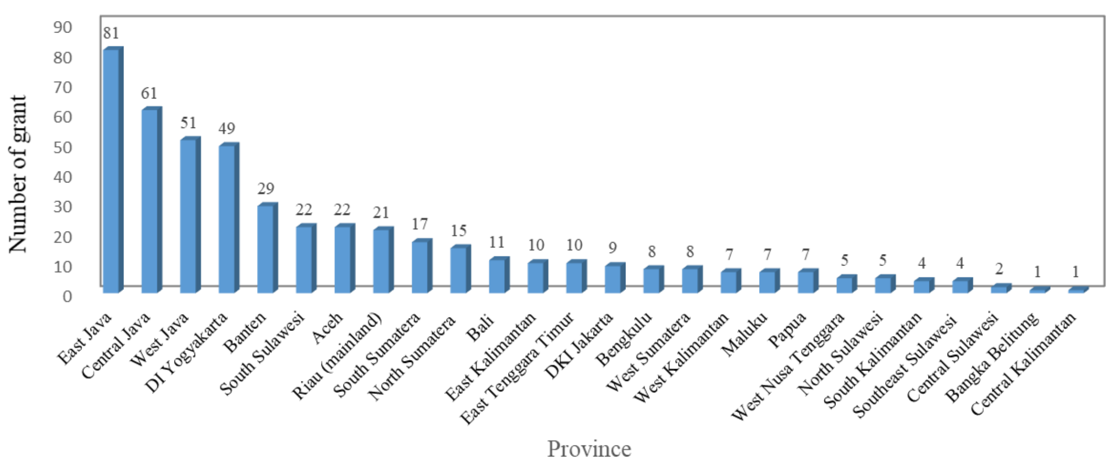

Figure 2. Distribution of biodiesel research funded by the Ministry of Research and Technology (2013-18)

Second, the National Energy Policy (KEN) targets the use of renewable energy to be 31% in 2050, nationally [19]. Therefore, the financing of research on biodiesel also showed a significant increase, especially from 2017 to 2019. During the 2013-2018 period, the financing trend followed the number of projects. However, in 2019, although the number of projects decreased from 78 to 75 titles, research funding provided by the government actually rose from IDR 9,627,003,610 to IDR 13,129,847,413 (an increase of 36%), as shown in

Figure 3. This increase in funding was partly due to an increase in packages research scheme funds provided, as regulated through a Minister of Finance Regulation regarding standard output costs.

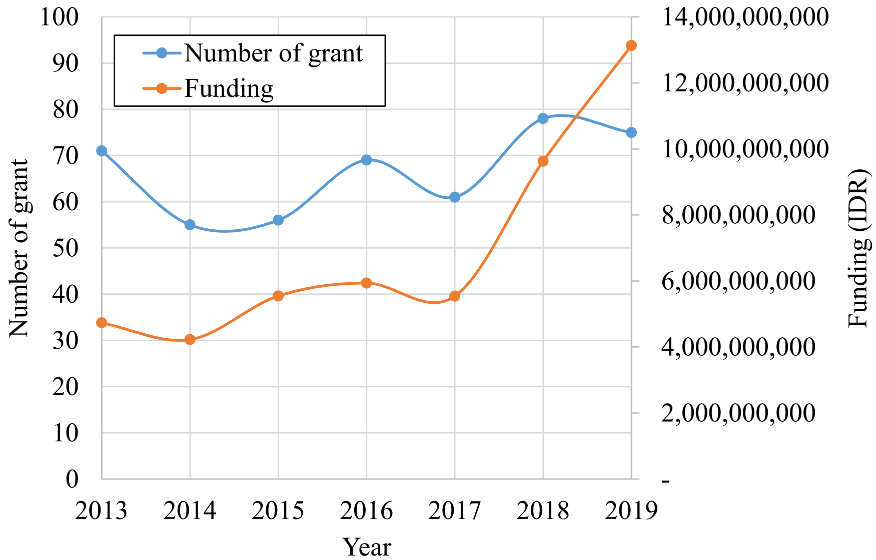

Figure 3. Funding distribution on biodiesel research by Ministry of Research and Technology 2013-2019

Third, from the data collected, applied research (PPT and PTUPT) is the most funded scheme by the government (Figure 4). This shows more research on the application of biodiesel compared to basic research. However, the important finding from the data is that the number of industrial cooperation consortium research is still small. Therefore, if the research trend continues on downstreaming and commercializing, there may be a surge in the implementation of biodiesel in Indonesia in the next few years.

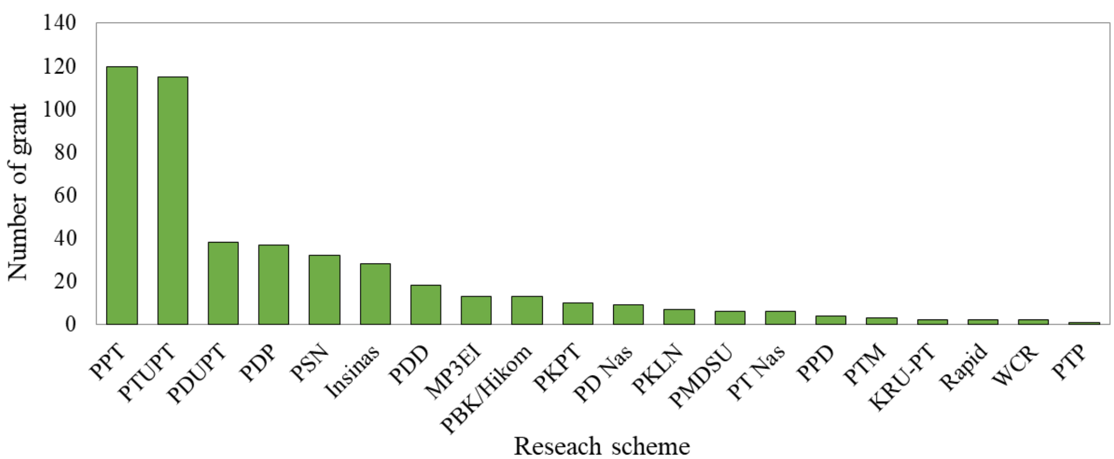

Figure 4. Funding distribution by title on biodiesel research by scheme

Fourth, although PPT ranked first in research funding, PTUPT and Insinas won the top ranking in funding. Meanwhile, funding for basic research such as PD Nas and PDUPT is still relatively small. In fact, basic research to improve the properties of biodiesel to become a standardized product may be more needed for commercialization purposes. The ranking of research funding according to the scheme is presented in Figure 5.

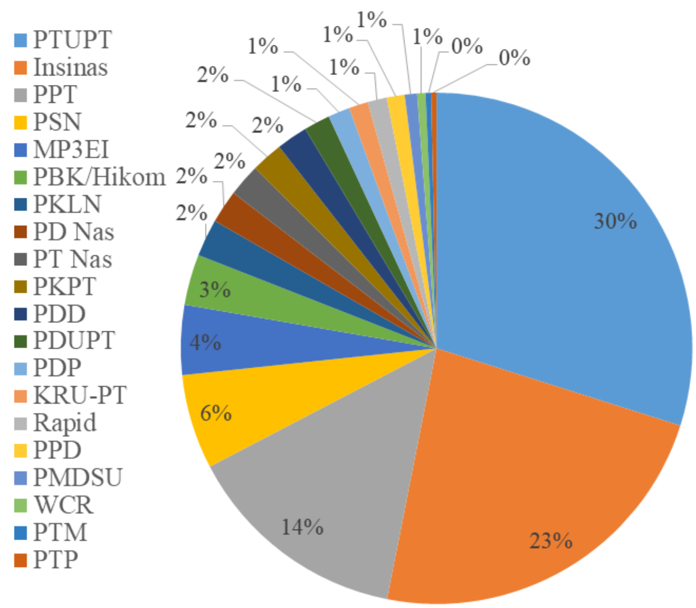

Figure 5. Funding distribution by scheme on biodiesel research by scheme

Finally, out of more than 100 institutions that received 2013-2019 biodiesel research funding, we presented the top 10 ranking in the number of research titles, as presented in Figure 6. ITS ranked first with 30 projects, followed by UGM and UNDIP. Of the top 10 ranking, BPPT is the only non-university research institution that is concerned in developing biodiesel. There are 14 projects recorded at BPPT through the Insinas funding scheme.

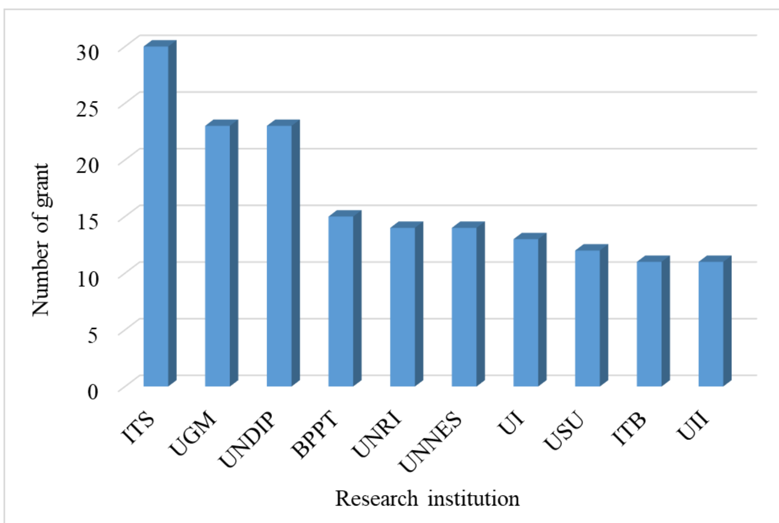

Figure 5. Top rank biodiesel research by institution 2013-2019 (ITS: Institut Teknologi Sepuluh November; UGM: Universitas Gadjah Mada; UNDIP: Universitas Diponegoro; BPPT: Badan Pengkajian dan Penerapan Teknologi; UNRI: Universitas Riau; UNNES: Universitas Negeri Semarang; UI: Universitas Indonesia; USU: Universitas Sumatera Utara; ITB: Institut Teknologi Bandung; and UII: Universitas Islam Indonesia)

3. Conclusion

Through evaluating this data, we found that there is a trend that can be recognized between the government's target to increase the use of biodiesel as a substitute for fossil fuels with the trend of funding for biodiesel research by the government through the Ministry of Research and Technology. Interestingly, this research funding is distributed almost in all research schemes, which are competitive research, assignment research, and capacity development research for researchers. This shows the potential for the sustainability of biodiesel research by utilizing Indonesia's biological resources, which in the future can reduce the import of fossil fuels.

4. Abbreviation

Insinas	Insentif Sistem Inovasi Nasional (Incentive for National Innovation System)
KRU-PT	Konsorsium Riset Unggulan perguruan Tinggi (Universities Research Consortium)
MP3EI	Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia (Master Plan for the Acceleration and Expansion of Indonesia's Economic Development)
PBK/Hikom	Penelitian Berbasis Kompetensi/Hibah Kompetensi (Competency Based Research)
PD Nas	Penelitian Dasar Kompetitif Nasional (National Competitive Basic Research)
PDD	Penelitian Disertasi Doktor (Doctoral Dissertation Research)
PDP	Penelitian Dosen Pemula (Research for Beginner Lecturers)
PDUPT	Penelitian Dasar Unggulan Perguruan Tinggi (Universities Basic Research)
PKLN	Penelitian Kerjasama Luar Negeri (Overseas Collaborative Research)
PKPT	Penelitian Kerjasama Perguruan Tinggi (Universities Collaborative Research)
PMDSU	Pendidikan Magister Menuju Doktor untuk Sarjana Unggul (Masters in Education Towards a Doctorate for a Superior Bachelor)
PPD	Penelitian Pasca Doktor (Postdoctoral Research)
PPT	Penelitian Produk Terapan (Applied Product Research)
PSN	Penelitian Strategis Nasional (National Strategic Research)
PT Nas	Penelitian Terapan Kompetitif Nasional (National Competitive Applied Research)
PTM	Penelitian Tesis Magister (Master's Thesis Research)
PTP	Penelitian Tim Pascasarjana (Postgraduate Research Team)
PTUPT	Penelitian Terapan Unggulan Perguruan Tinggi (Universities Applied Research)
Rapid	Riset Andalan Perguruan Tinggi dan Industri (University and Industrial Flagship Research)
WCR	World Class research

6. References

[1] A. Cavallo, "Elephant in the room: How OPEC sets oil prices and limits carbon emissions," *Bulletin of the Atomic Scientists*, vol. 69, no. 4, pp. 18–29, 2013.

[2] J. C. Dike, "Does Climate Change Mitigation Activity Affect Crude Oil Prices? Evidence from Dynamic Panel Model," *Journal of Energy*, vol. 2014, 2014.

[3] G. Schwerhoff and M. Sy, "Financing renewable energy in Africa – Key challenge of the sustainable development goals," *Renewable and Sustainable Energy Reviews*, vol. 75, pp. 393–401, 2017.

[4] A. Linzenich, K. Arning, D. Bongartz, A. Mitsos, and M. Ziefle, "What fuels the adoption of alternative fuels? Examining preferences of German car drivers for fuel innovations," *Applied Energy*, vol. 249, pp. 222–236, 2019.

[5] Y. Shao and M. Dessouky, "A routing model and solution approach for alternative fuel vehicles with consideration of the fixed fueling time," *Computers & Industrial Engineering*, vol. 142, p. 106364, 2020.

[6] Y. Kroyan, M. Wojcieszyk, O. Kaario, M. Larmi, and K. Zenger, “Modeling the end-use performance of alternative fuels in light-duty vehicles,” *Energy*, vol. 205, p. 117854, 2020.

[7] Y. Cheng and L. Wang, “A location model for capacitated alternative-fuel stations with uncertain traffic flows,” *Computers & Industrial Engineering*, vol. 145, p. 106486, 2020.

[8] B. Anderhofstadt and S. Spinler, “Preferences for autonomous and alternative fuel-powered heavy-duty trucks in Germany,” *Transportation Research Part D: Transport and Environment*, vol. 79, p. 102232, 2020.

[9] S. Chettouh, R. Hamzi, and K. Benaroua, “Examination of fire and related accidents in Skikda Oil Refinery for the period 2002–2013,” *Journal of Loss Prevention in the Process Industries*, vol. 41, pp. 186–193, 2016.

[10] B. Yuan and D. A. Wood, “A holistic review of geosystem damage during unconventional oil, gas and geothermal energy recovery,” *Fuel*, vol. 227, pp. 99–110, 2018.

[11] J. Lu, Z. Yang, H. Wu, W. Wu, J. Deng, and S. Yan, “Effects of tank sloshing on submerged oil leakage from damaged tankers,” *Ocean Engineering*, vol. 168, pp. 155–172, 2018.

[12] R. H. Shie and C. C. Chan, “Tracking hazardous air pollutants from a refinery fire by applying on-line and off-line air monitoring and back trajectory modeling,” *Journal of Hazardous Materials*, vol. 261, pp. 72–82, 2013.

[13] I. M. Shaluf, F. R. Ahmadun, and A. M. Said, “Fire incident at a refinery in West Malaysia: The causes and lessons learned,” *Journal of Loss Prevention in the Process Industries*, vol. 16, no. 4, pp. 297–303, 2003.

[14] K. Bhattarai, W. M. Stalick, S. Mckay, G. Geme, and N. Bhattarai, “Biofuel: An alternative to fossil fuel for alleviating world energy and economic crises,” *Journal of Environmental Science and Health - Part A Toxic/Hazardous Substances and Environmental Engineering*, vol. 46, no. 12, pp. 1424–1442, 2011.

[15] Statista, “Leading countries based on biofuel production in 2019,” *Energy & Environmental Services*, 2020. [Online]. Available: https://www.statista.com/statistics/274168/biofuel-production-in-leading-countries-in-oil-equivalent/. [Accessed: 02-Jul-2020].

[16] H. Lund, P. A. Østergaard, D. Connolly, and B. V. Mathiesen, “Smart energy and smart energy systems,” *Energy*, vol. 137, pp. 556–565, 2017.

[17] H. Stančin, H. Mikulčić, X. Wang, and N. Duić, “A review on alternative fuels in future energy system,” *Renewable and Sustainable Energy Reviews*, vol. 128, no. May, 2020.

[18] CEIC, “Indonesia Crude Oil: Imports.” [Online]. Available: https://www.ceicdata.com/en/indicator/indonesia/crude-oil-imports. [Accessed: 07-Jul-2020].

[19] A. Rahmanulloh, “Indonesia Biofuels Annual Report 2019,” Jakarta, 2019.

[20] F. Harahap, S. Silveira, and D. Khatiwada, “Cost competitiveness of palm oil biodiesel production in Indonesia,” *Energy*, vol. 170, pp. 62–72, 2019.

[21] K. Siregar, A. H. Tambunan, A. K. Irwanto, S. S. Wirawan, and T. Araki, “A Comparison of Life Cycle Assessment on Oil Palm (Elaeis guineensis Jacq.) and Physic Nut (Jatropha curcas Linn.) as Feedstock for Biodiesel Production in Indonesia,” *Energy Procedia*, vol. 65, pp. 170–179, 2015.

[22] H. Kamahara *et al.*, “Improvement potential for net energy balance of biodiesel derived from palm oil: A case study from Indonesian practice,” *Biomass and Bioenergy*, vol. 34, no. 12, pp. 1818–1824, 2010.

[23] A. S. Silitonga, A. E. Atabani, T. M. I. Mahlia, H. H. Masjuki, I. A. Badruddin, and S. Mekhilef, “A review on prospect of Jatropha curcas for biodiesel in Indonesia,” *Renewable and Sustainable Energy Reviews*, vol. 15, no. 8, pp. 3733–3756, 2011.

[24] M. H. Jayed, H. H. Masjuki, M. A. Kalam, T. M. I. Mahlia, M. Husnawan, and A. M. Liaquat, “Prospects of dedicated biodiesel engine vehicles in Malaysia and Indonesia,” *Renewable and Sustainable Energy Reviews*, vol. 15, no. 1, pp. 220–235, 2011.

[25] N. Indrawan *et al.*, “Palm biodiesel prospect in the Indonesian power sector,” *Environmental Technology & Innovation*, vol. 7, pp. 110–127, 2017.

[26] R. Rosid, B. Sudarmanta, L. Atmaja, and S. Özer, "An Experimental Study of the Addition of Air Mass Flow Rate Using a 30% Emulsion-Fueled Diesel Engine at High Load," *Automotive Experiences*, vol. 3, no. 2, 2020.

[27] E. Marlina, M. Basjir, M. Ichiyanagi, T. Suzuki, G. J. Gotama, and W. Anggono, "The Role of Eucalyptus Oil in Crude Palm Oil As Biodiesel Fuel," *Automotive Experiences*, vol. 3, no. 1, pp. 33–38, 2020.

[28] D. Ayu, R. Aulyana, E. W. Astuti, K. Kusmiyati, and N. Hidayati, "Catalytic Transesterification of Used Cooking Oil to Biodiesel: Effect of Oil-Methanol Molar Ratio and Reaction Time," *Automotive Experiences*, vol. 2, no. 3, pp. 73–77, 2019.

[29] H. Y. Nanlohy, H. Riupassa, I. M. Rasta, and M. Yamaguchi, "An Experimental Study on the Ignition Behavior of Blended Fuels Droplets with Crude Coconut Oil and Liquid Metal Catalyst," *Automotive Experiences*, vol. 3, no. 2, 2020.

[30] H. Y. Nanlohy, I. N. G. Wardana, M. Yamaguchi, and T. Ueda, "The role of rhodium sulfate on the bond angles of triglyceride molecules and their effect on the combustion characteristics of crude jatropha oil droplets," *Fuel*, vol. 279, p. 118373, 2020.

[31] A. C. Arifin, A. Aminudin, and R. M. Putra, "Diesel-Biodiesel Blend on Engine Performance: An Experimental Study," *Automotive Experiences*, vol. 2, no. 3, pp. 91–96, 2019.

[32] M. L. Sanyang, S. M. Sapuan, M. Jawaid, M. R. Ishak, and J. Sahari, "Recent developments in sugar palm (Arenga pinnata) based biocomposites and their potential industrial applications: A review," *Renewable and Sustainable Energy Reviews*, vol. 54, pp. 533–549, 2016.

[33] P. A. Handayani, A. Abdullah, and H. Hadiyanto, "Biodiesel production from Nyamplung (Calophyllum inophyllum) oil using ionic liquid as a catalyst and microwave heating system," *Bulletin of Chemical Reaction Engineering & Catalysis*, vol. 12, no. 2, pp. 293–298, 2017.

[34] M. Fadhlullah, S. N. B. Widiyanto, and E. Restiawaty, "The potential of nyamplung (Calophyllum inophyllum L.) seed oil as biodiesel feedstock: Effect of seed moisture content and particle size on oil yield," *Energy Procedia*, vol. 68, no. 2015, pp. 177–185, 2015.

[35] S. Supriyadi and P. Purwanto, "Enhancing biodiesel from kemiri sunan oil manufacturing using ultrasonics," in *E3S Web of Conferences*, 2018, vol. 31, p. 2014.

[36] W. S. Wulandari, D. Darusman, and W. Cecep Kusmana, "Land suitability analysis of biodiesel crop Kemiri Sunan (Reutealis trisperma (Blanco) Airy Shaw) in the Province of West Java, Indonesia," *J Environ Earth Sci*, vol. 4, no. 21, pp. 27–37, 2014.

[37] N. A. Fauzan, E. S. Tan, F. L. Pua, and G. Muthaiyah, "Physiochemical properties evaluation of Calophyllum inophyllum biodiesel for gas turbine application," *South African Journal of Chemical Engineering*, vol. 32, pp. 56–61, 2020.

[38] A. S. Silitonga, H. H. Masjuki, H. C. Ong, T. Yusaf, F. Kusumo, and T. M. I. Mahlia, "Synthesis and optimization of Hevea brasiliensis and Ricinus communis as feedstock for biodiesel production: A comparative study," *Industrial Crops and Products*, vol. 85, pp. 274–286, 2016.