BIODIESEL INDUSTRY IN THAILAND: THE ROLES OF ACTORS IN NETWORKS

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ABSTRACT

This paper assesses how public actors managed biofuel policy focused on biodiesel, and it can be effective in contributing to sustainability in biodiesel production related to networks. The Triad Network Model was applied to analyse the extent of public and private governance perspectives on the policy networks, economic networks and societal networks in the biodiesel industry. We used qualitative study in-depth interviews as the main method of interviewing involved actors in the biodiesel industry, both its feedstock as well as the crude palm oil industry and government agencies. We found that the sustainability of biodiesel production cannot be designed by a unique. The implementation of biodiesel policies was frequently adjusted based on the security of supply of main feedstock such as FFB and CPO, as well as competitive product industries such as palm cooking oil. In terms of sustainable production or environmental consideration, the roles of involved actors in economic and societal networks have limited interaction. The government agencies in the policy network have taken the most actions, both directly and indirectly. The main challenges in driving the biodiesel industry to sustainable targets based on possible feedstock are keeping stable policies, determining biodiesel policy on palm oil production balance for biodiesel production and palm cooking oil, making and implementing policies with consistence, and considering transparency. The biodiesel policy in Thailand should be in synergy with economic, social, and environmental goals and be concerned with the collaboration of involved actors on the tried network of biodiesel industry.

Keywords: Biodiesel, Triad Network Model, Palm Oil, Policy, Biofuel

INTRODUCTION

The biodiesel sector in Thailand has somewhat depended on palm oil feedstock. In recent years, oil palm as the Crude Palm Oil (CPO) has become the majority of the feedstock used to produce pure biodiesel (B100) in Southeast Asia and Thailand (Mukherjee & Sovacool, 2014).

The production and consumption of B100 are continuing increasing rapidly by the production 1,427, 1,568, and 1,845 million liters, and the consumption 1,395 1,568, and 1,794 million liters in 2017, 2018, and 2019 respectively (Prasertsri & Chanikornpradit, 2020). At the same time, the demand for biodiesel in global has grown along with and consuming about 10% from 19.5 to 43.5 billion liters in 2010 to 2019 (Tunpaiboon, 2020).

In 2007, the B100 was blended with petroleum diesel and sold in the Thai domestic market for the first time with B2 (2% biodiesel). Since 2008, the most common B100 blends have been B2 (2% biodiesel), B5, and B20. Currently, there are 12 biodiesel producers in Thailand with a total capacity of 8,312,242 liters per day. According to the 20-year Alternative Energy Development Plan AEDP 2018 (2018–2037), the target of 2.9 billion liters of biodiesel by 2036 was set in this (Ministry of Energy, 2018; Prasertsri & Chanikornpradit, 2020).

The Thai government has significantly influenced Thai agriculture through a variety of policies over the past three decades (Krasachat, 2001). The government strongly regulates palm oil

production and palm oil plantations both in processing and marketing. Oil palm and palm oil policies have had a direct impact on biodiesel production and consumption.

Long-term biodiesel policy planning was linked to the cost of feedstock development as the most important factor for future biofuel costs (Millinger et al., 2017). In addition, technological development to decrease the average cost of production and the emission of greenhouse gases are still interesting issues in biofuel development (Gaurav et al., 2017). Therefore, sufficient feedstock and its management are the main keys to biodiesel production in Thailand.

The policy's proposed solution facing dilemma. On the one hand, there are negative and positive impacts on involved network especially the feedstock sector that links with smallholder famers who are contained approximately 70% of all palm growers in Thailand and consumers who consume palm cooking oil. In addition, it meets with high cost of production and limited biofuel production capacity that depend on the policy and domestic feedstock market. This ultimately means that it will be difficult to reach the renewable energy target by Thai government policies. Expanding the plantation for feedstock areas, improving the efficiency of production, developing the policy arrangement, and implementing the policy are mechanism to support biodiesel industry toward sustainability (Nupueng et al., 2018). There are many both private and public actors who take the roles and collaboration in the network connection of biodiesel industry and palm oil sector and environmental issues to achieve sustainability.

To address this dilemma, this paper aims to assess the interactions of Thai biodiesel-related actors as nodes in networks that are related to policy implementation for sustainable biodiesel production. The research identifies the roles of networks in driving the development of the biodiesel industry and the responses of several actors in their networks. The Triad Network Model has been used and adapted to address the issues.

THEORETICAL BACKGROUND AND METHODOLOGY

Theoretical framework: Triad Network Model

The Thai palm oil sector is linked with many relevant industries and is highly complex. The expansion of the palm oil industry is linked with the biodiesel and crude palm oil industries, which have a relationship network. Both the palm oil and biodiesel industries in Thailand relate to all three components of economic, policy, and societal issues. Triad networks are economics, policy and societal network called Triad network (Mol, 1995) were used to analyse and achieve the main research objective. There are a large number of involved actors who have power to control their networks in both the biodiesel and Crude Palm Oil (CPO) industries. The perspective of the triad network model (Mol, 1995) (Figure 1.) has been recognized as the one concept of EMT (Ecological Modernization Theory) (Mol, 2003; Mol et al., 2014; Wattanapinyo & Mol, 2013) that there are carried the policy networks, economic networks, and societal networks. Mol & Spaargaren (2006) defined "the Triad Network Model is a conceptual model for analysing the extent to which the ecological perspective penetrates and transforms the social practices predominately governed by the three basic perspectives in modern society: the political, economic and socio-cultural". Each network (Mol & Spaargaren, 2006; van Koppen & Mol, 2002) that considers the actors to be most important in terms of perspectives and rationalities (Anh et al., 2011) can establish the combination of a specific analytical such as characteristic institutional arrangements and a limited number of interrelating (collective) actors. Tried Network Model was applied in several scholars to analyse understand why, how and to what extent external actors are involved (Anh et al., 2011; Chavalparit, 2006; Thongplew et al., 2016; Wattanapinyo & Mol, 2013).

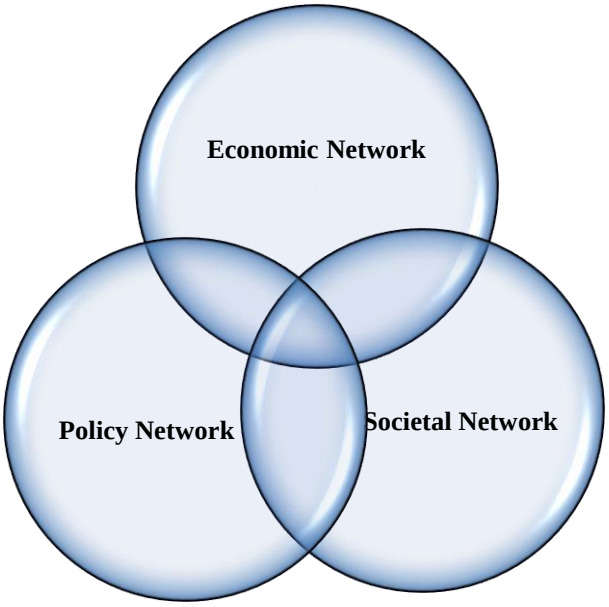

FIGURE 1
TRIAD-NETWORK MODEL: THE COMBINATION BETWEEN ECONOMIC, POLICY AND SOCIETAL NETWORK

According to this framework, the Triad-Network Model should study the involved key actors, their relationships, and their power and control in the network. Economic interactions between economic agents and the industrial sector *via* economic rules and resources within an economic network. In terms of policy networks, pay attention to interactions between industrial actors and involved state organizations that are linked with a political-administrative perspective. In the same way, societal networks aim at identifying relations between an economic sector and civil society organizations associated with the life world, both directly and indirectly *via* state agencies.

METHODOLOGY

A qualitative study using in-depth interviews was employed as the main method to look into the roles of the Thai government in developing the policy and its impact on the biodiesel production network and its involved networks, including the feedstock industry. The main data comes from 30 semi-structured interviews with participants and stakeholders in the biodiesel industry as well as palm oil as a feedstock in Thailand. We also interviewed government agencies, producer organizations of crushing mills and biodiesel plants, civil society organizations. We identified these interviewees using snowball sampling techniques to find the stakeholders who are involved in biodiesel network.

Triad Network Model: Analytical Biodiesel and Feedstock Industries

In this section, we adopted the Triad network to identify the role of actors in each network following the relationship between the CPO industry as feedstock and biodiesel industry with their three involved networks. The model in Figure 2 represents an economic, policy, and societal network. The biodiesel industry is a key component of the palm oil supply chain. The demand for the biodiesel market was related to the CPO market. The CPO industry needs imperative dependence on the biodiesel market, like a defensive alliance between industries and biodiesel facilitates the CPO industry by acting as a buffer stock.

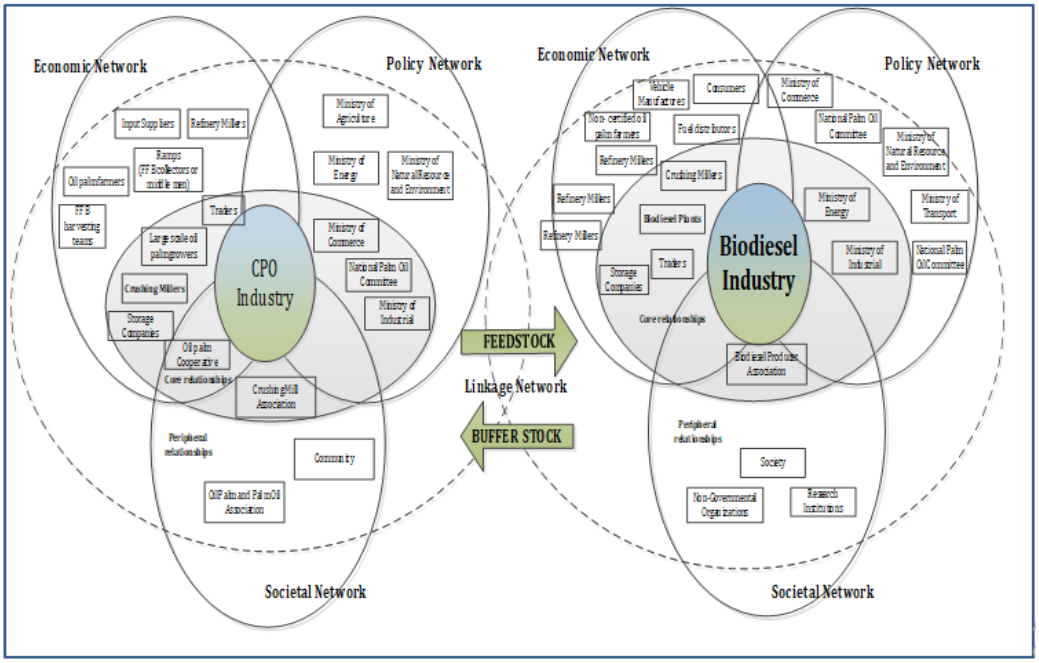

FIGURE 2
TRIAD NETWORKS RELEVANT TO BIODIESEL INDUSTRY AND CRUDE PALM OIL INDUSTRY AS FEEDSTOCK

Economic Network

Economic networks mainly focused on economics interaction and relationship between biodiesel producers and others economics involved actors in biodiesel industry. In the feedstock industry, the CPO producers are the main players who provide CPO to the biodiesel processing plants. The relationship between crushing millers and biodiesel plants has become more important in transferring the feedstock. Even though biodiesel plants play a main role in biodiesel production, their power in the business management of processing has been rather limited. In the business structure of biodiesel production, the Thai government dominates and manages the biodiesel blending with national regulation. When the government decides to increase or decrease the percentage of biodiesel blending, production begins. The decision depends on the market for FFB and palm cooking oil, considering the price of FFB at the upstream level and the price of palm cooking oil at the downstream level.

In 2018 and 2019, biodiesel production and consumption were increasing because of increased harvested area, an increased number of palm plantations, and the government's decision to adjust the blending rate from B1 to B10 (Prasertsri & Chanikornpradit, 2020). The policy by the Ministry of energy still has a direct effect on economic activities in the biodiesel industry.

The interview with the processors confirmed that this industry has less freedom in business management. The market mechanism has limited influence in trading. In Thailand, biodiesel is produced and consumed on the domestic market. Environmental improvement practices have been carried out less frequently by the actors involved in economic networks. They should focus on the business plan following the constant regulation changes.

In considering the upstream, the first actors with a limited role are oil palm farmers. The biodiesel market blending rate influences CPO supply and will continue to influence FFB prices and farmer income. Farmers have less negotiating power to pressure the upper market. Farmers have problems both with marketing and productivity in production because of smallholder characteristics. In the case of cooperative farmers, the cooperative, namely Krabi Palm Oil Community Cooperative Ltd., is one of the largest cooperative companies in the world. They provide the FFB and produce CPO for the biodiesel industry. They have attempted to produce commercial biodiesel, but without success.

In terms of downstream, the refinery plants that are palm cooking oil producers with the large-scale refinery mills have more power to control only purchasing volume. The CPO stock management system is one of the strategies of the refinery plants to manage CPO supply for cooking oil processing.

In Thailand, biodiesel is domestically produced for the domestic market. The actors involved in economic networks should focus on the business plan following the constant regulation changes. They agreed that the sustainability of the palm oil sector is important, but stable FFB and CPO prices have more effect on them than environmental issues.

Therefore, if government policies are unstable, they will have a problem managing their business. The government agencies play a main role in the production network and can select different policies to intervene in biodiesel production and consumption. The factors of policy adaption are commitment to the plan and the situation of the FFB market. All stakeholders in the chain were affected by their changes in the following manner.

Policy Network

The policy network represents interaction and institutional arrangements between industries and government organizations as well as the policy agencies. The analytical study is focused on the relationships between actors and their interdependencies, "the rules of the game", the resources of dependencies between actors and others in the network (Mol & Spaargaren, 2006).

The National Plan for the production and consumption of biodiesel in Thailand was used with the 20-year plan (AEDP) 2018 (2018 – 2037) by the Energy Policy and Planning Office (EPPO) under the Ministry of Energy. The Ministry of Commerce controls the price of cooking oil that directly affects the CPO market and continues to FFB market on the economic network. The blending percentage has fluctuated between B3 and B20 over the last 12 years (2008-2019), depending on policy decisions affecting the FFB market and the price of palm cooking oil.

The interviews with the government agencies demonstrate that the biodiesel and palm oil industries in Thailand are supported by the government in many dimensions. The combination of the biodiesel industry and the palm oil sector involves the ministries that are the Ministry of Energy, the Ministry of Industry, the Ministry of Agriculture and Cooperatives, the Ministry of Commerce, and the Ministry of Finance. The linkage across the government agencies' roles and collaborations among the Ministries was shown in Figure 3.

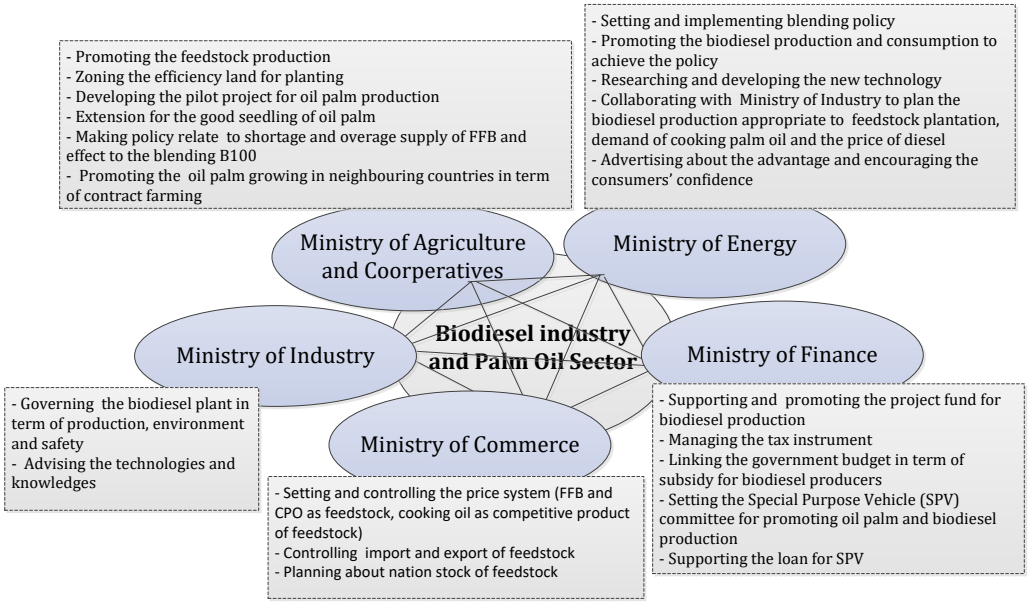

FIGURE 3
LINKAGE ACROSS THE GOVERNMENT AGENCIES AND THEIR ROLES IN BIODIESEL INDUSTRY

In terms of the policy process, the Ministry of Energy plays the main role in managing the percentage of biodiesel blending and collaborating with the Ministry of Industry to plan the biodiesel production appropriate to feedstock plantation, demand for cooking palm oil, and the price of diesel. They have implemented those policies by encouraging biodiesel production and consumption to achieve the policy. Triad Network perspective represent the relationships between the industrial sector and civil society organisations and their activities, both directly and indirectly through state agencies (Mol & Spaargaren, 2006). In this case, we explain the relations between the various civil society actors and the CPO industry, who have the main roles in economic issues

Societal Network

Societal networks in the such as NGOs, associations, communities, and institutions. In general, the roles of civil society organisations have been limited to policies involving sustainable improvement of industry. The associations and cooperatives (e.g., Crushing Mill Associations, Oil Palm and Palm Oil Associations, and Oil Palm Cooperatives) that have taken part in the core relations are active in influencing economic terms to support business advantages such as feedstock supply. All of them are Thai palm oil board members who set guidelines that link to the policy. In addition, the roles of the Crushing Mill Associations, which created cooperation among crushing mills, such as propulsion of sustainable palm oil production, managing the total CPO stock for risk reduction, promoting CSR projects in social service such as biomass projects for electricity in communities, and funding education funds in the areas around mills. The socio-culture involved in the community biodiesel sector is greater than that involved in the commercial biodiesel sector, and the amount of production is determined by government regulation. In addition, the reason for the mandated in blending B100 is that it is the quantity of production that is the only option for consumers of industrial sectors. Some societal organizations have a project to encourage the community to produce biofuel from used vegetable oils or animal fats to reduce household expenditure.

In addition, the Biodiesel Producer Association has the roles of management consulting and network making that are often applied in the context of knowledge management, where the objective is to help organizations better exploit the knowledge and capabilities distributed across their members. The network of involved actors that are related to biodiesel production, including the research institutions, were established by the government to research the new technologies such as pyrolysis oil (also known as bio-oil or bio-crude), Fatty Acid Methyl Esters (FAME), and Hydrotreated Biodiesel (HBD).

CONCLUSION AND DISCUSSION

The network in the biodiesel industry was governed by the government on all economic, policy, and social issues. The mechanism of system interaction with the network between CPO and the biodiesel industry in three different networks is closely interconnected, according to the Triad Network Model. The network involved both private and state actors. Material and non-material flow in production, policy making, law and regulation, production and marketing systems were specified for the amelioration of oil palm farmers at upstream level. The networks connect through interaction that comes from policy targets that are concerned about the income of oil palm farmers in the FFB market.

In recent developments, implementation of the policy and regulations has been challenged. The biodiesel industry is not only linked with the involved actors on its network, but also the feedstock industry and the competition industry play more important roles in affecting the industry. There are many barriers in implementation to achieve initial aims. All the steps in production and consumption of biodiesel and its feedstock were dominated by the government, considering the palm oil sector as the feedstock first. The issues to be considered for policy making are the price of feedstock like FFB and CPO domestically, the supply of FFB, CPO, and cooking oil, the percentage

blending policy that should be balanced with the FFB and CPO quantity, and the command and control for importing and exporting palm oil and B100 policy.

There are many actors who are involved in the linked networks, such as economic, policy, and social networks. The triad network model was used to investigate the role of actors in each network. Biodiesel production cannot go without managing feedstock such as palm oil. The biodiesel industry needs to be dependent on the CPO industry and the percentage of blending regulations that are decided by the government. The actors in this network have less freedom in feedstock management. They hardly emphasize environmental considerations. The business production plan was linked to government regulation that was unpredictable. On the policy network, government organizations still play a main role, and they can select different policies to intervene by command-and-control biodiesel production and consumption nationwide. In the case of societal networks, the roles of civil society organisations are limited to those involving sustainable improvement of both the biodiesel and feedstock industries. NGOs and civil society have promoted community biodiesel production more than commercial companies, although there are a few companies involved. Therefore, the government uses both direct and indirect interactions *via* economic and societal networks, especially for the policy agenda and its implementation.

The Thai government does less to emphasize sustainability in terms of environmental and social goals, but just mentions this somewhat in the policy document, but in practice they focus primarily on the FFB price and the market and on how to control FFB supply. The ratio of B100 blending was linked to the national stock of CPO as feedstock, and the feedstock for biodiesel was competed with by food sectors like cooking oil. The national production network for the biodiesel industry consists of manufacturing companies and feedstock sectors linked with government institutions through policy goals and regulation. The industry is highly controlled by the government to achieve its sustainable goal in the oil palm FFB market and its use as a buffer in the FFB market.

We can conclude that there are many reasons for the policy. B100's target was not reached because its characteristics as the biodiesel industry in Thailand were linked to economic, social, and political issues, and B100 production has less liberalization in terms of market mechanism. The Thai government, in particular, was always intervening for support economic issues that link with smallholder farmer income in the palm oil sector and also link with cooking oil consumers' food expenditure were considered in the first priority for arranging the biodiesel policy and its implementation. The adjustment of policy and regulation has relied on the price of key primary feedstock such as FFB at an upstream level in the biodiesel supply chain. The next step of re-planning according to sufficient feedstock and encouraging feedstock and biodiesel market liberalization may also be interesting for actors on involved networks in collaborating and participating in upstream to downstream processes with efficiency in all stages of the process, transparency and consistence of policy making and implementing, developing technology and innovation, explicit regulation and agreement between policy makers and involved actors in both the business and environmental sectors, and collaboration of all the actors on the chain for deciding share benefits among actors on the chain.

Overall, the sustainability of biofuels like biodiesel cannot be designed by a unique individual. It was a change from others such as government policy, the security of feedstock industries such as FFB and CPO, and competitive product industries such as palm cooking oil. The main challenges in driving the palm oil and biodiesel industry to reach their targets are according to possible feedstock and keeping the stability policy.

Empirically, scholars have shown the network of biodiesel industry in developing countries such as (Goswami & Hazarika, 2016; Mohammadi et al., 2016), the keys challenge of the biodiesel industries are stable of feedstock production and private and state actors in driving the higher market price. However, biodiesel production is still being promoted alongside sustainable palm oil in order to achieve a balance and stability in economic, social, and environmental goals. (Babazadeh et al., 2017) confirmed that the assessing feedstock cultivation areas trough economic, ecological, social facto is important for policy planning. In addition, (Živković et al., 2017) have shown that the convergence of technological, economic, social, and environmental challenges will

boost biodiesel advantages and may lead to produce sustainable biodiesel. The key driving force for increased biodiesel production will be government policies. To create and apply applicable sustainability criteria in a consistent manner worldwide as soon as possible, increased cooperation among governments and diverse stakeholders is required. And also at the local level, (Romprasert & Jermsittiparsert, 2019) have suggested that the state authorities such as the Ministry of Energy should promote biodiesel in the local community by making a development plan for villages that aim to contribute to the biodiesel project to create benefits for the communities.

Therefore, the relevant elements of success in the biodiesel industry in Thailand as a developing country where is domestic feedstock cultivation are: biodiesel national policy, biodiesel production, potential of feedstock management, biodiesel market, and corroboration among involves actors on the economic, social, and policy network.

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REFERENCES

Anh, P.T., My Dieu, T.T., Mol, A.P.J., Kroeze, C., & Bush, S.R. (2011). Towards eco-agro industrial clusters in aquatic production: The case of shrimp processing industry in Vietnam. *Journal of Cleaner Production, 19*(17–18), 2107–2118. https://doi.org/10.1016/j.jclepro.2011.06.002

Babazadeh, R., Razmi, J., Rabbani, M., & Pishvaee, M.S. (2017). An integrated data envelopment analysis–mathematical programming approach to strategic biodiesel supply chain network design problem. *Journal of Cleaner Production*, 147, 694–707.

Chanthawong, A., & Dhakal, S. (2016). Stakeholders' perceptions on challenges and opportunities for biodiesel and bioethanol policy development in Thailand. *Energy Policy*, 91, 189–206. https://doi.org/10.1016/j.enpol.2016.01.008

Chavalparit, O. (2006). Clean technology for the crude palm oil industry in Thailand [Wageningen University]. http://library.wur.nl/WebQuery/wdab/1815315

Gaurav, N., Sivasankari, S., Kiran, G.S., Ninawe, A., & Selvin, J. (2017). Utilization of bioresources for sustainable biofuels: A Review. *Renewable and Sustainable Energy Reviews, 73*(January), 205–214. https://doi.org/10.1016/j.rser.2017.01.070

Goswami, K., & Hazarika, A. (2016). Supply chain network of Jatropha based biodiesel industry in North East India. *Sustainable Production and Consumption, 6*(January 2016), 38–50. https://doi.org/10.1016/j.spc.2016.01.002

Millinger, M., Ponitka, J., Arendt, O., & Thrän, D. (2017). Competitiveness of advanced and conventional biofuels: Results from least-cost modelling of biofuel competition in Germany. *Energy Policy, 107*(February), 394–402. https://doi.org/10.1016/j.enpol.2017.05.013

Ministry of Energy. (2018). Alternative Energy Development Plan. https://policy.asiapacificenergy.org/node/4351

Mohammadi, S., Arshad, F.M., & Ibragimov, A. (2016). Future prospects and policy implications for biodiesel production in Malaysia: A system dynamics approach. *Institutions and Economies, 8*(4), 42–57.

Mol, A.P.J. (1995). The refinement of production. Ecological modernization theory and the chemical industry.

Mol, A.P.J. (2003). *Globalisation and environmental reform: The ecological modernization of the global economy*. The MIT Press.

Mol, A.P.J., & Spaargaren, G. (2006). Sociological perspectives for industrial transformation. In understanding industrial transformation: Views from different disciplines (33–52). Springer.

Mol, A.P.J., Spaargaren, G., & Sonnenfeld, D.A. (2014). Ecological Modernization Theory: Taking Stock, Moving Forward. In S. Lockie, D.A. Sonnenfeld, & D. Fishe(Eds.), Routledge International Handbook of Social and Environmental Change (October) 15–30. Routledge.

Mukherjee, I., & Sovacool, B.K. (2014). Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand. *Renewable and Sustainable Energy Reviews*, 37, 1–12. https://doi.org/10.1016/j.rser.2014.05.001

Nupueng, S., Oosterveer, P., & Mol, A.P.J. (2018). Implementing a palm oil-based biodiesel policy: The case of Thailand. *Energy Science and Engineering, 6*(6), 643–657.

Prasertsri, P., & Chanikornpradit, M. (2020). Biofuels Annual. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels Annual_Bangkok_Thailand_06-30-2020

Romprasert, S., & Jermsittiparsert, K. (2019). Energy risk management and cost of economic production biodiesel project. *International Journal of Energy Economics and Policy, 9*(6), 349–357. https://doi.org/org/10.32479/ijeep.8367

Thongplew, N., Kris van Koppen, C.S.A., & Spaargaren, G. (2016). Transformation of the dairy industry toward sustainability: The case of the organic dairy industries in the Netherlands and Thailand. *Environmental Development, 17*, 6–20. https://doi.org/10.1016/j.envdev.2015.11.005

Tunpaiboon, N. (2020). Industry Outlook 2020-2022: Biodiesel. https://www.krungsri.com/en/research/industry/industry-outlook/Energy-Utilities/Biodiesel/IO/io-biodiesel-20

Tunpaiboon, N. (2020). Industry Outlook 2020-2022: Biodiesel. https://www.krungsri.com/en/research/industry/industry-outlook/Energy-Utilities/Biodiesel/IO/io-biodiesel-20

van Koppen, C.S.A., & Mol, A.P.J. (2002). Ecological modernization of industrial ecosystems. In P. Len,. Pol, L.H., Wilderer, & Asano, T. (Eds.), Water Recycling and Resource Recovery in Industry: Analysis, Technologies and Implementation, (132–158).

Wattanapinyo, A., & Mol, A.P.J. (2013). Ecological modernization and environmental policy reform in Thailand: The case of food processing SMEs. *Sustainable Development, 21*(5), 309–323. https://doi.org/10.1002/sd.506

Worapun, I., Pianthong, K., & Thaiyasuit, P. (2012). Two-step biodiesel production from crude Jatropha curcas L. oil using ultrasonic irradiation assisted. *Journal of Oleo Science, 61*(4), 165–172. https://doi.org/10.5650/jos.61.165