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Identifying social and political obstacles to bioethanol production from sugarcane in East Java, Indonesia

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Table of contents

Table of contents **2**

Abstract **4**

Acknowledgements **5**

Abbreviations and acronyms **6**

1. Introduction **7**
1.1 Aim and research questions *8*
1.2 Significance of study *8*
1.3 Thesis outline *9*

2. Background **9**
2.1 Biofuel revolution *9*
2.2 Sugarcane industry *10*
2.2.1 Sugarcane production in East Java 10
2.2.2 Issues of Indonesia's sugar industry 10
2.3 Bioethanol industry *11*
2.3.1 Bioethanol from sugarcane 11
2.3.2 Indonesia's biofuel targets 12

3. Theoretical framework **12**
3.1 Multi-level perspective *13*
3.2 Technological innovation systems *14*
3.3 Political Ecology *14*

4. Methodology **15**
4.1 Case study *15*
4.2 Data collection *16*
4.3 Sampling *17*
4.4 Coding and data analysis *17*
4.5 Ethical considerations *18*
4.6 Limitations and delimitations *19*

5. Results **19**
5.1 Function 1: Entrepreneurial activities *21*
5.2 Function 2: Knowledge development *21*
5.2.1 Lack of quality seeds 21
5.2.2 Climate change effects 22
5.3 Function 3: Knowledge diffusion *22*
5.3.1 ISRI's lack of financial resources 22
5.3.2 Plantation- and sugar content determination systems 23
5.4 Function 4: Guidance of the search *23*
5.4.1 Top-down policy issue 23
5.4.2 Sugar import 24
5.4.3 Feedstock competition 24
5.5 Function 5: Market formation *24*
5.5.1 Market price of bioethanol 25

5.5.2 Export and tax regulations 26
5.6 Function 6: Resources mobilisation *27*
5.6.1 Lack of quality feedstock 27
5.6.2 Decreasing number of sugar factories 28
5.6.3 Farm-to-factory timing 28
5.6.4 Agricultural techniques and factory efficiency 29
5.6.5 Loan issues 29
5.6.6 Technical and financial issues 29
5.6.7 Expansion of land 30
5.7 Function 7: Creation of legitimacy *30*
5.7.1 Objection of legislative 30
6. Discussion 31
6.1 Authority *31*
6.2 Financial support *34*
6.3 Information *35*
6.4 Summary *36*
7. Conclusion 38
8. References 40
9. Appendixes 44

Abstract

Indonesia has implemented national policies and legislations to encourage biofuel production as means to achieve energy security and self-sufficiency and to reduce reliance of fossil fuel reserves. However, there is still no clear road-map for the socio-technological transition. While acknowledging economic impediments, this case study investigates social and political obstacles to bioethanol production from sugarcane in East Java, Indonesia. This study is based on Multi-Level Perspective and Technological Innovation System as integrated theoretical frameworks together with Political Ecology as an approach to get around the complexity of biofuels. Based on primary data, the research identifies several social and political obstacles to the bioethanol development. Indonesia's sugar industry is facing many issues and therefore this study considers a reboot of the sector to be a prerequisite for bioethanol development in Indonesia. The research finds that many obstacles are related to lack of mobilisation of resources, and cooperation is found to be key in facilitating the bioethanol transformation in the particular context. The inconsistency of policies and legislations of sugar import, bioethanol targets and export regulations is evident, and can be traced to be hampered by lack of government commitment and top-down policy structure. For the socio-technological transition to take off, it is essential for all stakeholders involved to strive for sugar- and bioethanol industries to be integrated, through measures of more effective communication tools, multi-stakeholder participatory processes and incentives for collaboration.

Key words: biofuels, bioethanol, sugarcane farming, sugar industry, socio-technological transition, Indonesia, East Java

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Abbreviations and acronyms

BPTP	Balai Pengkajian Teknologi Pertanian (Agricultural Technology Assessment Centre)
EBTKE	Ministry of Energy and Mineral Resources' Directorate General of New Renewable Energy and Energy Conservation
FGD	Focus Group Discussion
INSIST	Indonesian-Swedish Initiative for Sustainable Energy Solutions
ISRI	Indonesian Sugarcane Research Institute
MEMR	Ministry of Energy and Mineral Resources
MLP	Multi-Level Perspective
MSG	Monosodium Glutamate
KUR	Kredit Usaha Rakyat (Credit for the Poor)
PTPN	PT Perkebunan Nusantara X
TIS	Technological Innovation Systems

1. Introduction

The world's dependency on fossil fuel has caused unfavourable effects. As a sustainable option to tackle problems associated with lessening crude oil reserve, decreasing air quality, rising global temperature, unpredictable weather change, biofuels have attracted attention. To promote independency from fossil fuel, bioethanol is now favoured as the blend or fossil petrol substitute. This study aims to identify social and political obstacles, beside economic obstacles, to bioethanol production from sugarcane in East Java. It seeks to contribute with the findings as inputs for policy-making for deployment of bioethanol in Indonesia with focus on segments that offer particular advantages in terms of agricultural and industrial synergy, climate change mitigation and adaptation, economic value-added and social welfare creation.

In 2015, the government of Indonesia issued a new policy on mandatory biofuels targets which includes targets that fuel ethanol blending for transport should fulfil 20% by 2025 of the total gasoline fuel consumption (Khatiwada and Silveira, 2017: 351). Alleviation of poverty and unemployment, socio-economic development, fossil fuel substitution, and diversification of energy sources motivate the efforts being made through Indonesian biofuel policies. Furthermore, the government of Indonesia has developed preferential policies for sugarcane field expansion which can help increase sugar production and meet the surging demand for sugar (Obidzinski et al., 2016, In: Khatiwada and Silveira, 2017). Indonesia has a comparative advantage for biofuel production because of great availability of land, favorable climatic conditions for agriculture and low labor costs (Casson, et al., 2014). This study considers the potential of increased productivity of sugarcane industry to be linked to efforts in meeting the biofuel targets, through development of bioethanol production using sugarcane as feedstock.

Indonesia is a very large archipelago with around 6.000 inhabited islands and more than 250 million inhabitants (Cia.gov, 2017). There is an average 6.5% growth in gasoline consumption per year and gasoline demand is expected to continue increasing in the near future. The transport sector is one of the main sources of greenhouse gas emissions and local air pollution in urban centres. In this context, it is of importance for the government of Indonesia to find alternative fuel solutions. Nevertheless, in spite of the country's favourable conditions for biofuel deployment, the government's efforts to reduce fossil oil dependency, and some progress achieved lately in biodiesel production and blending, fuel ethanol production has not taken off (Khatiwada and Silveira, 2017: 352).

1.1 Aim and research questions

This study aims to evaluate if there exist any social or political obstacles for bioethanol production in East Java, Indonesia. It seeks to explore the relations (or non-existing relations) between stakeholders involved in the bioethanol development. By identifying any impediments to success, the study resultantly point in the direction of work needed to address gaps and overcome existing challenges that constrain the socio-technical transition. Using sugarcane as the feedstock for bioethanol production as a case study of special interest, vulnerability to climate change is considered together with the shift to low carbon development pathways, rather than analysing mitigation and adaptation measures separately. The case study will be framed in the overall context of enabling policies and institutions at national and provincial levels, to address complex barriers to sustainability and with the findings contribute to provide lessons for the longer-term development of biofuels in Indonesia. The research aims to answer subsequent research questions:

Which are the social and political obstacles to bioethanol production from sugarcane in East Java, Indonesia?

Which are the key actors - in terms of authority, financial support and information, in catalysing the transition pathway and how can they be supported to fulfil their roles?

1.2 Significance of study

Different studies have evaluated the amount of suitable land for sugarcane production in Indonesia. Research has also been conducted on energy production from sugarcane in Indonesia. Khatiwada and Silveira (2017) published the first scientific literature on the potential of fuel ethanol production from sugarcane in Indonesia. It provided an assessment of how to meet the domestic sugar demand and the ambitious bioethanol blending targets in the transport sector. The authors acknowledged that such information is particularly important at this point as the country has recently decided to abolish fuel subsidies applied to gasoline, enacted revised biofuel policies, and planned for sugar self-sufficiency (Khatiwada and Silveira, 2017: 353).

However, as several studies focus on economic obstacles, there is lack of research on social and political obstacles and the social network in the particular context. Therefore, this study aims to fill this knowledge gap by identifying and examining such obstacles in order to provide inputs for policy makers and private

investors of how to increase sugar productivity to meet the domestic sugar demand and the ambitious bioethanol blending targets in the transport sector – if possible. Importantly, as biofuel is embedded in a complex reality and many controversial debates, such as the food vs fuel debate, this study aims to provide a valuable overview of the social network, to identify how key actors can be supported to fulfil their role in the development in the most sustainable way possible. The chosen region of East Java in Indonesia, with focus on sugarcane as crop, is used for this study as it compared to other crops has potential to eliminate risks concerning food vs fuel debate.

1.3 Thesis outline

The next section of the thesis is the background, which includes a literature review of bioethanol set within the biofuel sector as well as the sugar industry. The theoretical framework is thereafter outlined. Following is a section regarding methodology, which includes research design, data collection, ethical considerations and limitations and delimitations. The results are then presented, followed by a discussion in which the results are analysed. Lastly, conclusions are drawn and suggestions for continued research are presented.

2. Background

This section provides a background for the case study in which context regarding biofuels, and more specifically bioethanol, Indonesia's sugar industry is outlined, with focus on province of East Java.

2.1 Biofuel revolution

Bioethanol is an energy source labelled under biofuels. The biofuels revolution responds to an assumed 'energy crisis', as the cost of capital inputs rises in an age of peaking oil supply. In order to reduce oil imports, governments attempt to develop an industrial biofuel complex to sustain 'energy security' (Borras et al, 2015: 576). At the same time, biofuels represent an interconnected and multidimensional phenomenon that is a new profitability frontier for agribusiness and energy sectors beset with declining productivity and/or rising costs (Magdoff 2008, McMichael 2009, Houtart 2010, McMichael 2010, In: (Borras et al., 2015: 576). Previous studies on the impacts and consequences of biofuels have discovered complex relationships between the state, capital and society, often highly specific to a particular locale (Borras et al, 2015: 583). Dauvergne and Neville (2010, In: Borras et al., 2015: 583-584), emphasise that

the timing of market entry, the nature of existing institutions and historical state-society land tenure relations will be particularly important for equal distribution of benefits from such development.

As Indonesia plans to meet sugar self-sufficiency by 2022, at the same time, has defined mandatory bioethanol targets, it is important to investigate the productivity of the sugarcane industry and potential to increase the production of sugar and bioethanol (Khatiwada and Silveira 2017: 352). The starting point of this study is to investigate social obstacles of the sugar industry as well as current bioethanol production, in order to contribute to the literature with suggestions of how the targets for sugar and bioethanol production can be simultaneously.

2.2 Sugarcane industry

2.2.1 Sugarcane production in East Java

Sugarcane is one of the major crops in Indonesia and is conventionally used for sugar production. The industry has persisted since Dutch colonial times when sugarcane plantations were established on existing smallholder agricultural lands, mostly in Central and Eastern Java (Nelson and Panggabean 1991, In: Obidzinski et al., 2016). Indonesia's sugar sector was self-sufficient until 1985 but cane yields have since then stagnated due to political, economic, and market dysfunctions. Noteworthy, from being a major world sugar producer in the early 19th century, the country is now one of the largest importers (Khatiwada and Silveira, 2017: 353). In 2013, 57% (3.34 million ton) of the total sugar consumption was imported (ibid) (Appendix 1). Indonesia currently has 63 sugar mills owned by 18 companies (Toharisman and Triantarti, 2016: 636). Most of the sugar mills are old and 65% of the mills have been operating for 100-184 years (Khatiwada and Silveira, 2017: 354). It should be noted that 70% sugarcane is cultivated on Java with smallholder sugarcane farming predominating the sector (ibid: 359).

2.2.2 Issues of Indonesia's sugar industry

Following the 1998 economic crisis, as part of an International Monetary Fund (IMF) rescue package, the Indonesian government liberalised sugar production and trade policies. Support programs for smallholder sugarcane production were removed, which is one of the reasons for stagnation of the industry (Rusastra et al. 2008, In: Obidzinski et al., 2016).

Many issues continue to plague the Indonesian sugar industry, ranging from aging factories, reduced sugarcane fields, new diseases and biosecurity issues, lack of good seed varieties, farm inefficiency, poor adoption of technology, lack of skilled human resources, slow pace of product diversification, low productivity to a flood of cheap imported sugar due to poor market regulation and lack of adequate research to support the industry (Toharisman and Triantarti, 2016: 363). Given these factors, Indonesian total sugarcane area, especially on Java, is declining (Toharisman and Triantarti, 2016: 367). Additionally, sugarcane has had to compete with other crops, especially rice and palm oil. Less attractive returns as compared to other crops have continued to discourage farmers in East Java from growing sugarcane. Therefore, sugarcane production to also be used for bioethanol is an alternative to expanding palm oil industries, which have had damaging impacts on the environment. The economic significance of sugarcane is relatively small compared with palm oil and industrial timber plantations, although sugar is considered a strategic commodity regarding employment opportunities (Casson, et al., 2014: 14). Evidently, Indonesia's sugar industry is facing many issues and therefore this study considers a reboot of the sector to be a prerequisite for bioethanol development in Indonesia.

2.3 Bioethanol industry

2.3.1 Bioethanol from sugarcane

Bioethanol is a renewable and sustainable liquid fuel that is expected to have a promising future in tackling today's global energy crisis and the worsening environment quality. Globally, bioethanol dominates the renewable energy supply in the transport sector (Aditiya et al., 2016: 632). In spite of low oil prices, global production of fuel ethanol increased by around 4% between 2014 and 2015. A major reason behind such development is that government policies in many countries are increasingly promoting ethanol production through various subsidies and blending targets. Bioethanol as a transport fuel contributes to reduce local air pollution, dependency on imported fossil oil and greenhouse emissions. Among the various biofuels, bioethanol from sugarcane is already commercially produced in many countries such as Brazil, where it is used as an octane enhancer (Khatiwada and Silveira, 2017). Results from an analytical hierarchy process showed that sugarcane is the most potential feedstock to produce ethanol in Indonesia. The analysis was based on criteria including 1) food crop with surplus production, 2) plant productivity, 3) yield of biofuel, 4) multipurpose energy plant, 5) plant development readiness, 6) government policy, and 7) uncompetitive land use for food crop/easiness to grow in marginal land (Hambali et al., 2015: 629).

2.3.2 Indonesia's biofuel targets

Biofuels have received increased attention in Indonesia since 2006 after the promulgation of a national energy policy, which was later replaced in 2014 with Government Regulation No. 79/2014 (International Energy Agency, 2017). Aimed at diversifying the country's energy mix, it includes a 5% minimum share of biofuel in the total national energy consumption by 2025. In 2015, the government of Indonesia issued a new policy on mandatory biofuel targets (presidential regulation no. 12/2015). Regarding transport, fuel ethanol blending of the total gasoline fuel consumption should fulfil 2% by 2015, 5% by 2016, 10% by 2020 and 20% by 2025 (Khatiwada and Silveira, 2017: 351). The main intention of the regulations is to reduce Indonesia's dependence on imported fossil fuel and cushion it from the erratic price fluctuations, but also to support regional development in rural areas (Hasibuan and Nazir, 2017: 277).

However, despite the new regulations, there is no road-map defining how the bioethanol blending targets will be achieved. Although bioethanol in Indonesia began to be produced from molasses in 2007, the activities were interrupted in 2010 due to economic regression and liberalising policies. This is in contrast to biodiesel production, which has seen successful development. According to Khatiwada and Silveira (2017: 351), "lack of economic competitiveness in the sugarcane agro-industrial sector, low yields, gasoline fuel subsidies, and volatile international prices of petroleum have hindered domestic production and use of bioethanol in Indonesia". Noteworthy, there is an average 6.5% increase of gasoline consumption per year and the demand is expected to continue increasing (ibid). In this context, it is of vital importance for the government of Indonesia to find alternative solutions to the transport sector and define the biofuels roadmap.

3. Theoretical framework

A comprehensive framework for addressing the complexity of biofuel development does not exist. This study therefore includes a combination of following theories as the foundation of its conceptual framework: Political Ecology, Multi-Level Perspective (MLP) and Technological Innovation Systems (TIS). MLP is utilised to analyse the level of entrenchment of the technology in the technical and social context. TIS is a useful approach to capture an analyse the dynamics that occur in the process of technology development, while Political Ecology helps to address the complexity of bioethanol development.

3.1 Multi-Level Perspective

MLP is based on three concepts to assess the development of socio-technical transformations, in this case biofuels; 1) 'Regimes' (meso) are a set of rules embedded in an engineering community's institutions and infrastructure, which shape technological innovations. 2) 'Niche' (micro) is the level at which innovation and can be developed – agriculture and biofuels. 3) 'Landscape' (macro) refers to the processes that occur within the wider political, social, cultural and economic background (Geels, 2002, 2010).

Socio-technical transformations are defined as major, long-term technological changes in the way societal functions such as transportation or energy are fulfilled (ibid). According to Geels (ibid), for socio-technical transformations to occur, human agency, social structures and organisations are essential as they influence the supply of and demand for technology. Therefore, technological change is ultimately context-dependent and is determined by developments at the levels of the existing regime and by local changes at the niche level, as well as the broader socio-technical landscape. Kemp et al. (2001) argues that it is the 'alignment' of developments at different levels that determines if a regime shift can occur and therefore, niches are defined as configurations in which innovation can develop.

Researching socio-technological transitions as in this case study, basing the theoretical framework on MLP builds on a crossover of interpretivism/ constructivism and conflict ontologies (Geels, 2010). Using such ontologies, MLP highlights concepts that are useful for this research: dynamic relations between 'agency and structure', 'change and stability', 'material interests and symbolic meanings', and 'rational strategy and institutional embeddedness' (Geels, 2010). MLP's combination of ontologies also allows analysis of power and political dynamics that contribute to existing lock-in effects and path-dependencies, and hinder the breakthrough of niche innovations and niche-regime formation (ibid). The importance of incorporation of, and cooperation between stakeholders is acknowledged, as it would increase the potential and enable 'window of opportunity' (Geels, 2002) to develop biofuel production in Indonesia. These dynamics captured in MLP have helped to guide this study in formulating research questions and methodology, to guide the research to assemble valuable findings in order to contribute to provide useful policy recommendations.

However, MLP has been criticised for undervaluing the role of agency and politics and for emphasising the 'needs' of technology as well as focusing too much on path dependency and technological trajectory in a techno-economic sense (Genus and Coles, 2008: 1440). To strengthen the analysis of agency by

relating it to power, civil society movements and cultural dimensions has been suggested to enhance the credibility of MLP for analysing socio-technological transitions.

3.2 Technological Innovation Systems

To meet the outlined critique of MLP, this study includes TIS to shed light on the importance of agency in biofuel transitions and form a comprehensive theoretical framework for this case study. TIS complements MLP as it enables a better description and understanding of the structure, dynamics and functions of innovation systems, and identify possible 'system failures' (Carlsson and Stankiewicz, 1991; Klein Woolthuis et al., 2005).

TIS underlines a number of processes, labelled as 'functions of innovation systems', that are highly important for well performing innovation systems (Hekkert, et al., 2007). In line with TIS, this research views system-level change as a process that can be enacted through the interactions of many actors and the resources they mobilise (Smith et al., 2005a). There is often lack of cooperation between key actors in the field (ibid), thus, network structure and actors' positions will be analysed. The analysis is based on their expectations, interests and willingness to mobilise resources for the growth potential of the new technology. However, TIS has been criticised for providing insufficient guidelines for practical implementation (Klein Woolthuis et al., 2005). Yet for this study, the combination Political Ecology, MLP and TIS, is believed to enable the analysis to generally capture the structural characteristics and dynamics of bioethanol as an innovation system, and more specifically enable identification of social and political obstacles to bioethanol production in East Java.

3.3 Political Ecology

Lastly, this research includes Political Ecology to overcome the limitations of MLP and TIS. Often, decision-making surrounding biofuel development is not holistic and overlooks the importance of comprehensive stakeholder participation. Political Ecology emphasises an in-depth understanding of social structures (Hollander, 2010) and importance of transparency (von Maltitz et al., 2009). Using Political Ecology to evaluate biofuel development, it raises questions such as: Where are the centres of power? What forms of resistance exist? What are the issues that unite and divide key actors around biofuels? (Borras et al., 2015: 576). The impact and consequences of the biofuel revolution are predicated on complex relationships between the state, capital and society (Borras et al., 2015: 583). According to Blaikie and Brookfield (1987: 17), development of biofuels cannot be understood in isolation from the

political economic contexts within which they are embedded. Thus, Political Ecology highlights many aspects of complexity that characterises biofuel development and such acknowledgment is essential for understanding obstacles to biofuel development. In addition, the study draws on Bryant and Bailey's (1997) actor-oriented approach to Political Ecology, which underlines the need to focus on the interests, characteristics and actions of different actors. This approach views conflicts over resources as an outcome of the interactions between the diverse, typically competing interests of different actors. By adopting this hybrid approach, it complements the theoretical framework for this research in order to capture the complexities of political, economic and ecological dynamics of bioethanol (Hollander, 2010).

4. Methodology

This section includes the methodology chosen for the study. The research design and methods used for data collection and analysis will be presented, followed by a presentation of ethical considerations and limitations and delimitations.

4.1 Case study

This thesis is designed as an intrinsic case study, in which detailed information is sought about the chosen case (Punch, 2014:121). In order to achieve the objective of investigating obstacles to bioethanol production from sugarcane in East Java and analyse the social network, a qualitative research design based on a literature study has been applied. The study is based on empirical data collected during a 8-week minor field study supported by SIDA (Swedish International Development Agency) between March-April 2017 in East Java, Indonesia[1]. Due to lack of studies covering the topic, collection of primary data was appropriate in order to answer the research questions.

[1] A map of Java, the island where East Java is one of four provinces, is included as Appendix 4. It indicates the places where the field study was conducted.

4.2 Data collection

The data collection was conducted in collaboration with the Swedish Energy Agency-funded project 'Indonesian-Swedish Initiative for Sustainable Energy Solutions' (INSIST), and its Indonesian partner Sustainability and Resilience (su-re.co). Data was collected by means of participant observation, qualitative semi-structured interviews and focus group discussion (FGD) with various stakeholders related to bioethanol production in East Java. The field data is supported by secondary data collected from a literature review of previous studies related to sugarcane industry and bioethanol development, as well as theories used as theoretical framework. As economic obstacles have previously been studied, and in attempt to narrow down the focus of the research, initially this null hypothesis was used for guidance: *There are no social or political obstacles, beside economic obstacles (i.e. uncompetitive market price of bioethanol against fossil fuel) for bioethanol production from sugarcane in East Java, Indonesia*.

In total, 14 interviews (Appendix 2) were conducted including 20 interviewees, meaning that in several interviews, there were more than one interviewee. One FGD was conducted with 7 stakeholder participants (Appendix 3). The structure of the questionnaires was inspired by questionnaires that were used for a similar INSIST study on biogas in Indonesia. However, as producer and end-user differ between biogas and bioethanol, the questions were largely modified. The incrementally improved questionnaires were further developed by pilot testing and feedback process with collaborators during the field work, who have previously conducted many other similar studies for Stockholm Environment Institute (SEI) and TRANSrisk (European Commission project). Subsequently, the creditability of the questionnaires and consequently the findings of this research was enhanced by the collaboration with experts in the field.

There were a number of predetermined questions, but the interviews were open-ended, which allows space for discussions (Bryman, 2008: 404). All interviews and FGD were recorded, and note-taking was done by the researcher and assisting researchers. There was an interview questionnaire for each type of stakeholder – farmer, sugar mill, bioethanol producer, research institute, government agency, and private sector. The FGD was held after all interviews had been conducted. This allowed the researcher to briefly summarise and analyse the collected data from interviews, to facilitate a fruitful discussion during the FGD's social network analysis exercise. Firstly, the discussion allowed the identified obstacles to be confirmed. Secondly, identifying the roles and the needs of all stakeholders involved, allowed recommendations to be formulated as means to strengthen the relations in the social network, in order to

improve the bioethanol industry in Indonesia. Furthermore, participant observation was conducted throughout the field work by note-taking.

4.3 Sampling

This study utilised purposive sampling, as it involves finding respondents befitting for the research question, in combination with the snowball sampling approach. By using already established contacts, it enabled connection with further informants within the relevant part of the field (Bryman 2012: 424). The organisations were selected on the basis that all occupied a position relevant to the investigation, the individuals interviewed also had key roles in the organisations and in-depth knowledge of the sugarcane and/or bioethanol sector. The snowball approach proved useful for finding informants such as farmers. Both the interview and FGD participants were mostly male, reflecting on the over-representation of men having higher level positions at research institutes, sugar mills, bioethanol factories and government agencies.

4.4 Coding and data analysis

Open coding and analysis were processes first initiated in the field and later intensified during the thesis-writing process. Thematic analysis was employed to analyse the data – applied by paying special attention to repetitions of topics, similarities and differences in experiences, theory-related data and 'missing data' (Bryman 2012: 579). The research focus is supported by the idea that system-level change is enacted through the interactions of many actors and the resources they mobilise, whether these are intended or emergent features of the transformation process (Smith et al., 2005a). Networks are not always cooperative (ibid) and therefore, the analysis aims to understand the network structure and position of actors that are incumbent and supportive of the socio-technical transition. It is based on their expectations, interests and willingness to mobilise resources for the growth potential of bioethanol.

In order to present and visualise the results in the following section, a table has been developed in which the most significant identified obstacles are categorised by the three levels of MLP (see 3.1) and seven functions in TIS (see 3.2). In the section of Discussion, Political Ecology supports MLP and TIS to critically analyse the results. Three categories *(authority, financial support and information)* have been selected to identify the role and needs of, as well as the relations between the different actors used in this study. These categories were used in interviews and FGD to map out the social network. *Authority* refers

to the moral or legal right or ability to control; a group of people with official responsibility for a particular area of activity (Dictionary.cambridge.org, 2017). *Financial support* refers to the provision of monetary resources including money or capital and credit (ibid). *Information* refers to any valuable technical, social, financial, and institutional information related to bioethanol production that if shared, can contribute to the socio-technical transition. By using these categories in the data collection, the data is already divided into different themes/codes, which facilitates the analysis. In summary, the thematic analysis seeks to identify obstacles of bioethanol development in East Java, as well as to find which actors that with further support to fulfil their roles, can contribute to overcome the identified obstacles.

4.5 Ethical considerations

Ethical considerations in field work in international contexts are critical. In order to undertake ethnical research, positionality has been taken into account to avoid biases (Sultana, 2007). The position of the researcher as a Scandinavian female university student results in certain biases. This means that the knowledge produced is partial, and as such, interpretations have historical and cultural situatedness (ibid). Regarding language, the researcher's positionality limited the capabilities to act ethically. As all interviews were conducted in Bahasa Indonesian, the researcher was assisted by one interviewer, one note-taker as well as one assistant translating to the researcher throughout the interview and FGD. Such measures proved helpful in maintaining the conversation to flow, while allowing the researcher to passively engage and guide the discussion. The research team includes only women, while most research participants are male, which may have affected the results.

Consent form and information sheet were provided to participants and signed before interviews and FGD. The information sheet included a general overview of the project, as well as specific information on the expected participation and handling of information generated with the research activities. To enhance transparency, the informants were informed of the rights of confidentiality, anonymity and the option not to answer and/or terminate the interview (Bryman 2012: 226, 390). All participants gave their consent to be referred to their real names. In the study, participants are referred to by the equivalent to Mr/Mrs in Bahasa Indonesian – Pak (Bapak) and Ibu before their surnames. A list of interview- and FDG participants are attached as Appendix 5.

4.6 Limitations and delimitations

As the research design is a case study, it implies limitations in terms of generalising the findings to a broader extent, as it has specific geographical location and background. However, as the study focuses on the region of East Java in its particular context, it does not aim to generalise any findings. The stakeholders related to the bioethanol production in East Java is context dependent and the purposive sampling method used may limit varied representative data.

Drawing on Political Ecology, the study stresses that biofuels represent a highly complicated technology-policy complex, linking multiple agendas, sectors and markets. With regards to delimitations, this means that general statements about whether biofuels are 'good' or 'bad' are obstructive as they overrule the importance of context in determining the actual outcomes of biofuels. For example, land use change emissions, which many researchers have expressed concern over (Borjesson and Tufvesson 2011; Yeh and Witcover, 2013; Mosnier, et al., 2013), is outside of scope for this study. The potential land competition that may arise as a result of sugarcane expansion has not been addressed either. With regards to the food vs fuel debate related to biofuels, this study considers the utilisation of sugarcane biomass for energy *and* food production. Lastly, study is limited for sugar and ethanol using first and second generation technologies, and does not consider production from other feedstocks. The former is ethanol produced from sugar juice and latter from agricultural residues (Wellington and Nilson, 2016).

5. Results

In this section, the interview results will be presented categorised according to the theoretical framework. A market scheme based on the secondary data was used in interviews to facilitate a discussion, and later modified using suggestions by the interview and FGD participants (see Appendix 6 and 7). The obstacles and relations in the social network were detected through a thematic analysis of the field data. A stakeholder list which includes the interviewees choices of the three most significant obstacles is attached as Appendix 5. Following is a table showing the identified obstacles categorised by the three levels of MLP and seven functions of TIS.

Following are the definitions of MLP's levels used in this study: 1) 'Regime' (meso) is the energy sector (for transportation) in Indonesia. 2) 'Niche' (micro) is bioethanol production from agricultural sector in East Java. 3) 'Landscape' (macro) is political, social, cultural and economic processes in Indonesia (Geels, 2002, 2010). The functions of TIS refer to: F1: Entrepreneurial activities, F2: Knowledge development, F3: Knowledge diffusion, F4: Guidance of the search, F5: Market formation, F6: Resource mobilisation, F7: Creation of legitimacy (Hekkert et al., 2007).

Table: Categorisation of obstacles

MLP levels / **Obstacles**	Regime	Niche	Landscape
Lack of quality seeds		F2, F6	
Climate change effects		F2, F3, F6	
ISRI's lack of financial resources		F3, F4	
Plantation and sugar content determination systems		F3	
Top-down policy issue			F4
Sugar import			F4
Feedstock competition		F4	
Market price of bioethanol	F5	F1, F5	
Export and tax regulations	F5	F5	
Lack of quality feedstock		F2	
Decreasing number of factories		F6	
Farm-to-factory timing		F3, F6	
Agricultural techniques and factory efficiency		F6	
Loan issues		F6	
Technical and financial issues		F6	
Expansion of land	F6		
Objection of legislative	F7		

5.1 Function 1: Entrepreneurial activities

There are currently few entrepreneurial activities of bioethanol production, more specifically fuel grade ethanol for transportation, in East Java. Activities relating to this function involve projects aimed to prove the usefulness of the emerging technology in a practical and/or commercial environment (Hekkert et al., 2007: 421-422). The presence of active entrepreneurs is a first and prime indication of the performance of an innovation system. Therefore, the lack of sales of fuel grade for the bioethanol producers (due to obstacles outlined below), indicate absence of successful performance (F1).

5.2 Function 2: Knowledge development

F2 involves learning activities, mostly on the emerging technology, but also on markets, networks, users etc. Research and development is a prerequisite within the innovation system. This function encompasses 'learning by searching' and 'learning by doing' (Hekkert et al., 2007: 422). It is also therefore that the lack of F2 is often a result of lack of F3 and F6. The obstacles of 'Lack of quality seeds' and 'Climate change effects' are good examples of how the decreasing productivity in sugarcane farming effects the sugar mills' performance, and resultantly also feedstock availability for bioethanol producers.

5.2.1 Lack of quality seeds

Lack of quality seeds relates to F2 and F6 at niche level. According to Pak Risvan **(**Interview 9, 2017-04-04), post-harvesting and off-farm manager at Indonesian Sugarcane Research Institute (ISRI), one of the main issues of the sugarcane industry is quality decrease. The sugar proportion of the sugarcane, often referred to as "rendenment" (Bahasa Indonesian: amount of sugar in 1 ton sugarcane), has decreased in Indonesia over the last few years. Ideally, sugarcane needs to be re-planted with new seeds every 8 years to avoid degradation (pest and disease). However, the sugarcane in East Java has not been re-planted for 10 years – mainly due to financial reasons. Sugarcane seeds of good quality is difficult to find and ISRI plays an important role in the research. Previously, ISRI received funding from government but it was halted due to bureaucratic barriers (see 5.3.1). As of now, ISRI receives funding from Australia (CSIRO) and some Asian countries, but it is not enough to produce new variety seeds of good quality (ibid).

There are subsidies and incentives for seeds and fertilisers but it is all of bad quality. A sugarcane farmer stressed that the government need better collaboration with research institutes before providing subsidies (Interview 2, Pak Junaedi, 2017-04-03). The head of a sugarcane farmer association (Interview 14, Pak Muhbin, 2017-04-05) also emphasised that as the governmental financial support to ISRI ended, it has

had significant consequences on the sugarcane yields. All stakeholders agree that it is mainly the lack of new variety seeds that is causing the significant decrease of the sugar content.

5.2.2 Climate change effects

Lack of support to farmers to combat climate change effects is related to F2 (in addition to F3 and F6) at niche level. The land condition significantly determines the quality of the sugarcane. Most of the interviewed actors, including Pak Efendi, general manager of Watoetoelis sugar mill (Interview 4, 2017-04-05) and Pak Setiawan, research and development manager at PTPN (Interview 12, 2017-05-05) agree that climate change has had a negative impact on the sugarcane yields. The financial production manager at the sugar mill Gempolkrep (Interview 6, Pak Sugianto, 2017-04-05) explains that climate change has prolonged the rain season and during the harvesting months when the sugarcane needs dry land, it now rains. The many floods that occur in East Java during rain season reduce sugarcane land by almost 40% a year.

5.3 Function 3: Knowledge diffusion

Activities of F3 involve partnerships between actors, but also workshops and conferences. The primary function of networks is to facilitate knowledge exchange between actors. It is important for technological transitions that policy decisions (standards, long term targets) to be consistent with the latest insights (such as agricultural and bioethanol technology, etc.) (Hekkert et al., 2007: 423). It is apparent that there is major lack of cooperation between stakeholders in sugar and bioethanol industries. Resultantly, many obstacles are categorised under this function.

5.3.1 ISRI's lack of financial resources

A major obstacle for Indonesia's sugar industry, which relates to F3 and F4 at niche and landscape level, is lack of knowledge development and exchange between ISRI and other actors. It is mainly due to lack of financial support. If supported, ISRI could play a key role for F3, as it is the primary research institute on sugarcane in Indonesia. They used to receive funding from the Ministry of agriculture through BPTP (Agricultural Technology Assessment Centre). However, since 2009 ISRI is labelled under the Ministry Indonesian State Owned Enterprises and there is a bureaucratic friction between the two ministries. Therefore, as a company, ISRI cannot receive any government funding (Interview 9, Pak Risvan, 2017-04-04). It now relies on research partnership with sugar mills and competitions (submitting proposals to the ministry). However, the funding is not enough for valuable research – which is the main reason why

Indonesia has not found a new variety of seed (ibid). ISRI's lack of financial support negatively affects farmers and sugar mills through decreased partnership and knowledge exchange. The bureaucratic issue is also related to F4, by inconsistent policies and lack of government commitment.

5.3.2 Plantation- and sugar content determination systems

The issues of plantation and sugar content (rendement) systems are related F3 at niche level, since increased knowledge exchange and partnership could be part of the solution. Pak Sugianto (Interview 6, 2017-04-05) argues that high quality sugarcane can be produced if it is planted on huge land with a plantation system. In East Java, only 20% of total sugarcane land is owned by sugar companies and 80% is owned by farmers. The pieces of land that every sugarcane farmer owns are small. This results in even lower quality and lack of feedstock for sugar mills. Pak Dadang, main coordinator for sugarcane plantation at BPTP, (Interview 13, 2017-04-05) emphasises that the lack of standardisation of sugarcane plantation technique and organisation results in fluctuating feedstock availability. In addition, sugarcane land in East Java has notably decreased from 2013 to 2016, as many farmers changed to other more attractive crops. One of the main reasons why farmers lost interest in cultivating sugarcane is the lack of standardisation of the sugar content determination system (see 5.6.1) (ibid).

5.4 Function 4: Guidance of the search

This function refers to activities that shape the needs, requirements and expectations of actors with regards to their support of the niche. It also involves for example hard institutions, such as policy targets. Exchanging ideas between actors is important for F4 (Hekkert et al., 2007: 423-424).

5.4.1 Top-down policy issue

With regards to the landscape level, as seen in the table, 'Top-down policy issue' is a significant obstacle regarding F4. The head of energy department at the Ministry of Energy and Mineral Resources (MEMR) in East Java**,** Pak Sujatmiko (Interview 11, 2017-04-06), points out such policy structure as one of the main hinders for bioethanol in Indonesia, including East Java. Bioenergy policies often face implementation difficulties because the national government generalise the provinces in Indonesia. "They didn't consider local potentiality and that is necessary for progress" (ibid). Hence, such top-down policy structure is disregarding the niche level for structural change. He also refers to the industry of fossil fuel

as ‘the mafia of fossil fuel’ and suggests that subsidy to fossil fuel must be addressed before bioethanol can be fully supported (ibid). Additionally, bioethanol is still not prioritised as biogas has higher policy priority and receives ‘real action’ (ibid; Interview 13, Pak Dadang, 2017-04-05). The policy prioritisation is an example of lack of achievement of F4.

5.4.2 Sugar import

The large amount of sugar import to Indonesia is also identified as a major obstacle for the growth of its sugar industry, which relates to F4 at the landscape level. The import amounted to 16.145.120 ton between 2010-2015 (Indonesian Sugar Cane Statistics, 2015: 20) (Appendix 1). This in turn affects the bioethanol development – linked to political and economic processes on the landscape level. Concerning the sugar import, interviewees often stress that policy makers are key for change. As expressed by farmer Pak Junaedi (Interview 2, 2017-04-03): “If the government really focuses on sugarcane as the top commodity in Indonesia, they should do their best to stop the import activity”. He is expecting the government to utilise their role in terms of reducing the sugar import and stabilising the national price of sugar (ibid). Pak Muhbin (Interview 14, 2017-04-05), further explains how the government’s commitment to sugar industry has weakened – effecting subsidies and other financial support, resulting in sugar mills’ increased production costs. However, he suggests that the government’s regulation and standard operational procedure need to be addressed, for example, by introducing fixed targets for import and production. These expectations of government policy commitment are therefore related to F4.

5.4.3 Feedstock competition

Feedstock competition relate to F4 at niche level. For sugar mills, there is an issue feedstock competition with Monosodium glutamate (MSG) factories, as farmers tend to sell more molasses to those instead of sugar factories **(**Interview 9, Pak Risvan**,** 2017-04-04). A suggestion by ISRI is to introduce a policy for sugar mills to receive more feedstock; sugar mills paying for all the sugarcane (molasses) and instead of paying for the shares. As a policy to boost the bioethanol sector, this factor relates to F4.

5.5 Function 5: Market formation

To stimulate innovation, one opportunity is formation of temporary niche markets. F5 involves activities that contribute to the creation of a demand of such by e.g. financially supporting the use of the emerging technology, or by taxation of competing technologies. Within niches, actors can learn about the innovation (function 2 and 3) and expectation can be developed (function 4) (Hekkert et al., 2007: 424).

5.5.1 Market price of bioethanol

The market price of bioethanol compared to fossil fuel relates to F5 at niche level. As mentioned in Methodology, this study acknowledged economic obstacles to exist. However, for an overall view of the obstacles, as it is linked to many other factors, it is also included in Results. As seen in the table, the market price of bioethanol is a significant barrier for development relating to F5.

PTPN is a state-owned enterprise with 11 sugar factories. PTPN started producing bioethanol from sugarcane molasses when the crude oil price reached more than $100/barrel (Pak Setiawan, Interview 12, 2017-05-05). Before 2010, molasses were sold directly to the food grade industries (MSG, etc). In 2010, PTPN started to build a 100 Klpd (kilolitre/day) molasses-based ethanol plant in Mojokerto, East Java. The factory – PT Energi Agro Nusantara (Enero), initiated usage of molasses for fuel grade in Indonesia and even the president of Indonesia visited the facilities. However, once established, the oil price dropped and fuel grade production was no longer profitable.

PT Pertamina, Indonesia's state-owned company for oil and gas, is the main potential buyer but as the price of bioethanol is not economically attractive compared to fossil fuel, the company hesitates to purchase. To maintain the business, Enero started selling to industrial grade factories (e.g. cosmetics, pharmaceutical, and food). Besides, Enero gains profit by selling CO2 (released during fermentation process) to industries producin carbonated beverages (ibid). Pak Rachman, director of Enero and vice director of Indonesian Biofuel Producers Association (APROBI) (FGD, 2017-04-07), explains that between 2014-2016, Enero has sold less than 0,1% of their capacity for fuel grade. The current price for molasses is IDR 2,000 and 4 kg are required for 1 litre of fuel grade (feedstock budget IDR 8,000/l). Meanwhile, the fuel grade price is only IDR 8,900/l, resulting in a margin of only IDR 900 for employment and energy costs (ibid). Enero's current cost of goods sold is almost IDR 10,000, but Pertamina only considers purchase from around IDR 6,000. Therefore, by targeting industrial grade – for which the price can reach IDR 11,500, the business is feasible (Interview 12, Pak Setiawan, 2017-05-05).

> "The price of flour/kg is more profitable than the price of bioethanol/l. We have already done all we could, we produced ready-to-use ethanol and we had 3000 kl [kilo litre] full tanks. In front of the director of Pertamina, president and vice president of Indonesia, I begged them to mix our ethanol with oil. But they didn't execute the programme"
>
> Pak Rachman (FGD, 2017-04-07)

Ibu Novayanti, business development manager at Pertamina, (Interview 1, 2017-04-10), agrees that the market price is a deadlock. Many gas stations have already been upgraded for storing bioethanol but none are in use. Discussions and negotiations to solve the purchasing issue have been unsuccessful (ibid). PTPN have had meetings with Pertamina's CEO: "He is willing to buy our product, but the market price does not support it" (Interview 12, Pak Setiawan, 2017-05-05). PTPN are not able to sell to other oil blending companies such as Total and Shell either, as they also compare with the market price. Ibu Novayanti (Interview 1, 2017-04-10) highlights that the sugar import discourages the growth of local sugar industry and in turn bioethanol development. She suggests that a solution for the industry could be to develop technology for third generation bioethanol (ibid). All stakeholders agree that the market price of fossil fuel compared with bioethanol is a leading as it hampers the market dynamics for the niche innovation. The market dysfunction (F5) also results in lack of entrepreneurial activities (F1).

5.5.2 Export and tax regulations

Export and tax regulations are identified as significant obstacles at both niche and regime level regarding F5. According to Pak Wiryono, (Interview 8, 2017-04-10), the main problem for bioethanol is the customs regulation. Ethanol is a dutiable good (IDR 20,000/l) – tax which makes export non-profitable. Until 2014, the crude oil price was low enough which enabled Enero to profit from exporting to Philippines and Sudan. There were plans to build another factory, but bureaucracy has hindered the company to continue exporting (FGD, Pak Rachman, 2017-04-07). Because of the same problems with regulations, Gula Energy stopped the fuel grade production (Interview 10, Pak Wiryono, 2017-04-05). The sugar mill Gempolkrep has plans to also start produce fuel grade (Interview 6, Pak Sugianto, 2017-04-05). Fuel grade innovation is considered a solution to increase the factory's productivity and decrease the production cost by diversification. In addition to the sugar price being stagnant and controlled by government, the production cost is increasing (see 2.3). Because of the many obstacles related to export regulations facing bioethanol producers, the factories are now hoping to find a solution in which they do not have to depend on Pertamina as a buyer.

Many interviewees suggest that the pricing issue should be enforced by a mandate for blending ratio of bioethanol for fuel. It is argued that the subsidy of fossil fuel is the reason why the price of bioethanol cannot compete with the price fossil fuel and if removed – bioethanol utilisation is expected to grow. In PTPN's plans for a second factory, production of alcoholic beverages (food grade ethanol) is also included. However, there will be lower social acceptance of food grade due to the religious value of the population

in the region. Therefore, PTPN prioritises fuel grade: "I prefer not to penetrate into the food grade since it will become a polemic in our main power and employment" (Interview 12, Pak Setiawan, 2017-05-05). The future of bioethanol therefore depends on the government's commitment to address this issue. "We expect the government to strengthen the export and import policy of bioethanol … because the establishment of this factory is the government's initiative to solve the fossil fuel issue" (Interview 7, Pak Ade, 2017-04-03). However, it is difficult for Pertamina to adjust the regulations for ethanol in Indonesia since alcohol is a taxable good. "I believe that if the ethanol is not a taxable good, Pertamina would be interested in buying our products" (Interview 10, Pak Wiryono, 2017-04-05). A solution would be to distinguish between bioethanol as liquor (alcohol) and bioethanol as fuel (ibid).

Another customs issue for fuel companies (Pertamina, Shell and Total) is that the facility (fuel tank) is used by more than one company, and it is therefore not clear who holds the facility, which is an issue with the customs. Discussion between fuel companies, Enero and directorate of EBTKE (Ministry of Energy and Mineral Resources' Directorate General of New Renewable Energy and Energy Conservation) are on-going but the issue remains unsolved (Pak Rachman, FGD, 2017-04-07).

Evidently, current export, tax and ownership regulations hamper the market dynamics for the emerging niche innovation. The actors are waiting for a mandatory from the government regarding customs – regulation adjustments that could stimulate the technological transition in the regime and niche level, stressed in F5.

5.6 Function 6: Resources mobilisation

Resource mobilisation refers to the allocation of financial, material and human capital and are necessary as a basic input to all other activities, most importantly for function 2. Typical activities are investments and subsidies, but can also include mobilisation of natural resources (Hekkert et al., 2007: 425). Significantly many obstacles are linked to F6 which demonstrates the lack of achievement of such function, which in turn also affects the other functions such as F1.

5.6.1 Lack of quality feedstock

As seen in the table, 'Lack of quality seeds' is a significant obstacle for F2 at niche level, but it also relates to F6. In addition to the lack of financial support to ISRI, the lack of standardised sugar content determination system also affects the productivity of the sugar mills significantly. The less sucrose the sugarcane contains, the less sugar can be produced. With the lack of collaboration between sugar mills,

there is little space for research to improve quality of the sugarcane. Farmers also lose their trust in the pricing system and in turn their motivation for producing good quality sugarcane (Interview 13, Pak Dadang, 2017-04-05). Standardisation sugar content determination system and transparency between sugar mills and farmers is therefore essential for growth of the sugarcane industry.

5.6.2 Decreasing number of sugar factories

Another major obstacle at the niche level is the decreasing number of sugar mills, relating to F6. All the on- and off-farm factors contributing to low quality of sugarcane and low productivity, has resulted in 7 factories in East Java currently facing bankruptcy. Sugarcane is considered as good quality if the sucrose content at least 7,5 or 6,5 minimum. Watoetoelis only produced 5,8 last year, which was the worst year they ever had and too low to cover the production costs. If their low productivity continues, they will be forced to be shut down (Interview 4, Pak Efendi, 2017-04-05). Sugar factories are facing bankruptcy despite the national demand of sugar being around 5 million ton and national supply only 2 million ton (Interview 13, Pak Dadang, 2017-04-05). The sugar price is regulated by the government. Production and employment costs rise every year, but the sugar price has remained the same in the past 5 years. This price regulation and supply-demand issue, which is a result of lack of government commitment to support its domestic sugar industry, shows significant dysfunction of F6. It is also associated with F5. All the interviewed stakeholders acknowledged that diversification of the sugar industry, for example through development of bioethanol, is one way to save the declining industry.

5.6.3 Farm-to-factory timing

This obstacle at niche level is associated with both F3 and F6. ISRI points out an obstacle to sugarcane productivity to be the delay between chopping on farm and delivery to sugar mill, which results in further decreased sugar content (Interview 9, Pak Risvan, 2017-04-04). For this reason, better transportation from farm to factory need to be in place. Furthermore, Pak Dadang (Interview 13, 2017-04-05) argues that there is a mismatch in timing between harvesting and sugar production. The cane is ready from September, but sugar mills prefer to receive the feedstock around April/May. As a result, sugar mills face an issue with feedstock availability – a result of lack of collaboration between sectors and efficient allocation of resources.

5.6.4 Agricultural techniques and factory efficiency

These issues are related to F6 at niche level. BPTP is helping farmers to increase sugarcane productivity by innovating new agricultural technologies and encourage farmers to improve agricultural techniques. To increase productivity, one of BPTP's recommendations is cleansing dry leaves from the plantations but because of adoption behaviour, only some areas in East Java are following the recommendations (ibid). Another major problem for Indonesia's sugar industry is that the factories in East Java are old and many have been operating for over 100 years. The machines and technological systems are inefficient and need restoration. The production cost is also affected by old labour and the new generation of labour lacks motivation for manual work and is attracted by other employment opportunities in urban areas (ibid). Therefore, sugar mills try to minimise the production cost by electrification (replacing manual labour with machines) (Interview 4, Pak Efendi, 2017-04-05; Interview 6, Pak Sugianto, 2017-04-05).

5.6.5 Loan issues

The loan issues at niche level are related to F6 as financial and material factors. One significant change which has affected the farmers' willingness to pay for tools, seeds, etc., is a new credit loan policy. Farmers are now highly encouraged by the government to apply for KUR (The Credit for the Poor). However, there are several problems with this loan. For example, the current credit system is directly between farmers and banks, and the banks require a guarantee directly from the farmers. It is therefore a high risk that the farmers are not able to pay back the credits. Before KUR, sugar factories acted as the guarantor for farmers and were responsible for the amount of credit for farmers. The cooperatives were only responsible for their registered members in their covering area not for other areas. As such, the guarantee was divided to two parties and it was likely that the credits would be fully paid (Interview 14, Pak Muhbin, 2017-04-05). Furthermore, the cooperatives take bank loans to use for fertilisers, etc. However, bureaucracy is one of the reasons why these loans, and in turn the provision of the fertilisers, are often late which means that the farmers do not have access to it when they need it (Interview 4, Pak Efendi, 2017-04-05). Another loan issue is that Enero is not granted any loans as the banks require the company to present the demand and list consumers (ibid).

5.6.6 Technical and financial issues

Technical and financial issues hindering the entrepreneurs to maintain business relate to F6 at niche level. For example, Pak Ade at Industri Gula Glenmore (Interview 7, 2017-04-03) explains that they experience

technical issues during production, resulting in further financial issues. For Enero, the technological facilities, such as engines, were granted by Japan's Ministry of Economy, Trade and Industry and the infrastructure was provided by PTPN. Since the technology is from Japan and suitable for sub-tropical climate, while Indonesia has tropic climate, there is an issue with the temperature which requires a lot of maintenance – increasing the production costs (Interview 10, Pak Wiryono, 2017-04-05).

5.6.7 Expansion of land

As seen in the table, expansion of land is a factor under the F6 for the regime level. Lack of expansion of land for sugarcane plantations is also identified as an obstacle. Indonesia has lots of available land, but its sugarcane area is just 400.000 ha which is a small amount if compared with Thailand's 1.700.000 ha. Therefore, many stakeholders express the need to expand the area (Interview 9, Pak Risvan, 2017-04-04). Khatiwada and Silveira, (2017: 357) also stress the necessity of expansion: "At present land use conditions (i.e., 0.47 Mha) it will be difficult to meet the 2% bioethanol target laid down by the government of Indonesia". However, there is no more land in East Java with good enough condition to plant sugarcane as it is too wet (Interview 6, Pak Sugianto, 2017-04-05). Pak Setiawan (Interview 12, 2017-05-05) suggests that the government should construct sugar companies in Madura. Other prospect lands are in Sumba, Sulawesi and Sumbawa (Interview 9, Pak Risvan, 2017-04-04).

5.7 Function 7: Creation of legitimacy

The rise of an emerging technology often lead to resistance from actors with interests in the incumbent energy system. To develop, a new technology has to become part of an incumbent regime, or it even has to overthrow it. F7 involves political lobbies and advice activities. This function, also referred to as 'advocacy coalitions', can function as a catalyst; they put a new technology on the agenda (F4), lobby for resources (fF6) and favorable tax regimes (F5), and by doing so create legitimacy for a new technological trajectory (Hekkert et al., 2007: 425).

5.7.1 Objection of legislative

This obstacle relates to F7 at regime level, as it is an example of resistance of the bioethanol development (niche level). MEMR proposed a policy to gain IDR 50–100/l from fossil fuel sales to support the energy security (taxation of gasoline to use for subsidy for bioethanol). A similar policy has been implemented for biodiesel. However, the legislative was objected by the People's Representative Council in MEMR, as it would increase the gasoline price (FGD, Pak Rachman, 2017-04-07).

6. Discussion

Following is a discussion in which the identified obstacles are further linked to the actors in the social network. The data analysed is from interviews previously presented together with the results from the FGD, in which a social network exercise was conducted. Hampering factors as well as solution suggestions are evaluated using the categories of *authority, financial support* and *information*. Key actors for each category are identified, followed by a discussion concerning how they can fulfil their role to contribute to Indonesia's bioethanol development. Regarding the categories of authority and information, lists of key actors with remarks are included as Appendix 8 and 9.

6.1 Authority

The baseline argument in this thesis is that sugar- and bioethanol industries need to be integrated. Lack of commitment from the authorities is one of the main reasons why the socio-technical transition has not yet taken off, according to the interviewees. The FGD participants agreed that policy consistency is the most significant obstacle regarding authority and MEMR was identified to play the most essential role for policy-making of bioethanol development. A representative from MEMR at East Java provincial level agreed: "We have the natural resources and the technology is already there. It [bioethanol sector] just need something to make it happen – a consistent and strong policy" (Interview 11, Pak Sujatmiko, 2017-04-06). Ibu Rinjani, (FGD, 2017-04-07) an official at provincial level at East Java Plantation Agency, stresses that "a good relationship among the stakeholders is top priority". The authorities' commitment is vital and expected from all actors. Farmer Pak Junaedi (Interview 2, 2017-04-03) explains that despite the many issues with sugarcane farming, what motivates him to continue is sugar being one of the top commodities in Indonesia, which increases his hope that government will always support the sugar industry. Evidently, lack of achievement of F4 – in terms of government commitment through consistent policies and targets, is significantly hampering the regime of bioethanol development.

Through the theoretical lens of MLP, further success of the technology is not only governed by processes within the niches (bioethanol together with agriculture), but also by developments at the level of the existing regime (rules that enable and constrain activities), and the socio-technical landscape (Kemp et al., 2001: 277; Geels, 2002: 1260). Notably, landscapes in contrast to regimes are in the sense of being beyond the control of individual actors and with regards to bioethanol, drivers for landscape changes can be e.g. climate change debate and peak oil. Regimes are characterised by lock-in and path dependence, which can

be more specifically related to this study's identified obstacles in terms of tax regulations. Regimes are also oriented towards incremental innovation (Geels, 2002) and is one of the factors that indicates that Indonesia's bioethanol transition – by being influenced by different degrees of power and politico-economic interests, occurs over a long period of time.

The vulnerability that farmers face due to climate change by the numerous risks to the agricultural production, indicates the importance of inclusive policies highlighted in Political Ecology. This is linked to inequality, which prevents poor and marginalised people from managing daily risk and coping with climatic and non-climatic shocks (Tschakert et al., 2013). Therefore, policy-making and investment at all levels must fundamentally support participatory and inclusive decision-making processes to ensure that adaptation strategies address the needs of farmers. This aspect is related to the landscape level of the technological transition. As argued by Dodman and Mitlin (2011, In: Brown at al., 2012: 18), "[s]trengthening the ability of local groups to negotiate to get more, rather than less, from local (and national) political processes requires making a more substantive institutional investment". Particularly, it is essential that the authorities listen to the needs of the farmers and follow coherent policies that ensure provision of tools, fertilisers, etc. in time to fully assist the agricultural practices. The delivery delay has been identified as one of the obstacles at sugarcane farming level for development (see 5.6.3). Lack of allocation of capital for sugarcane farming is therefore related to F6, but also F4 as it is linked to the 'Top-down policy issues' at a landscape level.

Regarding the niche level, the idea that bioethanol production is a way to optimise the sugar industry by product diversification is also shared by ministry officials at provincial level in East Java. Furthermore, it is acknowledged that fossil materials are declining and renewable energy is viewed as the solution (FGD, Ibu Rinjani, 2017-04-07). However, the authorities' commitment is lacking. For instance, Enero has a monthly meeting with MEMR but according to Enero, instead of a fruitful discussion of the many issues, it has mainly been eating at fancy places and has not been efficient for progress (FGD, Pak Hidayat, 2017-04-07). Another indication is the government's lack of regulation monitoring. "What they need to do is to monitor the implementation of their policy, e.g. to implement a reward and punishment rule. If the oil companies do not sign the MoU [agreement] to mix the oil with ethanol, MEMR would limit the crude oil import" (FGD, Pak Rachman, 2017-04-07). It was also suggested that MEMR needs a new specific agency to do the direct policy monitoring (FGD, Pak Garias, 2017-04-07). Evidently there is lack of government commitment to address and find solutions to the many obstacles, relating to F4. Furthermore, it was agreed

upon in the FGD that the Ministry of Finance plays an important role for the development as it could introduce a policy for granting subsidies. A suggestion discussed was for the General Director of Customs to consider ethanol as a source of energy and not a source of food. By denaturation, the ethanol can be modified to become undrinkable. By adjusting regulations, there would be no need for the customs to play a role in the bioethanol production (FGD, Pak Rachman, 2017-04-07).

Evidently, the government's regulations hinder niche innovation and the interview and FGD participants expect commitment and cooperation from the authorities. Pak Setiawan at PTPN (Interview 12, 2017-05-05) hopes that the government will push Pertamina to buy their product since it is the only potential buyer in Indonesia. Despite governmental obstacles, he prospects a bright future for Indonesia's bioethanol production: "I wish someday we will have multi-grade products, and that sugar companies will be changed into sugarcane-based industries, which will be able to produce sugar, ethanol, electricity, fertilisers, etc." (ibid). Pak Rachman (FGD, 2017-04-07) summarises his expectations:

> "What I expect is that the support from the government, through strengthened regulation, to the fuel producers in supporting the market. I hope the government will apply the reward and punishment system in regulation monitoring … Therefore, what I expect from INSIST is to provide this discussion as an input for the government policy in order to support the companies to achieve the cost and benefit balance to meet the need of the fuel producers. [Additionally,] It is essential to view the ethanol development from a wider range, not only limited to sugarcane".

To use the interview and FGD results as input for government policy is an example of agency's role in mobilising resources for change, which is emphasised in TIS. Institutional change is important for any technological change and lack of cooperation between actors is an example of TIS' 'system weakness'. A major output from the FGD is that the participants share a vision of modern, flexible sugar- and bioethanol industries that can make a strategic contribution to the national energy economy. TIS views system-level change as a process that can be enacted through interactions of many actors and the resources they mobilise (Smith et al., 2005a). One important finding of this research is the importance of actors' further cooperation to put pressure on authorities for better monitoring of policies. Therefore, this study – as part of INSIST's initiative to bring stakeholders together for discussion, is a promising first step for further collective action. F3 and F7 relates to the interviews and FGD seen as 'advocacy coalitions' to create input for the government (Hekkert et al., 2007: 425). Importantly, such political lobbying and advice activities can function as a catalyst; they put a new technology on the agenda (F4), lobby for resources (F6) and

favourable tax regimes (F5), and by doing so create legitimacy (F7).

6.2 Financial support

Regards financial support, banks are identified by the research participants as an actor that could play a vital role in the development. Banks can support many aspects of the sector: equipment, estate, etc., for farmers and sugar- and bioethanol factories. However, bioethanol actors are currently not granted loans since no off-taker agreements have been signed. Such an obstacle can also be referred to as a 'lock-in' (Geels, 2012), concerning disagreements of government regulations. Pak Sujatmiko at MEMR (Interview 11, 2017-04-06) suggested that Corporate Social Responsibility (CSR) projects and international non-governmental organisations (NGOs) could provide financial and technical services. ISRI in particular is in need of partnership for financial reasons, which could be with international development projects, NGOs, private sector or other investors (FGD, Pak Risvan, 2017-04-07). In line with MLP, also for this case of biofuel development, a regime shift is necessary for further financial support to actors which could then lead to a breakthrough of the bioethanol sector as a niche innovation. Accordingly, dysfunctional financial support indicates lack of achievement of F6.

MEMR's budget proposal regarding taxation of gasoline to be used for subsidy for bioethanol production was dismissed (see 5.7.1). Therefore, there is currently no government budget for bioethanol development (FGD, Pak Rachman, 2017-04-07). Taxation is one example of developments within the MLP's landscape that help stabilise a regime shift. However, introducing taxation on gasoline is difficult. Consumer subsidies for petroleum products and electricity in Indonesia accounted for almost 30% of all central-government spending in 2011, but was in 2015 decreased (OECD, 2016). To introduce tax on gasoline, and therefore increasing the price, is the main reason the council objected the ministry's budget proposal. With regards to MLP, lack of public acceptance is therefore another lock-in at regime level. Evidently, other than political will, as outlined in Authority (see 6.1), public acceptance is one of the greatest uncertainties for Indonesia's bioethanol development – relating to F7.

6.3 Information

Most importantly, all interviewees and FGD participants agree that ISRI and BPTP are the most central actors regarding the category of information related to sugar- and bioethanol industries. BPTP collaborate with ISRI and provides inputs from research regarding new seed variety and agricultural techniques (Interview 13, Pak Dadang, 2017-04-05). PTPN and the sugar companies have a research department (Balittas) that is directly linked to ISRI and BPTP (Interview 12, Pak Setiawan, 2017-05-05). However, since ISRI's status changed due to bureaucratic regulations, the collaboration with sugar companies has weakened. Unfortunately, there is lack of collaboration between the sugar mills and instead of ISRI providing first-hand information to farmers, varying information is instead shared from sugar factories to farmers. Hence, there is no coherent sharing system of information for sugarcane farming. The research support from ISRI is vital as they also have the partnership for research and capacity building with Australia and countries in Asia (Interview 9, Pak Risvan, 2017-04-04). For the many sugar factories that are about to be closed, all research on sugarcane development is important to improve the production. ISRI also collaborates with farmers through farmers' associations and is also an important information actor for bioethanol factories. Enero as well as Gula Energy have obtained training from the research institute and have collaborations for quality improvement (FGD, Pak Rachman, 2017-04-07; Interview 8, Pak Wiryono, 2017-04-10). East Java Plantation Agency wish to have more space to work together with farmers to provide training and knowledge of sugarcane farming. Ibu Rinjani (FGD, 2017-04-07) acknowledges that the country's sugar industry would benefit from closer collaboration between the agency and ISRI, BPTP as well as Balittas (Research Institute).

Notably, ISRI's research is essential and the cut of its government funding has significantly impacted the whole sugar sector. The disappointment of ISRI's restricted ability to provide research is expressed in many interviews. "I would say it is awful that [ISRI] is no longer funded by the government" (Interview 14, Pak Muhbin, 2017-04-05). This hampering factor to the development is related to F3 and processes on MLP's niche and regime level. Lastly, academia was included as an important stakeholder for information sharing as it can be a measure to address top-down policy-making and to promote bioethanol at academic level. According to Pak Hidayat at Enero (FGD, 2017-04-07), one of the reasons for the People's representative council dismissing MEMR's budget proposal is because most of the population do not comprehend the advantages of bioethanol. Therefore, lobbying activities for the public's awareness, for example through academia, is important for F7 and the niche innovation.

6.4 Summary

Decision-making surrounding biofuel development tend to overlook the importance of comprehensive stakeholder participation. In the case of bioethanol in East Java, the concern about general policy-making in a top-down manner was raised during interviews – even from the officials at the East Java's provincial department of MEMR. The lack of comprehensive feasibility studies before program implementation, as well as monitoring, has led to inefficient policies and the slow take-off for the socio-technical transition. Therefore, a system-level change is needed. In line with TIS, this could be enacted through the interactions of many actors and the resources they mobilise (Smith et al., 2005a; Hekkert et al., 2007). The importance of transparency and cooperation for development of biofuels is emphasised in Political Ecology. Thus, after analysing the identified obstacles using MLP and TIS, this thesis has used the social network analysis exercise during the FGD to explore and seek an in-depth understanding of social structures related to sugar and bioethanol sectors. Importantly, the many obstacles identified through the interviews were confirmed in the FGD. The results from all three categories clearly show, from a holistic perspective, that many identified obstacles could be solved through closer collaboration between stakeholders – at all levels.

While many obstacles are political, there are evidently also many that associate with social factors. For example, agricultural techniques could have been improved if farmers adapted ISRI and BPTP's farming recommendations. Notably, the lack of productivity and quality of seeds - partly rooted in social obstacles, lead to obstacles facing the sugar mills and in turn bioethanol producers. Furthermore, the objection of People's Representative Council to MEMR's policy proposal is another partly social factor which has hampered the development. Regarding the need of cooperation between stakeholders for progress, such aspect is regarded as social, as well as political. Importantly, development of bioethanol production in East Java also has a socio-economic aspect. As farmers provide the raw material, the industry can bring employment opportunities, and potential of increased income for already existing farmers.

The importance of inclusion of actors highlighted in Political Ecology has proven to be apparent in this case study. However, there are several reasons why such collaboration, such as ISRI's relation to the many actors that wish to share more research partnership, is absent. One of the reasons has been identified as a bureaucratic issue (ISRI now being private sector), resulting in a financial issue (ISRI not receiving any more government funding). Yet, by closer collaboration between the different governmental ministries, the bureaucratic and financial issues can potentially be solved. A more transparent, reflexive, and adaptable system is important. In other words, government commitment to pursue the blending targets is

essential and that can only be achieved by collaborating for the same goals. Hopefully, as Pak Rachman (FGD, 2017-04-07) mentioned, the results from the social network analysis in the FGD together with interview responses outlined in this thesis can be used as an input to put pressure on the government for better implementation and monitoring of policies for plant-based fuel. For the technological transition, it is essential for all stakeholders involved to strive for sugar- and bioethanol industries to be integrated, through measures of more effective communication tools, multi-stakeholder participatory processes, and incentives for collaboration. However, it is important to acknowledge that – in line with MLP, to achieve a regime shift does not depend solely on the agency of actors and their power relations, but also the norms and procedures governing the relationships and interdependencies of actors and resources. In line with TIS, it appears that bioethanol development in East Java has stagnated as it has hit a 'vicious cycle' (Hekker et al., 2007). Poor performance in Market function (F5) has affected Entrepreneurial activities (F1), resulting in less actors involved, which in turn reduces Creation of legitimacy (F7), which again affects Market function (F5). Notably, cooperation is key in facilitating connection between one function and another to become more aligned.

As a way forward for Indonesia's bioethanol sector is to develop flexibility of sugar mills. For example, many sugar mills are flexible in Brazil, i.e. ethanol and sugar can be simultaneously produced. The production is solely driven by market factors (F5) such as liquid fuel prices, as well as supply and demand conditions for both products (Khatiwada and Silveira, 2017: 359). Comparing with Brazil's driving market factors indicates the importance to overcome Indonesia's obstacles relating to F5. It is also essential to realise the prerequisite of modernising the agricultural sector and sugar factories to increase the productivity in all segments of the sugar industry. Furthermore, second generation technology of bioethanol has potential to significantly boost Indonesia's bioethanol production. There is scope for utilising agricultural residues, e.g., rice husks and wheat straw, in combination with lignocellulosic sugarcane biomass, for optimal production of energy services (Khatiwada and Silveira, 2017: 360). Thus, further research is required to investigate such implementation prospects in Indonesia and East Java, which relates to Knowledge development (F2), through Knowledge diffusion (F3), driven by Guidance of the search (F4), through Market factors (F5) and Creation of legitimacy (F7).

7. Conclusion

This study has investigated bioethanol production from sugarcane in East Java, to identify social and political obstacles to the development. It draws upon Multi-Level Perspective and Technological Innovation System as integrated theoretical frameworks together with Political Ecology as an approach to get around the complexity of biofuels. The framework facilitated the thematic analysis by categorising the data into MLP's niche, regime and landscape level and TIS' seven functions of technological innovation. This is based on primary data collected through a case study carried out in East Java, comprising 14 interviews and an FGD with stakeholders related to sugar- and bioethanol industries; farmer, farmer associations, sugar mills, bioethanol producers, research institutes, government agencies, and private sector (Pertamina). The findings are also based on secondary data in the literature review.

The study answers the research questions: *Which are the social and political obstacles to bioethanol production from sugarcane in East Java, Indonesia?* and *Which are the key actors - in terms of authority, financial support and information, in catalysing the transition pathway and how can they be supported to fulfil their roles?* Most significant obstacles were identified to relate to Resource mobilisation (F5), for example 'Lack of quality feedstock'. Obstacles such as 'Top-down policy issues', relating to Guidance of the search (F4), affect the other functions of Knowledge development (F2) with obstacles such as 'Lack of quality seeds', and Knowledge diffusion (F3) with 'ISRI's lack of financial resources'. Additionally, economic obstacles were confirmed to exist; Pertamina's purchasing issue and export and tax regulations make out major hinders for the development as it hampers any Entrepreneurial activities (F1). The FGD's social network exercise identified The Ministry of Energy and Mineral Resources to play the most essential role of authority, regarding policy-making of bioethanol development. Banks were identified as an actor that could play a vital role in the development for both stakeholders in sugar- and bioethanol industries regarding financial support. All interviewees and FGD participants agree that ISRI and BPTP are the most central actors regarding information related to bioethanol production from sugarcane in East Java.

The findings evidently show that Indonesia's sugar industry is facing several issues, hence why this study considers a reboot of the sector to be a prerequisite for bioethanol development. Indonesia has implemented national policies and legislations to encourage biofuel production as means to achieve energy security and self-sufficiency and to reduce reliance of fossil fuel reserves. However, there is still no clear

roadmap for the socio-technological transition. The inconsistency of policies of sugar import, bioethanol targets and export regulations is evident, and can be traced to be hampered by lack of government commitment and top-down policy structure. This study suggests that sugar and bioethanol programs should be tied together through integrated policies.

As stressed by Political Ecology, biofuels are highly complicated technology-policy complex; one that links multiple agendas, sectors and markets, which is evident in the findings of this thesis. The identified obstacles and relations between state, capital and society have also proven to be complex. Therefore, in attempt to get further around the complexity, while it is outside the scope of this study, an in-depth study of the influence of institutions on the socio-technical transition could provide vital information that could facilitate the progress of East Java's bioethanol production. This case study is based on a limited number of interviews and further research is suggested to include a wider range of stakeholders to confirm the significance of the findings. When investigating socio-technical transition such as biofuels, the importance of cooperation, transparency and inclusive and consistent policies is vital for such developments which has been outlined in this thesis. As several studies focus on economic obstacles, this research has filled the knowledge gap regarding social and political obstacles as well as relations between, and needs of, key actors the social network. Further, it has initiated an opportunity for many important stakeholders relating to the sugar- and bioethanol industries to meet for a fruitful discussion, which is an important step for further collaboration and advocacy coalitions to provide input for policy recommendations for the government. By mapping out the obstacles to the bioethanol production from sugarcane in East Java and linking it to the key actors involved in terms of authority, financial support and information, the study points in the direction of work needed to address gaps and overcome existing challenges that constrain the socio-technical transition.

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9. Appendixes

Appendix 1: Sugar import table

Tabel 1.4 Impor Gula Indonesia, 1986-2015
Table Sugar Cane Import of Indonesia, 1986-2015

Tahun/ *Year*	Impor/ *Import*			
	Gula *Sugar Cane*		Tetes Tebu *Cane Molasses*	
	Volume *Volume* (Ton)	Nilai *Value* (000 US$)	Volume *Volume* (Ton)	Nilai *Value* (000 US$)
(1)	(6)	(7)	(8)	(9)
1986	79 879	16 387	53	18
1987	129 756	25 657	82	26
1988	130 260	35 059	71	28
1989	325 479	112 120	451	121
1990	280 978	123 350	-	-
1991	73 986	26 677	-	-
1992	294 226	98 935	-	-
1993	167 988	52 114	13 346	2 033
1994	15 207	5 868	6 000	482
1995	544 300	237 055	34 219	14 655
1996	1 099 306	463 578	186 776	23 430
1997	578 025	231 702	95 874	10 762
1998	844 852	310 995	105 289	8 999
1999	1 398 950	346 452	185 007	12 368
2000	1 538 519	278 605	139 092	11 494
2001	1 284 469	237 463	184 775	16 754
2002	970 926	198 638	142 851	17 703
2003	997 204	215 777	82 388	8 001
2004	1 119 790	262 813	61 607	6 677
2005	1 980 487	585 263	52 861	8 038
2006	1 405 942	537 130	47 014	7 301
2007	2 972 788	1 040 194	54 635	8 075
2008	983 944	352 385	60 056	11 120
2009	1 373 527	567 034	80 289	18 839
2010	1 382 525	803 114	105 994	20 020
2011	2 371 250	1 638 729	57 028	11 238
2012	2 743 778	1 618 307	102 437	20 513
2013	3 343 803	1 730 392	94 712	20 636
2014	2 933 823	1 312 691	73 523	19 232
2015	3 369 941	1 254 473	97 001	18 714

Indonesia Sugarcane Statistics, (2015)

Appendix 2: Stakeholder list

Interview	Stakeholder	Stakeholder role	Stakeholder's choice of 3 most significant obstacles
1	PT Pertamina	State-owned oil- and gas company	Market price of bioethanol, Sugar import
2	Farmer	Farmer	Climate change effects, Lack of quality seeds, Lack of government commitment
3	Indonesia Sugarcane Farmer Association	Farmers association	Lack of quality seeds, Price fixing of sugar, Cooperation between actors
4	PT Watoetulis	Sugar mill	Climate change effects, Lack of quality seeds, Old machinery and labour
5	East Java Plantation agency	Government agency	Lack of quality seeds, Market price bioethanol, Cooperation between actors
6	PT Gempolkrep	Sugar mill	Lack of quality seeds, Technology/old machinery, Redenment system
7	PT Industri Gula Glenmore	Sugar mill	Lack of land for plantation, Lack of quality seeds, lack of product diversification
8	PT Gula Energy	Sugar mill and bioethanol producer	Government commitment of policies and regulations
9	Indonesian Sugarcane Research Institute (ISRI/P3GI)	Research institute	Lack of quality seeds (financial issue), Harvest issues (climate change and farm-factory timing, Feedstock competition with MSG factories

10	PT. Energi Agro Nusantara (ENERO)	Bioethanol producer	Market price of bioethanol, Technological issues, export & taxation regulations
11	East Java Energy and Mineral Resources Agency	Government agency	Top-down policy issue, Market price of bioethanol, Inconsistent policies (lack of feasibility studies)
12	PT Perkebunan Nusantara X (PTPN)	Sugar- and bioethanol producer	Market price of bioethanol, Harvest issues (climate change and farm-factory timing), Old factories
13	Balai Pengkajian Teknologi Pertanian (BPTP)	Governmental research institute	Sugar content determination system, Harvest issues (farmers' mindset - cleansing dry leaves, timing, etc.), Ownership sugarcane plantations, Feedstock availability
14	Sugarcane farmers association (in PTPN 10)	Farmers' association	Lack of quality seeds, Harvest issues (farm-factory timing, productivity, etc), Government regulations and standard operational procedure

Appendix 3: FGD participants

Focus group discussion
Surabaya, 2017-04-07

Name	Position	Organisation
Izmirta Rachman	President director	Enero
Puji Setiawan	Research and development manager	PTPN
Risvan Kuswarjanto	Off-farm manager	ISRI
Geovanni Garias P	Sales supervisor	Enero
Ariel Hidayat	Foreman manager	Enero
Sapta Rinjani P	Head of Sugarcane Plantation Division	East Java Plantation Agency
Kaemun	Head of Energy Division	East Java Energy and Mineral Resource Agency
Anna Carlsson	Researcher	Lund University
Novelita Mondamina	Researcher	Su-re.co
Auditya Sari	Researcher	Su-re.co
Mariana O Sialen	Researcher	Su-re.co
Yudiadra Yuwono	Researcher	Su-re.co

Appendix 4: Map of Java and East Java

Map of Java

Map of province of East Java

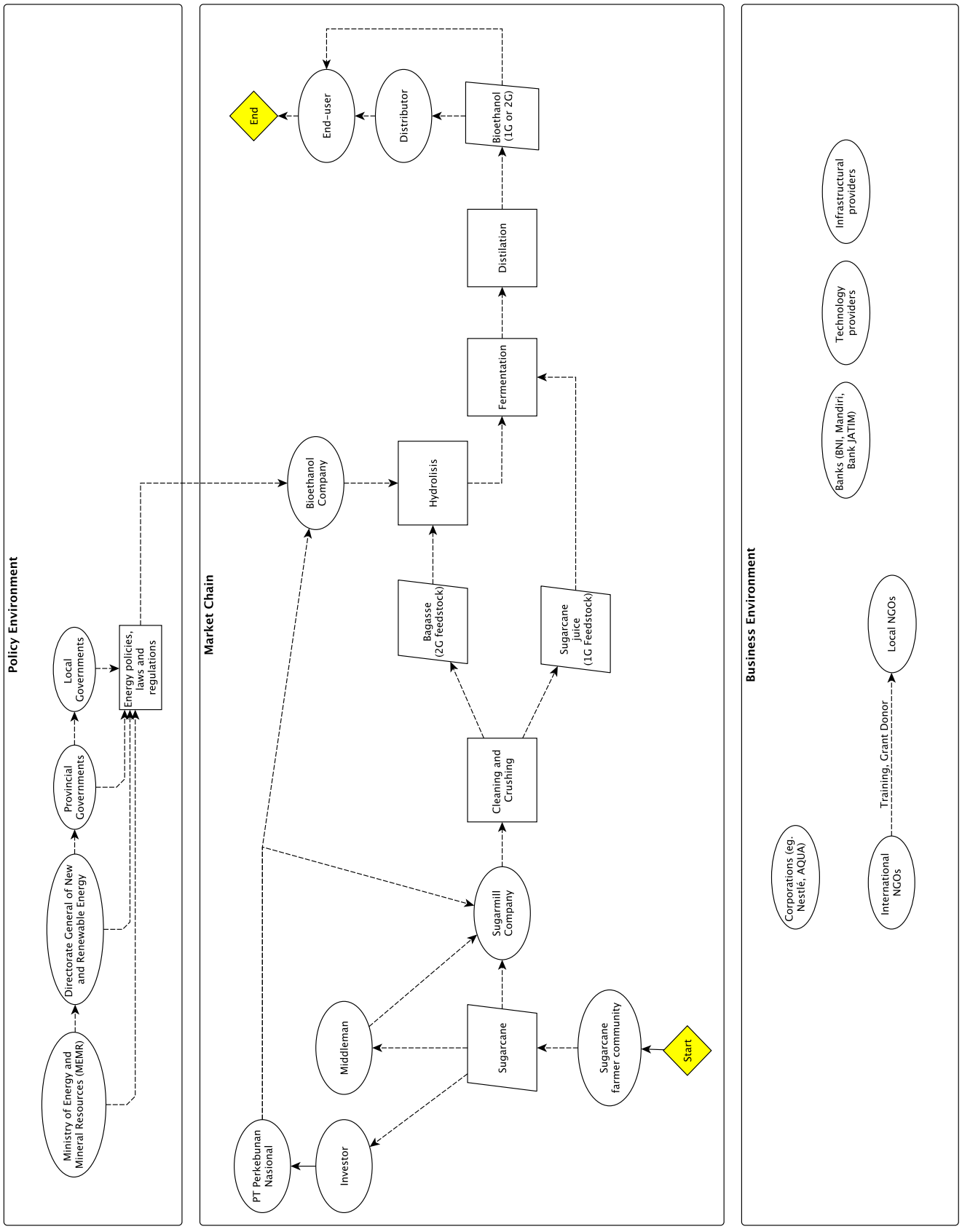
The field study was conducted in the surrounding areas of the cities that are underlined.

Reference: https://fs5k.wordpress.com/where-i-am-map/

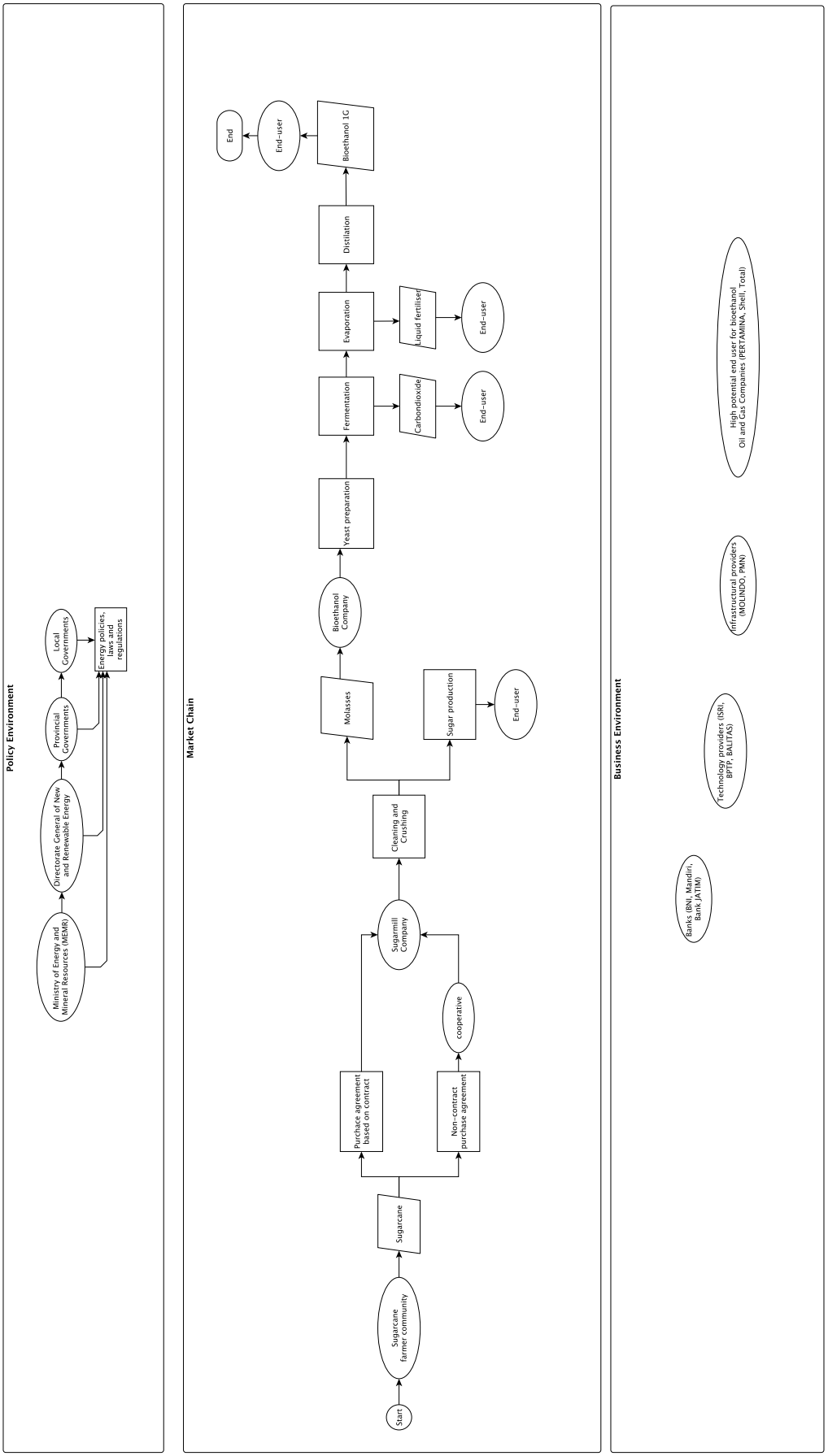
Appendix 5: Interview and FGD participants

Name	Organisation	Role	Location	Date
Dini Novayanti	PT Pertamina	Business Development Manager	Jakarta	2017-04-10
H. Junaedi	Farmer	Farmer	Jember	2017-04-03
H. Arum Sabil	Indonesia Sugarcane Farmer Association	Head	Jember	2017-04-03
Mohammad Arief Efendi	PT Watoetoelis	General Manager	Sidoarjo	2017-04-04
Sapta Rinjani	East Java Plantation Agency	Head of Sugarcane Plantation Division	Surabaya	2017-04-07
Sugianto	PT Gempolkrep	Financial Production Manager	Mojokerto	2017-04-05
Iskandar	PT Gempolkrep	Feedstock Preparation Manager	Mojokerto	2017-04-05
Erwin	PT Gempolkrep	Production Manager	Mojokerto	2017-04-05
Ali Gufron	PT Gempolkrep	Quality Insurance Manager	Mojokerto	2017-04-05
Adiono	PT Gempolkrep	Installation Manager	Mojokerto	2017-04-05
Ade	PT Industri Gula Glenmore	Manger	Jakarta	2017-04-03
Joko Budi Wiryono	PT Gula Energy	Director	Semarang	2017-04-10
Risvan	Pusat Penelitian Perkebunan Gula Indonesia (ISRI/P3GI - Indonesian Sugarcane Research Institute)	Post Harvesting and off farm Manager	Pasuruan	2017-04-04
Kukuh Sujatmiko	Ministry of Energy and Mineral Resources (East Java Agency)	Head of Energy Department	Surabaya	2017-04-06
Puji Setiawan	PT Perkebunan Nusantara X (PTPN)	Research and Development Manager	Surabaya	2017-04-06
Dadang	Balai Pengkajian Teknologi Pertanian (BPTP)	Main coordinator for sugarcane plantation	Malang	2017-04-05
Muhbin	Sugarcane Farmer Association in PTPN 10	Head	Mojokerto	2017-04-05
Izmirta Rachman	PT Energi Agro Nusantara	Director	Mojokerto	2017-04-04
Geovanni Garias P	PT Energi Agro Nusantara (PTPN)	Sales supervisor	Mojokerto	2017-04-04
Ariel Hidayat	PT Energi Agro Nusantara (ENERO)	Foreman manager	Mojokerto	2017-04-04

Appendix 6: Original market scheme



Appendix 7: Modified market scheme



Modifications of market scheme:

- Inclusion of Enero, Molindo (bioethanol producer), Etanol Ceria Abadi (bioethanol producer), and Acidatama (Agrochemistry Industry) – private sector actors as the producers.
- Inclusion of banks, such as BNI (Indonesian National Bank), BRI (People's Bank of Indonesia), Bank Mandiri, etc., as they have both retail and credit roles to UMKM (Small and medium-sized enterprises).
- Inclusion of AKR (Aneka Kimia Raya; petroleum and basic chemicals trading company) as the buyer, since they have signed a contract that they are going to buy bioethanol from Enero.
- Modification of Pertamina to role as buyer.

- Exclusion of Nestle and Aqua.
- Exclusion of Total (oil company), as there is no Total in East Java.

Appendix 8: Stakeholder list – Authority (Discussion)

Stakeholder	Role	Remark
Ministry of Energy and Mineral Resources (MEMR)	Policy-maker for bioenergy (bioethanol)	
Ministry of State-owned Enterprises	Policy-maker for state-owned companies	Essential ministry to integrate enterprises to achieve harmony between bioethanol producers and fuel companies.
Ministry of Finance	Policy-maker for customs, producers and buyers	Essential ministry to aid the industrial actors of ethanol, e.g. through temporary subsidy and provide incentive for the plant-based fuel. The ministry also regulates the taxation and can support bioethanol by making the regulation in the Directorate General of Customs more flexible, e.g. by removing the IDR 20,000/l tax regulation
Ministry of Trade	Policy-maker for allocation of import and export	To support the bioethanol sector, the FGD participants suggest that the ministry must organise the domestic needs before granting the export licenses to ensure the fulfilment of the domestic needs
National Economic Council	Providing input to the president, who in turn provides input to the legislative as a constitution	Pak Rachman, (FGD, 2017-04-07) suggested that it would be better if the renewable energy program is stated in the constitution and not just in the ministerial decree, as the mandatory level in the constitution is much higher than the ministerial decree
Aneka Kimia Raya (AKR)	Company engaged in energy retail	The company could play a more influential role

Appendix 9: Stakeholder list – Information (Discussion)

Stakeholder	Role	Remark
Indonesian Institute of Sciences (LIPI)	Provide research on energy, including bioenergy (bioethanol)	
ISRI	Provide information about the sugar-ethanol research	
PTPN	Provide information about sugarcane-bioethanol agribusiness	
MEMR	Policy-maker / program initiator	
BPTP	Provide information about the sugarcane plantation technology	
East Java Plantation Agency	Provide information about the plantation in East Java for the public and farmers	The agency is expected to support the sugarcane cultivation, cooperate with ISRI for research and cooperate with Balittas (Fiber Crop Research Institute) regarding issues with bureaucracy
Bioethanol Industries	Production of bioethanol	
Academics	Provide education of bioenergy (bioethanol) to the public	
Indonesian Ethanol Association (ASENDO)	Provide information about bioethanol industry	The development would benefit if the ASENDO advised the Ministry of Energy and Mineral Resources to synchronise with the industries and improve regulations to motivate Pertamina to buy

Indonesian Association of Biofuels (APROBI)	Provide information (financial, technical, institutional and human resources) about biofuels	
Puslitbang	Research and Development Centre	
Indonesian Climatology and Geophysical Department at Indonesian Agency for Meteorological, Climatological and Geophysics	Non-governmental organsation	Could play a more influential role in providing information to support sugar industry