Ali Sayigh
Editor

Renewable Energy in the Service of Mankind Vol I

Selected Topics from the World Renewable Energy Congress WREC 2014

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Chapter 1
Development Model of Renewable Energy Policy for Sustainable Bio-Pellet Industry in Indonesia Using Interpretive Structural Method

Erwin Susanto Sadirsan, Hermanto Siregar, Eriyatno and Evita H. Legowo

Abstract New and renewable energy development should be encouraged because Indonesia is net importer of oil. Government subsidy for transportation and electricity is more than Rp 300 trillion per year. Presidential Decree No. 5, 2006, mandates that energy-mix target by 2025 will be 17 % for new and renewable energy. The demand growth of energy is about 7 %, compared to developing countries with only 2–3 %. This study aims to develop renewable energy policy models concerning biomass for rural electrification; to identify the factors that influence price of feed-in tariff (FIT) determination, in particular wood-based biomass; and to design the role of social forest as raw materials for bio-pellet industry in sustainable supply chain. Research method using soft systems methodology (SSM) is the application of interpretive structural modeling (ISM) and strategic assumption surfacing and testing (SAST). The results showed that the key elements of development policy model are feasible biomass energy tariff, competent human resources, coordination among related local government offices, and community participation. Other important factors are funds and investments for business, microfinance, state-owned forest lands, and smallholder plantations policy one spatial regions plan institutions. The strategic assumptions have been identified, which are sufficient supply of raw materials to industry, availability of alternative potential industrial biomass raw materials in the local areas, the obvious trade system to accelerate the model implementations that requires regulatory support from local governments, inventory land use and forest area inventory, and support of community leaders.

Keywords Feed-in tariff · Social forest · Interpretive structural modeling · SAST · Bio-pellet industry

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1.1 Introduction

Indonesia as one of the oil-producing countries has a high export potential but unfortunately is currently a net importer. Fuel consumption is about 1.4 million barrels of oil per day (BOPD), while production is about 940,000 BOPD. Imbalance in supply and demand has resulted in enormous imports. Subsidies for fuel and electricity are very large, over US$ 300 trillion, and conditions of fluctuating oil prices reached $ 140 per barrel resulting in a very heavy burden on the government [14]. Development of alternative energy from new and renewable energy is a solution to reduce dependency on imported oil [5].

Development of alternative energy, related to the Presidential Decree No. 5, 2006, mandated that energy-mix target to renewable energy will be 17% by 2025. Implementation of this policy through Minister of Energy and Mineral Resources Regulation No. 4 2012 specifically regard to biomass feed-in tariff (FIT), and No. 19 year 2013 for waste products FIT. The revision to complement and reinforce the development of new and renewable energy requires policies that regulate the FIT for bio-pellet [15].

The role of government is very important to encourage the development of technology, incentive system, FIT and ease of licenses, fair competition with domestic industry alignments, and also to facilitate related variety of research and development [13]. In addition, the private sector should also contribute by ensuring high-quality raw materials to the biomass industry through optimizing corporate social responsibility (CSR) for community development as part of the entire supply chain system. This is in accordance with the provisions of Law No. 40 year 2007 on Private Companies that exploitation of natural resources is required to implement CSR for community development.

The development of biomass-based renewable energy needs continuity of feedstock [4]. It is strongly associated with land use and social conditions, related to community empowerment [6]. Raw materials can be continuously supplied with forest harvest, from both public forests and forest plantations. In this context, the development is directed to areas that have potency for widespread cultivated forest [10]. One of them is the Sumbawa Island, located relatively close to the island of Java, manages natural resource industries, for their own use and yet has investment opportunity. Study identified the potency of loading in West Sumbawa regency to the industrial biomass growth as a renewable feedstock [12]. In general, West Nusa Tenggara district also has a potential for the development of the biomass industry due to availability of sufficient land which could be utilized as energy plantation area. The gold mining company's existence could be one of the driving factors of energy plantation development and reforestation on mine locations. Utilization of biomass directly as firewood and charcoal for local cooking purposes is not included in the utilization of renewable energy. Electricity generation through biomass gasification process is included in the utilization of renewable energy. Under these circumstances the research aims are: (1) identifying factors that influence development of renew-

able biomass energy policy, based on forest biomass managed by people, (2) designing bio-pellet industry supply chain system with sustainable empowerment of community forests, and (3) developing renewable energy policy for biomass-based industry for rural electrification.

1.2 Research and Methods

The study was conducted with the soft systems methodology (SSM) through seven stages, namely: (1) identifying problems facing the situation, (2) expressing the problem statements in the form of Rich Picture, (3) developing root definition in accordance with purposeful activity system, (4) designing the conceptual model based on the root system definition, (5) comparing conceptual model of the problem situation, (6) discussing desired changes, and (7) taking remedial action as a solution [Checkland 1990, 3]. This approach is attempted to understand the problems that are complex and dynamic. Jackson conceptually stated that achieving [11] the objectives of complex situations will not be effective if done with approaches that are both pragmatic and mechanistic. Thus, these are needed for structured assessment and goal-oriented achievement.

Stages of the research conducted are literature review, expert surveys, and focus group discussions (FGDs). FGDs are carried out to bring the strategic assumptions with strategic methods assumption surfacing and testing (SAST) and expert surveys by the method of interpretive structural modeling (ISM) [16]. The ISM method is used to determine the key elements, hierarchical structure, and identify the characteristics of the sub-element based on the level of dependency and power driver. Approach using related system is done to solve problem through the system analysis and engineering policy [17]. The method analyzing the system involves six stages: (1) analysis, (2) problem formulation, (3) identification system, (4) alternative solutions establishment, (5) determination of the realization, and (6) validation (Fig. 1.1).

1.3 Results and Discussion

Renewable energy policy for the industrial private forest-based biomass has an input that is controlled or not controlled [14]. Uncontrolled inputs include land use, land-use rights, the exchange rate, the price of the product, and the market demand. Controlled inputs include appropriate technology, human resource quality, supporting infrastructure, access to finance, supply chain systems, and socialization. Controlled and uncontrolled inputs along with the input environment (legislation, government regulation, public culture, and agro-climate) produce the desired output in the form of job creation, the utilization of forest products that are

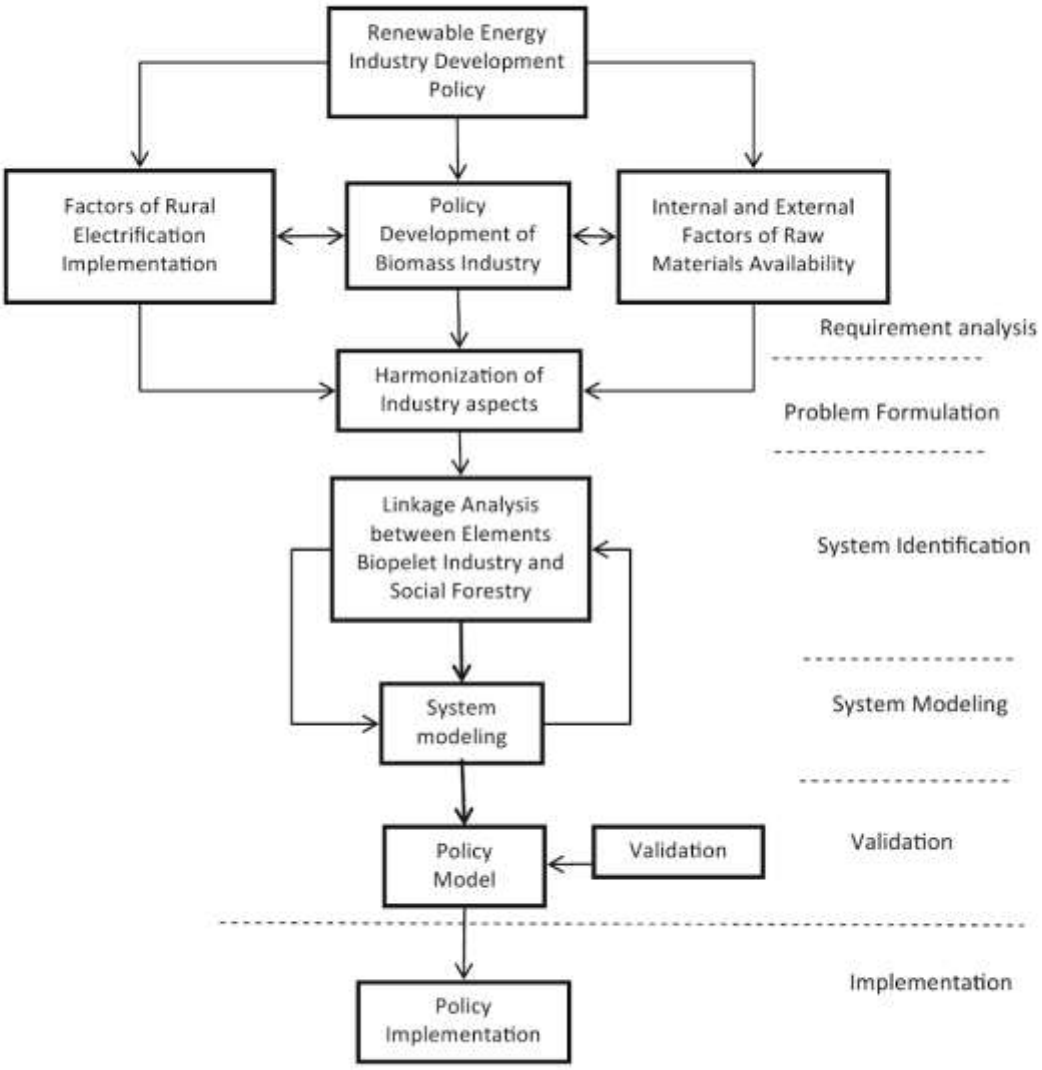

Fig. 1.1 Research framework

environmentally friendly, green small and medium enterprises (SMEs) growth, availability of renewable energy, and empowering people with viable biomass energy rates [2]. In addition to producing the desired output, the output is also obtained in the form of unwanted output: serviceability degradation, deforestation, high production costs, and low public participation. These undesirable outputs result into a feedback to management control and then the controlled input and renewable energy policy for the social forestry-based biomass industry will produce output that is controllable [18]. An input–output system is shown in Fig. 1.2.

The identification process of development of renewable energy problems is described in Rich Picture diagram (Fig. 1.3), which has three main issues: (1) land status, (2) environmental degradation, and FIT. These issues become the basis of goal-oriented activity, resulting in *root definition* model: "designing policy of supply chain system of biomass industry as a renewable energy source based on

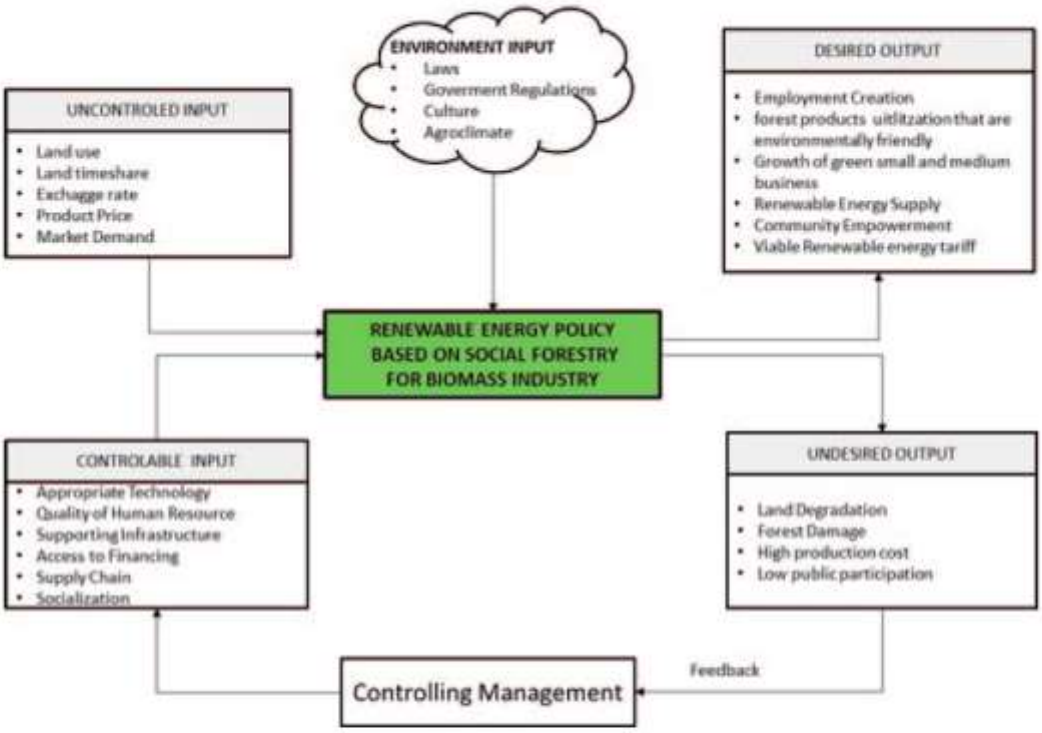

Fig. 1.2 Input–output system

bio-pellets which are viable, economical, insightful environment, involving the business, people and government efforts to achieve sustainability business, community development and rural electrification to support national energy security" [8].

To achieve the goal, activities model or purposeful activity model was structured. Objective conditions suggested that the investment financing for energy industry preceded the existence of power purchase agreement (PPA) [9]. With the investment activities, energy gardens can be developed which supply bio-pellet industrial raw materials as a source of energy for rural electrification power plant. It drives the economy in the region and in long run will strengthen the availability of renewable energy [6]. The overall activities of goal-oriented system were conducted by indicators of sustainability efforts, energy mix, and the electrification ratio.

1.3.1 Structure Model Development

Based on the expert opinion, there are six elements of the development program for the renewable energy policy model for biomass industry: (1) program goals, (2) the needs of the program, (3) the public sector, (4) the main constraint, (5) possibilities changes, and (6) the institution concerned. By using ISM analysis, we obtained

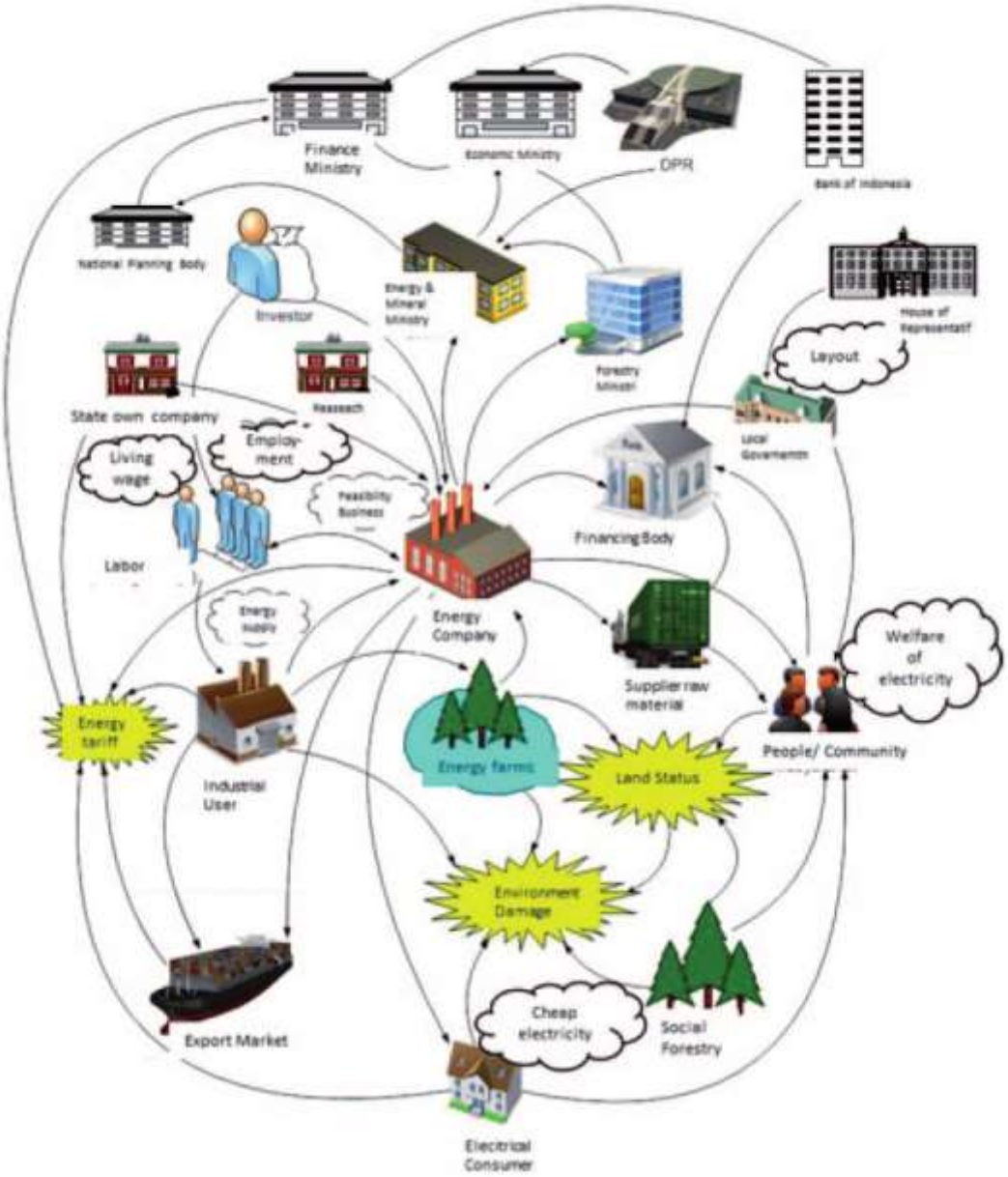

Fig. 1.3 Rich Picture

driver power-dependence matrix, which shows the key elements of each element as presented in Table 1.1.

It was identified that in every element programs there are sub-element keys of program goals, which determine the energy tariff. This shows that the purpose of the energy rate determination is independent variables in the energy policy system and play important role as driving force to the higher-level program although has small dependency to small program. In the context of bio-pellet industry, the economically viable FIT contributes to the achievement of social forestry empowerment and social welfare improvement [8].

Table 1.1 Key elements of renewable energy development based on bio-pellet

Key element	Sub-key element	Dependency
1. Program goals	Determination of energy tariffs	Increasing public welfare
2. The needs of the program	The competency of human resources Coordination among related local government offices Community participation Funds and investment banking business Microfinance	Raw materials industry
3. The public sector	Public figures	Electric consumers
4. The main constraint	Status of forestry land Policy HTR	Investments business High technology Limitations of regional infrastructure The level of skill and knowledge of HR
5. Possibilities changes	Urban planning, land-use planning	Increasing SMEs Entrepreneurship and work ethic Value-added management HTR Conversion of energy sources from fossil The availability of electricity in rural areas Feasibility and optimization of industrial land use
6. The institution concerned	The financial institution/bank NGO Professional associations energy field	Private companies/energy industry The local government

1.3.2 Assumptions Strategic Development Model

The basic assumptions of the renewable energy policy development model for sustainable biomass industry were obtained from FGD. The results of these discussions led to 27 assumptions which were grouped in three aspects: environmental, social, and economic. The assessment from expert based on level of importance and level of certainty identification drives to strategic assumption as shown in Fig. 1.4. Strategic assumptions are in quadrant II, which has a level of importance and high certainty. The assumptions of the environmental aspects are: sufficient supply of raw materials, availability of potential alternative industrial biomass raw materials in local areas, decreasing environmental damage, land and forest inventory, as well as agro-climatic suitability.

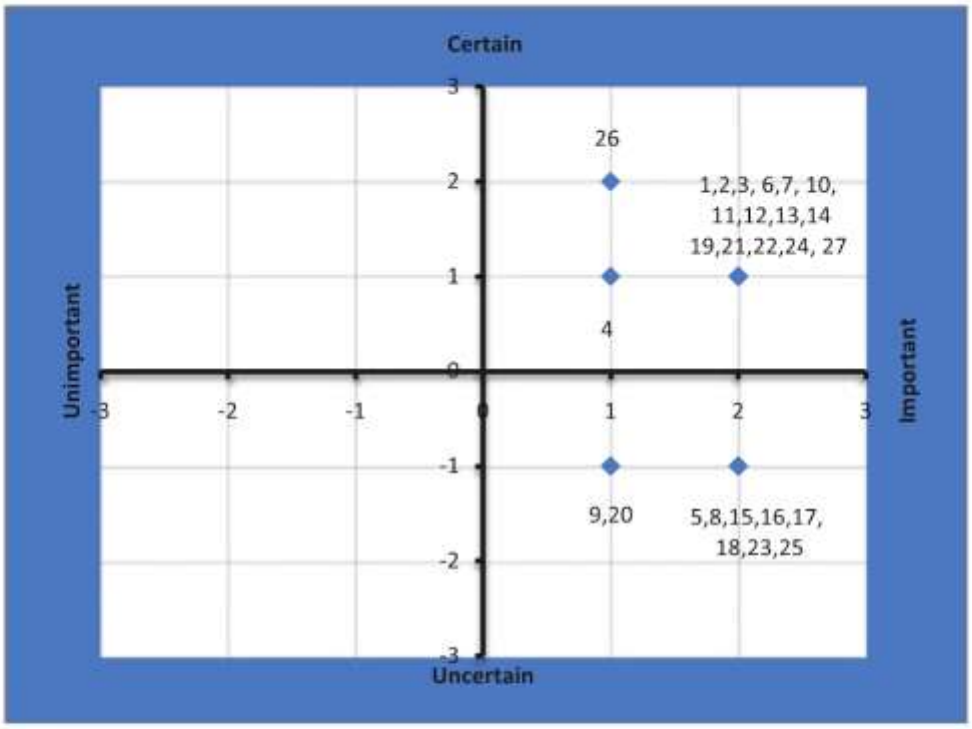

Fig. 1.4 SAST quadrant assumption

Strategic assumptions for social aspects are: support from community leaders, people involved and supporting the program implementation, support regulatory (licensing) and local governments, as well as well-distributed information and dissemination of biomass [1]. The strategic assumptions for economic aspects are: it can be used as a new energy source for locals, investors seriousness and commitment, support investment regulation, increased income, the existence of a clear trade system, and there is market potential for both local and export (underwriting market).

1.3.3 Intermediate Objective Map

Key elements of the program and the resulting strategic assumptions are used as *intermediate objectives map* as a connection to the ultimate goal of the policy model. Map objectives are expressed as claims, that is, claims of: (1) forest resources preservation, (2) energy forests development, (3) bio-pellet industry as green business, (4) viable bio-pellet industry, and (5) bio-pellet industry provider for rural electrification. Renewable energy policy for rural electrification is strongly associated with the industrial feasibility of energy generation feedstock providers [18]. Therefore, supply chain management is required which is supported by business financing, regional infrastructure, and regional policy. This is based on the existence of appropriate economical energy prices, fiscal incentive system, and government policy

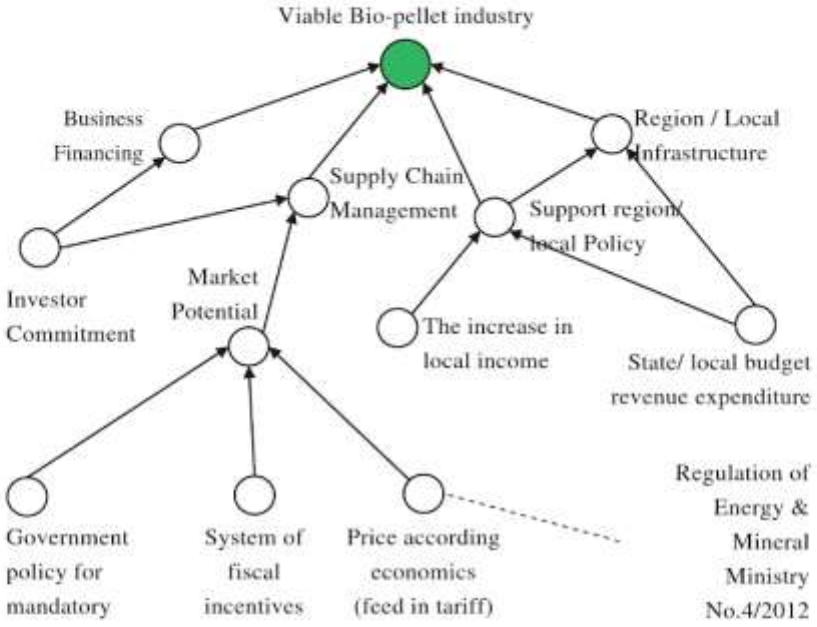

Fig. 1.5 IOM viable bio-pellet industry

for mandatory; this claim is shown in Fig. 1.5. Based on this approach, two models were developed: (1) the model of bio-pellet industry investments for electrification (Fig. 1.6), and (2) the model of supply chain and empowerment of social forestry (Fig. 1.7).

1.3.4 Implication

Policy implications of these two models are prioritized in three aspects: (1) supply chain system for bio-pellet industry, (2) an FIT, and (3) the empowerment of social forestry. In the aspect of supply chain system for bio-pellet industry, the integration of energy policy across sectors, that is, electrification, forestry, and empowerment that are environmentally friendly, is required. It is also a mandatory requirement that users of fossil fuels have obligations to consume biomass to generate electricity. In order to establish continuity of the bio-pellet raw materials, it requires support of bio-pellet adaptive technology, therefore assistance of research institutions to create effective innovations is needed [15].

Economic aspects associated with FIT are necessary to establish the type of renewable energy and biomass specifications. Governments also need to set incentives for bio-pellet industry, which will greatly affect the economics of bio-pellet product [9]:

- Support from the government to access funding.
- Joint Decree of the Ministry of Industry, Ministry of Energy and Mineral Resources, and the Ministry of Finance.

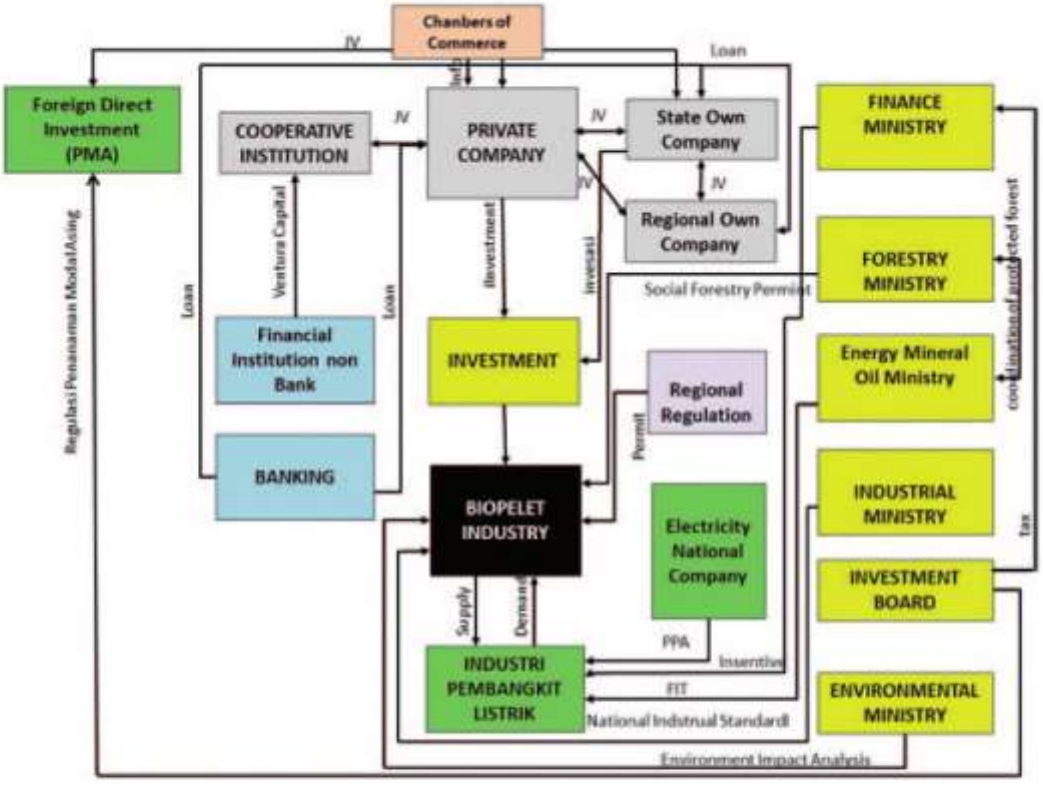

Fig. 1.6 Model of bio-pellet industry investment

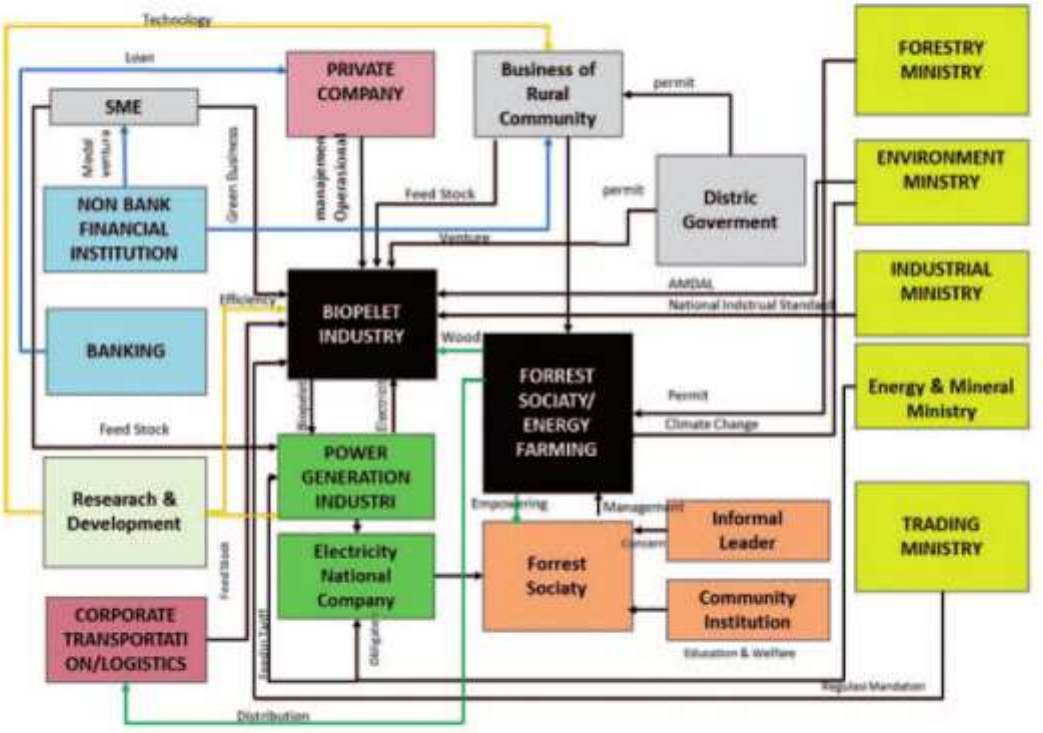

Fig. 1.7 Model of supply chain and empowerment of social forestry

- The government needs to provide a fixed-price FIT evaluated periodically to encourage the private sector to develop biomass-based renewable energy (bio-pellet base).

Sustainable industries based on natural resources cannot be separated from the existing businesses in the community, so that the community empowerment strategies are needed, particularly among the social forestry. This effort must be made in an integrated manner with the involvement of public, private, government, and other stakeholders. Strategic steps are as follows:

- Ministry of Forestry issuing a regulation that requires a minimum of 20% public forests for energy plantation
- Proactive local government to educate people on energy plantation and management of raw materials for biomass and bio-pellet.
- The licensing of bio-pellet industry will be issued if the private sector has a memorandum of understanding (MoU) with community agencies to manage public forests.
- Mandatory use of locals is prioritized for at least 50% of the bio-pellet production.

1.4 Conclusion

Factors that influence development of renewable biomass energy policy, based on forest biomass managed by people are: (1) the determination of the energy tariff, (2) competent human resources, (3) coordination between related local government offices, (4) an incentive system, (5) community participation, (6) banking and investment fund business, (7) microfinance, and (8) the need for local governments to design spatial regions and territories. These factors should involve financial institutions, NGOs, and professional associations. Bio-pellet industry supply chain model with sustainable community forest empowerment is supported by the parties of (1) The Central Government, including the Ministry of Forestry, Ministry of Environment, Ministry of Industry, Ministry of Energy and Mineral Resources, and Ministry of Commerce, (2) local government (LG), (3) financial institutions, (4) research institutions, and (5) private companies.

This system should be supported by The Central Government with various policies to maintain bio-pellet industry business continuity.

The model of renewable energy policy based on biomass industry for rural electrification involving SMEs is very much dependent on the non-banking agency funded to make a feasibility study as a condition of the PPA issuance by PLN (Perusahaan Listrik Negara) or State Electricity Company. This funding access is important for achieving the next step of rural electrification. Scheme of *independent power producer* (IPP) driving the growth of green business models for unused land utilization throughout Indonesia and mined land. The new IPP can happen when the

private sector gets support from community leaders and civil society to ensure the implementation of sustainable energy farms.

1.5 Recommendations

1. Determine viable energy tariff to stimulate sustainable biomass-based energy industry, which is subject to the provisions of fixed price.
2. Facilitate access to financial institutions/banks in biomass-based energy industry, namely the nonbank financial institutions through venture capital schemes.
3. Establish the rules of green banking in banking and financial institutions to have incentive for renewable energy developers with more attractive lending rate.
4. This study can be continued for any type of renewable energy technology based on the amount of generated power, the power plant site, and the technology used.

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