The Factors Used in Policy Decision Making for Promoting Direct Steam Generation Parabolic Trough Technology in Thai Food Industry

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Abstract

Direct steam generation from boilers is the most common technique, currently applied in Thailand food industry. To reduce its fossil fuel consumption and GHG emission, industry is focusing on the development of renewable energy technologies, and direct steam generation from parabolic trough is one of them. This study discusses decision making factors for promoting the use of direct steam generation in industrial heat process by parabolic trough technology. The factors were evaluated and applied by using literature review, personal communication with key personnel and questionnaires. The Analytic Network Process (ANP) was applied to suggest a ranking scale for the factors to be used in drafting their weights. The considered main factors were technology, economics, social, environmental and political. The results suggest that the financial mechanism, investment cost, technological maturity, reliability, safety and environmental gains can be used in decision making for the promotion of renewable energies in Thai food industry.

Keywords: *Policy decision making; Direct steam generation; Parabolic Trough Technology; Food industry; Analytic Network Process; Renewable Energy*

1. Introduction

Nowadays, most of boilers in the Thailand industrial sector use residual fuels or heavy fuel oils as raw materials to generate heat in order to produce large quantities of steam. According to Figure 1, energy consumed by food and beverage industries, leather and clothes, chemical, metal and steel product, paper, wood, basic metal industry and others was 40 %, 19%, 16%, 8%, 4%, 6%,1% and 5%, respectively. Use of these fuels also results in losing large amounts of budget and increases burdens on industrial sector. Additionally, these fuels affect the environment, as burning these fuels can produce Sulphur which results in air pollution, increased health risk and also accumulation of acid rain. Therefore, replacement of heavy oil by thermal renewable energy sources for steam production is a promising plan to reduce hazardous problems. Solar energy technology, like concentrated solar power technology, which can generate both heat and electricity, is a good alternative for the industrial sector, as the daily average solar intensity in Thailand (approximately 5 kWh/m^{2}day) has enough potential for concentrated solar power technology. Parabolic trough solar thermal system, being simplest and the most commercial CSP technology can reduce steam production cost to the industrial sector and it is also an environment-friendly technology which follows the green industry policies issued by the Ministry of Industry.

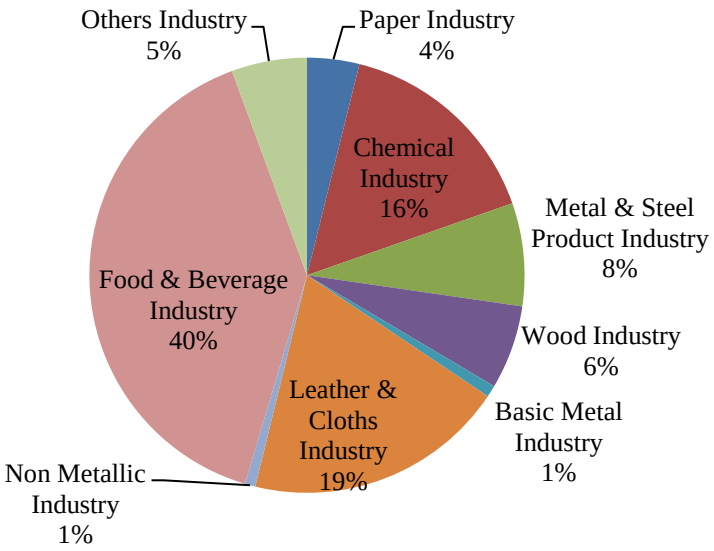

Figure 1 Number of Boiler by Industrial Sector [1]

2. Methodology

In order to formulate the decision making model for direct stream generation (DSG) parabolic trough system for thermal industries, the variables involved are finance, social, economic, environmental and technology. In the present study, Analytic Network Process or ANP Theory, ANP, was used as multi-criteria decision making tool which allows decision makers to model more complex decision making problems. Briefly, ANP principle is applied to build the network problem model by evaluating problem as a network of interdependent element (alternative and criteria) shape in to clusters. Firstly, all elements are identified to each group into clusters. Secondly, all specified influences related to each criterion and alternatives are placed in a matrix tabular that are formed by all the elements of the network. Thirdly, calculating all pair wise comparison matrices is performed which is called, un-weighted super matrix and later build the weighted super matrix based on the questionnaire and priorities of the clusters. Then, limit super matrix has been achieved by manual calculation. Finally, results of the decision making process are obtained.

There had been utilizations and applications of ANP which are reviewed by several researchers such as exploring renewable energy pricing with analytic network process [2], establishment of weights and re-accredit of a program of a university[3], priority determination in strategic energy policies in Turkey using ANP with group decision making [4], selection of photovoltaic solar power plant investment projects - an ANP approach[5], an ANP approach to measuring design change impacts in modular products [6], applying ANP in logistics service provider selection [7], a hybrid MCDM method to evaluate supply-chain development strategies[8], technology selection for product innovation using ANP[9], selection of renewable energy sources for sustainable development of electricity generation system using AHP: A case of Malaysia [10], modelling decision making as a support tool for policy making on renewable energy development[11], applying the ANP model for selecting the optimal full-service advertising agency[12], ANP approach for selecting strategies influencing the productivity of knowledge women workers[13], application of ANP in lean production system justification[14], project portfolio selection in electrical company based on the ANP[15], prioritization of renewable energy sources for Turkey by using a hybrid MCDM methodology[16]. ANP can be used as a significant tool for modelling decision making for policy making on renewable energy development.

Literature review revealed that ANP was used for studying a biomass power plant project [11]. For this case study, two scenarios have been classified all criteria relative biomass power plants factors and design on one of typical scenario and another one an ideal scenario was proposed. The results of this case study shows that new decision criteria has impacts on capital investment for biomass power plants and highest priority from public entity in a holistic point of view as "idealistic scenario" can make the right way to develop renewable energy policies according to the ANP decision model. However, there are no previous research works to determine scenario model for renewable energy policies based on the ANP method of DSG parabolic trough system. Therefore, this paper was focused on the study of factors used in decision making of DSG parabolic trough technology for thermal industries process.

3. Results and Discussion

From an extensive literature review about evaluation criteria for renewable energy technologies application, which was focused on direct steam generation in industry, based on cost and clean perspectives for sustainable energy planning 4 indicator were considered, namely Technical, Economical, Environmental, Social [17]. Another reference, project dealing with complicated risks in urban regeneration projects, urban planners require an effective tool to assess the potential risks associated with regeneration projects. Comprehensive risk assessment criteria, based on the requirements of Social, Technological, Environmental, Economic and Political (STEEP) factors and the decision-making support model, were established and provided [18]. More interesting of great importance as it can help energy policy makers in the design of better strategies for the promotion of renewable energies, such as biomass, were found 71 criteria for selecting renewable energy power investment projects and presented to decision makers that can be grouped in 5 criteria: Financial indicators, Incomes, Projects and Authorizations, Local environmental impacts, Policies and Strategies. In this paper, the criterion was determined into 5 groups as follows: Technological factors, Economic factors, Social factors, Environmental factors and Political factors.

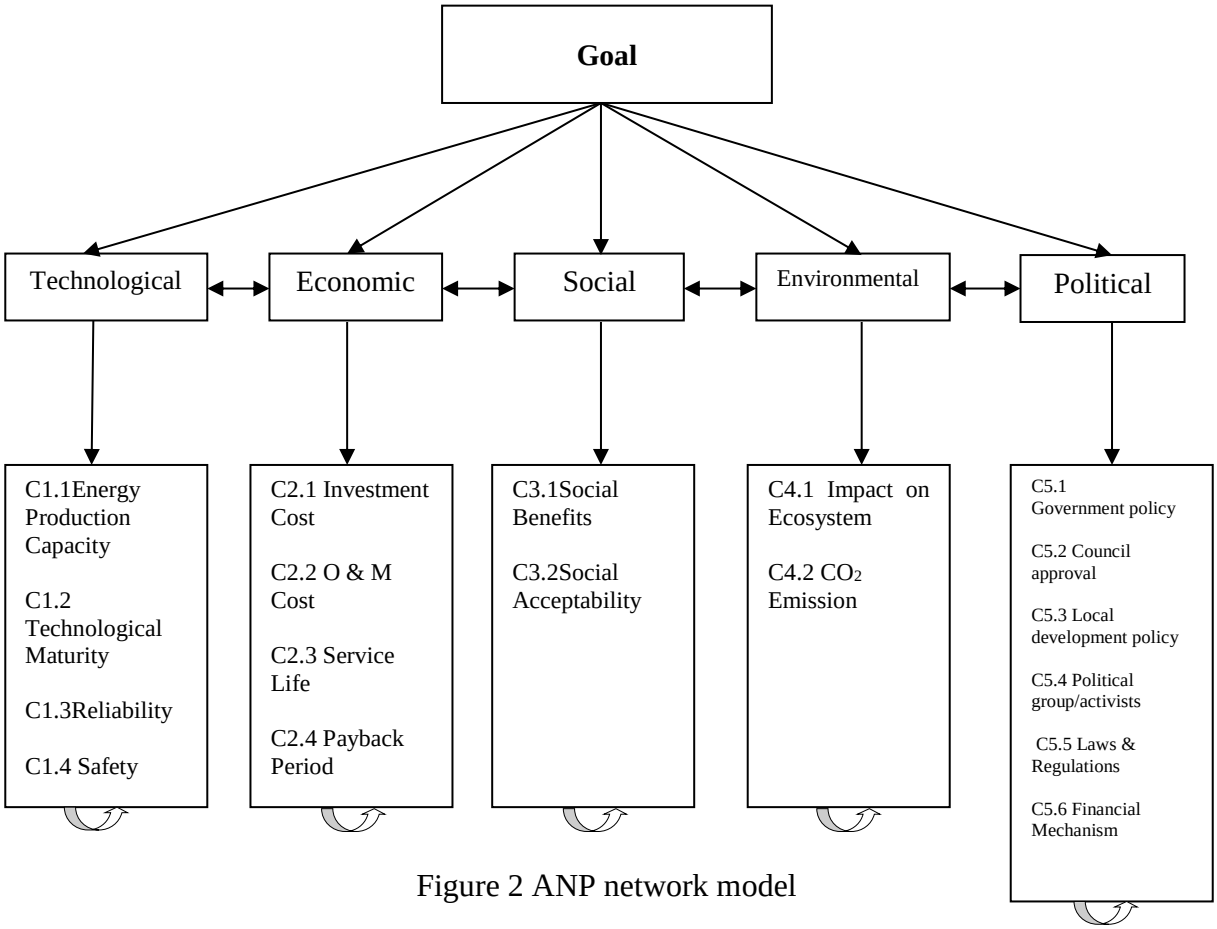

Figure 2 ANP network model

3.1 Consistence of installation and maintenance requirements with local technical know-how;

- **Suitability for process heat:** whether or not a technology or energy source is suitable for the generation of on-site process heat;
- **Cost of energy:** assessment of the levelized cost of energy over the lifetime of the system, including the cost of equipment, installation, maintenance and fuel;
- **Price volatility:** assessment of how volatile the price of the fuel source is. Oil and grid electricity have been especially volatile in many developing countries;
- **Carbon intensity:** assessment of the carbon intensity of the energy derived from the fuel or technology. Normally measured in tones of CO_2 per unit of energy (e.g. MWh)
- **24 hour availability:** whether the energy output (in this case process heat) is available on a 24 hour basis to serve constant production processes. Boilers using fossil of biomass fuels can be run constantly. Solar energy is limited to daylight hours but CSP systems with storage can produce heat for several hours after sunset;
- **Scalability:** an assessment of how easily a system could be scaled up if heat demand at an industrial facility increased significantly. Boilers can easily be upgraded, or additional ones added as they do require a large amount of space. Adding to a CSP or PV system could be constrained by available space;
- **Local component supply:** being able to replace system components easily is important to industrial users and more complex components may need to be imported. PV panels for example are not made in many developing countries. This may lead to supply issues, and limits local job creation opportunities;

- **Ease of maintenance:** it is advantageous for industrial users to be able to maintain all parts of their process heat systems. Those with complex components may be difficult or expensive to maintain.

3.2 Potential / Climatic conditions

This criterion is only concerned with the geographical potential of a certain region. The scale proposed considering the available renewable energy technology.

3.3 Reliability

In term of assessing renewable energy, continuity and predictability of performance, the Parameters used in Multiple Criteria Decision Making Methodologies for Drafting out Renewable Energy Sources Support Schemes. It is important to know the conditions of continuous operational patterns. This condition is often a characteristic of a given technology and does not indicate a factor of unreliability.

3.4 Value of Environmental Benefits (VEB)

Renewable energy sources, which are often (but not always) carbon-free, are among the technology options available to reduce carbon emissions in the electricity sector [7]. Governmental policies regarding environmental protection and emission reductions are amongst others mainly based on the promotion of RET. The VEB can be calculated using two scenarios, the renewable energy certificates and the certified emission reductions scenario.

3.5 Certified emission reductions (CER)

The CER is based on the Clean Development Mechanism of the Kyoto Protocol. The registered CDM project obtains one CER for each 1 ton of CO_2 reduced by the project. Besides, the sale of CERs represents an additional source of project income. However, the development of a CDM project generated extra costs for the project developer, also known as transaction costs. These costs are related to the formalization and validation of the CDM project, as well as the monitoring and verification of the emission reductions.

3.6 CO_2 Emission

Environmental benefits of the reduction of pollutant emissions; with a direct price for emissions via either an emissions tax or tradable emissions permit system the fossil fuel sector has an incentive to lower its emissions rate until the marginal cost of reduction equals the emissions price.

3.7 Land requirement

This criterion represents one of the most critical factors for the intervention site, especially where the human activities are relevant factors of environmental pressure.

3.8 Sustainability according to other environmental impacts

Landscape impact, acoustic emissions, electro-magnetic interferences, bad smells, and microclimatic changes are evaluated. This parameter can be considered highly subjective since it includes impacts such as landscape changes.

3.9 Government policy

Renewables can be seen as a way to reduce carbon emissions, to promote industrial development, to decrease fossil fuel imports, and meet other policy goals. Each of these goals leads to a different set of programs and technologies. The examined criterion assesses the qualitative relevance of the above considerations, with regard to government support, the tendency of institutional actors, and the policy of public information.

4. Conclusion

According to the results the best alternatives way for policy makers in the field of renewable energy development could be ranked best according to the CSP-parabolic trough decision making models for heat industrial renewable energy policy. The results and outcomes of this research noted that the parameters concerned with technological maturity, reliability, safety, government policy, financial mechanism, investment cost and environmental gains issues were amongst the higher ranked factors. More government's laws and regulations issue on decision making process should be taken into consideration in order to explain in decision making for the promotion of Direct Steam Generation Parabolic Trough Technology in Thai food industry.

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