Challenge of Renewable Energy Transition towards Krabi’s Sustainable Energy City

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Abstract This paper is a review article collecting relevant data and information for developing a transition model towards a sustainable energy city: a case study of Krabi Province, Thailand. An expanding tourism sector in Krabi is increasing energy demand, which continues to grow year after year. Meanwhile, the energy supply of the province relies on the centralization of the southern and central regional energy system to the national grid transmission system. According to the 2018 National Power Development Plan, Krabi is projected to shift to regional grid decentralization; coupled with increasing its power generation from renewable energy with affordability and community participation. Therefore, Krabi Vision 2020, which is a provincial master plan, would lead the direction of Krabi’s plan towards energy transition. Increasing renewable energy investment and disruptive technology to secure the potential of solar, biomass, biogas, wind and mini-hydro is paving the way to shift Krabi to a sustainable energy future. The implementation of a sustainable energy transition across the province, would bring benefits for the local economy, environmental conservation, and energy security. To achieve this energy transition, Krabi requires coordination of smart policy, local and government participation, and sound planning. This review study suggests that the transition towards a sustainable energy future depends on identifying the political barriers, and the adoption of effective management practices.

1. Introduction
Growth of population and urban centers is challenging government and policy makers to create smart cities and shifting to sustainable development goals [1]. Simultaneously, urbanization and regional development can generate unexpected environmental pollution and ecological damage. A shortage of resources and a decrease in biodiversity is challenging regional, national and global organizations to reduce their impact through sustainable development. Sustainability and environmental security in regional development is an important aspect when planning for a harmonious city [2]. The coordination and integration across nations is an essential requirement for energy sustainability strategies [3].

The demand of regional and urban centers is increasing, putting pressure on the supply chain and straining available resources, which have the potential to affect the quality of life. It is the goal of a regional renewable energy transition to reduce a region’s impact on the environment and increase people’s awareness of their impact on the current climate change crisis. National energy policy will increase a share of renewable energy on the grid, which depends on the potential, regulation enforcement and political will. A sustainable and renewable energy future depends on decentralization of energy generation and the diversification of energy sources.

In the global effort for climate change mitigation renewable energy is one part of the solution of reducing greenhouse gas emissions and climate change impacts [4]. Growing renewable energy sources does not
only bring environmental benefits but also positively impacts the economy and energy sectors. Energy markets and policies driving the energy transition is emerging in nations, which targets to achieve a grid powered by renewable energy. The challenge is the transition from fossil fuel to renewable energy generation as a plan for a country and a master plan of regional planning for energy and its management. Even though the global price of renewable energy is continuing to decrease, energy policy is not adequately taking advantage of the high potential of renewable energy to contribute to the existing energy supply. Ambitious policy is needed to increase the share of renewable energy in the energy portfolio.

A global trend of renewable energy has directly affected ASEAN’s energy policy. ASEAN Power Grid as a master plan of Asian countries has been one of the intergovernmental targets of efforts and activities to get a closer reach to the goal of reducing regional energy intensity of at least 8% by 2015 (based on 2005 levels), and the collective target of 15% of total installed power capacity from renewable energy sources by 2015. The ministers have also agreed to consider a higher level of commitment in terms of energy intensity reduction and installation of renewable energy beyond 2015 in reference to other international and regional commitments [5]. On the other hand, the ASEAN power grid has not been addressing a concrete policy to achieve that target, and it seems that the supply of electricity for the national grid is still putting the priority on fossil fuel generation.

As Thailand is a key player in the Southeast Asia region, harvesting the potential of renewable energy is dependent on balancing against fossil fuel energy generation. The aim of this research is to investigate the phenomenon of sustainable energy transition at a provincial level that relates to national energy planning. The beginning identifies key aspects of the direction of national energy policy, provincial energy implementation and the transition capacity related to policy makers, institutions and public acceptance.

2. Energy Transition

Transition thinking is to frame the evolution of energy changing in term of traditional to technological development from the dependable fossil fuel to de-carbonisation initiatives [6]. Energy transition can be conceptualized as a socio-technical term being a sort of crossroads between institutional development and policy paradigm [7]. The multi-level perspective is disrupted in terms of structure and demographics of the economy, environmental and social factors, and depends on various factors of legislation, technology and innovation etc.

The unexpected phenomena require understanding the adaptive transition that relies on knowledge, skill and capacity experiencing across initiative. The interconnection of energy transition involves socio-technical, techno-economic, and political actions [8] emerging to deal with complicated situations requiring effective management. This transition process is challenging society which tends to be stubborn when facing major structural changes.[9].

The pattern of energy transition is significant in regards to the potential of renewable energy to be adopted for energy demand and consumption. As various countries move forward technologically, infrastructure and institution practices [10] with relevance to stakeholder perspectives in various states including adopters, non-adopters and potential adopters. Renewable energy market prices reduction, higher rate of return investment, feed-in-tariff agreement policies etc. are all potential factors impacting a renewable energy transition [11][12].

Reduction in negative environmental impacts is a main goal of climate change mitigation and sustainable development. Energy transition becomes a main dimension of city management to deploy it at scale of renewable energy utilization. The potential of renewable energy depends on the interconnection of landscape, management, and investment to secure. City planning priority coordinates with energy transition [13] that illustrates the strategy and indicator to create it long-term. The pathway of energy transition relates to social-spatial in context of distance [14], which refers to cluster and location of land use management.

The transition towards sustainable energy city covers the integrated dimension of geographical, deployed policy and adopters. The disruption takes place in residential, business and governance models.
also approach the justice procedures. Transition management improves a level of public participation and increases the engagement groups [15] to create the public acceptance of change. The emergence of energy transition is from the bottom as a social movement under informal, pluralistic and is politically driven [16].

3. Research Approach
This research demonstrates the investigation of energy demand and supply, coupled with the potential of provincial renewable energy, national energy supply plans and its energy planning to further initiate a mechanism of sustainable energy transition in Krabi province. The aspect of island context energy transition as small utilities, low population density which increase the need to invest more in a decentralised system, energy storage [17] and transition towards renewable energy [18]. Adopting a transition to city sustainability is connected to institutions and stakeholders taking an accountability of, and the pathway to utilize the potentials of energy resources for electricity generation balancing the demand for growth. Political wills for renewable energy is essential to shift the potential compatibility with democratic patterns [19]. Renewable energy transition which takes place in Krabi province to enhance economic, energy and environmental factors as a sustainability framework is based on the important key points of energy transition and mechanism to apply the initiative sustainable energy transition. Reviewing relevant issues of sustainable energy city development in the aspects of energy policy and implementation plan to achieve compliance of national and regional power development plan such as industrial, tourism countries’ development. Then, identify a map of provincial and national energy infrastructure systems including the exiting and expanded grid connection and investment; it is necessary to conduct an integrated plan of electricity generation, distribution and fuel sources management.

An initiative mechanism of the sustainable energy transition would cover the interdisciplinary triangle of sustainable development and the energy transition governance as shown in figure below and analysis of the sustainable policy, participatory and planning of energy security. That directly relate to the environmental impact concern with drivers, pressure, state of natural capital and response framework to local and national policy-decisions [20]. The frequency of using indicators like economic, environmental and institutional, and environmental aspects as a tool to approach sustainable creation with the indices for the public, policymakers and scientists to integrate a plan and practice [21][22][23].

Ultimately, to process and deliberate a transition towards sustainable energy future is that engaging the kinds of people experiments from diverse perspective to participate with and understanding its energy transition values [24]. Participatory planning defines organisation and individuals in combination with transition dynamics pathways [25].
Krabi’s Sustainable Energy City

Transition process

Figure 1: Transition towards Krabi’s Sustainable Energy City

Note: Applied from Policies, Actors and Sustainability Transition Pathways: A study of the EU’s energy policy mix Marie, L., et al., 2018; and the Interdisciplinary Triangle of Sustainable Energy Development.

Energy sustainability covers main aspects of energy security consisting of availability, accessibility, affordability, and acceptability; however, the process of transition management refers to energy justice and just transition [26][27]. The balances of the internal economy, which relies on tourism, fishery, and agriculture and the external economy concerning environmentally friendly dimension that is targeted to reduce emissions from the point sources are very challenging. The transition process is linked to institutional policies representing key organisations and structural reforms for fundamentally impacting energy creativity [28] and participation to drive the transition direction and initiate the pattern of sustainable energy transition of Krabi province.
Research Methods and Data Collection:

1. Collecting secondary data of cases study of renewable energy transition.
2. Study a system of energy exiting and infrastructure planning and investment.
3. Mapping renewable energy potential of Krabi province.
4. Investigating the procedure of renewable energy transition systems in Krabi province.
5. Study the institution and mechanism of the sustainable renewable energy transition and institution of Krabi province.
6. In-depth interviews with local government agencies, provincial energy authorities and energy agencies, tourism businesses, agriculture, industry, households, and financial sectors etc.
7. In-depth interviews with energy policy makers including local, provincial, and national levels.
8. Analysis of the pathway of transition towards Krabi’s Sustainable Energy City.

3.1 Thailand Renewable Energy Transition

Thailand’s Power Development Plan 2015 indicates the pathway of a country energy planning for 20 years targets; mainly dependent on fossil fuel supply as natural gas base load is about 70 percent. To continually in 2018, Ministry of Energy and energy agencies have proposed the revised power development plan 2018 upon the reasons of the derails of Independent Power Producer (IPP) investments and behaviors of energy consumption changing to more renewable energy increasing, self-generating and peak load at the night time. Referring to PDP report [29] indicates to decentralize the management of fuel sources and power plant in each region, its energy security, distributed energy generating and promote private sector for competitive market.

Figure 2: The new version of Thailand’s Power Development Plan, EPPO 2018
The new version of Thailand’s Power Development Plan targets renewable energy to supply the grid for the next 20 years with 20,766 megawatts expected to come online from 2019 to 2026. An opening quota of 100 megawatts solar rooftop transmission and later intensive growth after 2027 is planned. The Southern Energy System covers electricity installation of 2,164 megawatts while the regions demand is 2,624 megawatts. Additional supply from central energy transmission leads energy policy makers and agencies promoting new power plants in the southern area to secure the increasing demand in the long term, with public debate on kinds of energy sources and benefits.

The potential of renewable energy in Thailand as a top renewable energy investment destination in Southeast Asia is great, but government policy hinders its development. Relevant policy has been endorsed to help streamline investments and reduce unnecessary regulation. Since 1994, renewable energy installation in country has expanded its capacity reaching 1,000 megawatts in 2006, and increasing to 2,000 megawatts in 2010, in 2016 its generating over 5,000 megawatts. The Renewable Energy Act offers the possibility of easing the transition to renewable energy and its implementation in the country [30]. It has the potential to help encourage the province to research and develop a renewable energy investment plan as a small and independent power producer, highlighting the potentials of producing solar energy from the rooftops of urban homes and rural area, visible institution buildings and communities in the country. It would be empowering a capacity of energy transition on energy revolution, increasing renewable energy and energy efficiency implementation.

There are many benefits that the Renewable Energy Act can offer if it is approved. One of these is showing what people can do in their homes and buildings, and how can they achieve energy independence through solar energy, with the intention of breaking the myths surrounding solar energy e.g. myths on cost-competitiveness, reliability, practicality, etc.

These features will create the perception that producing your own electricity from renewable energy is the path to energy security and energy independence. Since 2013, Thailand has been raising the subject of Renewable Energy Act with the public and later pushing on policy work to the Department of Alternative Energy Development and Efficiency, [31] finally ending at the Ministry of Energy drafting and National Legislative Assembly. On March 18, 2015 the Committees of the National Legislative Assembly has officially announced the platform of Renewable Energy Law Drafting Public Hearing for renewable energy alignments including renewable energy experts, renewable energy policy working groups, renewable energy investors, civil society and people to raise their finals comments.

In 2014, the National Reform Council [32] passed the resolution on the “Solar Rooftop” expansion scheme - expecting that in the first 5 years (2015-2019) there will be about 100,000 solar rooftop modules (not exceed 10 kilowatt) for households with total installed capacity of 500 MW and in the next 20 years about 1 million solar rooftops with installed capacity of 5,000 MW. If the Thai government is aggressively promoting the investment of solar energy industry [33] including solar PV module production, Thailand is expected to be a winner on this area of renewable energy in the next 10 years.

The next step as policy expectation, for Thailand NRC is to push for the renewable energy law to be passed by the parliament to ensure a proper, just, fair, and sustainable supporting mechanism for clean renewable energy development. In terms of renewable energy policy is that Thailand’s Alternative Energy Development Plan (AEDP 2012-2022) has promoted production and consumption of renewable energy by setting a challenge target of increasing alternative energy share up to 25% by the year 2022. The national energy planning indicated that the increasing electricity demand would be secured with additional fossil fuel power plants installation as a base load, even fulfilled implementation of the national energy efficiency strategy.

In a country, the barriers of renewable energy installation and its supply on grid are continuing arguments on policy makers and the public. Not only lacking a sufficient support of renewable energy law and regulations but also there are a variety of technology transfers, grid transition systems, technical developments and value of the investment.

To lead urban and regional renewable energy implementation required investigating of the potential of renewable energy supply and integrated on grid into the remaining energy infrastructure and further invests to grid expansion. The potential of renewable energy in country is increasing in a proportion of
total power generation, which is different in each regional geographical area, including: solar, biomass, and wind energy. However, the dependable capacity to secure its supply is low compared to an advance renewable energy investment in developed countries and fluctuate flowing supply in some conditions. The implementation of regional renewable energy is just a part of the potential of renewable energy; a planning on energy, environment, and economic aspects are the keys for achievement.

In 2016, Asian countries joint agreement under ASEAN Community to power international trade competition composes of ASEAN Security Community (ASC), ASEAN Economic Community (AEC) and ASEAN Socio-Cultural Community (ASCC). The AEC identified the direction of regional energy development under the umbrella of Head of ASEAN Power Utilities/Authorities (HAPUA), including ASEAN Power Grid with sharing energy resources, effective management and energy security \[34\]. For long-term implementation, the Electricity Authority of Thailand (EGAT) and Provincial Electricity Authority (PEA) must integrate the transmission system to further supply electricity to neighboring countries with expected increasing demand.

3.2 Krabi’s Energy Overview

Krabi is one of 77 provinces in Thailand located at the southern part of Andaman Sea, it has high potential for renewable energy development as the first province of country within the next 10 years. The renewable energy capacity on grid is up to 40 percent, which sourced from biomass and biogas to feed some sub-districts of the province to reach the regional renewable energy utility. However, the potential of other energy sources is going to be researched to reduce the risk of dependent energy supply.

In terms of renewable energy transition in Thailand, it has become the first case development in a country under ‘Krabi Vision 2020’ \[35\] and ‘Krabi Goes Green’, provincial planning has addressed the relevant sustainability of development, and energy planning, increasing renewable energy as a part of that strategy. However, the provincial plan requires the factors and indicators of city growth, economic development, energy security, environmental impact reduction and the climate change risk in relation to the island geography. Krabi has a population of nearly 450,000 people in 8 districts. It is a target of the energy demand supply chain of provincial electricity generation.

Krabi electricity grid management is enforced by Provincial Electricity Authority of Thailand (PEA) to balance the distribution of demand and supply in the province with 10 stations covering the region as shown on the map in figure 2. The provincial electricity transmission is distributed as a monopoly of the Electricity Generating Authority of Thailand (EGAT) and peak load supply from internal renewable energy generating by PEA (Provincial Electricity Authority). Krabi peak load demand of the 3 years is continually increasing between 2015 and 2017, from 134.1 to 144 megawatt as shown in figure 4.

The energy supply for Krabi province is a significant consideration as tourism contributed to visitors of over 6.5 million peoples in 2017 and is expected to grow yearly. As tourism revenue dramatically increases up to 105 million baht in the same period, that shows the strong connection pillars of tourism, agriculture and fishery to secure local economic, energy and environment share.
According to PEA, Krabi province is a tourist city with a high number of hotels, resorts and shops where its peak electricity consumption occurs in December as Krabi’s peak tourist season. This is
different from the overall peak of the country, which lies in the months of April - May, with late evenings as the peak demand hours. The peak hourly consumption behavior of Krabi province is obviously different from non-tourism provinces. Krabi’s electricity consumption lies in the 90 -145 megawatt ranges, rising sharply from 7 to 10 am, gradually increasing during the daytime. The highest electricity consumption is observed in the evening. It peaks at 7pm. with 145.64 megawatt of electricity consumed, while the lowest electricity consumption is about 90 megawatt at night from 12 pm. - 6 am.

The average hourly electric consumption comparison during weekends and weekdays of Krabi Province in 2017 shows the 24-hour electricity consumption looks the same throughout the week. Electricity consumption increases rapidly from 90 megawatt to 125 megawatt during 08.30 am. – 10.30 am. Then, a slight increase from 125 to 130 megawatt occurs during the daytime, which increases at 06.00pm. and peaks at 08.30 pm. The peak usage of weekends is higher than that of the weekday's peak at around 3.5 megawatt. The maximum monthly demand for electrical power in Krabi Province in 2017 shows that there are big differences that correlate with Krabi’s peak tourism seasons. The lowest electricity consumption occurs in June, with 132.63 megawatt and the lowest average electricity consumption occurs in the range of 132 to 137 megawatt from May to September. However, the electricity demand begins to rise again in September, reaching its peak in December with 145.64 megawatt of electricity and gradually decreases until the end of April when the tourist season ends.

Figure 5: The Statistic of Krabi Electrical Demand-Supply (Unit) 2008-2017
The energy demand of Krabi province fluctuates increasing in residential, business and other sectors. Residential energy consumption of around 150 units is the major demand of province and the small, middle business including other sectors and large business respectively. In 2014, Krabi province has officially announced a provincial master plan of ‘Krabi Vision 2020: Krabi Goes Green and Green Tourism Plan’, and that declaration of Krabi Vision 2020 is the first vision of provincial uptake in the country. In terms of energy systems of the province, it is under the PEA distribution system and also under the Electricity Generating Authority of Thailand (EGAT), which has full authority to manage the national grid system of the country. Renewable energy planning of Krabi is significantly diverse with key tourism destination islands, Ramsar Site Conservation on Krabi Estuary Ramsar site covering main city of Krabi, the biggest seagrass conservation of Thailand and some Environmental Protection Area on land and under the sea which requires a theory of wetland management as human-dominated landscapes threaten or expanded city in complex of provincial development.

3.3 Krabi’s Renewable Energy Transition
Since 2004, Krabi province has begun generating electricity from palm wastes. According to the status of renewable energy supply indicates that the most significant sources comes from biomass, biogas and solar energy [36]. Biomass investors are integrating the sharing of internal and external stakeholders, working closely with palm planting business as a majority of provincial agriculture production. Biomass and biogas have the installation capacity approximately 53 megawatts that generate from internal palm and relevant bio-energy fuel sources. And the latest market share is solar farm producing about 18 megawatts however; the limitation of land use becomes a factor of its development. Solar rooftop is expected to be further invested depending on renewable energy policy and the potential of electricity generation. In 2018, solar energy has been projected and official commercial operation date to supply the grid with the following increasing in the context of sub-district cooperative and governmental financial support. Wind energy and mini-hydro energy is expected to be studied as a possible area for investment as well. The installation capacity of wind energy plans to further discuss small onshore wind with speed less than 6 metres per a second under the island geography. In 2010, Prince of Songkla University had a study of the installation capacity of mini-hydro approximately 100-1,5000 kW across
the province [37] and those additional renewable energy plans to be developed for further energy supply on grid.

**Table 1**: Krabi’s Renewable Energy Status, Provincial Electricity Authority, Thailand, 2019

| Company                        | Plant         | Fuel   | Installation Capacity MW | Actual Grid Supply MW |
|--------------------------------|---------------|--------|--------------------------|------------------------|
| Wanna Chaideker                | Photovoltaic  | Solar  | 0.007                    | 0.007                  |
| Thai Green Co.,Ltd.            | Photovoltaic  | Solar  | 5                        | 5                      |
| Kaset Klongya Cooperative      | Photovoltaic  | Solar  | 4.16                     | 4.16                   |
| Smart Solar Power Co.,Ltd.     | Photovoltaic  | Solar  | 4.64                     | 4.64                   |
| Mar Solar Co.,Ltd.             | Photovoltaic  | Solar  | 5                        | 5                      |
| Solar PV Total                 |               |        | 18.81 (26.1%)            | 18.81 (31.1%)          |
| Krabi Waste to Energy Co.,Ltd.| Gas engine    | Biogas | 1.616                    | 1.5                    |
| Clean Power Associate Co.,Ltd. | Gas engine    | Biogas | 1.021                    | 0.99                   |
| Sarab Biogas Energy Co.,Ltd.   | Gas engine    | Biogas | 2                        | 2                      |
| Thai Integrate Palm Oil Co.,Ltd.| Gas engine | Biogas | 0.95                     | 0.95                   |
| Thai-Indo Palm Oil Factory Co.,Ltd.| Gas engine    | Biogas | 3.2                      | 1                      |
| Namhong Power Co.,Ltd.         | Gas engine    | Biogas | 3.189                    | 3                      |
| Modern Green Power Co.,Ltd.    | Gas engine    | Biogas | 3.189                    | 3                      |
| Univanit Palm Oil Co.,Ltd.     | Gas engine    | Biogas | 2.856                    | 2.856                  |
| Sri Charcoun Palm Oil Co.,Ltd. | Gas engine    | Biogas | 3.189                    | 3.093                  |
| Asean Palm Oil Co.,Ltd.        | Gas engine    | Biogas | 1.65                     | 1                      |
| Univanit Palm Oil Co.,Ltd.     | Gas engine    | Biogas | 5.516                    | 2.856                  |
| Multi-industry Palm Oil Co.,Ltd.| Gas engine | Biogas | 2                        | 1.9                    |
| Biogas Total                   |               |        | 30.38 (42.2%)            | 24.14 (39.9%)          |
| Multi-industry Palm Oil Co.,Ltd.| Steam turbine | Biomass | 4.05                     | 1                      |
4. Discussions

Thailand power development is centralization system, majority with fossil fuel or natural gas combined cycle being the main drivers. Meanwhile, domestic natural gas supply from the Gulf of Thailand is becoming insufficient which necessitates the need to import LNG (Liquefied Natural Gas) instead. Upon policy reviews, the proportion of imported electricity is also increasing; with the current trend electricity supply in Thailand will become more import dependent. In terms of renewable energy investment under the new version of Power Development Plan, solar rooftop seems to be significantly increasing. The policy to promote more solar rooftops is challenging and would be an opportunity for a transition towards “Krabi Goes Green” or “Krabi’s Sustainable Energy City.”

In general, a country plans to diversify sources of electricity generation both from fossil fuels and renewable energy in order to fulfill sustainable energy supplies while maintaining security, economic (electricity cost), environmental and social acceptance. However, which sources of electricity generation are selected depend on policy and potential supply of each province. Moreover, renewable energy purchasing is a challenge in regard to its energy security on the grid. Krabi Vision 2020 collaborates with decentralisation systems of renewable energy, renewable energy policy, disruptive technology and the potential of renewable energy capacity, which present challenges and opportunities for transition towards Krabi’s Sustainable Energy City. The growth of Krabi province as a famous tourism destination with an abundance of biodiversity is pushing the local administration and policy-makers to create a secure energy supply, properly manage the environment, manage economic distribution, and mitigate climate change impacts. In total with those perspectives, renewable energy management and smart planning is necessary to reach those indicators of green energy development and green city implementation. The pathway of renewable energy transition to increase the renewable energy on grid has also required some relevant key factors to be considered as following.

4.1 Infrastructure

The potential of energy sources is based on various areas across sub-district territory. Cost of fuel transportation is challenging for energy management in the long term. The limitation of power plant investment is directly connected with the location of fuel sources. Transition towards energy self-reliant systems requires management of infrastructure to supply energy resources for electricity generation. City planning is a key part of this process that can help resolve conflicts of energy investment, and land grabbing as the transition system expands. The potential of Krabi’s energy transition is from local power plant development and decentralization of renewable energy investment, differs at each location. Wind energy is expected to utilize across the coastline, in the areas of island or high potential of high winds. In terms of solar investment, the location is more suitable for solar rooftop than solar farm due to land restriction; hence, communities are the targets of solar household producers to feed electricity on the grid. Biomass and biogas are the fundamental energy investment in the province, as Krabi is one of the top palm planting areas in the southern region, which provides electricity generation supply to provincial consumers. The settlement of biomass and biogas plants nearby fuel source supplies assists with their own scale management. And the latest electricity supply plans to invest from municipal solid waste,
covering garbage consumption in province. The project is under the responsibility of local governor and business investment.

4.2 Ownership
Energy decentralization means the sharing of electricity management as power dynamics involving local communities, investors and policymakers to make a decision on that transition. The benefits of energy transition would transfer directly from the majority of investors and government to communities’ stakeholder. Various models of energy development as sustainable transition are useful to key beneficiaries, compared to the centralization system. The ownership begins from the level of public participation including national policy, provincial policy and investment patterns. Resource owners, power plant holders, public participation, power of relevant policies, implementation and monitoring are the dimension of the ownership word.

4.3 Land use
The local economy is important to take into account when the planning the energy future. The pattern of local development under the umbrella of Vision Krabi 2020 identifies the key provincial income dependent on tourism, agriculture and fishery. The interconnection of the economy and energy transition will dictate the direction of provincial development planning. The balance of limited resources, conflicts and how to be sustainable is under consideration with short and long term transition planning. Land grabbing has some lesson learn from other cities and would impact natural resources, as well as social and economic aspects. The transition from dependent energy city to further self-sufficiency needs to take into account the positive and negative impacts when changing land to produce electricity. Renewable energy transition pathways should eliminate biodiversity and ecosystem exploitation to achieve a green economy and assure fair development [38].

4.4. Job creation
Renewable energy creates the potential of job and economic growth [39]. Renewable energy job creation is relevant to sustainable development goals, directly on goal 8 decent work and economic growth. Referring to the IRENA report [40], Thailand employed some 102,600 people, with most of the jobs in feedstock supply. In 2017, the data from the Office of Agricultural Economics of Thailand (OAE) indicated that a total of 5,826,000 farmers’ households planted four key crops including rice, rubber, palm oil and sugar cane that yielded raw materials for biomass energy with a combined value of 688,580 million baht. In 2019, according to the Energy Policy and Planning Office, it is shown that biomass energy production would add up to 41,813 million baht in value, and has the potential to increase the added value of agricultural products at the rate of 6.1% which is equivalent to adding an income of 7,176 baht per household for 5.8 million households.

5. Conclusion
Krabi province is being significantly transformed as the first province of Thailand to exploit local energy resources supplying energy generating systems. Renewable Energy Transition towards Krabi’s Sustainable Energy City can be a model to benefit a the provincial economy, distribute its benefits fairly and secure local industries of tourism, fishery and agriculture. As present the renewable energy supply is over 60 percent and continual research and development to reach more capacities including the expansion the vision of energy seller across provincial borders.

This paper illustrates the phenomenon of a renewable energy transition in Krabi, its relation to the provincial planning pattern, provincial energy system, energy investment and further sustainable energy transition. The geography of a city as island and land parts requires the complex transition of land use, infrastructure and ownership. And the sustainability of policy, planning and public participation adapts to be practiced in province when the citizen of a city understand and accept its energy transition.
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