CHAPTER V
CONSTRAINS FOR LOW CARBON ELECTRICITY DEVELOMENT

5.1 Important constrains hindering the low carbon electricity development

The power industry plays a unique role in climate change, being by far the largest sector both in emissions and opportunities to reduce them. However, power sector has many characteristics that make implementation of greenhouse gases mitigation less challenging than in most other sectors. First, this sector consists of a relatively small number of large companies, which are used to regulation and to take regulatory incentives into account when prioritizing investments. Second, consumer implications are relatively limited (except for a potentially higher electricity price) and third, compliance is comparatively easy to measure and monitor (Blyth, 2010; McKinsey and Company, 2009). Reducing the GHG intensity of energy will require development and deployment of major breakthroughs in energy efficiency, demand reduction, fuel diversify to lower emission such as renewable energy, nuclear, clean coal, capturing GHGs emission with carbon capture and storage (CCS). This chapter aims to present important and potential roles of low carbon electricity development based on current GHG emission abatement opportunities and options for promoting low carbon electricity in Thailand.

This section examined why low carbon electricity development are not fully implemented. Constrains related to regulation, nature of electricity development, technical and economic issues are identified. Understanding these constrains are very important parts led to future improvement of the functions and success of low carbon electricity development. Major number of obstacles inhibiting the expansion of low carbon electricity development can be divided into three categories: regulatory-related barriers; technical and environmental-related barriers and economic-related barriers. The following sections describe each category in more detail.

5.2 Institutional Constrains

Politics and regulatory on energy and environment are key factors that could accelerate or delay the development. The most obvious barriers relate to the inconsistent political support for renewable energy development. Unlike subsidies and incentive for conventional fuel technologies, policies aimed at encouraging renewable energy have changed frequently; despite of high potentials to generate electricity from renewable sources in Thailand, these policy uncertainties prolong the speed of development and wide adoption of renewable energy. To be a force for change, governments must help to reduce uncertainty for investments in higher cost. By supporting in the following areas will remove barriers and uncertainty, facilitate the establishment of efficient markets, and drive technological innovation and investment.

To reducing the policy inconsistency between government organizations (in numbers) and policies that promote clean energy expansion in regulation (siting and licensing), generation (typically fueled by renewable energy); financial support (e.g. fuel subsidize, soft loans, etc.) and expansion policies. For example, to obtain licenses for power plants construction and operation required a lot of processes before obtained the license. Power plants shall obtain (1) license for the energy industry operation[18], (2) licensed from Department of Industrial Work for Industrial Operation, (3) Environmental Mitigation Measures of Environmental Impact Assessment (EIA), under section 46 of the Enhancement and Conservation of National Environmental Quality Act 1992 (B.E. 2535) required an EIA report before submitting for license, (4) permission from local administration and (5) Health Impact Assessment (HIA) report.

Mendonça, Jacobs et al. (2010) expressed renewable energy investor, manufacturer or operator already knows, the variability of policy relating to renewable energy technologies serves as a serious impediment. Entrepreneurs seeking investment from individuals and institutions often require consistent conditions upon

---

[18] Section 47 of the Energy Industry Act B.E. 2550 (2007) define roles of power industry shall obtained license from the commissioner before starting operation. The ERC has issued 5 types of licenses in the electricity and 4 types of licenses in the natural gas.

which to make decisions. Forecasts of profitability (usually require data concerning tax credits, depreciation schedules, cash flows and the like, well into the future) introduce an extra level of uncertainty into the decision-making process when policy makers frequently change the factors that go into these financial calculations. Most (if not) all technologies for generating electricity will require multiple permits. These permits are intended to consider the local impacts on the land, water, and air that occur during the installation and operation of these technologies. Depending on the size and location of the generating facility, permits from local zoning boards, state agencies, and federal agencies may be required. In the case of traditional electricity-generating facilities, such as those that use coal and natural gas, there is a long and evolving licensing process that has been applied across the country.

Social opposition or NIMBY[19] effects for new power plant development has delayed the construction of several major renewable energy projects. While proponents cite the environmental, economic, and energy security benefits to be gained from these projects, opponents cite the negative impacts, which often include potential damage to local ecosystems, loss of aesthetic value to the natural landscape, and the opportunity cost of land use. For example, biomass and biofuels require large amounts of land that could instead be used for agricultural purposes. Hydropower is becoming increasingly difficult to locate potential site; most major potential sites are already being used, and ecological considerations are preventing the exploitation of remaining ones. Siting renewable energy projects can also lead environmentalists against one another. Although an exhaustive review of local impacts and permitting issues is beyond the scope of this study.

Permitting issues for biomass, wind, geothermal, and photovoltaics is discussed; most of the areas that have high potential for alternatives energy development in Thailand e.g. wind, small hydropower and geothermal are belonging to government and inaccessible by the project investor. The government has been promoting biomass power plants among the private sector. At the present time,

---

[19] Not in My Backyard or NIMBY refer to someone who objects to siting something in their own neighborhood but does not object to it being sited elsewhere.

biomass power plants - most of which fall into the category of Very Small Power Producer (VSPP), referring to a generating capacity of not more than 10MW - using bagasse, cornstalks, woodchips, rice husk, and waste from palm trees sell electricity to EGAT. However, government should reduce gap between different organization in roles and activities collaborating on similar documentation requirement for shortening complex process and long period of licensing. For biomass, geothermal, and solar, the guidance for permitting is less well developed. Most of the opposition against biomass power plants is based on the air pollution that results in burning the organic matter to create energy. As well, many locals are angry that they have been left out of the decision-making process.

Article 67 of the Constitution[20] says that individuals and communities have the right to conserve, protect and to benefit from local natural resources and biodiversity, and prohibits any projects or activities which can cause serious negative impacts to the environment, natural resources and public health. The Constitution further states that if the authorities want to pursue a project with the potential to cause these negative impacts a comprehensive EIA must be conducted. This must include a public hearing process with the participation of locals and independent environmental and public health organizations. Local communities can file a lawsuit against government agencies, local authorities or state enterprises if they do not follow the rules. Table 12 summarizes some of the most important regulations that apply to all large electricity generating facilities. Local communities feel the rules are being manipulated to deny them participation in the process and they are distrustful of assurances from the government and the companies involved that environmental impacts will be minimal. They feel a thorough study is essential to ensuring the protection of their lifestyle and environment.

---

[20] Under Thai Constitution 2007 (B.E. 2550), section 67 paragraph 2, states that project or activity which may seriously affect the quality of environment, natural resources or health shall not be permitted, unless its impacts on the quality of environment and on health of people in affected communities has been studied and evaluated, and consultation with the public and interested parties has been organized.

Table 12 Some of the important regulations that apply to all electricity generating facilities

Criteria	Statutory Citation	Law and Regulations
Siting and Licensing	Defines qualifications, procedures and conditions of the application for license	Notification of Energy Regulatory Commissioner (B.E. 2552) issued Pursuant to the Energy Industry Act B.E. 2550 issue on 12 October 2552
	Define qualifications, procedure and condition for licensing	The Ministerial Regulation, No. 19 (B.E. 2549) issued Pursuant to the Factory Act B.E. 2535 issue on 10 May 2549
	Prescribed types of industries, rules, procedure and criteria for Environmental Impact Assessment Report Preparation	Notification of the Ministry of Natural Resources and Environment (B.E. 2552) issued on 31 August 2552
	Prescribed qualification and condition for apply industrial permit	Notification of Ministry of Industry No. 22 (B.E.2551), issued on 22 July 2551
	Type and period of Energy Industry License	Notification of Energy Regulatory Commissioner (B.E. 2551) issued Pursuant to the Energy Industry Act B.E. 2550 issue on 4 December 2551
	Procedure for applied the Energy Industrial License	Notification of Energy Regulatory Commissioner (B.E. 2551) issued Pursuant to the Energy Industry Act B.E. 2550 issue on 4 December 2551
	Defines qualifications, procedures and conditions for COD	Notification of Energy Regulatory Commissioner (B.E. 2552) issued Pursuant to the Energy Industry Act B.E. 2550 issue on 12 October 2552
	Prescribe rule, Procedure, Method and Guideline for Preparation of the Environmental Impact Assessment	Notification of the Ministry of Natural Resources and Environment (B.E. 2552) issued on 29 December 2552

Criteria	Statutory Citation	Law and Regulations
	Report for Project or Activity which may Seriously Affect Community with respect to Quality of Environment, Natural Resources and Health	
	Rules and Procedures for the Health Impact Assessment of Public Policies	Declaration of the National Health Commission (B.E. 2552)
Emission standard	Prescribed type, level and concentration of air pollution emission from power plant	Notification of Ministry of Science and Technology (B.E.2538), issued on 25 December 2538
	Prescribed type, level and concentration of air pollution emission from power plant	Notification of Ministry of Science and Technology (B.E.2549), issued on 5 April 2549
	Control emission standard from power plant, measurement, report and verification methodology	Notification of Ministry of Industry (B.E.2547), issued on 28 September 2547
	Control emission standard from power plant, measurement, report and verification methodology	Notification of Ministry of Science and Technology (B.E.2538), issued on 25 December 2538
	Emission control from MSW power plant	Notification of Ministry of Science and Technology (B.E.2550), issued on 17 June 2550
	Prescribe power plant with capacity higher than 29 MW in must install Continuous Emission Monitoring (CEMs)	Notification of Ministry of Industry (B.E.2544), issued issue on 11 December 2544
	Prescribed type, period and methodology for information transfer from CEMs	Notification of Department of Industrial Works (B.E.2550), issued on 11 December 2550
	Prescribe emission control of Mae Moh power plant	Notification of Ministry of Science and Technology No. 3 (B.E.2545), issued on 27 January 2545
	Prescribe emission standard from old power plants	Notification of Ministry of Science and Technology No. 2

Criteria	Statutory Citation	Law and Regulations
		(B.E.2542), issued issue on 2 December 2542
Emission standard	Prescribe emission standard from power plants	Notification of Industrial Estate Authority of Thailand No. 79 (B.E.2549), issued on 4 September 2549
	Emission control from cement and co-firing in power generator	The Ministry of Industry Notice (B.E. 2548), issued on 8 November 2549
	Control emission from MSW power plant	Notification of Ministry of Science and Technology (B.E.2540), issued on 17 June 2540
Emission monitoring	Environmental monitoring and reporting	Notification of Department of Industrial Work (B.E.2528), issued on 16 December 2528
	Environmental monitoring and reporting	Notification of Ministry of Industry No. 11 (B.E. 2544), issued on 11 December 2544
	Prescribe roles and responsibility of pollution control officer in power plant operation	The Ministerial Regulation, No. 2 (B.E. 2535) issued Pursuant to the Factory Act B.E. 2535 issue on 24 September 2535
	Prescribe the monitoring and reporting methodology of pollution monitoring	Notification of Department of Industrial Work (B.E.2551), issued on 21 March 2551
	Prescribe the environment and safety report of power plant	The Ministerial Regulation, No. 3 (B.E. 2535) issued Pursuant to the Factory Act B.E. 2535 issue on 24 September 2535
	Prescribe qualification of environmental staff in power plant with capacity higher than 10 MW	Notification of Department of Industrial Works (B.E.2547), issued on 24 December 2547

Renewable energy tends to be strongly supported by public opinion, while activities such as the use of nuclear and fossil energy, the burning of waste, chemical factories and the construction of roads are often met with resistance. This has implications for the nature of local siting conflicts. However, the opposition against a specific project is often connected to local residents having a negative perception of the developer and of the limited opportunity they have to influence the planning process. Moreover, renewable energy, notably the readily available biomass, is good for Thailand but the government has to ensure investors carry out their projects responsibly. However, many small power plants avoid the EIA process because regulations state that plants with less than a 10 MW capacity don't need to conduct an EIA. For example, biomass power plant which will use coconut waste as its energy source in Tap Sakae district of Prachuab Khiri Khan Province has faced a strong protest from the locals, even though many will earn extra income from selling coconut waste to the plant. The community's skepticism looms when investors consistently build 9.9-megawatt plants to avoid the environmental impacts assessments required by law for any power plant exceeding 10 megawatts in capacity, initially the plan was for a 5 MW capacity plant but this was changed to 9.6 MW.

5.3 Technical and Environmental Related Barriers

As discussed in previous chapter, renewable energy can potentially play an important role in stabilizing greenhouse gas emissions and mitigating climate change. Renewable energy has many environmental benefits as well as some negative attributes. To secure broad public and policy support to promote renewable energy development, it is essential to include not only the climatic aspects, but also other broader economic, environmental, and social benefits in any analysis. It is therefore not possible to link the global scenario analysis directly to requirements for specific policies at a national level. The fact that a project is concerned with renewable energy does not mean that it will be automatically welcomed by everybody. The lessons concerning inclusive planning processes are as important here as in the siting of other facilities. People who oppose a facility are not usually negative towards renewable energy per se, even if they are critical of the location chosen and the way in which it has been selected.

5.3.1 Environment opposition for renewable energy development

Most potential impact of renewable are hydropower, wind, biomass projects have been increasingly associated with negative ecological and socio-economic impacts. Various techniques implemented to minimize the ecological impacts: e.g., fish ladders, careful operation of reservoirs, and integration of powerhouses into the landscape, and noise reduction. Since most impacts are site-specific, each plant design requires individually appropriate environmental safeguards. Generally small hydropower projects have a higher level of public acceptance, as these sites can frequently be adapted to remediate local environmental concerns. On the positive side of other renewable energy technology, e.g. wind turbines generate electricity without air pollutants that conventional power plants emit in great quantities. However, much of the negative impact of wind turbines has been associated with avian collisions especially with birds and potential noise pollution.

Perhaps the most vociferous environmental concern relates to the death of birds ("avian mortality") and bats ("chiropteran mortality") resulting from collisions with wind turbine blades (Mendonça, Jacobs et al., 2010). Randolph and Masters (2008) show evidence of avian collision in the northern California wind farms cause unacceptably high mortality rate of birds the public cares most about raptors. Moreover, renewable energy facilities have many characteristics in common that distinguish them from the siting of other facilities, and it is useful to discuss them in general terms.

Centralized and large-scale utility renewable power plants can require large amounts of land, and when these systems are built in densely forested areas or ecosystems rich in flora and fauna, they can fragment large tracts of habitat. For example, the enormous tracts of land requirement for construction wind turbine have seen extensive technical development during recent years. If located in a pristine area, more development of road and another facility will certainly impact the native environment. Although most renewable technologies use only a fraction of the water used by thermoelectric plants, some renewables, such as geothermal, hydroelectric, and solar thermal, can be water intensive. Energy technologies that withdraw and consume less water will have both public benefit and economic advantages in the marketplace moving forward. One option is to develop electricity from sources that use very little water, such as wind and PV. Other options include developing technologies that limit the use of water with fossil-fuel electricity sources or use alternate sources of water, such as reclaimed or saline water.

5.3.2 High variability of renewable energy cause unstable of grid security

Ensuring power supply security requires a deeper understanding of grid- related issues than those related to energy supply availability. Naturally varying renewable energy sources certainly provide secure quantities of energy when considered over a specific duration but do not necessarily guarantee the secure delivery of power as and when needed. The significance of the separation of requirements for energy delivery and power delivery gives rise to separate power supply-related questions, such as those concerning plant capacity, generation load factors, system capacity planning margins, probabilistic measures of system power supply security, and backup plant requirements. From the viewpoint of a power system operator, some of the difficulties associated with renewable source variability affecting the delivery of electrical power are as follows: (1) uncertainties in predictions of power available at any given time, leading to scheduling difficulties, although obviously the degrees of uncertainty vary with the length of forecasting horizon; (2) magnitude of fluctuations in power output, where small fluctuations can be accommodated easily, but larger fluctuations require special countermeasures; and (3) speed of fluctuations, where slow changes in resource availability and, hence, power output are usually predictable, but fast changes are less so.

In all national electricity supply systems, the power demand varies over the course of a day; there is a rise and fall every 24 hours, with usually a night-time minimum and a daily maximum. To assess the contribution that renewable or other sources of energy can make to electricity supply, the distinction between energy and power has to be kept clearly in mind. Whereas the commercial operation of each generation plant is measured against total energy delivered, in Thailand the EGAT acting in its roles as Thailand System Operator (SO) under Energy Industry Act

2007[21], has to ensure that the power generated (the rate of delivery of energy) balances the power demand at all times, otherwise the system fails. The related issues are indentified as following;

5.3.2.1 Plant availability

In addition, there are generating plant performance abilities to be considered, such as power conversion limits where generating plant can operate efficiently only within certain limits of energy availability. This is an important concern because even a brief power outage can cause millions of dollars in damage. Two of the most talked about forms of renewable energy, solar and wind power, suffer from intermittency, which means they cannot produce power 24 hours a day, seven days a week. For example, wind farms generate power only when the wind is blowing within a certain range of speed. Wind and hydropower are site specific; excellent locations can produce very high power densities. When there is too little wind, the towers do not generate power; but when the wind is too strong, they must be shut down for fear of being blown down. And even when they function properly, wind farms' average output is less than 30 percent of their theoretical capacity.

Wind farms unfavorably impact grid related power system operations. However, this is an inherent consequence of the application of wind power but not attributable to an individual turbine. With the expansion of wind power and the increase of wind power ratio in a local grid, such unfavorable impact will likely become the technical bottle neck for wind power integration. Wind power decreases accuracy of load forecast and therefore affects power grid dispatching and operation. Moreover, wind power impacts frequency control of power grid, voltage regulation, power supply quality, fault level and stability of power grid. At present, it is hard to say whether building wind farms and running a grid will be possible without fossil

---

[21] Under section 87 of Energy Industry Act 2007 (B.E. 2550) describe roles and responsibility of EGAT System Operator (SO) to control, management and overseeing of the energy system for ensure the overall system balance, security, stability, efficiency and reliability. However, the system operator shall fairly instruct licensee operating the electricity industry to generate electricity and shall not exert unjust discrimination.

fuels, especially because no viable renewable fuel in 'liquid' form is evident (Laughton, 2007; Moomaw, 2008; Tzimas, A.Georgakaki et al., 2009; Verbruggen, Fischedick et al., 2010).

5.3.2.2 Variation of raw material supply

Theoretically, the earth can feed all the people alive today, yet even now 800 million people are affected by hunger. They suffer from hunger because they are too poor to buy food, not because too little food is available or insufficient land on which to grow it, however, vast areas are taken up with the production of feed crops for the livestock industries in industrialized countries (Solino, Prada et al., 2009). Government currently has launched ambitious programs to enhance investments in renewable energy e.g. wind, solar, biomass, and other clean renewable energy sources. Biomass power plants are believed to have less environmental impacts, which is not really true. Fossil fuels like coal, oil, and gas are good and convenient sources of energy, and they meet the energy demands of society very effectively. Fossil fuel resources are finite and not renewable. Biomass, on the other hand, grows and is renewable. A crop cut this year will grow again next year; a tree cut today may grow up within a decade. The intensive cultivation of biomass may stress water resources, depleting soil nutrients, and displace open space by withdrawing land from other natural uses. Large-scale production of biomass for energy purposes could compete with use of land, water, and energy for production of foods or woods and grasses for construction of shelters.

The limitation of raw material supply has recently become the prominent barrier for expansion of renewable energy utilization especially for biomass. Due to seasonal and spatial variation of biomass supply, moreover, the quantity and quality of renewable resources has become the prominent barrier. It restricts the power plants unable to have a continuous operation or operate to the full capacity. This greatly affects the cost-effectiveness of the business, Most of biomass resources can only produced during harvesting season; for example, period of sugar harvesting is limited (5 months from December to April, see also in Figure 35). Thus, electricity from the sugar factory is mostly seasonal (Baguant, 1984; Krewitt, 2008)

The potential from biomass supply is widely distributed throughout the country depending on seasons. Particularly, rice is main agricultural product. The rough estimate of rice statistics data in Thailand were represented as major harvest and second harvest. Major harvest would be from May-June until November-December. Second harvest is from December-January until May-June. Accordingly the data are represented as wet season (major harvest) and dry season (second harvest). Table 13 present variation of some agricultural product in year 2008 to 2009, according to major harvest and second harvest. Ubon Ratchathani, Nakon Ratchasima, Burirum, Surin and Roi-Et province covered 75 percent of total yield (capacity), however, major harvest would be from May/June until November/December and second harvest is from December/January until May/June (see example of seasonal variation of rice production of Thailand in Figure 35 and Table 13). Figure 36 (left) indicates the rice production data (both seasonal variation and spatial distribution) in the year 2009 and while Figure 36 (right) gives the information on density of rice straw produced, i.e. tones of rice straw produced with respect to the provincial area in Thailand. Figure 36 to Figure 42 presented potential area for biomass energy development in Thailand.

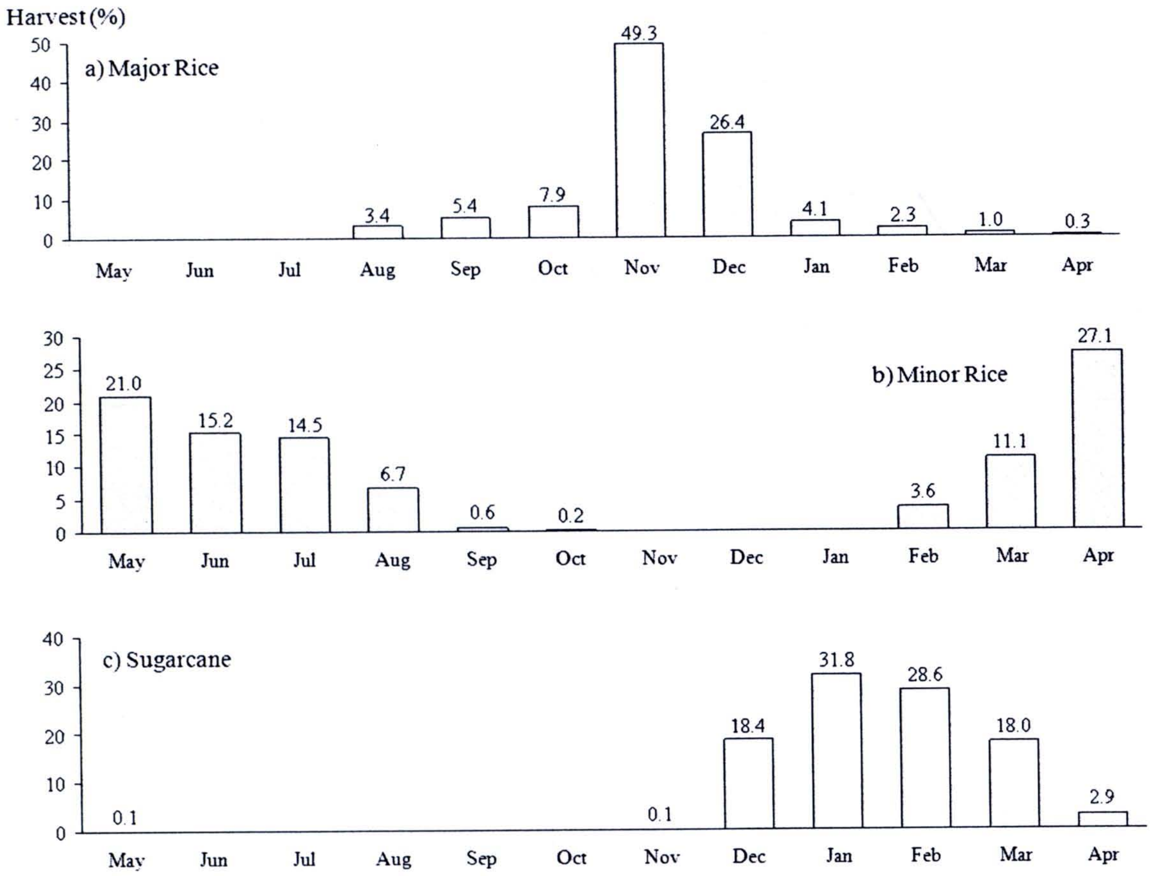


Figure 35 Seasonal Variation of Major Agricultural Products in 2008-2009

Source: Using data from Office of Agricultural Economics (2009)

Table 13 Seasonal Variation of Major Agriculture Products

Products	Production (%)																			Harvest period
	2008							2009												
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Major Rice			3.37	5.40	7.93	49.30	26.37	4.06	2.31	0.98	0.28									Nov-Dec
Second Rice								3.58	11.10	27.14	20.99	15.23	14.50	6.68	0.62	0.16				Apr-May
Corn Maize			13.76	27.70	18.01	17.32	12.39	6.14	2.96	0.95	0.64	0.10	0.03							Sep-Nov
Millet						5.09	42.22	33.85	18.07	9.77										Dec-Jan
Cassava					5.41	10.99	15.16	20.91	15.21	12.08	9.36	2.41	0.85	1.85	2.41	3.36				Dec-Feb
Sugarcane						0.11	18.41	31.84	28.64	18.01	2.93	0.06								Jan-Feb
Pineapple								8.30	9.21	8.84	7.96	13.95	11.69	3.66	2.30	5.29	8.30	10.46	10.04	May-Jun
Soybean		0.52	11.00	9.11	2.14	3.72	1.31		4.73	38.65	27.43	1.39								Mar-Apr
Green bean		6.87	1.62	0.82	7.91	33.04	29.11	0.33	0.92	9.08	9.20	1.10								Nov-Dec
Peanut		2.57	21.34	18.01	9.89	9.33	6.59	1.18	2.03	9.76	15.18	3.53	0.59							Aug-Sep
Rubber								11.62	8.04	3.83	2.49	6.75	8.00	8.78	9.55	10.36	10.92	8.35	11.31	Sep-Oct
Palm oil								6.37	6.84	9.83	8.54	8.34	7.52	7.30	7.72	8.41	9.44	9.96	8.73	Oct-Nov

Source: Using data from Office of Agricultural Economics (2009)

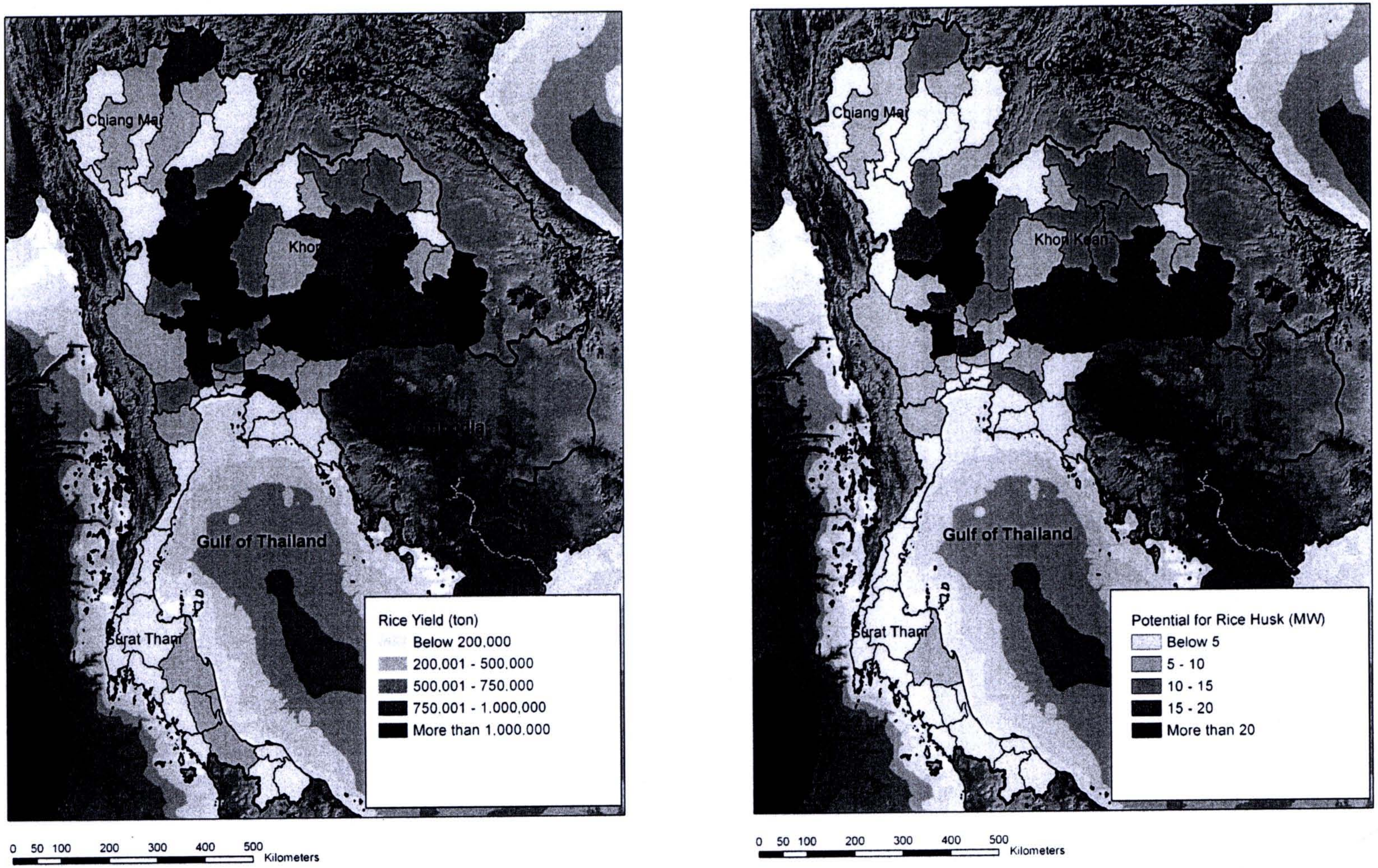


Figure 36 Yield and Potential of Rice Husk for Electricity Generation in 2009

Source: Using data from OERC (2010), DEDE (2009) and OAE (2009)

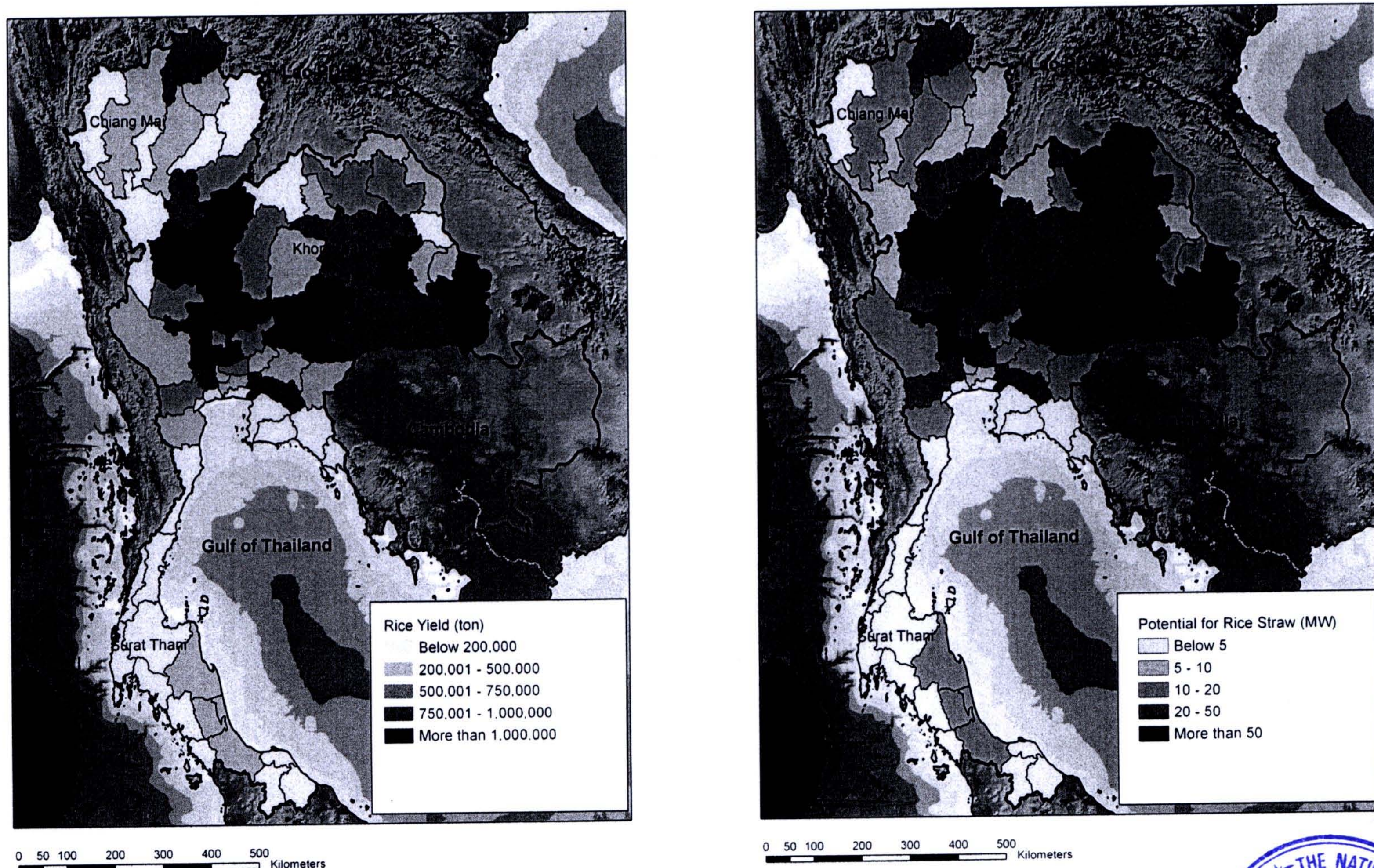
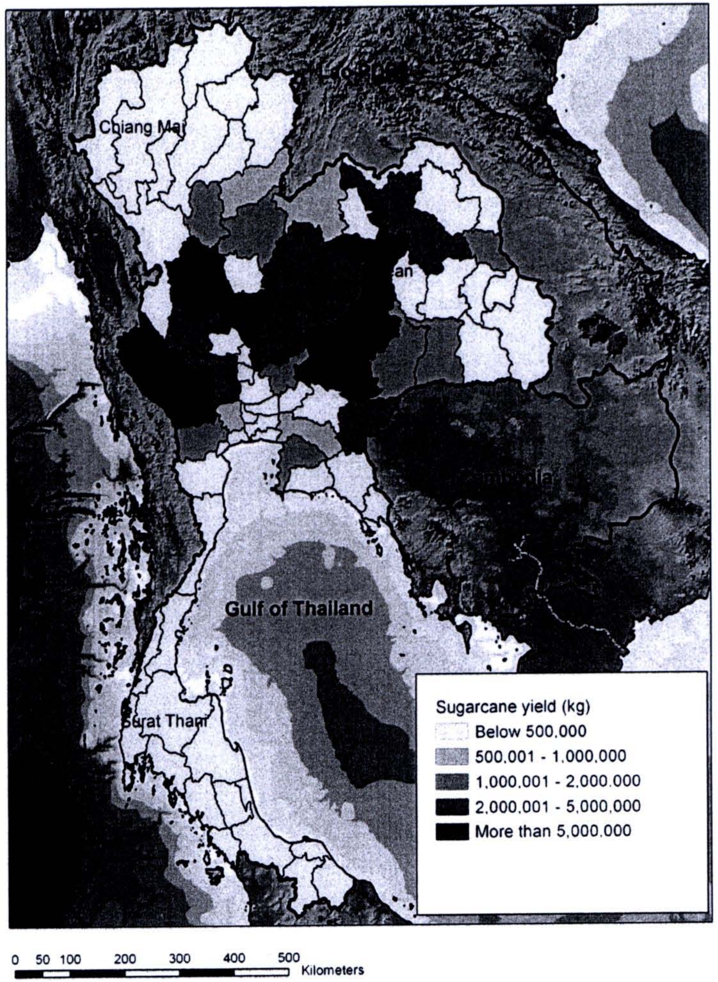


Figure 37 Yield and Potential of Rice Straw Residue for Electricity Generation in 2009

Source: Using data from OERC (2010), DEDE (2009) and OAE (2009)



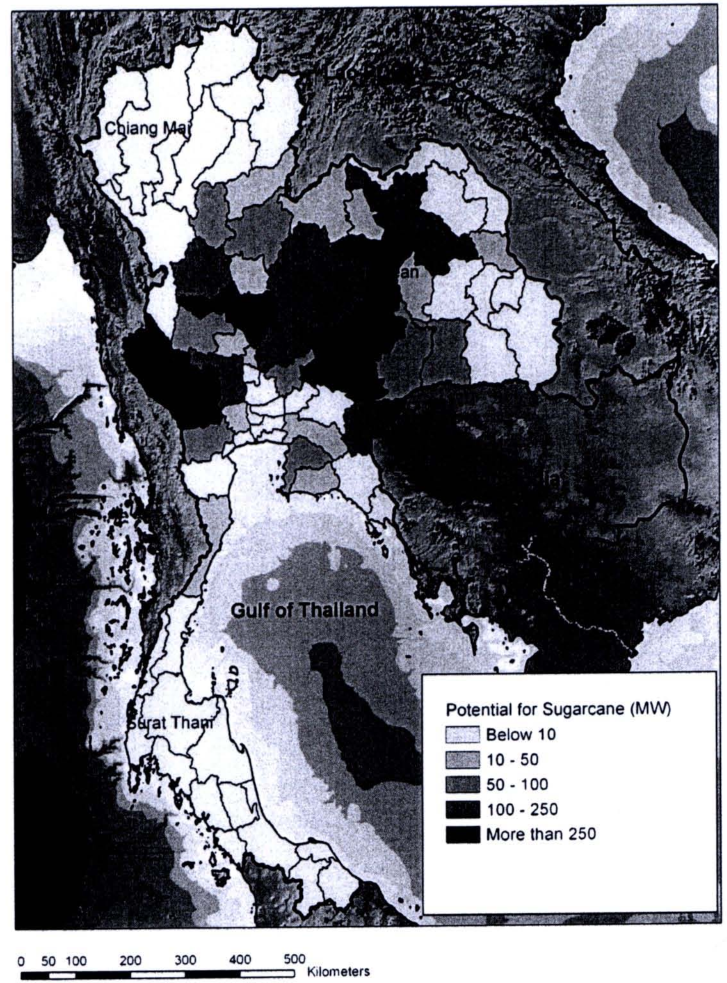


Figure 38 Yield and Potential of Sugarcane for Electricity Generation in 2009

Source: Using data from OERC (2010), DEDE (2009) and OAE (2009)

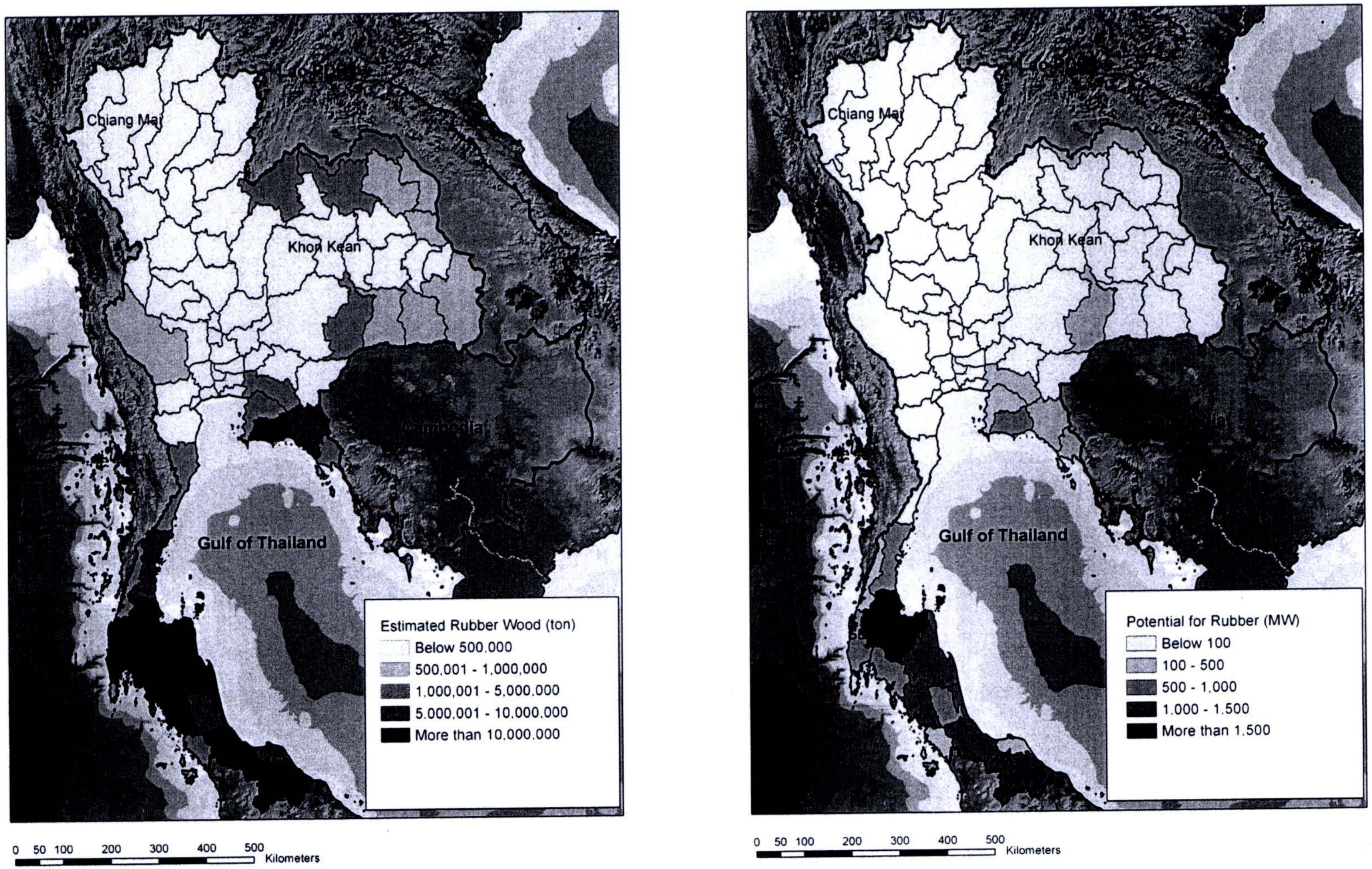


Figure 39 Yield and Potential of Rubber for Electricity Generation in 2009

Source: Using data from from OERC (2010), DEDE (2009) and OAE (2009)

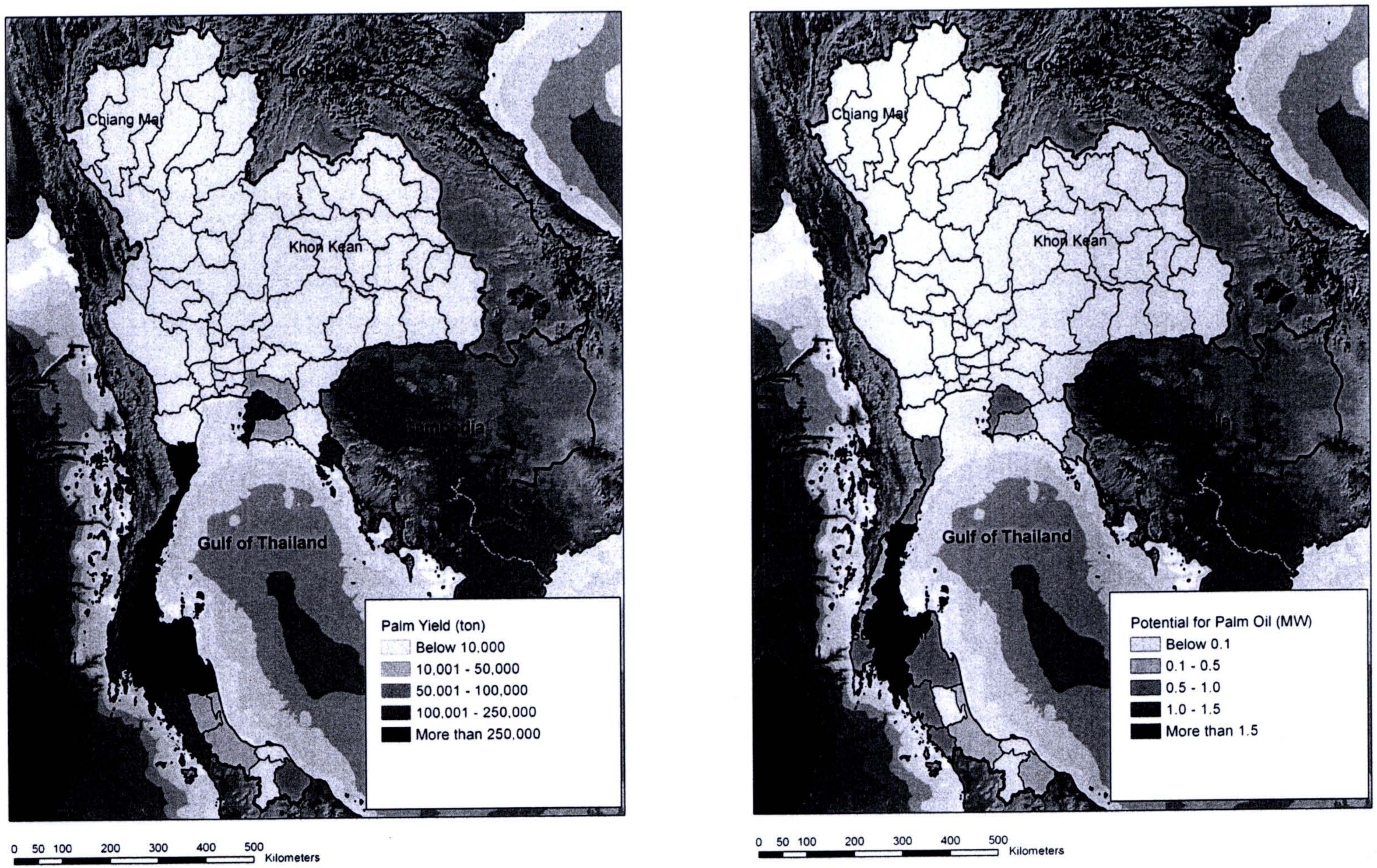


Figure 40 Yield and Potential of Palm Oil Residue for Electricity Generation in 2009

Source: Using data from from OERC (2010), DEDE (2009) and OAE (2009)

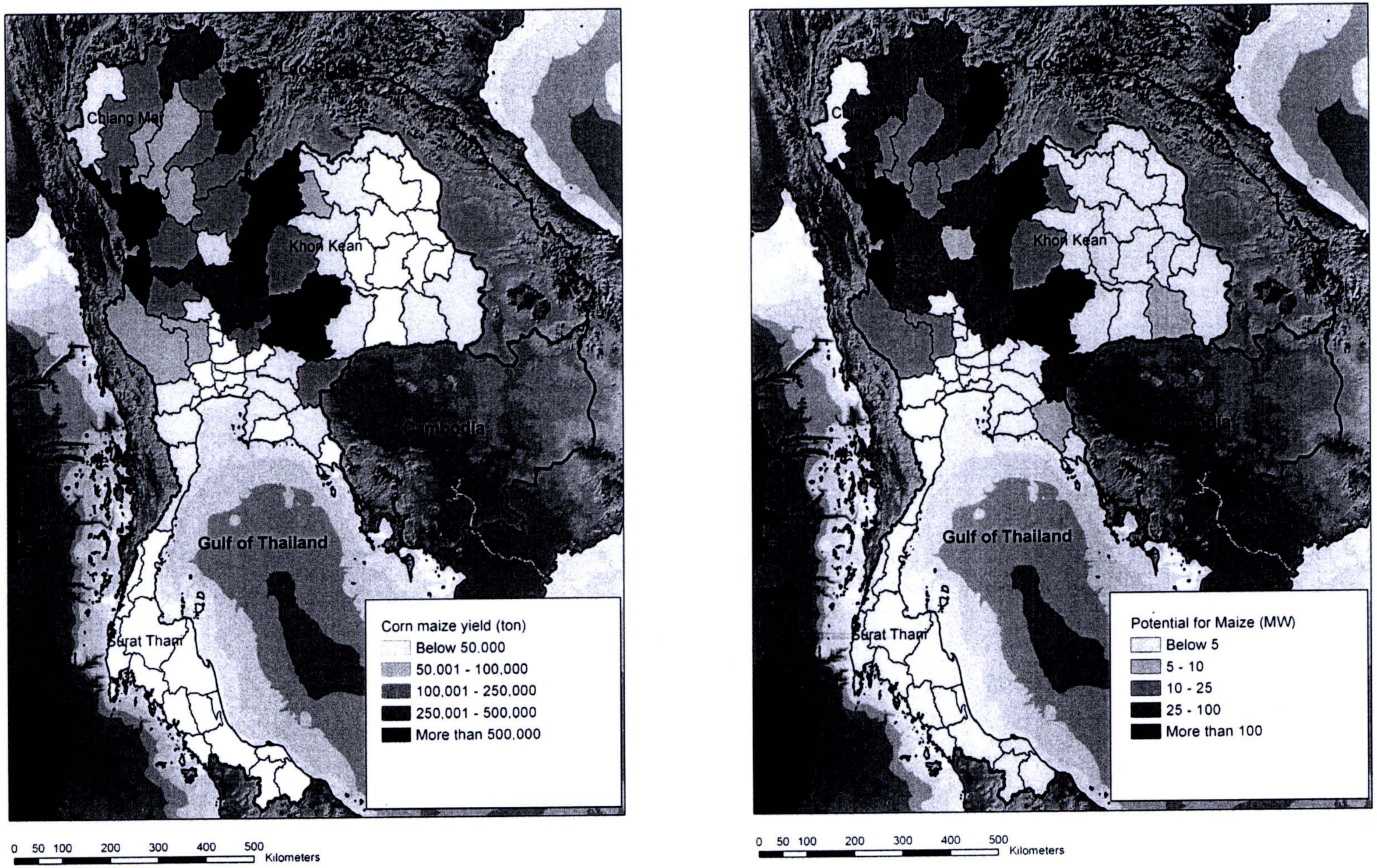


Figure 41 Yield and Potential of Corn Maize for Electricity Generation in 2009

Source: Using data from OERC (2010), DEDE (2009) and OAE (2009)

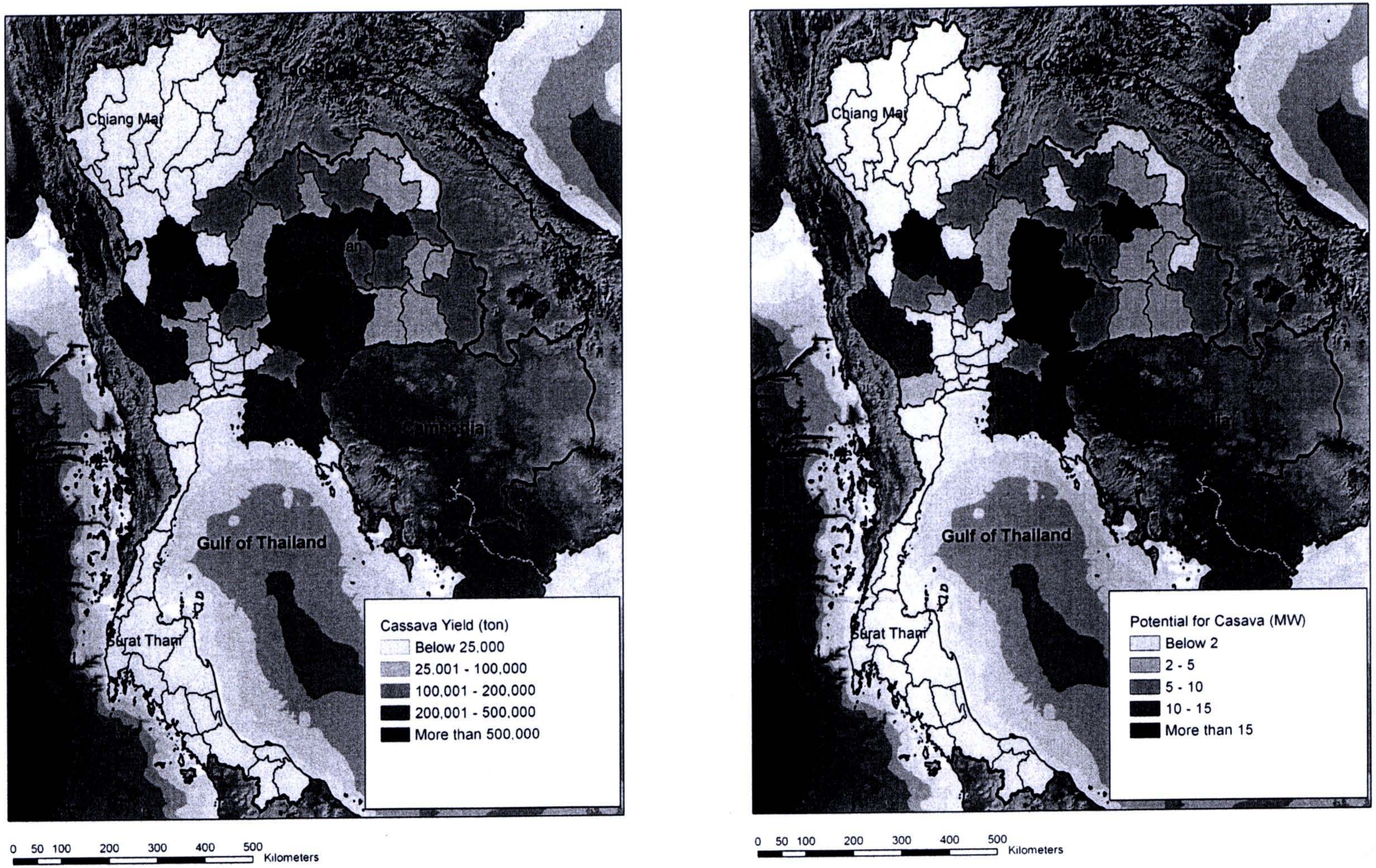


Figure 42 Yield and Potential of Cassava Residues for Electricity Generation in 2009

Source: Using data from OERC (2010), DEDE (2009) and OAE (2009)

5.4 Economic Related Barriers

5.4.1 Lack of available start-up finance for renewable

Thailand has much potential to generate power from renewable energy. Nevertheless, systematic support and promotional policy guidelines of the government is currently necessary to help alleviate the investment cost for renewable energy-fueled power generation development so as to eventually enhance its commercially competitiveness, which will be a key mechanism to further promote the development of appropriate power generation technology from each domestic renewable energy sources. Renewable energy project developers face financial barriers of a long payback time, lack of bank confidence and a shortage of money for feasibility studies. Specific country situations, such as policies that restrict PPA length and political instability, further complicate the prospects of attracting foreign investors and earning loans.

Renewable energy projects are unique in their demands on project financing because the necessary of feasibility studies, the long payback period due to the high initial project costs, and the perception of high risk for some technologies. Expensive feasibility studies must be undertaken to identify the proper site for development. The resource assessment and initial environmental impact reports are considered pre-investment and may or may not be repaid, depending on whether or not the project is developed. It is usually taken on by the company interested in development with the expectation that capital invested during this time will be recovered through the operation of the plant. However, in countries with significant political risk, this investment is lacking and prevents projects from even being considered (Lokey, 2009).

The project developers can struggle to secure financing since renewable energy projects tend to have a long payback time before the high capital costs will be recovered. Table 14 summarized an overview of the levelized and investment costs of renewable energy versus the levelized cost of conventional energy and Appendix C presented more detailed on levelized cost of Thai's power industry.

Table 14 Investment and Average Generation Costs for Various Energy Technologies

Technology	From Literature Review		This study (Appendix C)	
	Average generation costs (US ¢/kWh)	Investment costs (US $/Watt)	Average generation costs (US ¢/kWh)	Investment costs (US $/Watt)
Natural gas combined cycle	3.5	0.6	4.50	1.725
Coal	4.8	1.2	4.76	1.52
Nuclear	4.8	1.8	-	-
Wind	5.5	1.4	-	-
Biomass	6.5	2	7.20	2.03
Geothermal	6.5	1.5	-	-
Small hydropower	7.5	1	-	-
Photovoltaics	55	7	-	-

Source: Using data from The IEA (2010) and Lokey (2009)

Generation costs include the initial cost of investment and fuel; whereas the investment costs only take into account the construction costs of the system. Typically, an acceptable internal rate of return on a power plant project is 25 percent; however, investment funds will occasionally not accept lower than a 30 percent return on investment. This translates into approximately a four to five year payback. Hydro projects will sometimes have up to a ten year payback. In many countries, power utilities still control a monopoly on electricity production and distribution. In these restrictions in the absence of a legal framework, independent power producers may not be able to invest in renewable energy facilities and sell power to the utility or to third parties under Power Purchase Agreements (PPA). The reason these projects are still pursued is that they can operate for over 100 years and recover the costs of investment over a long period of time. Because of these special circumstances, renewable energy projects will often need a long-term PPA of up to 20 years to get financing. This agreement will ensure to the bank that the project owners have off-takers, will purchase the electricity for a set price or utilities, and may negotiate power purchase agreements on an individual ad-hoc basis. This making it difficult for project developers to plan and finance projects on the basis of known and consistent rules.

Ministry of Energy defines a Small Power Producer (SPP) as either a private or state enterprise that generates electricity either (1) from non-conventional sources such as wind, solar and mini-hydro energy or fuels such as waste, residues or biomass, or (2) from conventional sources (natural gas, coal, oil) and using cogeneration (combined cycle units capable of producing power and steam). Both IPPs and SPPs have long-term power purchase agreements with EGAT as the single buyer. The PPAs allocate market risk to EGAT (and its captive ratepayers) leaving SPPs and IPPs to manage the operating and fuel price risks. SPP contracts are between 5 and 25 years with terms and specifications set by EGAT, the national power monopoly.

EGAT has defined two types of purchasing rates for buying SPP power, non-firm and firm power. The value of non-firm power is determined by EGAT's short- run avoided energy cost. Firm power means the SPP can guarantee availability of electricity supply during the system peak months. Payment to firm SPPs is determined by EGAT's long-run avoided capacity and energy costs. Indeed, the barrier to greater renewable energy penetration is the lack of enabling policy and regulatory frameworks, policy for what purpose or to promote which subject usually favor traditional energy sources. SPPs to date are not very cost effective but investors still do it because it is the policies from the government to promote SPPs by provide adder, for example, some of the benefits derived could be the sale of steam to industries. SPPs incentives come from several sources to make the business cost-effective.

As for other sources of renewable energy, especially the biomass, this is the time for biomass in Thailand. Usually power producers are free to make these PPAs with large consumers, but some countries do not permit it. Lokey (2009) give an example on PPA arrangement, the Power producers in Mexico are free to arrange PPAs, but they must be structured so that the off-taker has at least a 1 percent share in the power producers' operations. Also in Nicaragua (Lokey, 2009), the power producer must pay from 15 to 30 percent of the price negotiated in the PPA to the state utility as a transmission tariff and there is currently no wholesale electricity market. Regarding to CDM project development, the multilateral development banks, that understand the risks of renewable energy CDM projects, can offer project financing, but often do so in exchange for taking most of the CERs revenues by offering low CERs prices or a small percentage of CERs for the project owner. CDM-specific financial barriers like penalties for not producing the CERs promised, difficulty choosing the legal rules to follow for enforcement of the ERPA[22]. However, language barriers and asymmetric CERs price information create complex and confusing financial negotiations for project developers (The United Nations Framework Convention on Climate Change, 2010c).

If a project begins producing energy before it is registered, it cannot qualify for CDM. The project started CDM process in 2002. The first PDD which was prepared by Mitsubishi Securities was finished in May 2003. In October 2003, EB 11 approved the proposed baseline and monitoring methodology of Pichit Project. Unfortunately, Thailand, as a host country, is still in the process of adopting CDM framework and regulations. Once this process is done, expected sometime in March-April 2006, the application and approval process of CDM project in Thailand will be started. Such a time-consuming process prevented the Company from being able to proceed for the EB registration with the Approved Methodology 0004 (AM0004) within 2005. The Company has to revise the PDD by changing from AM0004 to ACM0006 instead. However, the Company is expecting to complete the registration process by the end of 2006.

A key role for government is to focus on policy design and legislation to attract private sector investment. As renewable energy technology becomes more commercially mature, government will become less significant as providers of the direct capital support needed to make up the cost difference relative to conventional

---

[22] Emissions Reduction Purchase Agreement (ERPA) means transaction that transfers carbon credits between two parties under the Kyoto Protocol. The buyer pays the seller cash in exchange for carbon credits, thereby allowing the purchaser to emit more carbon dioxide into the atmosphere. The standards for this agreement are outlined by the International Emissions Trading Association.

This agreement usually involves two countries; however, it may occur between a country and a large corporation. Buyers expect their carbon emissions to be above the level allocated to them by the Kyoto Protocol, while the seller expects to produce less. Often, the seller has implemented new technology or is developing a new project that is expected to lower its greenhouse gas emissions.

generation. Mallon (2006) express the importance of cost internalization (environmental and social damage cost) made cost of renewable comparable with thermal (nuclear and fossil) electricity generation. Siegel et al. (2008) expressed investments of renewable energy companies not only generate revenues by providing clean, green power for consumers, but they can also generate additional revenues by simply offering an "offset" to companies that emit less greenhouse gas emissions (GHG). It is clearly beyond the budgets of most government to directly inject money into renewable in order to fast track a competitive industry. A handful of demonstration projects might be useful, good examples of financial incentive provided by the Ministry of Energy is "ESCO Venture Capital Funds" for providing equity for small renewable energy and energy efficiency projects undertaken by small entrepreneurs with limited capital. The fund should also be provided financial assistance for equipment leasing, credit guarantee facility, technical assistance and carbon market (Amranand, 2009).

5.4.2 Renewable energy is more expensive than conventional fuel when the externalities are not priced

Fossil fuel always subsidized by government, government set price at which they can sell their renewable power to the grid, thus effectively providing essentially a guaranteed return on the renewable energy investment and making it easier for renewable energy projects to obtain banking approval for the capital costs of the project. For example, waste incineration is not likely to be cost-effective at this time in Thailand. Incineration of municipal solid waste is a costly and operationally complex, as compared to landfills. Government subsidies are only possible sources of financing, however this issue is not a widely discussion upon by the public, politicians, and international financial institutions. Feed-in tariffs in practice have definitely provided a hugh boost for renewable energy projects. Another barrier or driven constrains of biomass utilization are still high in price. Fluctuation of fossil fuel price also affects the competitiveness and utilization of renewable energy. Moreira expressed most of modern biomass utilization are being more favorable or more attractive driven by energy security motivation (2008).

Fossil fuel price has been increasing in the last 3 year due to various reasons, when fuel price are high, some industries change their main fuels from fossil fuel to use rice husk for lowering price. Average price of rice husk has increased from 767-799 THB/ton in 2006 to 864-1,042 THB/ton in 2009. However, when the fossil price was dropped, demands for biofuels also decreased. The government should refocus its energy development strategy and consider more on how to deliver the actual price of energy to the citizens, instead of lowering the price to favor industrial development without carefully considering externality environmental and social costs. For example, Tester et al. (2005) indicated that if fossil fuel prices rise to include cost of carbon management, consumers may also modify their consumption patterns. Through a system known as carbon trading, a market - based mechanism that helps mitigate the increase of carbon dioxide in the atmosphere, renewable energy companies (as well as other entities that provide offsets, such as forestry management companies, for instance) can sell carbon credits to companies that emit carbon dioxide into the atmosphere and want to balance out their emissions.

Mallon (2006) expressed current renewable energy is only more expensive than thermal (nuclear and fossil) generation if the environmental and social impacts, the 'externalities[23]', are not priced. Failure to acknowledge this in some way leads to distorting policy frameworks. Furthermore, renewable prices are declining and even in the most hostile markets they will continue to converge in price with conventional energy sources without externality pricing. The prices of goods bought and sold in markets prior to this form of intervention tend not to include the environmental cost of production, consumption and disposal, this costs are known as 'externalities' (Connelly and Smith, 2006; Goodstein, 2005; Prindle, Zarnikau et al., 2010). The use of economic instruments is not only concerned with providing internal incentives to polluters and resource users to reduce their emissions or to reduce their inputs. It also seeks to internalize the external costs of pollution and resource depletion. The challenge is how to internalize all externality (e.g. environmental damages cost) caused by using fossil fuels, and set up a financial structure i.e. tax system to bring the right energy price to consumers. This will help promoting the fair

---

[23] Economists define "pollution" as a negative externality described as a cost of a transaction not borne by the buyer or seller. Pollution is termed an externality because it imposes cost on people who are "external" to the producer and consumer of the polluting product.

competition between renewable energy and traditional fuels and bring the country to a sustainable future. It should be noted that without subsidies, biomass power projects are unable to compete with fossil fuel power plants due to the difference in scale on which conventional plants and renewable energy plants operate (Sookkumnerd, Ito et al., 2005).

5.4.3 Lack of Research and Development to reduced cost on imported technology

Photovoltaics are already an economically competitive technology in several niche applications. Small applications are often supplied with small batteries or button cells, compared to household electricity prices of around 20 cents/kWh in Germany. For example, the costs with photovoltaics can quickly explode to several hundred Euros per kWh. It takes about 280 mignon cells[24] to store one kilowatt hour using high-quality alkaline manganese batteries (Quaschning, 2010). Now, no one would ever think about buying 280 mignon cells to run a washing machine just once. However, with small applications we often tend to be willing to pay whatever it costs to buy batteries. It is often the infrequent use of these small applications that even makes using electricity affordable. Photovoltaics can compete with this type of high energy cost even under the cloudiest conditions. It is often an economic alter- native even to large battery systems. However, photovoltaics will have to relinquish its niche role if it is to become effective in protecting the climate. This will only happen if it becomes a grid-connected system and replaces conventional power plants.

Whereas small-scale photovoltaic island systems[25] are already competitive today, the energy production costs for grid-connected photovoltaic systems are in most cases still higher than normal market prices. It currently only makes sense to install large numbers of grid-connected photovoltaic systems if state incentive schemes are available. Even if the quantity of solar power is still relatively small, in the medium term photovoltaics will be able to provide the largest share of environmentally compatible electricity supply. From a purely mathematical standpoint, it could be used to supply the world's entire energy needs. This would

[24] Mignon cell or AA battery is a standard size of battery

[25] Isolated system or non grid connected system

only take a fraction of the surface of the Sahara Desert to accomplish. Even countries like Great Britain, Germany and France would be able to cover all their electricity requirements through photovoltaics. On the other hand, from a technical perspective it is not a good idea to rely solely on one technology for the future supply of energy. Photovoltaic systems work well in combination with other renewable energy systems, such as wind power, hydropower and biomass systems. A well-planned combination of systems will increase supply reliability and avoid the building of large storage systems to ensure sufficient supplies are available at night and during the winter.

Costs will have to drop further before large numbers of countries start using photovoltaics on a considerably larger scale than at present. Past experience has shown that major cost reductions are possible. Whereas the price of photovoltaic modules was still around 60 inflation-adjusted US dollars per watt in 1976, by 2007 it had already dropped to around 3 dollars per watt (Quaschning, 2010). What is crucial for cutting costs is an increase in production. If production quantities rise, then costs will drop noticeably due to the effects of streamlined production and also because of technical advances. During the past 30 years cost savings of around 20% have been achieved due to a doubling in the total quantities of photovoltaic modules produced. There is nothing to indicate that this development will not continue. It is possible that the prices of photovoltaic modules could fall below US$ 1 per watt by 2020. As a result, the current cost to generate electricity using photo- voltaic systems would have shrunk to about one fourth (See also in Figure 43).

This would then make photovoltaic systems very interesting to end users in Central Europe, even without the need for any government subsidy schemes. A photovoltaic system would be able to produce electricity more cost-effectively for household use than an energy supply company could deliver to the household. In the sunniest parts of the world photovoltaics could produce energy more cost-effectively than any conventional alternatives. For that reason, the main markets for solar energy in the long term will be in places other than Western Europe. The absence of efficient renewable energy generation technologies and supports of skilled manpower and spare parts is one of the prime technical barriers (Quaschning, 2010).

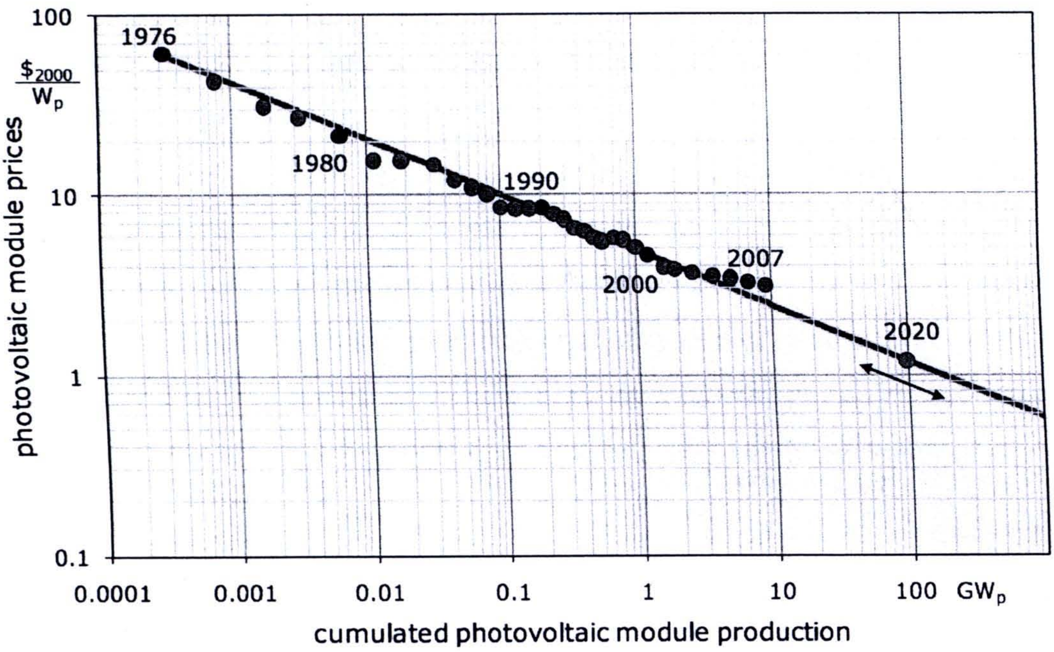


Figure 43 Development of inflation-adjusted photovoltaic module prices on the basis of total quantity of modules produced worldwide

Source: Quaschning (2010)

For example, domestic wind power technology has not well developed in the country, so the advanced and large wind power sector has to rely on imported technology. Given the available wind resources and climatic conditions, it is difficult to further develop wind power sector in Thailand by using imported technologies. The technology has to be tailored to adopt in the hot and humid climate and low wind speeds prevalent in Thailand. In long-term, this can pose substantial barrier if we continue importing foreign technology for wind energy development in Thailand. Another example in solid waste utilization, characteristic of solid wastes in Thailand has high moisture contents therefore have low calorific value which is unsuitable to use in power generator and required additional processes to improve fuel quality e.g. installation of waste separation unit or manual waste separation (Tchobanoglous, Theisen et al., 1993). Increase efficiency of waste separation can help increasing the yield of biogas generation but it also requires public education on waste management.

Proven, cost-effective technologies may still be perceived as risky if there is little experience with them in a new application or region. The lack of visible installations and familiarity with renewable energy technologies can lead to perceptions of greater technical risk than for conventional energy sources. These perceptions may increase required rates of return, result in less capital availability, or place more stringent requirements on technology selection and resource assessment. "Lack of utility acceptance" is a phrase used to describe the historical biases and prejudices on the part of traditional electric power utilities. Utilities may be hesitant to develop, acquire, and maintain unfamiliar technologies, or give them proper attention in planning frameworks. Finally, prejudice may exist because of poor past performance that is out of step with current performance norms. In next chapter, policy suggestion for low carbon electricity development will be presented.