CHAPTER III
GENERAL SITUATION IN THAILAND'S ELECTRICITY SECTOR

3.1 Evolution of Thailand's electricity development

3.1.1 Before establishment of Ministry of Energy

During the 1970's, approximately 90 percent of Thailand's commercial primary energy consumption (including non-energy use) was imported mostly petroleum products. The discovery of natural gas in the Gulf of Thailand and lignite in the Northern part of the country reduced amount of import dependence to about 60 percent. During early 1990s when high growth in power demand existed, the government developed several initiatives to privatize state electric utilities then firmed up after 1997, and engage independent power producers (IPPs) through the use of long-term power purchase agreements[15] (PPAs) for supply of electrical power into the grid system. Thailand's power system has a single buyer structure that the Electricity Generating Authority of Thailand (EGAT) currently provides 53 percent of the country's electricity supply. EGAT plays not only the main role in generating country's electricity generation but also in operating all high voltage transmission lines, and monopolizing the buying power of the country's electricity (Amranand, 2009).

EGAT sells bulk power to two distribution utilities; (a) the Metropolitan Electricity Authority (MEA) responsible for the sale of electricity within Bangkok and surrounding areas; and (b) the Provincial Electricity Authority (PEA)

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[15] Power Purchase Agreement (PPA) is a legal contract between an electricity generator (provider) and a power purchaser (host). The power purchaser purchases energy, and sometimes also capacity and/or ancillary services, from the electricity generator. Such agreements play a key role in the financing of independently owned (i.e. not owned by a utility) electricity generating assets. The seller under the PPA is typically an independent power producer, or "IPP." Energy sales by regulated utilities are typically highly regulated, so that no PPA is required or appropriate.

responsible for electricity sale in the remaining parts of the country. Lastly, private power producers sell electricity to the electric utilities under power purchase agreements or users located nearby. Since early 1990s when high growth in power demands existed, the government developed several initiatives to privatize state electric utilities and engage independent power producers (IPPs) with long-term power purchase agreements (PPAs) for supply of electrical power into the grid system (See also in Figure 9).

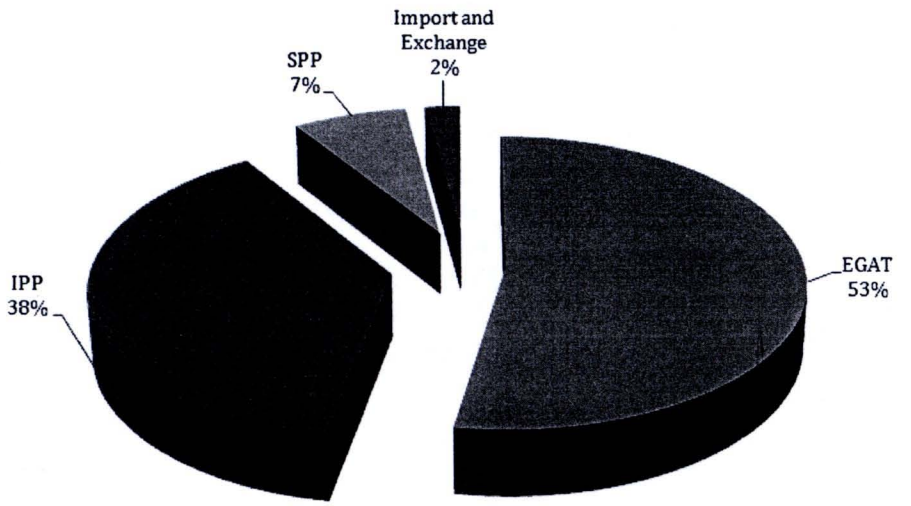

Figure 9 Share of Electricity Supply in 2009

Source: Using data from Ministry of Energy (2010)

Amranand (2009) describe the electricity development in the period before 1991, there was no private power producer supplying electricity into grid. The National Energy Policy Office (NEPO) had been trying to introduce private sector investment since 1989 through implementation of regulation to require the electric utilities to buy power generated by small private power producers, but the policy faced heavy resistance by the electric utilities and their labor unions. In 1992, SPP regulation for purchase power from Small Power Producers was finally approving under the government of Anand Panyarachun and the announcement of IPPs program in 1994 for larger power plants.

The SPP program allowed private investment in the generation of electricity using the cogeneration system and generation of electricity using renewable

energy. The criteria for selected SPPs using steam usability, efficiency of the cogeneration system and size of facilities. In 2001, government introduced the Very Small Power Producer Program (VSPP) for allowing SPP with sale into the grid of less than one MW. The VSPPs can also sell to any one of the three electric utilities (EGAT, MEA and PEA) depending on their connectivity to grid transmission system (Figure 10 illustrate distribution of power plant classified by types of producer).

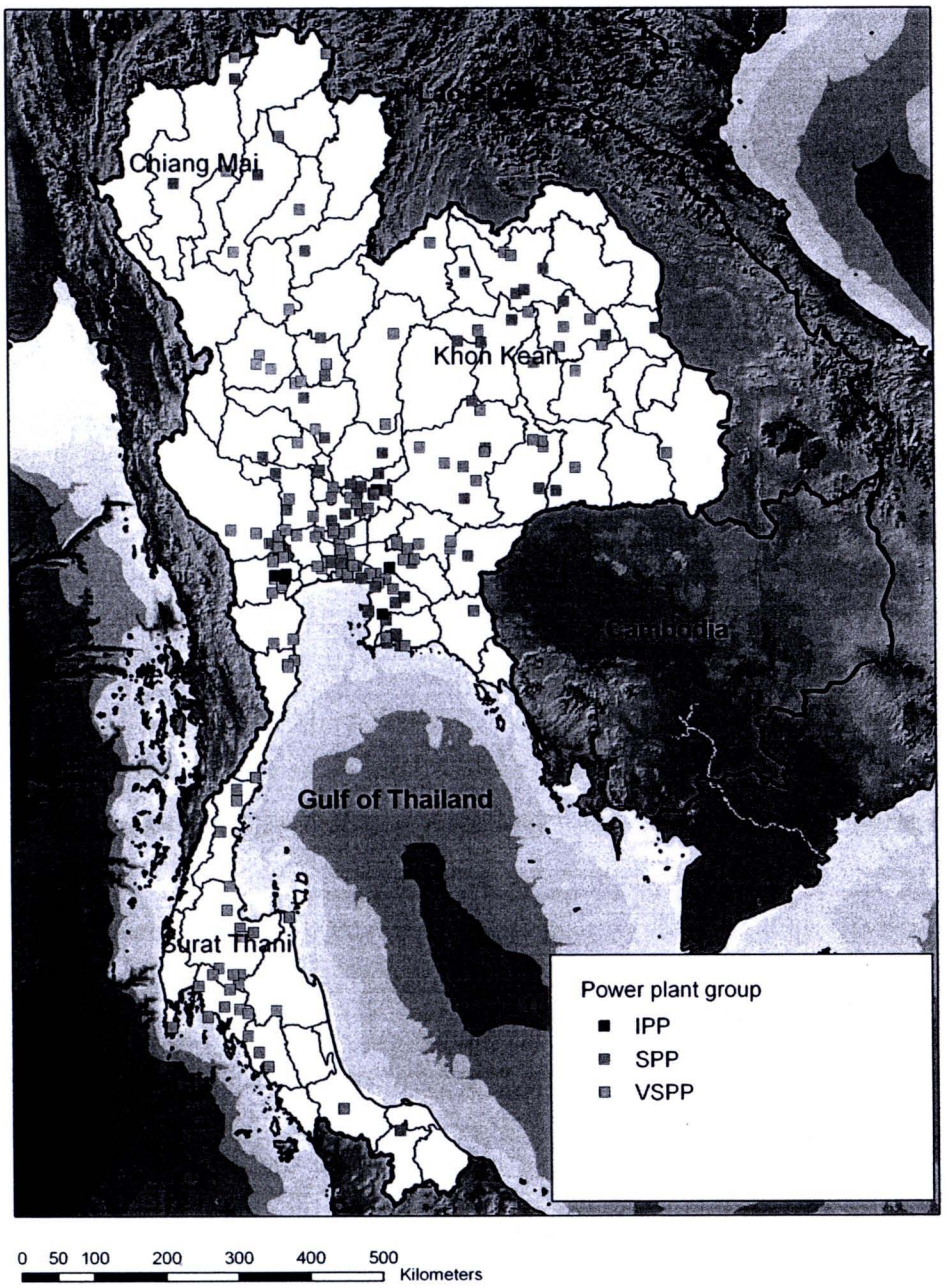

Figure 10 Distribution of Power Plants Classified by Types of Producer

Source: Using data from OERC (2010)

In addition, the government also launched a program to encourage the renewable energy SPPs by providing an additional tariff for a period of 5 years from the Energy Conservation Fund using adder system. The "adder" was determined through a competitive bidding system that resulted in approval of 14 projects with average "adder" of 0.18 baht per kWh (US¢ 0.56), representing approximately 5 percent increase from the normal tariff. With a relatively low level of adder, it is not surprising that all of the 14 projects were using bagasse, paddy husk, or woodchips as fuels. By the end of 2006, there were about one hundred SPP and VSPP projects supplying 2,344 MW of electricity to the grid, but since most of these facilities also sold electricity to users nearby, total generating capacity were around 4,160 MW. Almost all of these projects were those launched before 2002 as very few projects were initiated after the establishment of Ministry of Energy.

3.1.2 The establishment of Energy Regulatory Commissioner (ERC)

The most significant development in the regulation of Thailand's energy sector is the passage of the Energy Act B.E. 2550 since December 11, 2007, an Energy Regulatory Commission was appointed in February 2008 consisting of seven members, to serve as an independent agency responsible for regulating and monitoring power and gas sectors to ensure the reliability and security of the power and gas supplies. However, the Commission works within the policy framework established by the National Energy Policy Council (NEPC), chaired by the Prime Minister.

The Commission is primarily responsible for reviewing a national power development plan for submitting recommendations to the Cabinet. For regulating and approving gas transportation and electricity tariffs including the automatic tariff adjustment mechanism or commonly known as the F_t tariff; issuing licenses; regulating the energy sector in a fair and transparent manner; ensuring the delivery of quality and reliable energy services and protecting the rights and interests of energy consumers, local communities and general public.

Moreover, the Act provides for specific responsibilities and authorities for the Commissioner in fulfilling its mandate are the Power Development Fund[16]. The Fund is to be used as a channel for implementing the subsidy arrangements for underprivileged power consumers; rehabilitating localities; compensating people affected by power plant operations, and the promotion of renewable and environmentally friendly energy. Revenue for the fund is provided by a levy on power generators through the electricity tariffs. All power plants have to pay a levy to the Fund during the plant commissioning at the following rates.

3.2 Current Status

Since 1968, Thailand electricity supply services have all been taken over by the state government and operated under state enterprises under a law empowering its monopoly. The state utilities accumulated assets and built up their manpower to expand and operate the power system to serve the whole country (Chirarattananon and Nirukkanaporn, 2006). Thai power system has a single buyer structure that the Electricity Generating Authority of Thailand (EGAT) currently provides about 53 percent of the country's electricity supply.

3.2.1 Generation capacity

The electricity supply system in Thailand consists of a single tightly interconnected grid that serves the entire country using 'circle-network system' to connect the whole country in an electric ring structure. Energy Policy and Planning Office (2010a) reported at the end of 2008, the country's power system had a total installed generating capacity of 29,891.65 MW, 4.77 percent higher than the prior year, consisting of the generation capacity from EGAT's power plants totaling

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[16] Under section 93 of the Energy Act B.E. 2550 (2007) provide roles and responsibility of commissioner to set up the Power Development Fund to be (1) used as capital to support extensive extension of electricity service provision to various localities so as to decentralize prosperity to provincial areas; (2) to develop the local communities affected by the operation of a power plant; and (3) to promote the use of renewable energy and technologies in the electricity industry operation that have less impact on the environment, with due consideration on the balance on natural resources; and (4) to create fairness for power consumers".

15,020.96 MW, accounting for 50.25 percent of the country's total capacity. Domestic private power producers and neighboring countries totaling 14,870.69 MW or 49.75 percent of the country's total generation capacity, comprising 12,151.59 MW from domestic independent power producers (IPPs), 2,079.10 MW from small power producers (SPPs) under firm energy contracts, and 640 MW power import from Laos and Malaysia.

The deepening world economic crisis and the domestic political unrest have severely affected on country's export, manufacturing, and tourism industries, thus resulting in declining electricity consumption growth. The country's gross energy generation throughout 2008 totaled 148,200.93 million kWh, a mere 0.87 percent increase from the preceding year, comprising energy generation from EGAT's own power plants and electricity purchased from private power sources. EGAT's power plants provided 63,930.68 million kWh of electrical energy, accounting for 43.14 percent of the country's total generation. EGAT's generation was 2.80 percent lower than the previous year. Its generation energy mix included natural gas (accounting for 25.13 percent of the country's total electricity), lignite (12.60 percent), hydropower (4.69 percent), and diesel oil (0.71 percent). Additionally, EGAT's renewable energy power plants including geothermal, solar cells and wind power plants also supplied totally 2.00 million kWh of energy. EGAT has continuously decreased its generation from the high priced oil to keep its production cost to the lowest possible. Compared with the prior year, it's fuel oil-based and diesel oil-based generation was reduced by 68.90 percent and 15.94 percent respectively. Generation from hydropower also decreased 12.69 percent whereas natural gas-based and lignite based generation increased from the previous year by 3.56 percent and 0.97 percent respectively (Electricity Generating Authority of Thailand, 2008).

3.2.2 Electricity demand

Energy Policy and Planning Office (2010a) reported the electricity consumption in Thailand classified into three principal end-user sectors including industrial, commercial and public services, and residential sector. The electricity consumption increased from 56,279 to 134,937 GWh during 1993 to 2008 and peak demand of electricity increased from 9,730 to 22,568.2 MW during 1993 to 2008. The

industrial sector is the largest electricity consumer with growing demand at average of 7.5 percent per year. The energy-intensive industries dominated demands are petrochemicals, steel mills, refineries and cement plants. The power sector in Thailand like many other developing countries is heavily dependent on fossil fuels. Much of this capacity based on thermal and combined cycle generation where natural gas alone contributes to over 73.90 percent of total electricity generation, followed by lignite and coal at about 17.40 percent, hydropower at 3.63 percent and fuel oil at 1.38 percent respectively (Figure 11).

Electricity consumption increased 5.52 percent from the prior year to 127,930.30 million kWh. Industrial sector continued to be the biggest consumers accounting for 48.84 percent of the country's total electricity consumption, followed by business or commercial sector (24.77 percent), residential sector (21.04 percent), and other sectors (5.35 percent). In 2006, the consumption in the industrial and business sectors grew at the slower rates of 4.77 percent and 6.76 percent respectively while residential and other sectors saw the consumption growth rates of 5.61 and 6.41 percent (Electricity Generating Authority of Thailand, 2007). EGAT's electric energy sales throughout the year 2008 increased barely 1.40 percent year-on-year to 141,557.89 million kWh.

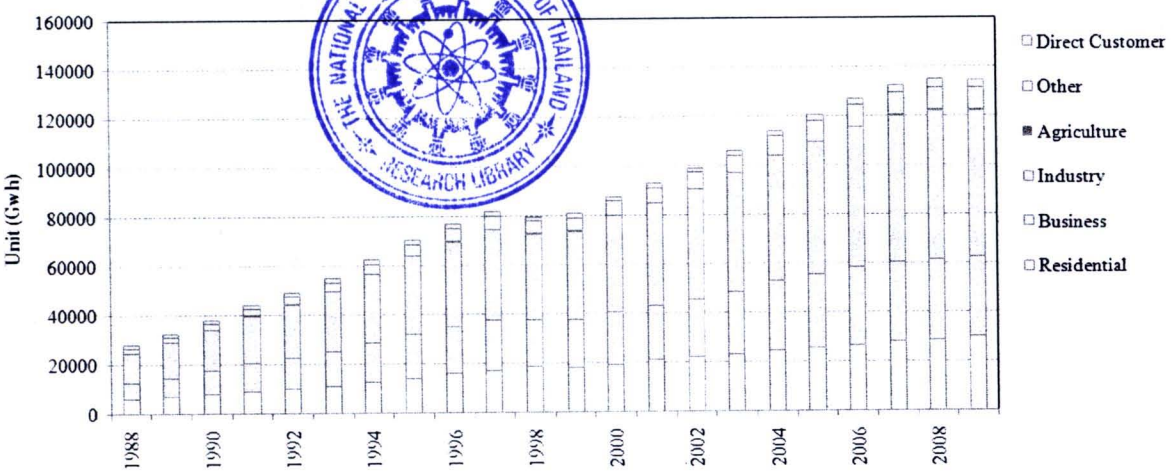

Figure 11 Electricity Consumption by Sector from 1988 - 2009

Source: Using data from Energy Policy and Planning Office (2010a)

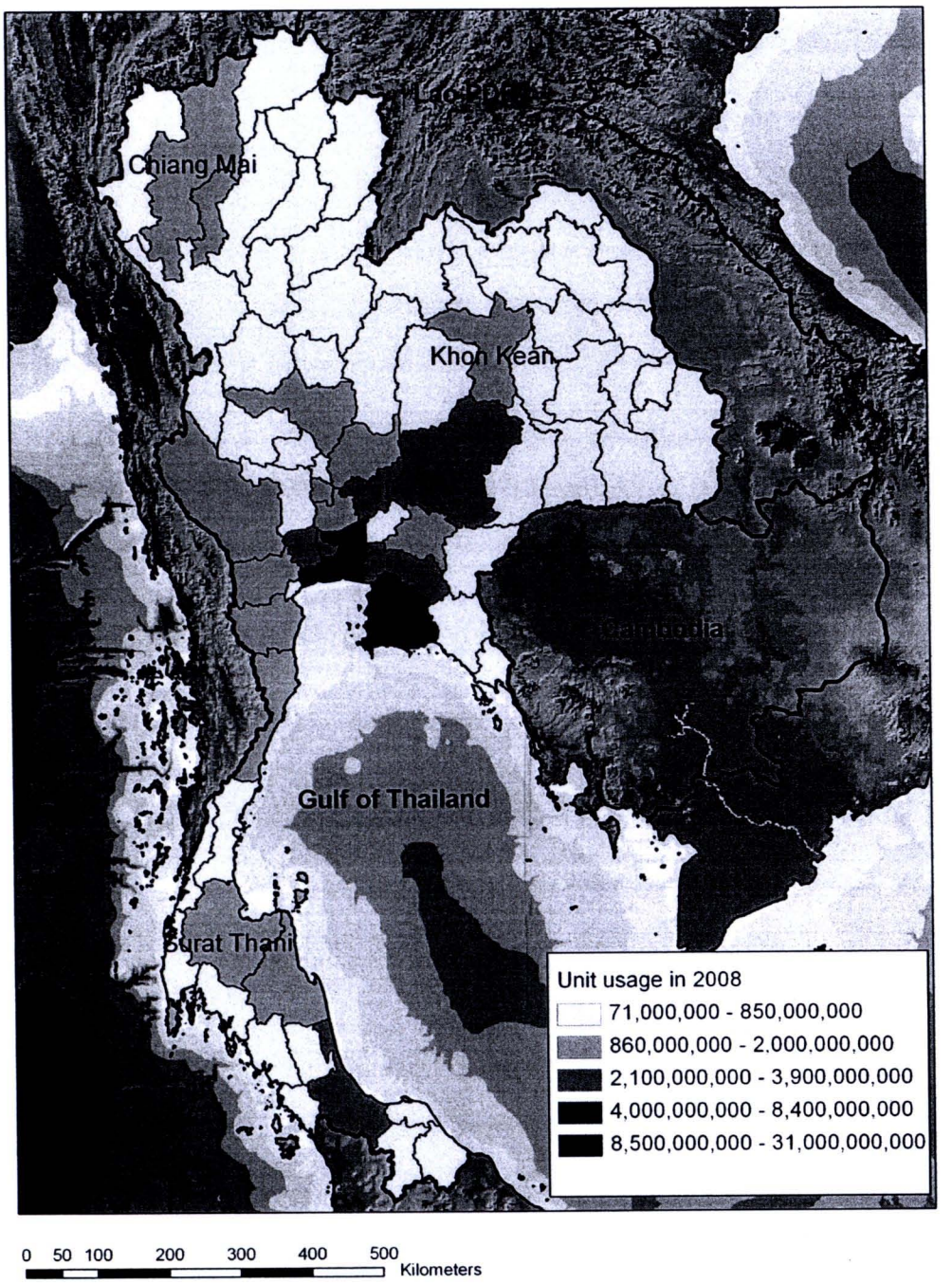

Figure 12 Electricity Consumption in 2008

Source: Using data from OERC (2010)

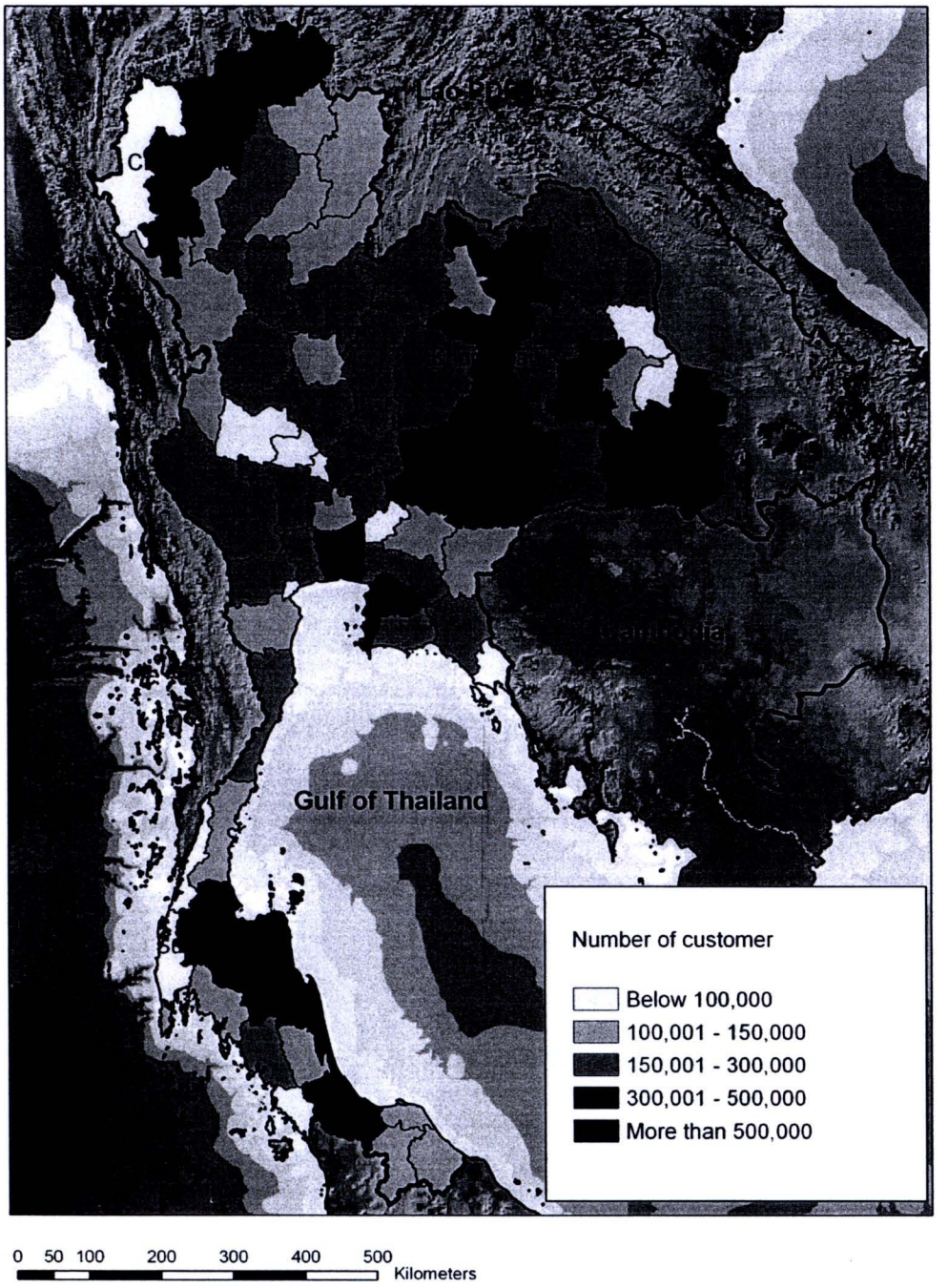

Figure 13 Number of Customers in 2008

Source: Using data from OERC (2010)

The dropping sales growth was attributable to the softening electricity demand caused by decelerating economic expansion. EGAT's sales volumes in 2008 consisted of 94,859.95 million kWh of energy (67.01 percent) sold to the Provincial Electricity Authority (PEA), 43,598.23 million kWh (30.80 percent) to the

Metropolitan Electricity Authority (MEA), 1,622.49 million kWh (1.15 percent) to a small number of direct customers, 961.10 million kWh (0.68 percent) to neighboring utilities, and 516.12 million kWh (0.36 percent) to other minor customers (Electricity Generating Authority of Thailand, 2008).

Compared to the year 2007, the sale volumes to PEA increased only 1.83 percent whereas the sales to MEA increased marginally from last year. The energy sales to neighboring utilities grew 29.06 percent due mainly to the increased portion of electric energy sold to the Cambodia via Electricite du Cambodge (EDC)[17] since November 2007. On the other hand, the energy sales to EGAT's direct customers dropped by 1.90 per cent because of sluggish economy. The sales portion to other minor customers increased 13.68 percent from the preceding year (Electricity Generating Authority of Thailand, 2008). As of October 2009, peak generation of electric power system was recorded at 22,045 MW and peak demand of electricity was 123,857 GWh with 77 percent of Load factor (Energy Policy and Planning Office, 2010a).

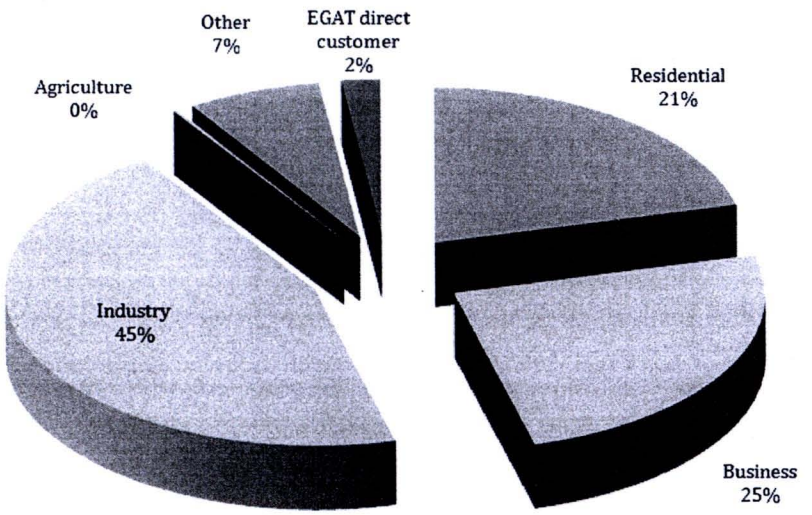

Figure 14 Electricity Consumption in 2009

Source: Using data from Ministry of Energy (2010)

[17] Cambodian electricity company

3.2.3 Fuel consumption

Electricity production by the utilities correspondingly increased from 4,400 GWh in 1970 to about 44,000 GWh in 1990 because of the start using natural from the Gulf of Thailand. This amount obtains around 12.78 percent of total energy consumption. In 1990, the total installed capacities in the power sector amounted to 8,500 MW this amount are six fold increase from about 1,300 MW in 1970.

Electricity Generating Authority of Thailand (2009) reported total of Thailand's capacity can be classified as hydro power plants of 3,764.2 MW (13.6%), thermal power plants of 9,666.6 MW (34.8%), combined cycle power plants of 12,806.0 MW (46.0%), gas turbine and diesel power plants of 972.4 MW (3.5%), and renewable power plants of 279.3 MW (1.0%) including the Thailand-Malaysia interconnection (1.1%).

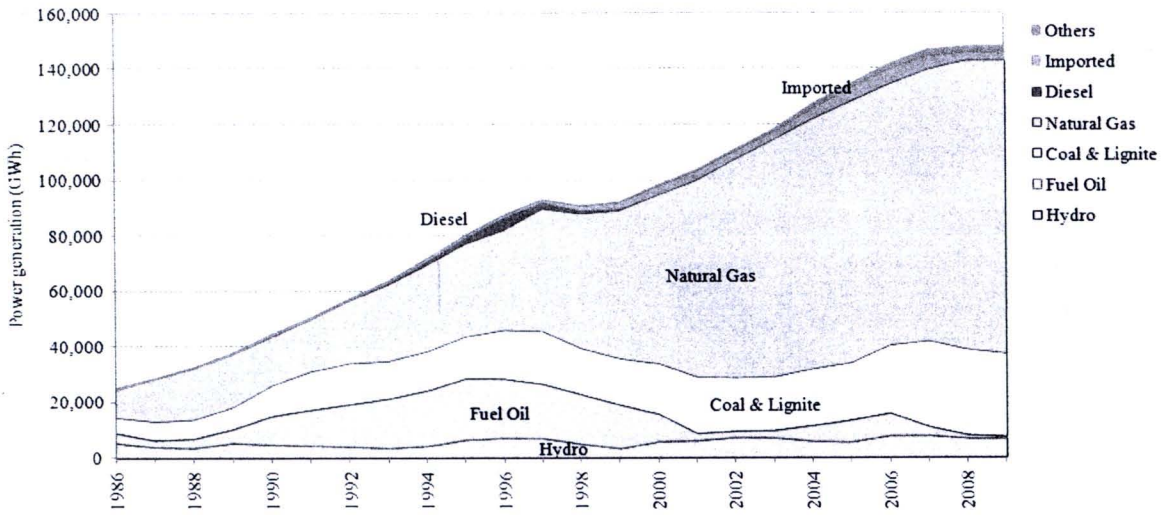

Figure 15 Capacity and Fuel Share of Thailand's Electricity Generation

Source: Using data from Ministry of Energy (2010)

3.2.3.1 Natural gas utilization

For natural gas utilization in electricity generation, Thailand uses 74 percent of its natural gas supply for power generation and 70 percent of its power comes from gas-based technology and the rest based on coal, hydropower and renewable energy (Energy Policy and Planning Office, 2010a). Nakawiro (2007) express high dependence on natural gas in power generation raises concerns about

security of electricity supply that could affect competitiveness of Thai manufacturing and other industries at the global level (Figure 16). Although natural gas supply of Thailand is from domestic resources, the country could be vulnerable from high gas dependence in its power generation (Energy Policy and Planning Office, 2010a).

In 2008, natural gas utilization at EGAT's own generation facilities amounted to 339,786 million cubic feet or 302,471 billion Btu equivalents. The gas supplies came from various gas fields including the Gulf of Thailand, Nam Phong, Phu Hom, Sirikit, the A-18 field of the Thai-Malaysian joint development area (JDA) in the Gulf of Thailand, Arthit, and Myanmar's Yadana and Yetakun gas fields. EGAT's gas utilization decreased 0.74 percent from the prior year but produced electric energy 3.56 percent more (Energy Policy and Planning Office, 2010d).

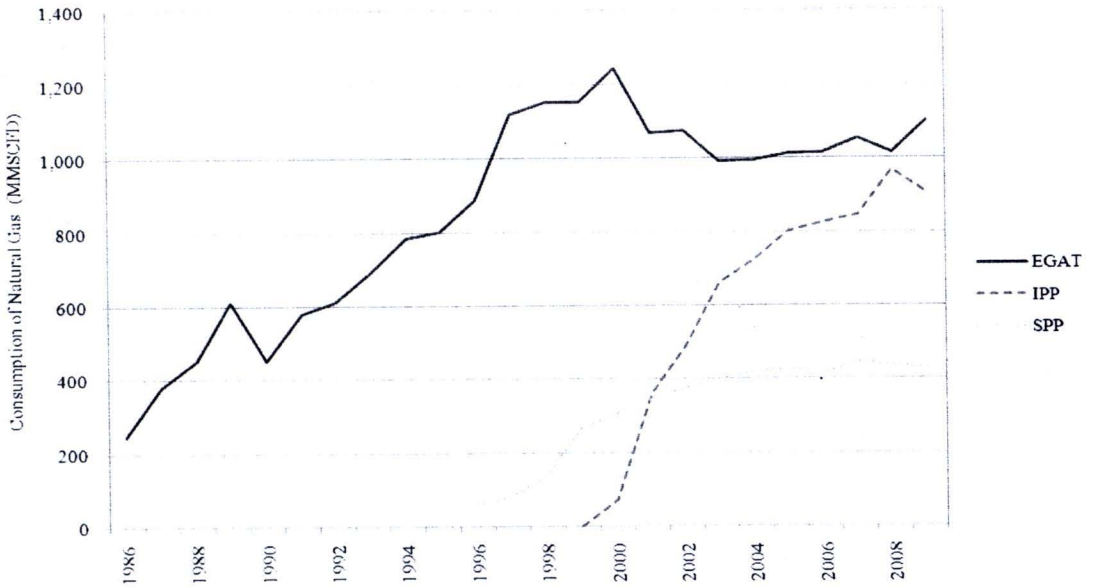

Figure 16 Natural Gas Consumption for Electricity Generation

Source: Using data from Ministry of Energy (2010)

Nakawiro and Bhattacharyya (2007) indicated natural gas has played its crucial role for electricity generation in Thailand for years. Although the country obtains various benefits from gas-based generation technology, it has been recently revealed that high gas dependence in power generation makes the Thai economy vulnerable over time. In the near future, continued growth in electricity demand is likely to make the country vulnerable from gas dependence in power generation. The

Office of the Energy Regulatory Commissioner (OERC) (2010) reported the installed capacity of natural gas based power plant in Thailand reached 26,216 MW. Of this, the power capacity from 9,036 MW from EGAT, 12,832 MW from IPP, 4,307 MW from SPP and 39.94 MW from VSPP power plant.

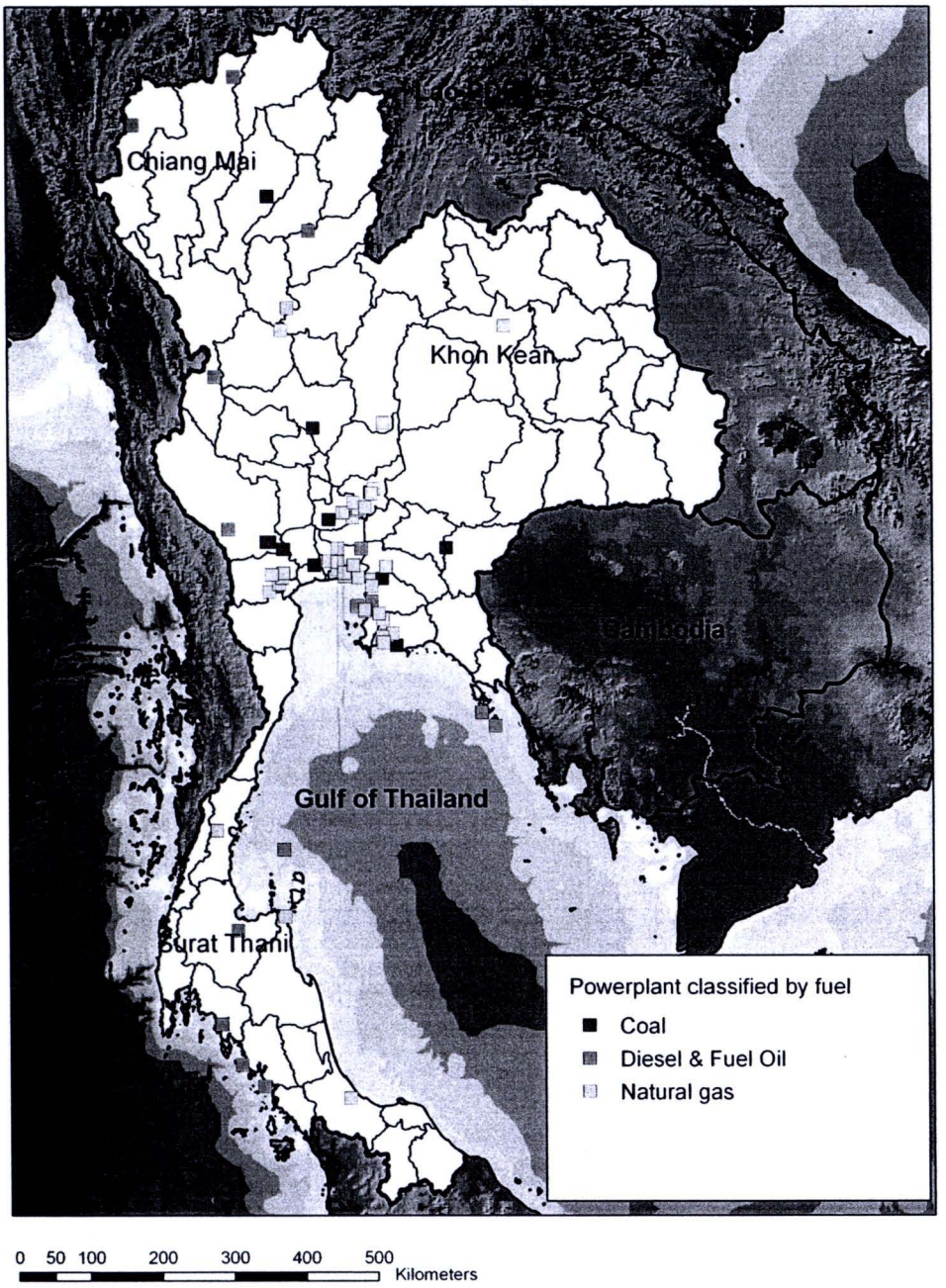

Figure 17 Distribution of Major Power Plant Classified by Fuel

Source: Using data from OERC (2010)

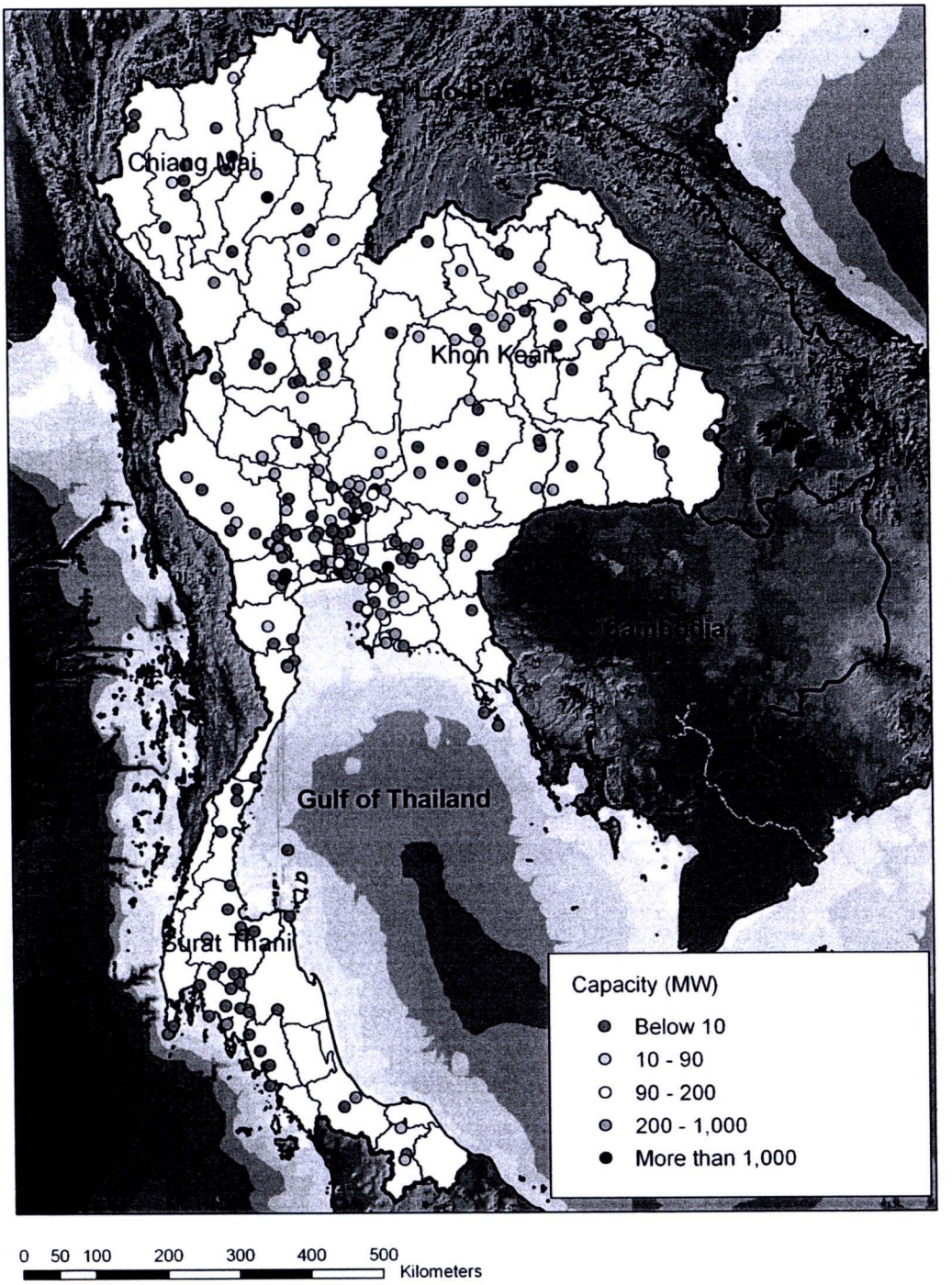

Figure 18 Distribution of Power Plant Classified by Capacity

Source: Using data from OERC (2010)

3.2.3.2 Diesel and Oil utilization

For diesel and fuel oil utilization in electricity generation, shares of oil in Thailand's Total Primary Energy Supply (TPES) have been relatively stable in the range between roughly 40 percent and 50 percent in the last 35 years. Oil represented 42 percent of TPES in 2006 while natural gas accounted for 28 percent of TPES in the same year. EGAT has continuously reduced its dependence on the high-priced oil for its own power generation. Oil procurement management was aimed at substituting for other types of fuel only in emergency. As a result, fuel oil consumption at EGAT's power plants was reduced by 68.52 percent from 786 million liters in the previous year to 247 million liters.

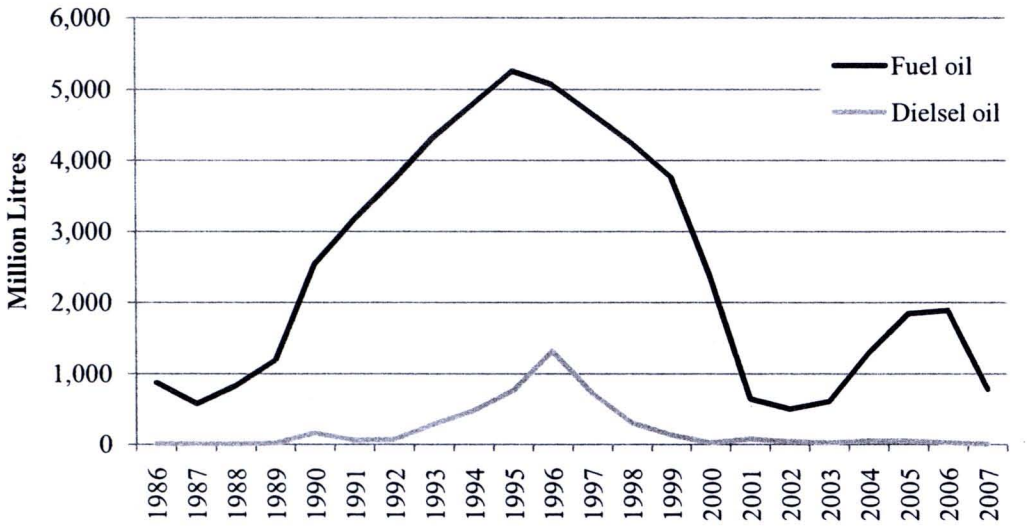

Figure 19 Fuel Oil and Diesel Oil Consumption in Electric Generation from 1986-2007

Source: Using data from Energy Policy and Planning Office (2008)

Electricity Generating Authority of Thailand (2008) reported the utilization of diesel oil also decreased 16.46 percent to 7.26 million liters in 2008. This utilization used for primary combustion of the fossil fuel-fired boilers of Mae Moh, South Bangkok, and Krabi thermal power plants; as standby fuel for running peak load power plants; and used in fuel swapping tests of gas-fired power plants. However, the consumption of diesel oil for the country's electricity generation increased considerably from 8 million liters in 2007 to 50 million liters in 2008 as

IPPs' power plants had to use diesel oil as natural gas substitute during the period of gas short supply caused by damage on Myanmar's Yetagun pipeline system and the production delay of PTT's Arthit gas field. The Office of the Energy Regulatory Commissioner (OERC) (2010) reported the installed capacity of oil based power plant (diesel and fuel oil) in Thailand reached 26,216 MW. Of this, the power capacity from 954.9 MW from EGAT (grid connected), 19.92 MW from EGAT (isolated), 12.14 MW from SPP and 8.37 MW from VSPP power plant.

3.2.3.3 Coal and Lignite

Lignite is another major domestic energy source for power generation and industry. In 2008, the average production of lignite was 49,468 tons per day. For coal and lignite utilization in electricity generation, EGAT's Mae Moh Lignite Mine produced and supplied totally 16.41 million tons of lignite to Mae Moh power plants in 2008, an increase of 2.18 percent from the prior year. Figure 20 illustrate pattern of coal and lignite consumption in electricity generation.

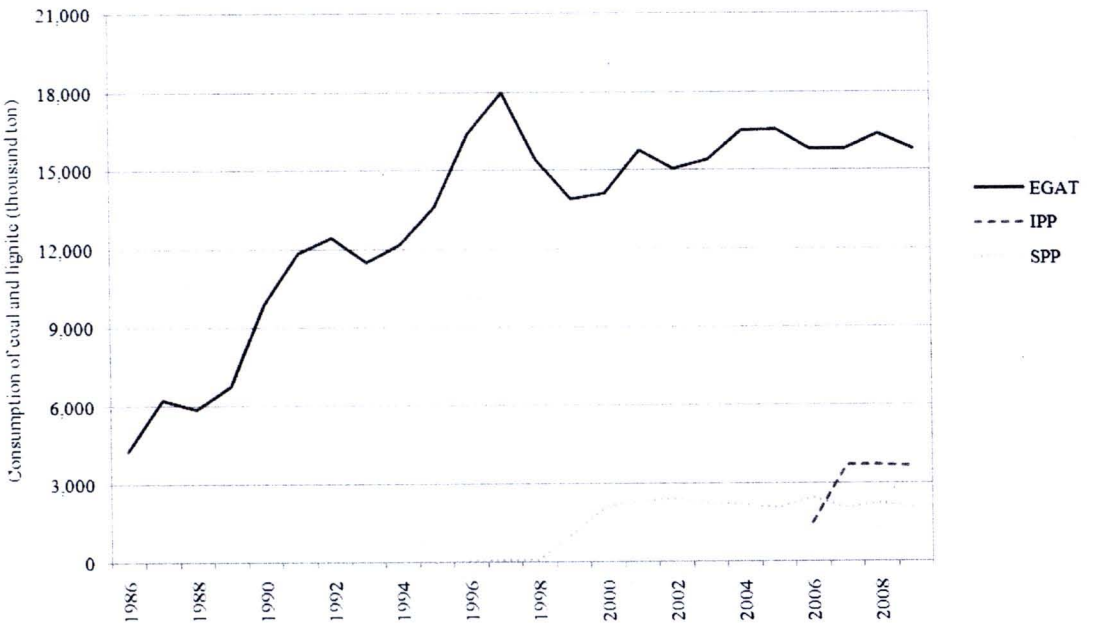

Figure 20 Coal and Lignite Consumption for Electricity Generation

Source: Using data from Ministry of Energy (2010)

The Office of the Energy Regulatory Commissioner (OERC) (2010) reported the installed capacity of coal fired power plant (lignite and bituminous) in

Thailand was 4,766.37 MW. Of this, the power capacity from 2,400 MW from EGAT (lignite), 1,436.96 MW from IPP (bituminous), 899.17 MW from SPP and 30.20 MW from VSPP power plant.

3.2.4 Renewable energy utilization

Since energy demand is projected to keep increasing, renewable energy and alternative energy are considered potential options to accommodate the increasing energy demand. Renewable energy utilization will help reducing not only the country's dependency on imported energy but also risks of volatility of imported fuel prices. At present, the development of renewable/alternative energy has become a country focus by promoting wider utilization of renewable energy to replace conventional energy consumption and motivating people to use energy efficiently and economically (Figure 21). This section gives an overview of alternative energy utilization in Thailand in several aspects including technological and supplying potential of biomass, biogas, municipal solid waste, hydropower, wind, solar, geothermal and nuclear energy to check on how obtainable for Thailand to achieve the latest AEDP target leading toward a low carbon electricity in 2022.

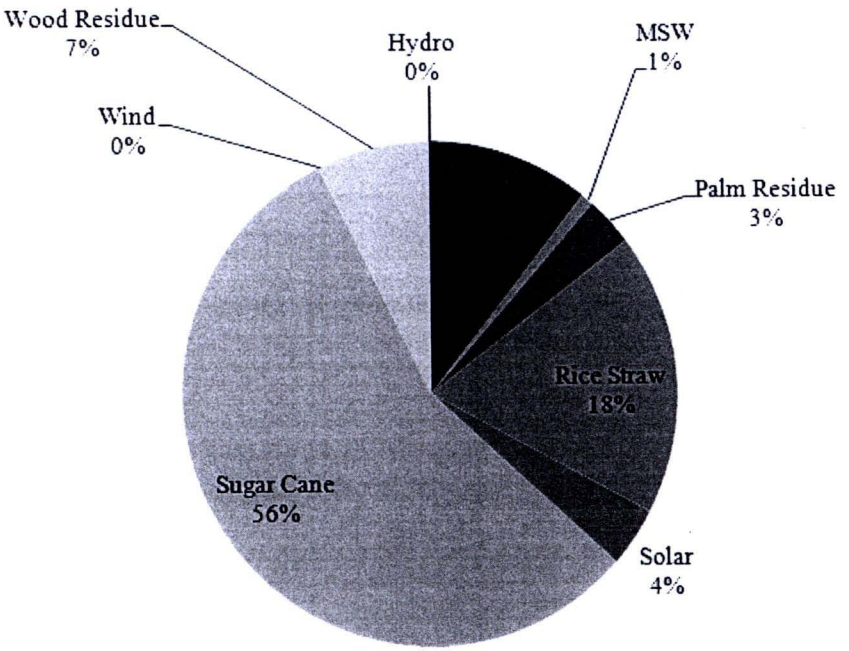

Figure 21 Renewable Energy in Electricity Generation in 2009

Source: Using data from Ministry of Energy (2009)

3.2.4.1 Biomass

Thailand is an agricultural country with huge agricultural stocks, such as rice, sugarcane, rubber sheets, palm oil, and cassava. The processing of these agricultural products generated large amounts of residues, which some parts are used as fuel in several industries. The amount of agricultural residues is about 61 million ton a year, of which 41 million tons, which is equivalent to about 426 PJ of energy, was left unused. Currently, biomass is the primary source currently covered approximately 4 percent of the country low carbon electricity.

Ministry of Energy (2008) indicated three main biomass sources in Thailand are from agricultural residues, forest industry and residential sector. The employable biomass energy in Thailand mainly includes crop residues, firewood, manure, domestic garbage, industrial organic waste residue, and wastewater. The most promising residues used as fuel sources in electricity generation and cogeneration are rice husk, bagasse, oil palm residue and rubber wood residue (See also in Figure 23). The utilization of biomass applies in wide range of conversion technologies such as direct combustion, thermo-chemical conversion, biochemical conversion, direct liquefaction, physical/mechanical extraction, and electrochemical conversion. Based on commercial application so far, direct combustion and thermo-chemical conversion are the most applicable technologies for utilizing biomass for heat and power generation (Suramaythangkoor and Gheewala, 2010). The potential from biomass supply is widely distributed throughout the country depending on seasons. Particularly, rice is main agricultural product. The rice statistics data in Thailand were roughly represented according to major harvest and second harvest. Major harvest would be from May/June until November/December and second harvest is from December/January until May/June (Figure 24).

The Office of the Energy Regulatory Commissioner (OERC) (2010) reported the installed capacity of biomass power generation in Thailand reached 1,751 MW. Of this, the power capacity from 632 MW from rice husk, 106 MW from bagasse and 32 MW from wood residue. EPPO (2010b) reported in March 2010, there are 76 biomass power plants in operation (637 MW), 30 plants in the negotiation period with PEA and MEA (234 MW), 40 plants in acceptable period but not yet

singing PPA contract (290 MW) and 211 power plants in the construction period and waiting for Commercial Operation Date (COD) at 1,586 MW (Energy Policy and Planning Office, 2010c). Under the 15-years of AEDP, government set targets of biomass utilization in electricity generation in 2022 into three periods, short-term (2008-2011) at 2,800 MW, mid-term (2012-2016) at 3,220 MW, and long-term (2017-2022) at 3,700 MW respectively.

3.2.4.2 Biogas

Thailand is known as a food producing and supplying country. Food and agro industry generated significant amount of organic wastes, which are good ingredients for biogas production. The productions of biogas are mainly from anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, sewage, municipal waste, and energy crops. In Thailand, biogas resources are from industrial wastewater and livestock manure, which have potential of 7,800 and 13,000 TJ per year, respectively. Central region produced highest BOD loading of 2,233 ton/day, which was more than half of the total BOD loading. The amount of wastes can be used to produce 620 million m^3 of biogas, which is equivalent to about 13,000 TJ or 308 ktoe of energy, in anaerobic digesters (Prasertsan and Sajjakulnukit, 2006). Although cattle residues show the highest energy potential of 41 percent of the total energy potential, the ongoing biogas promotion program is emphasized on manure utilization from pig farms. In the future, the government certainly has to put more focus to utilize resources from cows as well (Figure 25).

The OERC (2010) reported the installed capacity of biogas power in Thailand reached 146 MW. Of this, the power capacity from 74.96 MW from industrial waste water and 97 MWh from pig manure. EPPO (2010c) reported in March 2010, there are 41 biogas power plants in operation and sale power to grid at capacity of 43 MW, 15 plants in the negotiation period with PEA and MEA (41 MW), 31 plants in acceptable period but not yet signing PPA contract (44 MW) and 33 plants in the construction period and waiting for COD (72 MW). Under the 15-years of AEDP, government set targets of biogas utilization in electricity generation in 2022 in three periods, short-term (2008-2011) at 60 MW, mid-term (2012-2016) at 90 MW and long-term (2017-2022) at 120 MW respectively.

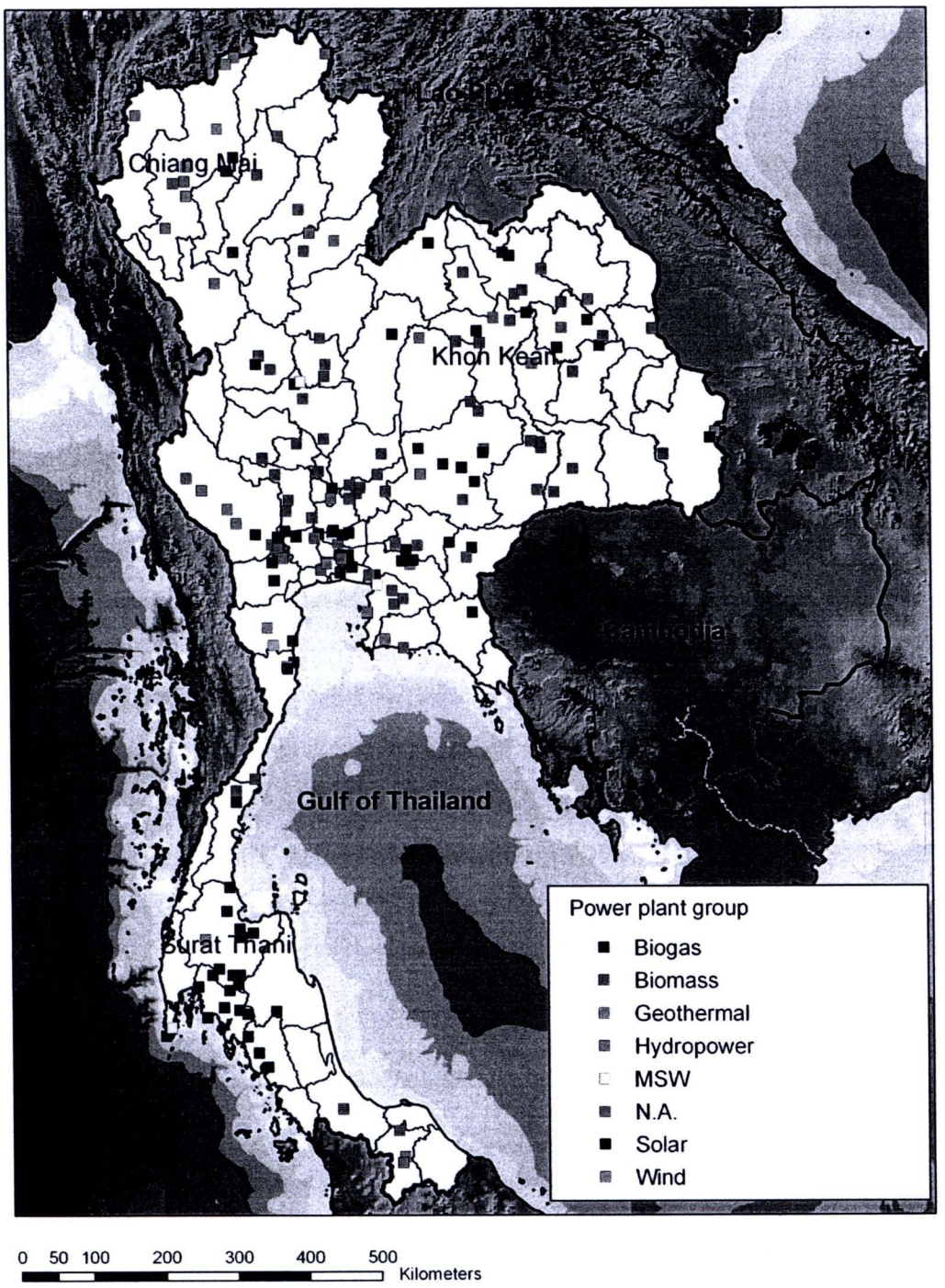

Figure 22 Distribution of Renewable Power Plants in 2010

Source: Using data from OERC (2010)

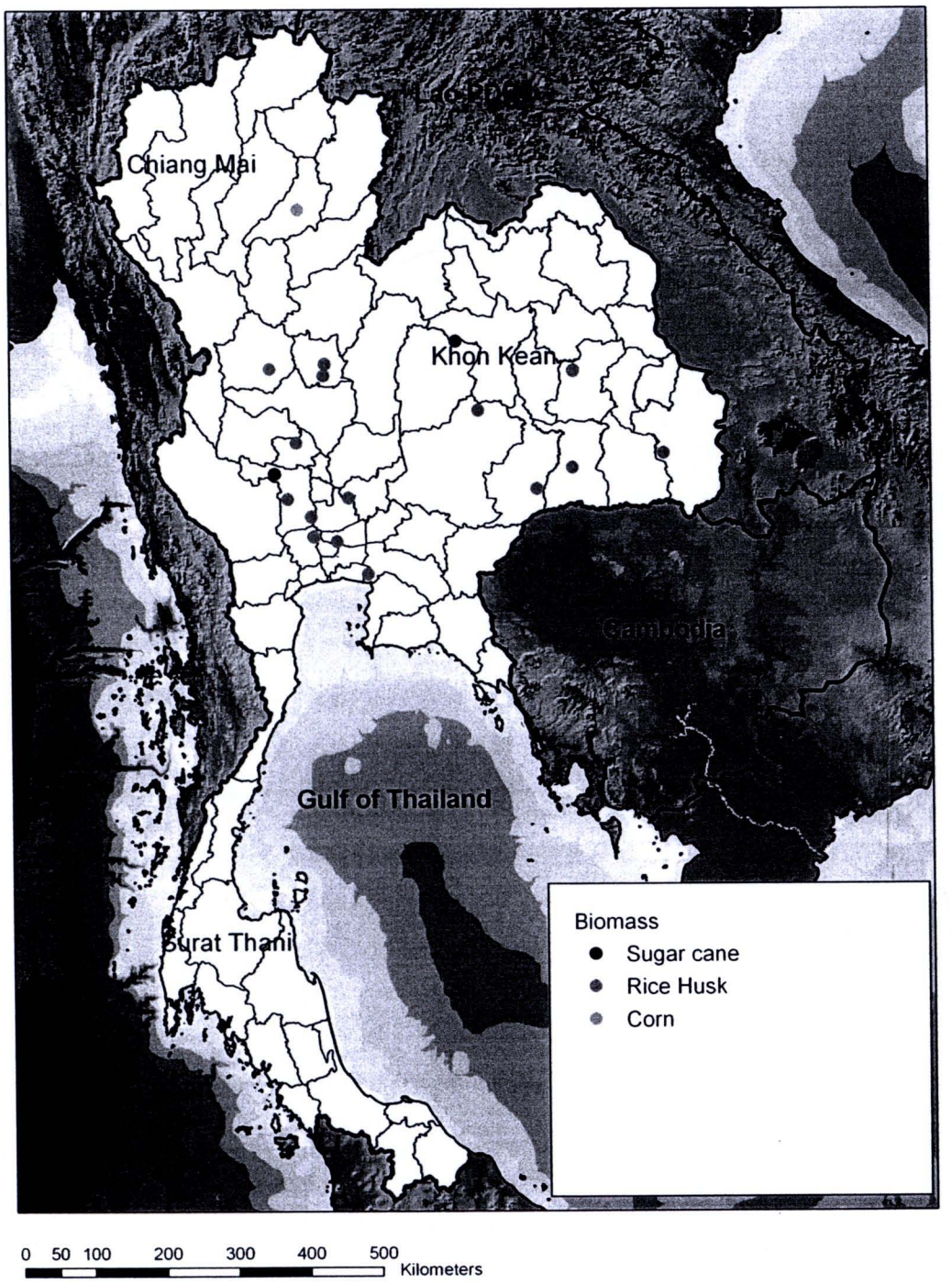

Figure 23 Distribution of Major Biomass Power Plant in 2010

Source: Using data from OERC (2010)

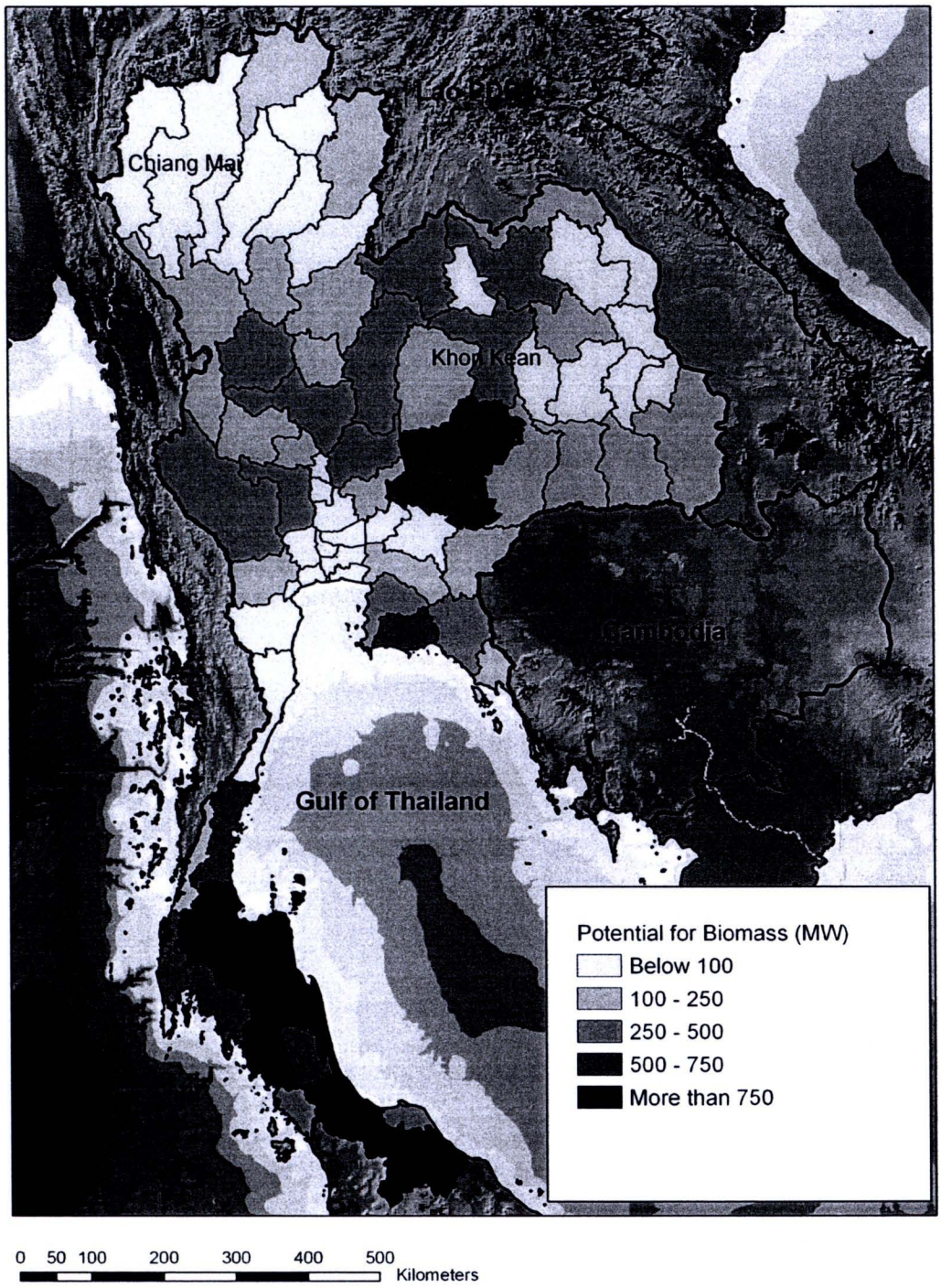

Figure 24 Estimated Potential of Biomass for Electricity Generation in 2009

Source: Using data from OERC (2010), Department of Alternative Energy Development and Efficiency (2009) and Office of Agricultural Economics (2009)

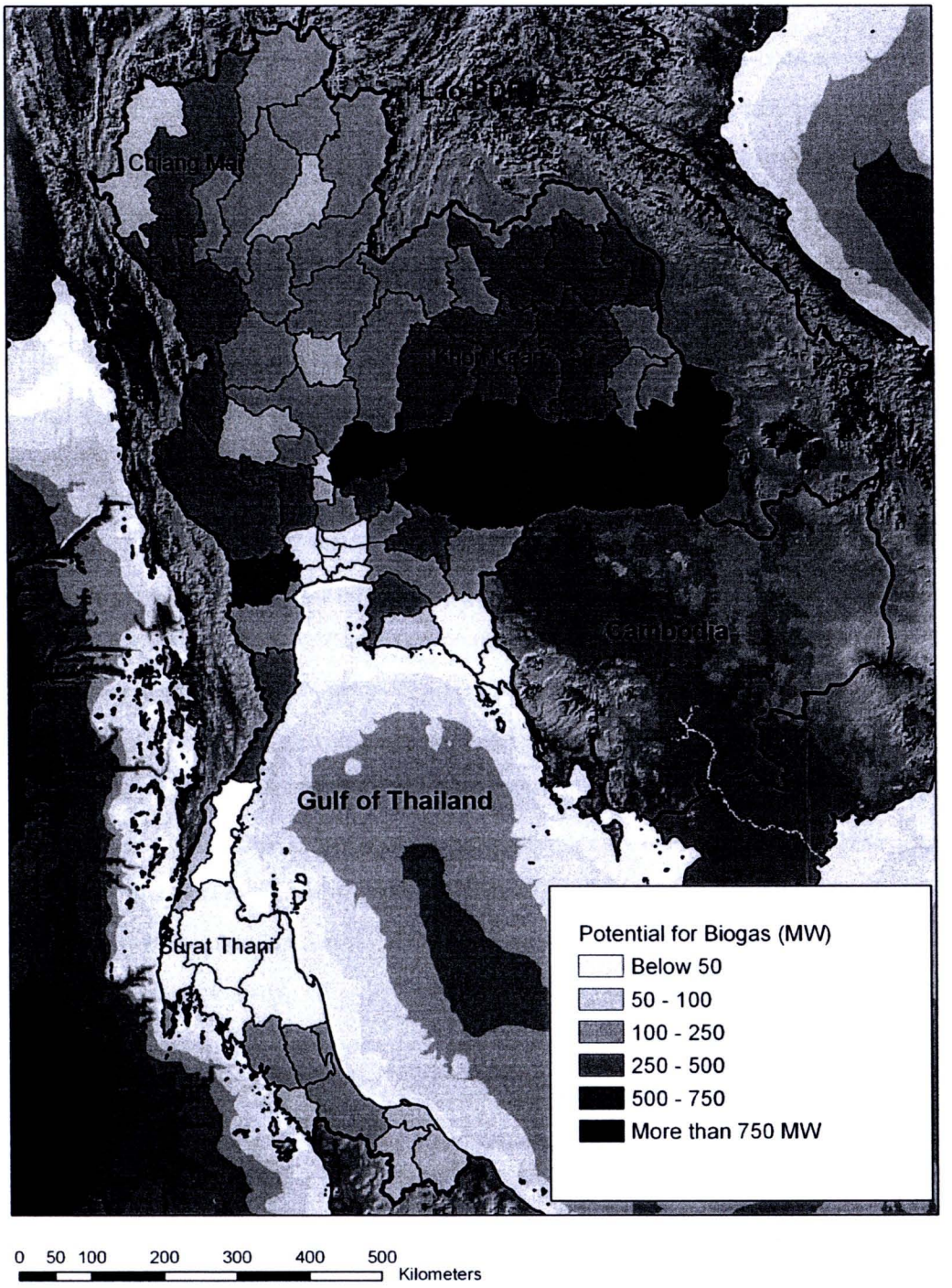

Figure 25 Estimated Potential of Biogas for Electricity Generation in 2009

Source: Using data from OERC (2010), Department of Alternative Energy Development and Efficiency (2009), Office of Agricultural Economics (2009) and Department of Livestock Development (2010)

3.2.4.3 Municipal Solid Waste

Management of municipal solid waste (MSW) has continued to be an important environmental challenge due to increase in production and consumption of goods. The threat of global climate change become a driving force and great opportunity to change MSW management practices to reduce greenhouse gas emissions in Thailand (Liamsanguan and Gheewala, 2008). Huge amounts of waste are generated daily and its management is a considerable task to not only promote recycling and reuse, efficient waste collection and disposal system, but also increase financial capability and effective participation of government, public and private sectors.

Thailand generates approximately 14.5 million tons of Municipal Solid Waste (MSW) annually. Chiemchaisri et al. (2007) clarify the physical composition of MSW varies according to consumer patterns, lifestyle, and economic status. The detailed composition of MSW in Thailand dominated by food waste (41–61%), followed by paper (4–25%) and plastic (3.6–28%). Within landfills, microorganisms that live in organic materials such as food wastes or paper cause these materials to decompose and produce landfill gas typically comprised of roughly 60 percent methane and 40 percent carbon dioxide. Total numbers of landfills in Thailand that actively operate are ninety while total incinerators are three. There are more than three hundred opened-disposal sites in the country. Despite large numbers of landfills, only a few of them properly operate and maintain (with methane gas collection) because no regulation mandates for methane collection.

The OERC (2010) reported the installed capacity of electricity from municipal solid waste in Thailand reached 13 MW. EPPO reported in March 2010, there are 8 municipal solid waste power plants in operation and sale electricity to grid at 11 MW, 10 power plants in the negotiation period with PEA and MEA (305 MW), 15 plants in acceptable period but not yet signing PPA contract (68 MW) and 14 plants in the construction period and waiting for COD (96 MW). Under the 15-years of AEDP, government set target of biogas utilization in electricity generation in 2022 in three periods, short-term (2008-2011) at 78 MW, mid-term (2012-2016) at 130

MW and long-term (2017-2022) at 160 MW respectively (Energy Policy and Planning Office, 2010c).

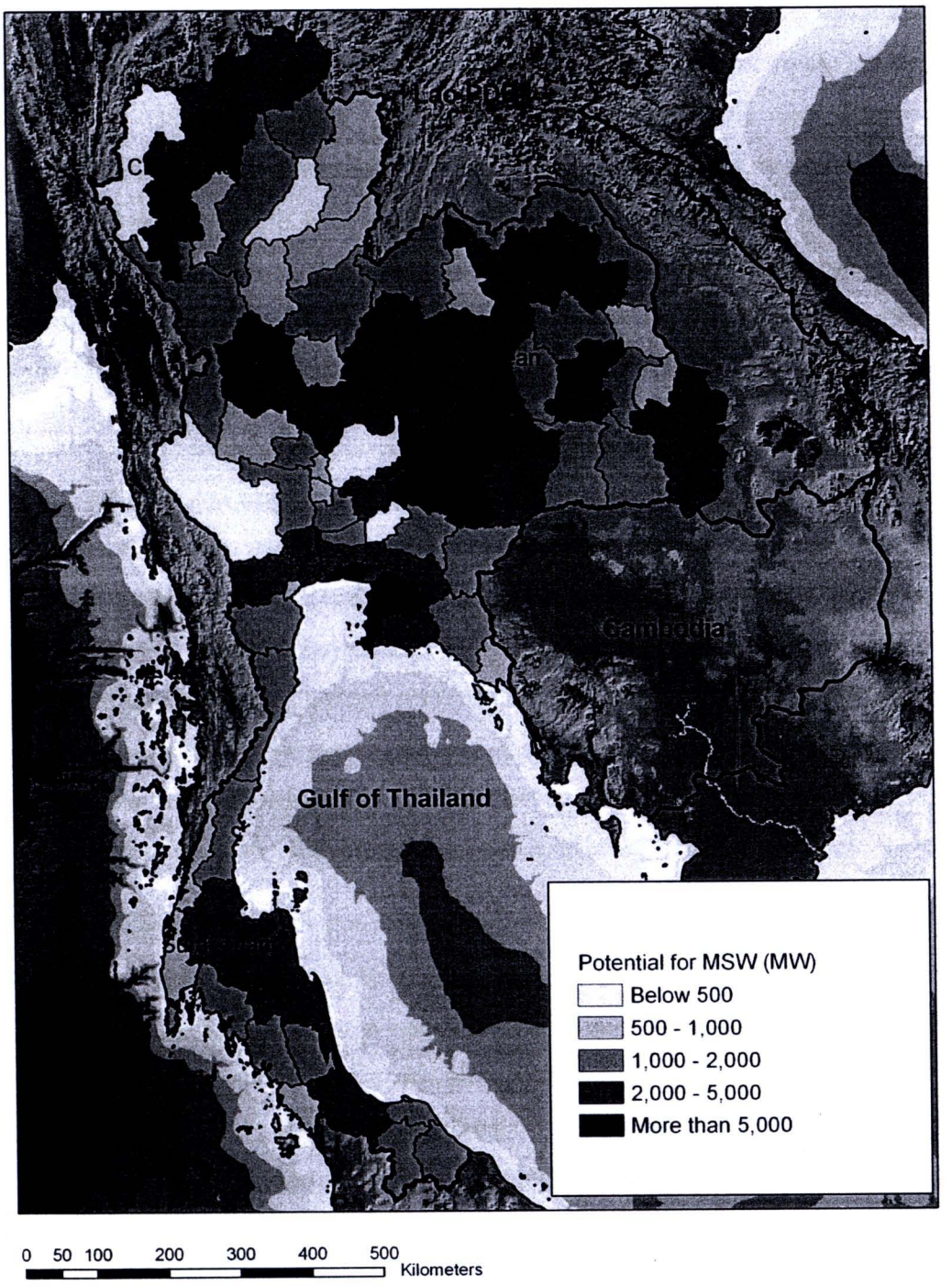

Figure 26 Potential of Municipal Solid Waste for Electricity Generation in 2009

Source: Using data from OERC (2010) and Department of Alternative Energy Development and Efficiency (2009)

3.2.4.4 Hydropower

Water supply for the whole part of Thailand is plentiful, except in the northeastern part of the country during the dry season. Thai's culture has long been intimately related with water, but not in a seafaring way, instead mainly in a local transport and irrigation mindset. Based on geographical characteristics watershed of Thailand divided into 25 river basins, average of annual rainfall is about 1,700 mm and total annual rainfall of all river basins is about 800,000 million m^3 of which 75 percent of the amount is lost through evaporation, evapotranspiration and the remaining is in streams, rivers, and reservoirs. Hydropower is the second major source of low-carbon electricity for Thailand.

Hydropower produces only small amounts of CO_2 as a byproduct from dam construction and operation, but in some cases may produce significant amounts of another greenhouse gas, methane. However, hydropower resources are difficult to exploit due to the environmental impact on the resource areas a power project would entail. Therefore, future development of hydropower resources will be limited to a few small-scale projects that are considered most economical and environmental friendly. As part of the rural electrification program, the small hydropower developments are promising plan. From survey of MOE presented Thailand has potential to development of small hydropower at existing irrigation project.

According to the PDP-2010, EGAT planned to increase capacity by constructing small hydropower at total capacity of 49 MW within 2012 (Ministry of Energy, 2009). There are many existing irrigation dams and reservoirs of Royal Irrigation Department (RID) designed and constructed for irrigation and flood control. Six existing and under construction dams of RID were studied and proposed by EGAT to develop the small hydropower projects with the total installed capacity of 78.7 MW. High potential micro-hydro powers are clustered in the northern areas of the country (Electricity Generating Authority of Thailand, 2010b; Pienpucta and Pongtepupathum, 2009).

EPPO (2010e) indicated hydropower existing potentials for development is at 15,155 MW. By the end of December 2009, the OERC (2010) reported the installed capacity of hydropower in Thailand reached 3,438 MW. EPPO

reported in March 2010, there are 7 hydropower projects in acceptable period waiting for COD at capacity of 6.3 MW. Under the 15-years of AEDP, government set target of hydroelectric utilization in electricity generation in 2022 in three periods, short-term (2008-2011) at 165 MW, mid-term (2012-2016) at 281 MW and long-term (2017-2022) at 324 MW respectively.

3.2.4.5 Wind

Wind energy technology currently has conquered many startup problems and has attained in a new, more mature phase. It is one of the promising alternatives to implement for low-carbon electricity generation. The average wind speed in Thailand is moderate to rather low, usually lower than 4 meters per second; therefore, wind energy is currently used almost exclusively for propelling rooftop ventilators and water-pumping turbines. Throughout Thailand's long coastline, there is a rich resource of wind energy with great development potential. Currently, a further detailed study is being carried out in areas where the wind potential is high, mainly along the southern coastlines of Thailand, to obtain more data with a view determining the feasibility to develop projects for wind power generation (Energy Policy and Planning Office, 2010e; True Wind Solutions, 2001).

The study of Prabamroong et al, (2009) estimated total feasible areas for wind farm installations with respect to total area in each region of the country is found to be 95 percent for Central region, 88 percent for Eastern region, 94 percent for Northern region, 79 percent for Northeastern region, and 91 percent for Southern region. This study suggested that most of areas in Thailand have high potential for installing wind farms.

By the end of December 2009, the OERC (2010) reported the installed capacity of wind power in Thailand are in very small amount about 0.38 MW. As of March 2010, EPPO (2010c) reported there are 3 wind power projects in operation, 19 in the negotiation period with PEA and MEA (762 MW), 16 projects in acceptable period but not yet signing PPA contract (560 MW) and 6 power plants in the construction period and waiting for COD (26 MW). Under the 15-years of AEDP, government estimated potential of wind energy utilization with 1,600 MW capacity and set target of wind energy utilization in 2022, short-term (2008-2011) at 115 MW,

mid-term (2012-2016) at 375 MW and long-term (2017-2022) at 800 MW respectively. Noticeably, the government proposed to increase renewable energy from wind power to 800 times more from the current capacity in 2022. This will require significant amount of investment, which the government needs to carefully develop an appropriate driving policy to succeed this ambitious goal in 12 years.

3.2.4.6 Solar

Almost every area in Thailand exposes to high sunlight intensity since locating near the equator. Therefore, high potential for solar utilization exists. Government promoted solar cells or photovoltaic (PV) cells for power generation with a demonstration project for utilization of solar energy and integrated systems of PV/hydropower and PV/wind energy (Jivacate, 1994). Since 1976, the Ministry of Public Health and the Medical Volunteers Foundation used solar electricity for communication equipment in rural health station in isolated area that far from grid system. Several government agencies under the MOE have been undertaking studies and development of PV technology. For example, DEDE has studied and explored the potential of solar energy utilization by establishment of solar cell battery-charging station in various rural villages and Border Patrol Police Schools located outside the grid system (Green, 2004).

By the end of December 2009, the OERC (2010) reported the installed capacity of solar power in Thailand are 7.8 MW. EPPO (2010c) reported in the end of March 2010, there are 51 solar power projects in operation with capacity of 7.7 MW, 121 projects in the negotiation period with PEA and MEA (996 MW), 61 power plants in acceptable period but not yet signing PPA contract (218 MW) and 341 plants in the construction period and waiting for COD (3,265 MW). Under the 15-years of AEDP, government set target of solar energy utilization in 2022, short-term (2008-2011) at 55 MW, mid-term (2012-2016) at 95 MW and long-term (2017-2022) at 500 MW, respectively. The proportion of solar energy is about 10 percent compared to total renewable energy target, which seems to be relatively low, despite the great potential of solar intensity throughout the whole country. High investment cost per unit of electricity might be a major barrier, which suggests the government should find the way to develop R&D and support domestic solar industry.

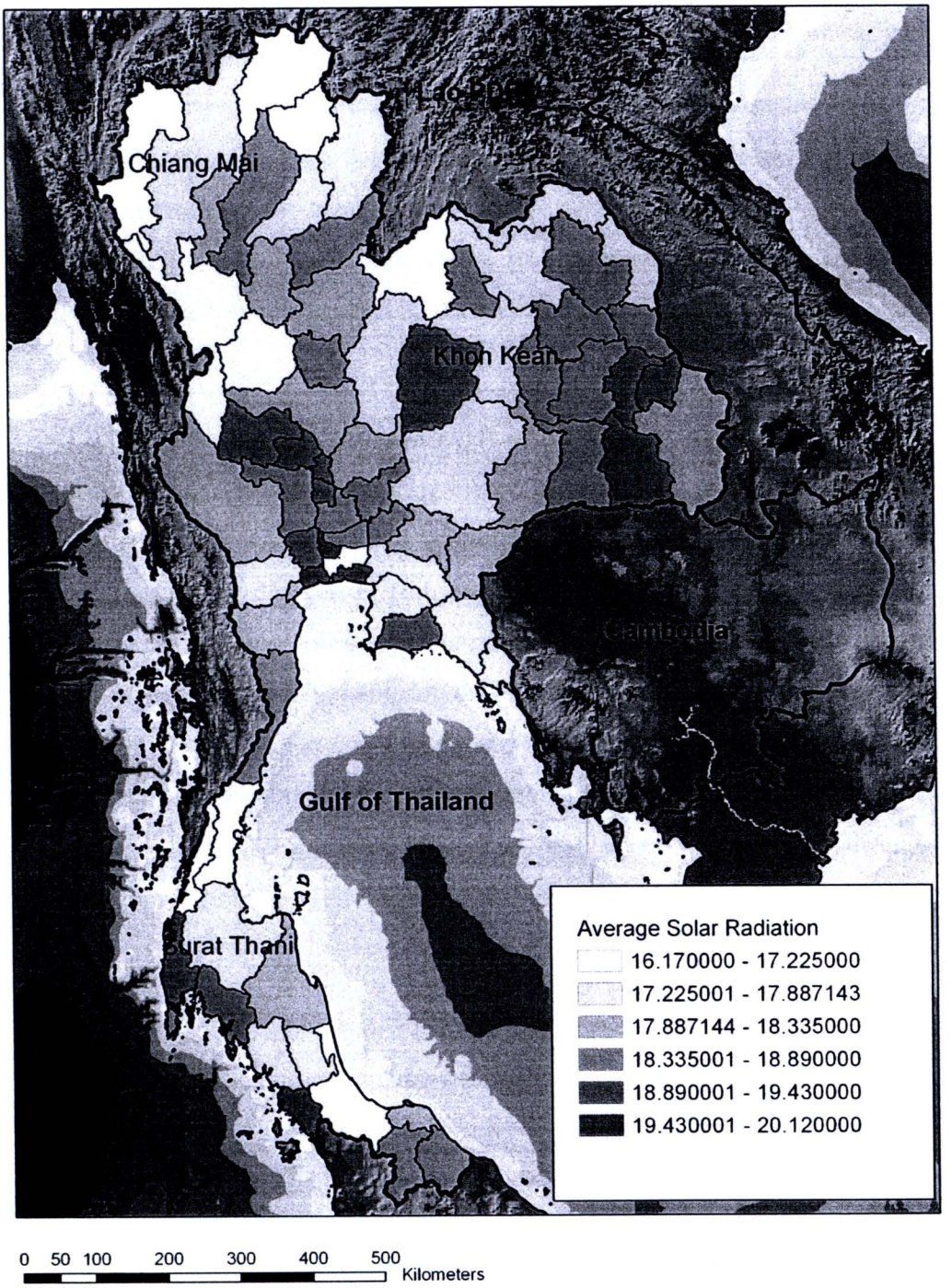

Figure 27 Average Solar Radiation

Source: Using data from OERC (2010) and Department of Alternative Energy Development and Efficiency (2009)

3.2.4.7 Geothermal

Geothermal energy is natural energy from the internal heat of the earth; the temperature varies with respect to the distance from the earth surface (geothermal gradient) - the deeper from the earth surface, the higher temperature. At the depth of about 25-30 kilometers, the average temperature will be around 250-1,000°C. There are approximately 64 geothermal resources in Thailand, but major ones are in the northern part of the country, especially the geyser field at Fang District in Chiang Mai Province (Figure 28).

Currently, EGAT is operating a 300-kW binary cycle geothermal power plant at Fang District, generating electricity at about 1.2 million kWh per year, which helps reduce oil and coal consumption for power generation. In addition, other benefits derived from the waste heat of hot water used in the power plant. The temperature of hot water, after being used in the power plant, will decrease from 130°C to 77°C, which can be used for drying agricultural products and feeding the cooling system for EGAT's site-office space. Some other non-energy uses of hot water from geothermal sources are for physical therapy and tourism (Energy Policy and Planning Office, 2010e). Due to limited geothermal resources in the country, Thailand has small potential to produce more renewable energy from this area.

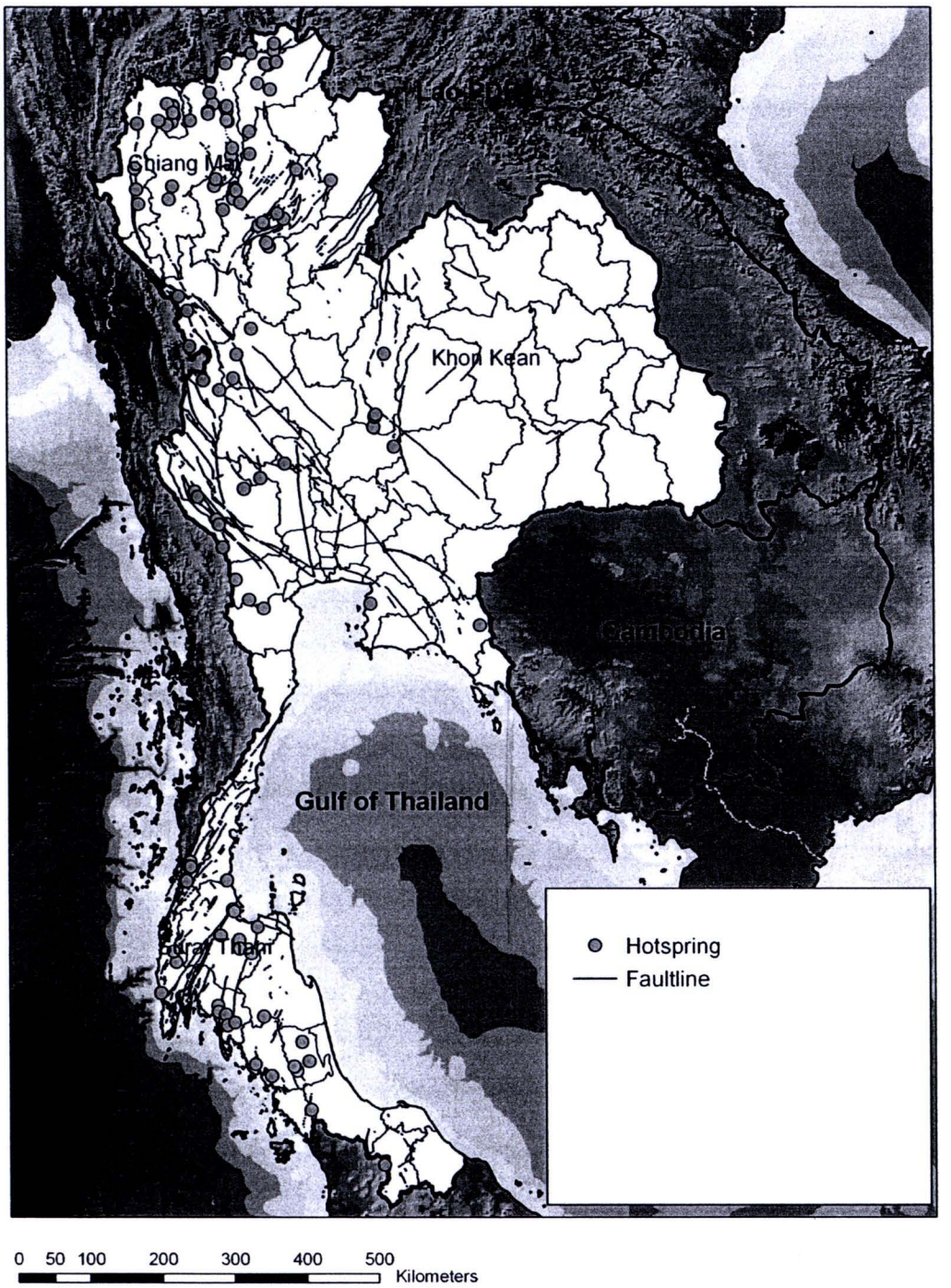

Figure 28 Location of Hot Spring in Thailand

Source: Using data from OERC (2010) and Department of Mineral Resources (2010)

3.2.5 Transmission and distribution

Electric power is brought from the power generating plant to the end user through a complex system of high-voltage, medium-voltage, and low-voltage power lines that are collectively known as the grid. The grid was never "designed" in the sense that a group of sophisticated engineers looked over the entire county's collection of power plants and load centers and laid out an optimized system of wires to connect them all (Figure 29). On the contrary, it mainly just grew from what we had years ago by adding a patchwork of transmission lines to get the power to load centers that changed over time. Generating plants used to be near cities and the grid was mainly local. Power plants were then moved away from cities as real estate values went up, and the grid began to stretch out (Richter, 2010).

Most grid-management systems aim to transport electricity over as short a distance as possible. In many large countries, the overall system consists of a number of separate grids, sometimes with quite different characteristics, that can be linked together (Chi-Jen, 2009; Hammerschlag, Pratt et al., 2007; The International Energy Agency, 2005; 2009b). The International Energy Agency (2009b) reported much more electricity is produced than is ever used. Transmission and distribution (T&D) losses and direct use in power plants equates to 14.3 percent of the electricity produced worldwide (8.8% is lost through T&D, which includes commercial and technical losses). While losses are significantly higher in developing countries, in absolute terms, the United States and Europe lose the most electricity – because of the sheer size of their electricity markets. The two most efficient countries are Canada and Japan, with losses of only 9 to 11 percent. For Thailand, EGAT (2010a) reported T&D loss in EGAT, MEA and PEA transmission line only 2.5, 3.6 and 5.1 percent respectively.

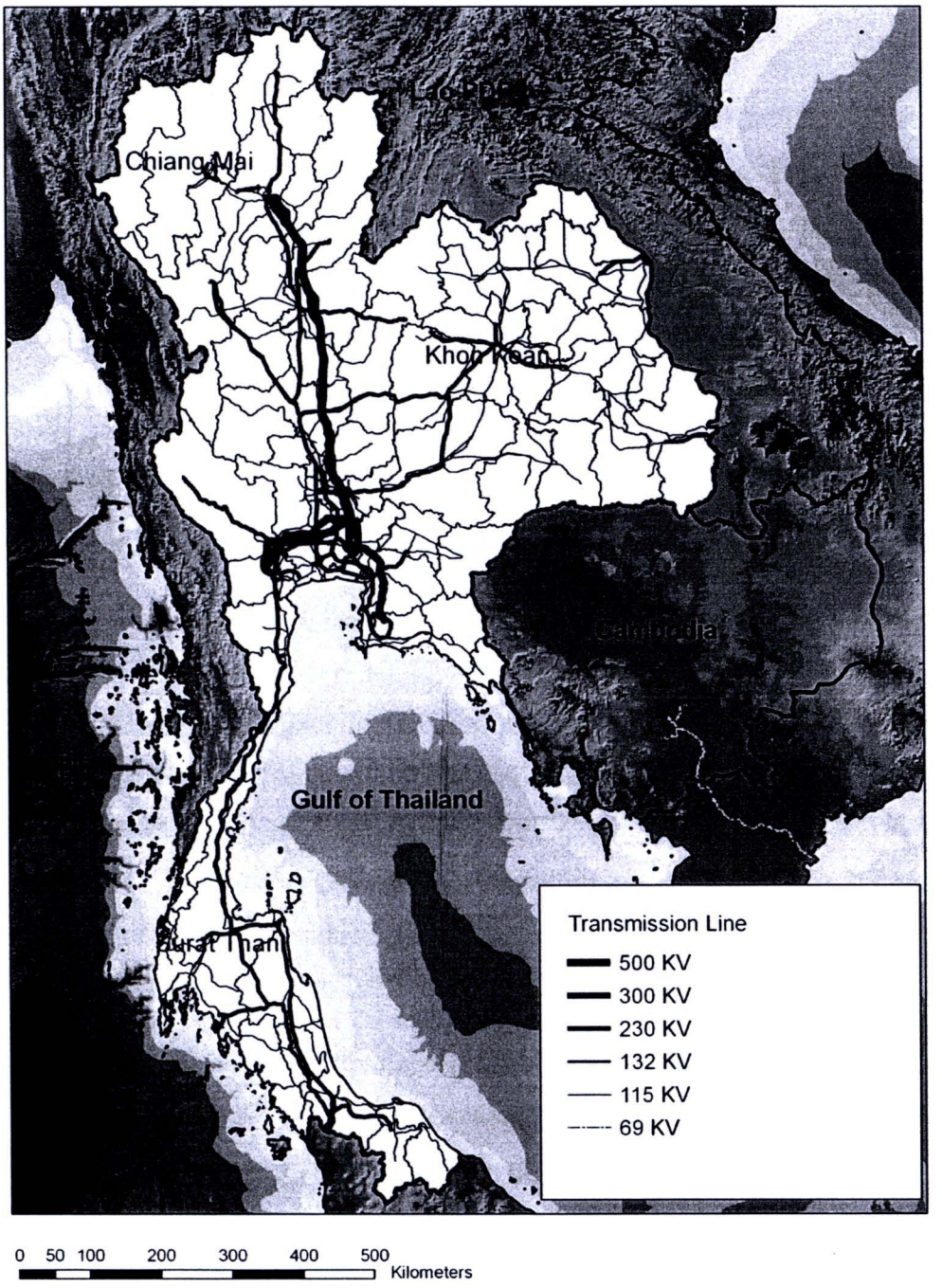

Figure 29 Distribution of Transmission Line

Source: Using data from Office of the Energy Regulatory Commissioner (2010) and Electricity Generating Authority of Thailand (2010a)

3.3 Summary of Findings

Thailand is facing an urgency to enhance its energy security and capacity to cope with global warming impacts, as demands on fossil fuel consumption keep rising. This paper reviewed the latest situation on renewable powers and developmental strategies toward low carbon electricity generation in Thailand. Government recently has spent tremendous financial and legislative supports to promote the uses of indigenous renewable energy resources and fuel diversification while contributing in reduction of global greenhouse gas. Major policy challenge is on which types of renewable energy should be more pronounced to ensure sustainable future of the country. Regions in Thailand present different potentials for renewable supply on biomass, municipal wastes, hydropower, and wind.

To maximize renewable energy development in each area, location is matter. Currently, energy-derived biomass is widely utilized within the country, however if droughts happen more often and severe, it will not only affect food security but also energy security. Life cycle of biomass energy production may cause other social issues on land and chemical uses. Meanwhile, deployment of wind and solar energy has been slow and needs to speed up to the large extent in comparison with energy proportion from biomass. Nuclear power has already been included in the Thai power development plan 2010 (PDP-2010).

Next chapter, I reviewed the electricity expansion policy that include Power Development Plan (PDP), Alternative Energy Development plan (AEDP), the concept of low carbon electricity abatement and emission scenario to understand Thailand's characteristics under different assumption.