Guideline for Environmental Health Surveillance in Risk Area : Biomass Power Plant

Department of Health and
Department of Disease Control
Ministry of Public Health

Preface

The development of surveillance, warning, public communication, and environment and health challenge contribution system is one significant measurement under the integrated plan for environment and health of the fiscal year 2015. It has been integrating among various agencies of the Ministry of Public Health to aim to reduce risk factors affecting the health of public and reduce morbidity of environmental disease.

The tendency of health impact and complaint from environment pollution in the risk area has been higher. So, Department of Health and Department of Disease Control have been integrated moving forward to reduce such problems. The guidelines for environment and health surveillance conducting in various risk areas polluted from golden mining, biomass electricity generating, outdoor burning, air particulates, high morbidity of gastrointestinal disease from food and water, electronics waste, is one integrated activity. It aims to be the guidance for the public health official to effectively and appropriately solve the problems. The public health is ultimately protected and the environmental risk factors are reduced.

This publication is the second version which its content has been improved. However, welcome for any recommendations, please contact the Division of Health Impact Assessment, Department of Health, Ministry of Public Health.

The Publication Team

March, 2015

Contents

Contents

Chapter 1
Introduction

1.1 Background and rational

The electricity has been necessary and consumed much more since the development of industrial and economics in Thailand has been quickly developing. In 2013, the amount of electricity consumption was 173,475 million units which were almost generated from natural gas 65%, from lignite/coal resource 21%, only 14% from other resources. Among thus 14%, its generating resources are from hydro power 4%, imported 7%, recycling power 2%, and from oil 1%. (Bureau of National Energy Plan, 2014) Almost of power generating system is the large scale and generated resource is from fossil. Although thus generated resources have been adequate and consistent for power generating requirement for economic development, but for its negative impact to environment and health has been unavoidable. Since 2008-2013, there have been complaints which are almost particulates and odor from the operation. Especially from the small plants (less than 10 MW), such as the plants located in Ubon-ratchathani, Prachuab-kirikan, and Burirum. For greater than 10 MW is located in Roi-ed province. Therefore, prevention and surveillance system of environmental health impact from biomass power plant is necessary to conduct continually.

1.2 Objectives

1) To be informed about knowledge on the process, activities, pollutants, and health threats from biomass power plant.
2) To be a guideline for preparation of surveillance and monitor of health impact of the people living nearby power plant.

1.3 Target group

Public health practitioner

1.4 Components

Chapter 1: Introduction; The situation of biomass power plant in Thailand.

Chapter 2: Process, pollutants, and health impacts; addresses the process, pollutants, and health impacts, including health impact from biomass power plant.

Chapter 3: Environmental surveillance; addresses the related and environmental significant indicators for monitoring.

Chapter 4: Health surveillance; addresses the related and significant health indicators for monitoring and assessing of health impact.

Chapter 5: Risk management and communication; addresses the guideline of risk management, and communication.

Chapter 6: Related legislations; addresses the legislations, agencies, and environmental and health standard related to biomass power plant.

Chapter 2
Process, Pollutions and Health Impacts

2.1 Definition

Biomass is organic material remained or disposed from agriculture or industry such as rice husk from rice mill, bagasse from sugar production, wood remained from rubber wood industry, organic waste from palm oil refinery etc. (Energy for Environment Foundation, 2006)

Biomass fuel is fuel derived from organic matter or living matter and productions from agriculture, livestock, and foresting such as woodchips, rice husk, rice straw, bagasse, trunk and leaves of sugarcane, palm fiber, palm shell, palm empty bunch, vegetable waste, biogas, manure, solid waste from the agricultural production industry, etc. (The Announcement of Ministry of Industry, 2006)

Biomass power plant is the electricity generating from the above mentioned biomass fuel which some generated from single source, or some generated from mixed source, or from hydro power (The Office of National Energy Policy Committee, 2000).

2.2 Biomass Power Plant in Thailand

In the year 2010, the National Energy Policy Committee (NEPC) endorsed the Thailand Electricity Generating Plant Development Plan: year 2012-2030 (PDP 2010) which was emphasized the security and sufficiency of electricity generation

and promote the renewable electricity generation according to the plan of renewable energy 15 years. Afterward, in the year 2011, the cabinet endorsed the Alternative Energy Development Plan: AEDP 2012-2021, the promotion of alternative energy development, aiming for 25% usage within 10 years (2012-2021), is to increase alternative consumption replace fossil energy. And NEPC has set the goal that Thailand can increase at least 5% to generate energy from renewable source within the year 2030. It means that in the year 2030 Thailand can generate the electricity from renewable source 20,546.3 MW as 29% of the whole generating power. However, the ministry of energy will revise such renewable electricity generating plan by considering the potential of alternative sources as shown in table 2-1.

Table 2-1: The Plan of Electricity Generating from Renewable Source during the year 2012-2021 and 2022-2030

Source	Year 2012-2021 (MW)	Year 2022-2030 (MW)
Solar	1,806.04	1,995.7
Wind	1,774.3	199.4
Hydro Power (Local/import)	3,061.4	2,742.5
Biomass	2,378.7	223.5
Biogas	22.1	24.1
Solid waste	334.5	17.8
Total	**9,377.4**	**5,203.0**

Source: The Ministry of Energy (2012) (PDP2010 the third improved issue)

As such information as shown in the Table 2-1, Thailand has generated the electricity mainly from renewable sources since the year 2013. Mostly is the heat energy form (64.1%) from solar, wind, small hydro power scale, biomass, natural gas, solid waste and bio energy (ethanol and biodiesel). The minority is from biomass (19.1%), and electricity (16.3%). From the report of renewable energy usage in Thailand (year 2013), Department of Renewable Energy, the final energy consumption by fuel in Thailand is namely from fossil 76.22% or 75,214 x 10^3 tons equivalent to crude oil, from renewable source 10.94% or 8,232 x 10^3 tons equivalent to crude oil, and from traditional renewable energy 10.74%, imported hydro power 1.5% and large hydro power 0.6%.

For usage the renewable energy (1.94%) for the final energy consumption, mostly is the heat form (7.02%), the minority is biofuel (2.14%), electricity (1.74%), small hydro power scale (0.04%). Comparing to other renewable sources such as solar, wind, small hydro power scale, biogas, and solid waste, it found that the rest of agricultural production or biomass was mostly used for heat generating and electricity generating. The biomass was increasingly used for electricity generating 2,320.8 MW and for heat generating 4,694 x 10^3 tons equivalent to crude oil in the year 2013, comparing to the year 2009 (base year) it was used for electricity generating 1,618 MW and for heat generating 2,987 x 10^3 tons equivalent to crude oil.

2.2.1) Biomass in Thailand

There are various kinds of biomass in Thailand which is able to use for electricity generating. Biomass can be converted to the energy which each kind of biomass has different potential of energy generating (as shown in table 2-2).

Table 2-2: The potential of Energy Generating from Biomass in Thailand

Type	Residues	Energy Generation Rate	Heat Value (MJ/Kg)
Sugar cane	Bagasse	0.25-0.28	7.37-9.25
	Crest	No data	15.48-17.39
Paddy	Rice husk	0.21-0.23	13.52-14.27
	Rice straw	0.447-0.49	10.24-12.33
Tapioca	Trunk	0.08-0.09	15.59-18.42
	Rhizome	0.2	5.49
Palm oil	Palm bunch	0.32-0.428	7.24-17.86
	Palm fiber	0.147-0.19	11.4-17.62
	Palm shell	0.049	16.9-18.46
	Bunch stalk	No data	9.83
	Empty bunch	0.32	7.24-16.33
Coconut	Coconut meal	0.362	16.23
	Coconut shell	0.16	17.93
	Coconut bunch	No data	15.40
	Stalk	0.24	16.00
Corn	Cob	0.82	9.62-18.04
	Trunk	No data	9.83
Peanut	Shell pellets	No data	12.66
Cotton	Rind	No data	14.49
Soybean	Trunk	No data	19.44
Millet	Trunk and leaf	No data	19.23
Lumber	Trunk and leaf	No data	14.98
Rubber	Branch	No data	6.57
	Sawdust	No data	6.57
	Slab	No data	6.57

Type	Residues	Energy Generation Rate	Heat Value (MJ/Kg)
Eucalyptus	Root Rind	No data No data	4.92

Source: National Energy Policy Committee Office, 2002; Department of Renewable and Preservative Energy, Energy Ministry, 2002**.**

2.2.2) A Number of Biomass Power Plant Tendency

There are 135 plants of biomass power plant in Thailand, located in the north 1 plant, in the central 34 plants, in the northeast 44 plants, in the east 14 plants, in the west 14 plants, and in the south 28 plants. (Energy Plan and Policy Office, 2013) Each plant located in each region has used the kind of biomass source for power generating differently which depend on its quantity. For example in the central, the northeast and the north region, its resource is rice husk and lumber, and in the south region, its most resource is palm bunch. Rice husk is the most kind of source for power generating, the minor ones are lumber, and palm bunch orderly (table 2-3).

Table2-3: A Number of Biomass Plants in Each Region (February, 2013)

Region	Capacity less than 10 MW	Capacity greater than 10 MW	Total
North	1	-	1
Northeast	26	18	44
Central	20	14	34
South	25	3	28
East	4	10	14
West	5	9	14
Total	81	54	135

Source: Energy Plan and Policy Office, 2013

2.3 Process of Biomass Power Plant

In Thailand, there are 4 technologies for biomass power plant namely:

1. Direct-fired technology
2. Co-Firing technology
3. Gasification technology
4. Pyrolysis technology

1) Direct-fired technology; It is the most famous one. The technology for the conversion of biomass for electricity generating fuel by combusting in the boiler and transfer the extreme heat and high pressure to the steam which connected to electricity generator.

While the electricity is produced, the heat from the steam is also produced which it is called that the steam and electricity are cogenerated technology. Which is high efficient for rice mill, saw industry, sugar production industry, and dehydrated agricultural production and wood drying industry. However the direct-fired technology for electricity generation plant must be more than 5 MW which is proper for investing, since the high cost of steam turbine and air pollution prevention included.

2) Co-Firing technology; it is cogenerated technology between biomass and coal for electricity generation.

3) Gasification technology; it converts biomass-solid to gas or synthesis gas (syngas) in the combustion section of gasifier. The incompletely combustion, carbon monoxide, hydrogen, and methane gas produced, is occurred by oxygen controller. Thus gases are induced heat directly or used to operate electricity generator. Gasification technology is proper for small scale of electricity generating (not exceeding 1 MW). It is not popular usage technology since the tar clean-up corrodes the equipment.

4) Pyrolysis technology; it is similar to gasification technology. Its operation started by dehydrating biomass fuel then cracking its chemical bond by high temperature, various gases are produced such as carbon dioxide, carbon monoxide, methane, and hydrogen, including water, acetic acid, formic acetone acid, tar, and char. Tar and char are gas-production which is the final stage of gasification process. (Department of Renewable and Preservative Energy, 2009)

Phrases of biomass power plant operation and its health hazard;

Plant Construction phrase

It is similar to general construction preparation. Construction is base adjustment, water reservoir preparation for electricity generating. The material, machines, and man-power transportation, worker-resident building, foundation construction, machinery equip, utility system all are prepared.

Operation phrase

The electricity production from biomass is similar to heat power. The raw material is burned to be heat power and the heat power is used for steam condensing. Then, the steam generates electricity. The involving systems of electricity operation are biomass fuel combustion, and steam turbine as shown in figure 2-1. The details of operation are;

1) Raw material purchase and transportation; the owner usually sign agreement to purchase the raw material from the submit seller. Some bought from others. The raw material are transported and stored at the plant. The raw material transportation rate depends on the amount of raw material of each season, in the rice harvest season, for example, the husk transportation rate is higher.

2) Fuel preparation prior to electricity and steam turbine generation process; the volume of biomass fuel properly preparation is necessary for steam turbine combustion section, except bagasse and rice husk which are able promptly used.

3) Fuel transporting to combustion section of boiler; biomass fuel used for electricity generation are both of main fuel and supplement fuel which is delivered by conveyor belt, and feed to the combustion section by tractor.

4) Combustion system in boiler; the fuel is ignited to the required temperature in the combustion chamber. There are various combustion systems depending on the kind of the structure of combustion chamber which depends on the type and efficiency of fuel.
For ash in ash zone will fall to the bottom of furnace, called as bottom ash, be cleaned-up and its temperature be reduced by conveyor to the tub. For the fly ash will be trapped by dust collector before emission.

5) Steam Turbine and Generator; the qualified raw water is boiled in the boiler by using biomass as fuel until be steam, the condensed steam in condensing turbine generates electricity. The steam from condensing turbine is recondensed in condenser and its temperature is reduced in cooling tower, then it is reused.

6) Electricity Transformer; the partly electricity from generator will be stepped down to be used in the electricity generating plant by the step-down transformer, for the remained power will be stepped up by the step-up transformer in order to sell to the Electricity Generating Authority of Thailand.

7) Cooling Tower; the cooling tower of electricity generating plant is close system composing of condenser and cooling tower. The condenser condenses steam from steam turbine by heat exchanging. The temperature of coolant from cooling tower will

be reduced before being reused. However, the blow-down water is necessary to be released and the make-up water is necessary to reproduced since the concentration of water in the cooling tower is increased due to partly evaporated coolant.

8) Raw water preparation and water treatment; electricity generating operation needs the high volume of water. 120 cubic meter of water is needed for 1 MW electricity generating. (National Energy Policy Committee Office, 2000) Raw water using in the electricity generating plant is usually from groundwater or rain water. Its reservoir has adequately water for whole year production. The raw water needs to be treated by coagulating, filtering before used in the boiler. For this stage the coagulant, regeneration substance, slag prevention substance, and algae control substance are needed.

9) Ash transportation; Ash 1-3 % approximately is produced from biomass electricity generating, 10-20% approximately is produced from rice husk and straw electricity generating. The challenge problem from biomass electricity generating is daily high amount of ash and treatment. The ash is stored in the storage and is transported to the purchaser.

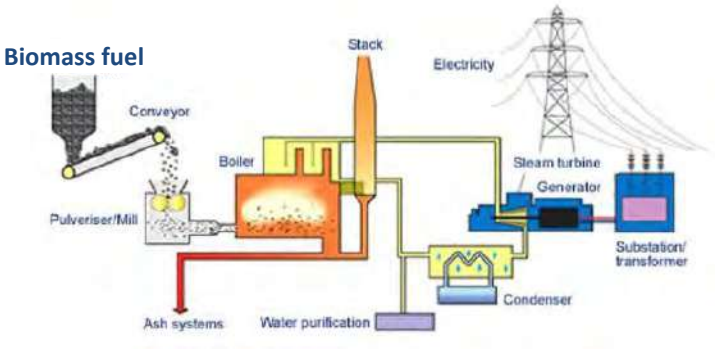


Figure 2-1 Direct-fire Technology

2.4 Pollutants of Each Biomass

Biomass energy generating emits particulates and fume which consist of various toxic chemicals such as Polycyclic Aromatic Hydrocarbon (PAHs) and volatile organics. For the kind of sources composed of carbon enable generate carbon dioxide gas, for the kind of sources composed of sulfur enable generate sulfur dioxide gas, and for the kind of sources composed of nitrogen enable generate nitrogen dioxide gas. Bagasse as the source of energy is the most carbon composition comparing to the other sources. Palm fiber and rice husk are the minor. It is the cause of combustion and fly ash occurrence.

Comparing the number of fly ash from rice husk, bagasse, and palm fiber, the most is from bagasse (53.8 mg/gm of fuel). Since bagasse has the amount of volatile organics more than others. For fine particulates (dp<1.1 micron), it is also mostly found in bagasse (44.92 mg/gram of fuel), the minor found in palm fiber (28.0 mg/gram of fuel), and in rice husk (17.6 mg/gram of fuel) orderly. For coarse particulates (dp>1.1

micron), it is also mostly found in bagasse (8.84 mg/gram of fuel), the minor found in rice husk (8.28 mg/gram of fuel), and in palm fiber (7.93 mg/gram of fuel) orderly. For particulates 0.07-0.43 micron size, it is mostly found in bagasse (14.28 mg/gram of fuel), palm fiber (10.53 mg/gram of fuel), and rice husk (6.73 mg/gram of fuel) minor found orderly (Patraporn Sae Teaw and others, 2012) as shown in table 2-4.

Table 2-4: The Composition of Fuel

Composition	Type of Fuel		
	Bagasse	**Palm fiber**	**Rice husk**
ash (% dried weight)	18.9	7.9	18.4
Moisture value (% wet weight)	3.4	8.8	10.1
Volatile organics (% dried weight)	65.6	59.2	54.2
Fly ash (milligram of particulate/gram of fuel)	53.8	36.0	25.9
Fine particulate(dp<1.1 micron)	44.92	28.0	17.6
Coarse particulate(dp>1.1micron)	8.84	7.93	8.28
particulate 0.07-0.43 micron size	14.28	10.53	6.73
Carbon (% dried weight)	41.6	39.4	33.8
Hydrogen (% dried weight)	3.4	3.4	3.5
Nitrogen (% dried weight)	1.1	0.3	0.4
Sulfur (% dried weight)	0.1	0.0	0.0

2.5 Pollutants and Health Impacts

Pollutants and health impacts from biomass power plant both in Thailand and from other countries' study are as following:

1. Air pollution
    - particulates (TSP, PM_{10}, $PM_{2.5}$)
    - Nitrogen oxide (NOx)

- Sulfur dioxide (SO_2)
- Carbon monoxide (CO)
- Ozone (O_3)

2. Noise pollution
3. Accidents and traffic
4. Stress and nuisance
5. Water pollution and water shortage
6. Solid waste and hazardous waste

2.5.1 Particulates

The amount of particulates emitted from biomass combustion varies on operating control. It affects the community and environmental health. The most size of particulates emitted from combustion is smaller than 2.5 micron ($PM_{2.5}$) and smaller than 10 micron (PM_{10}) which enable inhaled through lung and lung alveoli. Biomass electricity emits particulates size 30- 80 milligram/kilowatts electricity which is not as much as emitted from coal source electricity generating which emits more than 1,000 mg/kW electricity (National research council, 2009). In big cities, we found that the particulate matter effects not only visibility but also equipment and household cleanliness. Particulate matter is harmful to respiratory system. The efficiency of lung function is decreased. The patients of respiratory and cardiovascular disease admitted increase. The respiratory disease morbidity is increased which be analyzed from the absenteeism from work and school statistics. And the statistics of cardiopulmonary disease mortality is higher. (Bates &Raizenne, 1995) (WHO, 2006)

2.5.2 Sulfur dioxide (SO_2)

The amount of pollutants emitted from biomass power plant varies on the type of fuel and technology. Biomass power plant emits rarely sulfur dioxide since plantation composing of the little sulfur. It emits 40-490 mg/KW. Sulfur dioxide is a colorless and pungent gas. Sulfur dioxide reacts with water to give sulfuric acid which is high corrosion. Sulfur dioxide is harmful to all system of health. It enable penetrate to the respiratory system, decrease the efficiency of cilia movement and decrease the efficiency of particulate mitigation in the respiratory system as consequence. Acute and chronic disease is the consequence of sulfur dioxide effect. (WHO, 2006; Public Health College, Chulalongkorn University, 2001)

Acute effect

- Nasal, bronchia, eyes, skin allergies. Obstruct breathing, cough, and increase phlegm.
- Urticaria, rash.

Chronic effect

- Upper respiratory infection
- Loss of odor and taste
- Pulmonary edema and pulmonary infection
- Chronic bronchitis and pulmonary fibrosis
- Systolic blood pressure related to particulate matter mixed sulfur dioxide
- Sulfur dioxide is more harmful when it is mixed with other pollutants such as particulate matter causing COPD, nitrogen dioxide causing increase respiratory morbidity and absenteeism for work or school, ozone, sulfate, < 10

micron particulates, and acid aerosol decrease efficiency of lung function, acid aerosol

2.5.3 Oxide of Nitrogen (NOx)

Oxide of nitrogen is as major toxic gas polluting from this industry. The production of oxide of nitrogen from biomass fuel is not different from last century fossil fuel. The amount of NOx is 290-820 mg/electricity MW which depends on the quantity of nitrogen of each kind of plantation source for fuel, and the temperature of combustion. Higher temperature produces higher amount of oxide of nitrogen (National research council, 2009).

There are various kinds of oxide of nitrogen contaminated in the atmosphere. They are Nitrous oxide (N_2O), Nitric oxide (NO), dinitrogen oxide (N_2O_3), nitrogen dioxide (NO_2), dinitrogen trioxide (N_2O_2), dinitrogen tetra oxide (N_2O_4), and dinitrogen pend oxide (N_2O_5) (Mulpruek Patana,1997). NO and NO_2 are most found. These gases react to water give nitric acid which irritates the respiratory system. The health effect is as following; (WHO, 2006)

Acute effect

- Irritate and increase breathing resistance which causes coughing, angina, and bronchitis
- Aggravation of asthma
- Bronchitis

Chronic effect

- Chronic diseases such as headache, sleepy, nausea, tired, constipation, oral and throat mucous infection
- Bronchitis or pulmonary edema

2.5.4 Nitrogen dioxide (NO_2)

Nitrogen dioxide is from the reaction of nitric oxide which is mainly from combustion. Nitrogen dioxide is unstable gas and changed to ozone when exposed sunlight. The level of concentration in the ambient is not harmful to health. Even found in laboratory that the high concentration irritates respiratory tract and increase allergens affect allergenic patient, increase reaction of respiratory tract, and associated to mortality. Hospitalization of respiratory disease and pro-long nitrogen gas exposure affect the pulmonary function both in children and adults, was reported. But such health effect might be from exposing mixed gases, not from single nitrogen gas, since nitrogen dioxide exposure is unable to study separately. The important role of nitrogen dioxide is it is the main component of the secondary toxic pollutant production and it enhances other pollutants more health affecting (WHO, 2006).

2.5.5 Ozone (O_3)

Ozone is from the reaction of hydro carbon component substance and oxide of nitrogen with the sunlight stimulant. The high level of ozone is found in the area where is far from the source such as the country side. The level of ozone concentration varies on day time and season. In the afternoon of summer, the high level of ozone is found. The ambient value guideline from World Health Organization is not exceeded 120 microgram/cubic meter or 60 PPB (WHO, 2006).

Ozone affects both of acute and chronic health effects. It can cause acute death in all age groups. Every 10 microgram/cubic

meter or 5 ppb increasing level can cause higher risk of respiratory mortality (0.2-0.6 %). Every 5 microgram/cubic meter or 5 ppb increasing level can cause higher hospitalization rate of respiratory disease (0.5-0.7 %). It is found that in the high level of ozone concentration period, the asthma medication in children was increasingly used. In addition, the decreasing efficiency of lung function is negative impact from ozone. The long term effect of ozone is decreasing efficiency of lung function, respiratory and pulmonary tract irritation. Increasing of asthma in children and adults, lung cancer morbidity and mortality has been remarkably considering.

2.5.6 Carbon monoxide (CO)

Carbon monoxide is from incomplete combustion. The amount of carbon monoxide depends on the efficiency of combustion technology. It is colorless, odorless, and tasteless. The human sensory is unable to detect. Its detector is scientific equipment.

Carbon monoxide decreases the amount of oxygen in the body. The oxygen shortage of affected organs especially heart, brain occur. Large amounts of CO can overcome in minutes.

Loss of consciousness, fatigue, and foot and hand weakness, and heart attack morbidity increasing are health effect from carbon monoxide (WHO, 2003).

2.5.7 Polycyclic aromatic hydrocarbon (PAHs)

Polycyclic aromatic hydrocarbon (PAHs) is benzene ring chemical group (2-6 rings) which is composed of hydrogen and hydro carbon. Polycyclic aromatic hydrocarbon (PAHs) is from

incomplete combustion of organic matters. Its toxic causes cancer. It is main challenge of environmental health.

2.5.8 Noise pollution

Noise pollution is mainly from machinery operation, some from fuel transportation. The nuisance and loss of hearing are consequences from noise pollution. The nuisance affect happening in the night time and the hearing loss happening in the excessive noise pollution area or prolong continuity exposure. Noise level (24 hours (Leq) at the public area shall not exceed 70 dB(A), for the day-night time, USEPA has suggested 55 dB(A). (Energy for Environment Foundation, 1996)

2.5.9 Accident and Traffic

Biomass fuel transportation affects increasing of vehicles around the plant's area. The traffic, road damaged, and road accident are consequences. In addition, the people living nearby the plant might be affected from the plant's accident.

2.5.10 Stress and Nuisance

The people living nearby the plant might be anxious on the impact from the plant. They might feel annoyed from the wastewater, odor, and air pollution (gas and particulates) from the operating. Moreover, they feel unsafe and anxious on health impact from the operating.

2.5.11 Wastewater and Water Shortage

Biomass electricity generation consumes the number of water as same as the electricity generation from fossil fuel. It uses for the temperature of system reduction by 60-140 gallons/MW once through for cooling tower, 4-800 gallons/MW once through for cooling pond. (National research council, 2009)

The shortage of water consumption affects the community and nearby agricultural activities. Moreover, wastewater from operating pollutes water resource. The high temperature of wastewater's outlet affects the ecological system.

2.5.12 Solid waste and Hazardous Waste

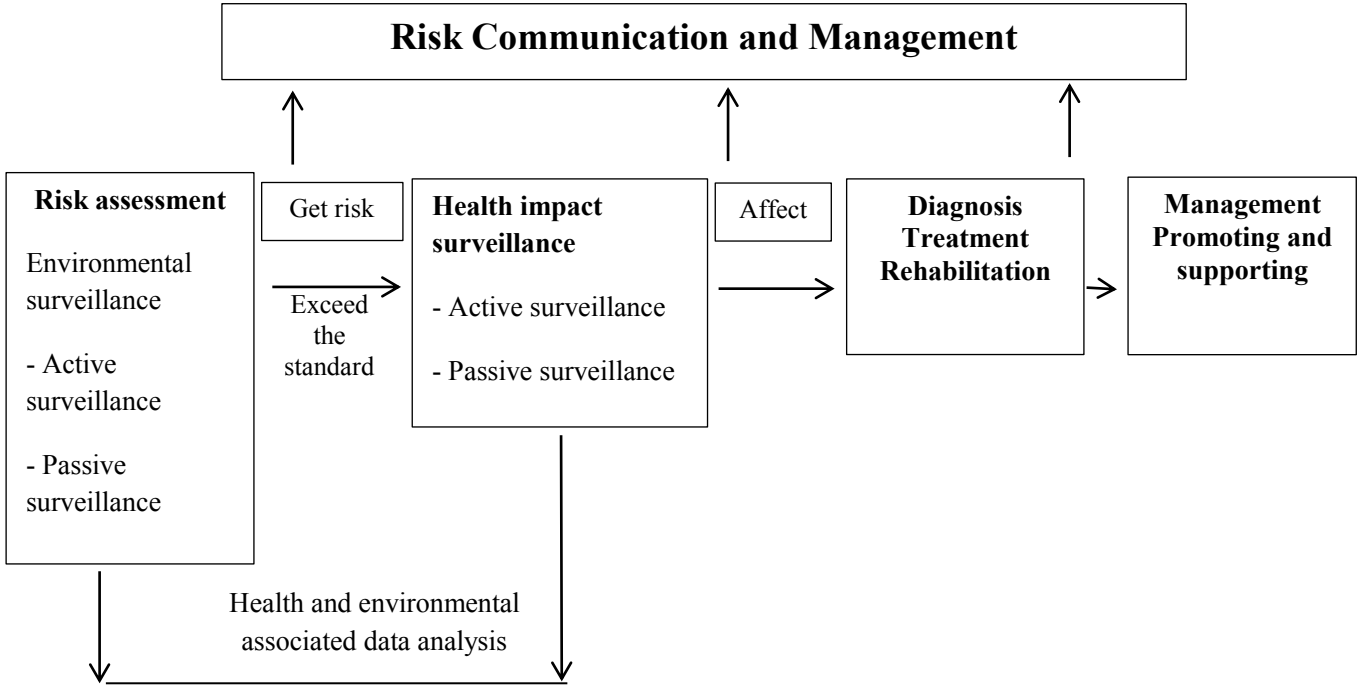
The number of solid waste and ash from the plant which might contain heavy metal must be treated in order to prevent community impacts. Water resource and ground water might be contaminated from the leachate of hazardous waste. The toxicants from waste which composed of volatile organics might affect the quality of ambient air. Dirtiness and sight pollution are the effect of the huge of garbage. (Mulpruek Patana,1997)

Chapter 3
Environmental Surveillance

Health impact surveillance on biomass power plant started with consideration of pollutants or health hazard which pollutes the water, air and soil. Since people living in the surrounding area might expose the pollutants. Then the framework of environmental indicators is defined for monitoring the environmental pollution. The primary data, got from environmental monitoring, and the secondary data, got from the other sources, are analyzed to assess and report the health impact in case of the pollutants are exceeded the standard to the public and the relevant agencies so that the worse situation has to be properly managed.

The continuity of health impact surveillance after public communication on such situation has to be conducted by the public health official. The health impact surveillance can be done by passive surveillance or active surveillance. The passive surveillance is done by assessing the data of the related disease patients got service in the health care center. The active surveillance involves searching the related disease patients or the risk group in order to get more relevant disease morbidity. Both types of surveillance are the burden of the public health official including detecting, treating, and rehabilitating of the related disease patients (as shown in figure 3-1).

Figure 3-1: The flow chart of health impact surveillance



Surveillance Process

1**. Data collection**: identify the related environmental and threatening factors, and related diseases and symptoms data and collect them.

2. **Data analysis**: statistically analyze and assess the data and forecast the situation by means of the mathematical model so that the results covering contaminated environment, prevalence and tendency of related disease, could be shown.

3. **Data dissemination**: the assessed data is disseminated to the relevant agencies including the policy maker and/or the public.

4. **Resolution**: the assessed data is further utilized for the problem solving, associated policy and projects developing.

However, the evaluation of surveillance process is importance, the first and following steps of the process might be redone in order to improve the prevention and/or the mitigation of problem.

Environmental surveillance is systematic and continuously conducted composing data analysis, interpretation, dissemination to the stakeholders, and mitigation and prevention. The environmental surveillance covers the environmental monitoring data or the biological monitoring data including the data from searching, screening. The air pollution, water pollution, and food chain indicators which have to be analyzed for the environmental surveillance of biomass power plant are shown in table 3-1. The identification of contaminated area has to be the first step. In case

of pollutants are found, the environmental surveillance has to be further conducted.

The public health practitioner should collect the environmental data around the plant within 1 km. distance at least in order to be baseline data for environmental and health impact assessment.

3.1 Source of Data

The Secondary data

The public health practitioner cooperate the authorizing agencies (Energy Regulatory Commission of Thailand, Regional Energy Regulatory Commission) and the relevant agencies such as Provincial Industrial Office, Regional Environmental Office, Natural Resources and Environment Office. The environmental monitoring data has been reported every 6 months by the biomass power plant sizing up to 10 MW. The report has been proposed to the authorizing and relevant agencies. The parameters are identified as shown in the environmental impact assessment such as TSP, PM_{10}, SO_2, NO_2, O_3, CO, noise nuisance, wastewater quality including pH, BOD, COD, color, odor, TSP, and TDS.

The primary data

The biomass power plant sizing smaller than 10 MW is unnecessary to report the environmental monitoring data every 6 months as identified in regulation. Therefore, the public health official should monitor the environment around the workplace so that the monitoring data is useful for surveillance. The significant parameters have to be monitored are TSP, PM_{10}, SO_2, NO_2, O_3,

CO, ambient sound level (Leq 24 hr, Lmax), noise nuisance, wastewater outlet quality including pH, TDS, TSP,BOD, COD, color, and turbidity.

3.2 Area Identification

Since the air pollutants are the dominant pollutants from the biomass power plant. Therefore, the identified area for assessing the community health impact is beneath the wind direction area which is the most risk area. Besides air pollution, water pollution and noise pollution are also important to monitor. Noise pollution is from machinery cleanliness, water pollution is from the water cleansing the pile of fuel and ash through the water resource or the agricultural area.

3.3 Parameters and Instruments

Environmental quality and monitoring indicators of the biomass power plant which the owner has to report twice a year to the authorizing and relevant agencies are shown in table 3-1 and figure 3-2.

Table 3-1: Sample collection and analysis

Environmental quality	Indicators	Sampling equipment	Samplings method and Analysis
Air quality	Total Suspended particulate (TSP)	High Volume Sample	Use the high volume sampler gravimetric collect the air sample through the glass fiber filter at 55-60 cubic foot flow rate for 24 hours. And calculate the different weight (mg/m)

Environmental quality	Indicators	Sampling equipment	Samplings method and Analysis
			of filter before and after sampling by gravimetric method.
	PM_{10}	PM-10 High Volume Sample	Use the Vacuum Pump Hi-Volume sampler to collect the air sample through the quartz filter 8x10 inch size selective at 40 cubic foot flow rate for 24 hours. The bigger than 10 micron particulate size is trapped and the smaller one is collected through the filter. And calculate the weight (mg/m) of smaller than 10 micron particulates weight in the laboratory by gravimetric method.
	$PM_{2.5}$		Deposit the particulate sample 10 and 2.5 micron size by Thermo Scientific Model Partisol-FRM 2000. The air sample is sucked through the inlet of the instrument which trapping only 10 micron size of particulate. Then, the sample will thoroughly flow through the WINS impactor to select bigger than 2.5 micron particulate. The smaller 2.5 micron particulate will be

Environmental quality	Indicators	Sampling equipment	Samplings method and Analysis
			deposited on the Polytetrafluoroethylene (PTFE) filter for 24 hours. Then, the smaller 2.5 micron particulate sample is calculated the weight (mg/m) in the laboratory by gravimetric method.
	Nitrogen dioxide (NO_2)	Chemiluminescence	Chemiluninescence Method is the method for nitrogen dioxide gas collecting and analysis by NOx Chemiluminescence analyzer. It is automatic measurement. Nitrogen oxide will oxidize to Nitrogen dioxide in the presence of ozone. This reaction produces a quantity of light at 600 nanometer of wave length which can be measured (ppm) for every hour.
	Sulfur oxide (SO_2)	SO_2 Analyzer	UV-fluorescence Method is the method for sulfur dioxide gas collecting and analysis by SO UV-Fluorescence analyzer. It is automatic measurement. Ultraviolet reacts sulfur dioxide gas in the photomultiplier

Environmental quality	Indicators	Sampling equipment	Samplings method and Analysis
			tube connected electronic cycle and the reaction produces a quantity of light which can be measured ppm average for every hour.
	Carbon monoxide (CO)	CO Analyzer	Carbon monoxide is detected by CO Non Dispersive Infrared Analyzer. It is automatic measurement. Infrared ray is absorbed and measured ppm average for every hour.
Ambient sound	Disturbed level	Integrated Sound Level Meter (Leq, L90)	Background sound level (L90), Leq 5 min, and disturbed level, Leq 5 min, are measured. The methodology is declared in the Industrial Work Department's regulation (year 2010).
	Sound level 24 hour	Integrated Sound Level (Leq,Lmax, L5,L10, L50,L90)	Sound level is measured dB(A) by Integrated Sound Level Meter at Leq 1 hr, Leq 24 hr, and recorded for 24 hours continuity.

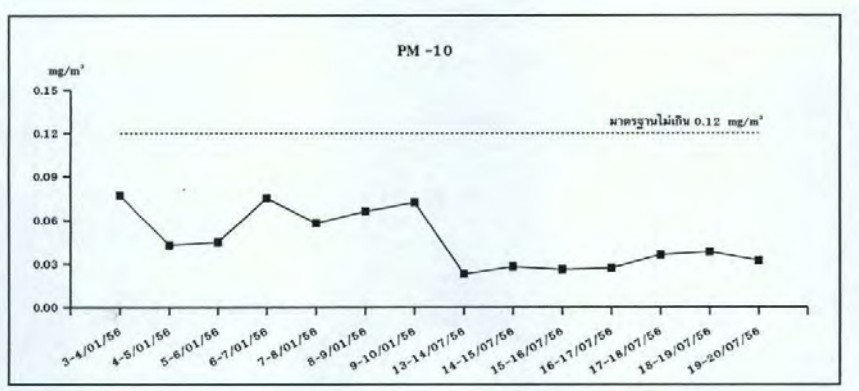


Figure 3-2: Demonstration of the Amount of PM_{10} Measurement at Baan-Samed school, Surin Province.

Source: Report of Prevention and Mitigation for Environmental Impact (January – June 2013) from Biomass Power Plant 17 MW Project located in Surin province, Mung Charoen Biomass Company (limited)

Chapter 4
Health Surveillance

Health Surveillance is the system of continuous observation, collection, analysis, and interpretation of health–related morbidity and mortality, and significant data from biomass electricity generation for disseminate to the involving groups. There are 2 types of health surveillance.

1) Passive surveillance: it is a collection of health–related data or problem which might be affected from the biomass power plant such as asthma, allergy, upper respiratory infection, chronic bronchitis, dermatitis, allergic rash, ascariasis, heart failure, cardiovascular disease, etc.

2) Active surveillance: it is continuous searching, collecting, and monitoring the health–related data or problem which might be affected from the biomass electricity operation. Such data is probably complete such as environment and health related data, particulate exposure data etc.

4.1 The preparation of health surveillance

- **Personnel capacity development**: it is the important step for health surveillance preparation. The public health practitioners including district, sub-district level and public health volunteers' capacity is developed regarding health impact from biomass electricity operating, pollutants, and health threat issue. Besides such target groups, the local administration officials, involving agencies, and the people living nearby the plant should be given

such issues. So that the cooperative reduction and prevention of health impact from the operation takes place.

- **Processing**: the local public health practitioner provide the personnel who have experiences on management of the health impact from other area to share their knowledge and experience.

4.2 Community map/risk map

- **Community map** is a tool for identify other pollution sources and risk group around the electricity plant and its management.

- **Processing**: community walk done by sub-district health promotion hospital's official or public health volunteer.

- identify the biomass power plant location.
- identify the other workplace within 1 km. distance where emit pollution such as department store, landfill, market, rice mill etc.
- identify the households around the plant.
- identify the village water supply, surface water resource, waterway, road, health center, school, temple, and hospital etc. (as shown in figure 4-1).

Figure 4-1: Community map

4.3 Health Status Management

To continuously collect and assess the health impact-related data of the people living nearby the biomass power plant and compare to the country health status. The significant indicators of assessment are as shown in table 4-1, the health impact-related morbidity as shown in table 4-2 and 4-3.

Table 4-1: Health Surveillance Plan

Activity	Indicator		Target group/area	Analysis method	Frequency	Data source
	Disease	ICD-CODE				
Health status collection	Asthma	J45 J46	-community surrounding workplace	-3 years retrospective analysis -sub-district and village morbidity analysis comparing to the province's, country's statistics	yearly	Hospital/sub-district health promotion hospital
	Allergy	J30 J302 J303 J304				
	Upper respiratory infection	J00 J01 J05 J06				
	Chronic Obstructive	J44				

Activity	Indicator		Target group/area	Analysis method	Frequency	Data source
	Disease	ICD-CODE				
	Pulmonary Disease (COPD)			- forecast the incidence and prevalence rate of the diseases.		
	Chronic bronchitis	J40 J41 J42				
	Dermatitis Itching rash Allergic rash	L029 L309 L24 L248 L249 R21				
	Ascariasis	H10 H101 H102 H103 H109				
	Heart failure Cardiovascular diseases	I50 I200 I201 I208 I209 I211 I212 I213 I214 I219 I24 I249 I252 I259				

Table 4-2: The sample of incidence of particulates caused disease in the area of sub-district health promotion hospital, year 2010 (by monthly).

Disease	Jan.	Feb.	Mar.	Apr.	May	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.
Dermatitis from allergy (case)	50	59	59	58	58	60	61	50	59	61	60	65
Respiratory infection (case) rate/100,000 populations	51	54	60	63	61	71	79	64	67	77	78	88
Acute ascariasis (case) rate/100,000 populations	116	127	96	121	111	136	132	102	101	131	126	106

Table 4-3: The sample of incidence of particulates caused disease in the area of sub-district health promotion hospital, year 2010-2013.

Disease/symptom	2009	2010	2011	2012	2013
Dermatitis from allergy (case) rate/100,000 populations	204 6,800	484 16,133	700 23,333	1,222 40,733	803 26,766
Respiratory infection (case) rate/100,000 populations	604 20,133	606 20,200	813 27,100	996 33,200	853 2,843
Nasal mucous and throat infection (case) rate/100,000 populations	1,278 42,600	1,368 45,600	1,505 5,013	588 19,600	883 29,400
Acute ascariasis (case) rate/100,000 populations	146 4,866	221 7,366	674 2,246	693 23,100	597 19,900

4.4 Health Risk Check-up The air pollution is the dominant pollutant of biomass power plant. The vulnerable or risk group (children, elderly, asthma, cardiac patients) taken the pollutant might be seriously sick. Therefore, surrounding people health check-up is necessary (as shown in table 4-4).

Table 4-4: Health-Risk Examination Plan

Activity	Data/Indicator	Target group/ area	Analysis method	Frequency	Data source
Health examination	Yearly health status	- workers	- case/percentage of pulmonary dysfunction patient - tendency analysis by yearly comparison	yearly	Provincial labor office
	Pulmonary function test such as FVC,FEV_1, FEV_1/FVC,PEFR, $FEF_{0.1\text{-}1.2}$, $FEF_{25\text{-}75\%}$)				
	Chest x-ray				
	-yearly health check-up - pulmonary function test such as PEFR	- The vulnerable or risk group (children, elderly, asthma, cardiac patients)	- case/percentage of pulmonary dysfunction patient - tendency analysis by yearly comparison – tendency analysis of children pulmonary function comparing to other different pollution situation area	yearly	Provincial public health official

*Remarks: FVC= Forced Vital Capacity is the volume of gas that be exhaled from fully inhalation by exhaling as forcefully and rapidly as possible (ml/l).

FEV_1= Forced Expiratory Volume in 1 sec is the volume of gas that be exhaled in the first second of a forced exhalation.

FEV_1/ FVC ratio is the ratio of forced expiratory volume in the first second to forced vital capacity. The FVC ratio is the indicator for obstructive respiratory tract.

$FEF_{25-75\%}$= Mean Forced Expiratory Flow during the middle half of FVC (ml/sec or l/min)

PEFR = Peak Flow Rate is the maximum flow rate of exhalation (ml/sec or l/min).

Chapter 5
Risk Management and Risk Communication

Risk communication is conducted after environmental and yearly health surveillance data collection. It is benefit for the public. The detail of risk communication is the particulates pollution quantity, the health effect, and health prevention and mitigation (as shown in table 5-1). In case of high tendency of pulmonary dysfunction morbidity found, the surveillance has to be seriously taken by the workplace owner, involving agencies.

Table 5-1: Risk Communication of Particle Pollution (USEPA)

PM_{10} concentration ($mg./m^3$)	**Health impacts**	**Prevention measurement**
exceed 420 351-420	• upper respiratory system(cough, difficult exhalation) • ascariasis • chest pain, headache, arrhythmia, fatigue • nausea, dizziness, unclear of sight • pneumonia, asthma, Chronic Obstructive Pulmonary Disease (COPD) • pregnant who getting risk of low birth weight • heart attack, lung cancer • death	1. contemporary avoiding rain water consumption 2. closing windows and doors of building to prevent fume or haze 3. avoiding outdoor exercise 4. for the risk group, keep indoor staying 5. in case of outdoor activity, particulate protection is necessary 6. in case of arrhythmia, nausea and fatigue, consulting physician is necessary
121-350	• Upper respiratory tract symptom (cough, difficult exhalation) • conjunctivitis • nausea, chest pain, headache • arrhythmia, fatigue	1. for the risk group, avoiding outdoor activity 2. in case of outdoor activity, particulate protection is necessary 3. for allergy, behave of physician suggestion 4. in case of arrhythmia, nausea and fatigue, consulting physician is necessary

41-120	• Upper respiratory tract symptom (cough, difficult exhalation) • Eye irritation	1. closely situation follow up 2. outdoor burning is prohibit to reduce the amount of particulates 3. for the risk group, decreasing exercise duration 4. well medication preparation for respiratory tract disease patient
0-40	none	none

The air quality index evaluation of ambient covering ozone 1 hour average, nitrogen oxide 1 hour average, carbon monoxide 8 hours average, sulfur dioxide 24 hours average, and PM_{10} 24 hour average comparing with the national air quality data from air quality index (Air Quality Index: AQI) should be informed to the public. Thailand AQI is categorized 5 levels, 5 colors by the range of air quality condition, level of health concern as shown table 5-2

Table5-2: Air Quality Index of Thailand

AQI	Air quality condition	Color	Health concern level
0-50	Good	blue	Not affect
51-100	Moderate	green	Not affect
101-200	Unhealthy	yellow	For respiratory tract patient, avoiding outdoor exercise. For children, elderly, avoiding long time outdoor activity
201-300	Very unhealthy	orange	For respiratory tract patient, avoiding outdoor exercise. For children, elderly, avoiding outdoor activity
>300	Hazardous	red	Avoiding outdoor activity. For respiratory tract patient, keeping indoor staying

Air quality index calculation

$$Ii = \frac{I_{ij+1}-I_{ij}}{X_{ij+1}-X_{ij}} - (X_i-X_{ij})+I_{ij}$$

X_i = air pollutant concentration from air sampling measurement

X_{ij} = minimum value of air quality concentration range of Xi

X_{ij+1} = maximum value of air quality concentration range of Xi

I_i = air quality index

I_{ij} = minimum value of each air index quality range of Ii

AQI = Air Quality Index

There are 2 types of air particulate. They are ambient particulate and particulate reacting with liquid or solid in the ambient.

Sources of particulate distribution are from nature such as soil, sand, forest fire and from human activity such as traffic, transportation, construction, and industry.

Health impacts:

- Coarse particulate cause nuisance, dirtiness of clothes, house, and/or eye irritation.

- Smaller than 10 micron particulate (smaller than hair diameter 5-20 times) affect the respiratory tract such as pulmonary irritation, pulmonary trauma, pulmonary dysfunction, bronchitis, asthma.

The prevention of air particulate for public:

- closing windows and doors of building to prevent fume or haze
- To clean house, car, and office. Avoid bad air quality place.
- Put disposable mask up
- Air purification device installation if necessary.
- Contemporary avoiding rain water consumption
- For long term, cover planting on the space is able to reduce ambient particulate diffusion

Personal particulate prevention suggestion for respiratory tract patient such as cardiovascular, hypertension, respiratory disease, allergy, and asthma

- Personal medicine promptly preparation for emergency
- Avoid outdoor exercise
- Personal face mask is necessary for outdoor staying
- Immediately consult physician or health center in case of emergency respiratory tract sickness such as difficult exhalation, fatigue etc.

Chapter 6
Relevant Legislations

6.1 Relevant Legislations

Biomass electricity generating plant is categorized in the type 3 under the law “Industry Act, 1952”. It means that it must be approved before built up. For the operating, it involves several legislations which involving to several organizations (as shown Table 6-1).

Table 6-1: The Relevant Regulations Involving to Biomass Electricity Operating

Content	In-charge organization	Remark
1. Commercial registration	Department of Business Development, Ministry of Commerce	Application form is available and commercial registration is enable conducted via website www.dbd.go.th
2. Industry operation permission 2.1 in case of request to the Provincial Industry Office(PIO) - PIO corporates the Sub-district Administration Organization, inspects register building and reports - Public declaration after inspection - Energy Regulatory Commission (ERC) corporates the Industrial Work Department (IWD) to consider ERC approves	-The Provincial Industry Office -Department of Industrial Work, Ministry of Industry	- All capacity of biomass electricity operation - Industry Act, 1992 defines that for industry type 3 has been permitted from the authority and has to perform following the criteria, ensure the safety of workers and the public. - Industry ministerial order 2 (year 1992) defines the location of industry, internal building engineering, and pollution emission control. - For 5-10 MW capacity of biomass electricity operation, it has to attach the EIA Study when asking

Content	In-charge organization	Remark
		permission or industry expanding, as defined in Industry Ministry Announcement.
2.2 in case of request to the Energy Regulatory Commission Office (ERCO): - The ERCO corporate Industry ministry and ERC make decision on the permission.	The Energy Regulatory Commission Office	All capacity of biomass electricity operation have been defined in Energy Operation Act,1997 that - Section 47 defined that either business running or not, has to be permitted from ERC - Section 48 defines that for the energy business, has to perform following the industry regulation, the building control regulation, the city planning regulation, or the energy development and promotion. The ERC is the authority body who ask for the consideration of such various regulations. For smaller than 10 MW capacity which is unnecessary to study EIA,

Content	In-charge organization	Remark
		has to seriously perform following the Code of Practice: CoP which was announced in January 2013 by the ERC. The CoP has defined the construction preparation, construction, and business operation, including building demolition. In addition, the business owner has to report the environmental checklist to the ERC.
3. Construction permission: 3.1 In case of request to the Local Administration Office (LAO), the business owner has to propose the fulfilled construction permission application form (B1) to the LAO.	The Local Administration Office (LAO), Ministry of Interior	Section of The Building Control Act, 1979 has defined the criteria of construction, reconstruction or demolition to ensure the safety, security, disaster, public health, environment protection, city planning, architecture, and traffic facility which is under controlling of the local government agency.

Content	In-charge organization	Remark
3.2 In case of under the Industrial Real Estate Authority (IREA) area, the business owner has to propose the fulfilled construction permission application form to the IREA.	The Industrial Real Estate Authority	
4. Electricity sell and electricity merchandise contract - The business owner proposes the electricity sell application form and electricity network linkage system to the Metropolitan Electricity Authority (MEA) or the Provincial Electricity Authority (PEA).	The EGAT, MEA, PEA	
Industry construction and Machine installation		
5. Electricity generation permission license: -The business owner proposes the generation permission to the ERCO. The ERCO grants the license after	The Department of Renewable Energy Development and Energy Reservation, Ministry of Energy The Electricity Regulation Commission Office (The license	

Content	In-charge organization	Remark
investigating the electricity system and security prevention	permission application form is PK1.	
6. Electricity merchandise permission license: - The business owner proposes the electricity permission license fulfilled application form to the ERCO. - The ERCO grants the license which the owner has to pay the fee.	The Electricity Regulation Commission Office	
7. The MEA investigate and certify the system, signs the contract with the business owner. The MEA inform the starting date of purchasing.		
Remark: The projects which have to study EIA, EHIA	The Natural Resources and The Environmental Policy Office, Ministry of Natural resources and Environment	1. The biomass electricity generation up to 10 MW has to study EIA. 2. The biomass electricity generation up to 150 MW has to study EIA and EHIA.

Content	In-charge organization	Remark
In case of nuisance occurrence	The Local Administration Office	The Public Health Act 1992, announced that in case of nuisance occurrence including environmental threat to the nearby residents, the operation be harmful to the health such as odor, noise, heat, toxic, vibration, particulates etc.

6.2 Emission Control Standards

There is air pollution, waste water pollut ise pollution related to the biomass power plant as shown in the table 6-2.

Table 6-2: Emission Control Standards

Pollutants	Department of Pollution Control Ambient air pollution standard	World Health Organization (2005)
NO_2	- 1 hr. average not exceed 0.17 ppm - 1 yr. average not exceed 0.03 ppm	- 1 hr. average not exceed 200 ppm - 1 yr. average not exceed 40 ppm
SO_2	- 1 hr. average not exceed 0.30 ppm - 24 hr. average not exceed 0.12 ppm - 1 yr. average not exceed 0.04 ppm	- 10 min. average not exceed 500 ppm - 24 hr. average not exceed 20 ppm
O_3	- 1 hr. average not exceed 0.10 ppm - 8 hr. average not exceed 0.07 ppm	- 8 hr. average not exceed 100 ppm
CO	- 1 hr. average not exceed 30 ppm - 8 hr. average not exceed 9 ppm	-
PM_{10}	- 24 hr. average not exceed 0.12 µg./m^3 - 1 yr. average not exceed 0.05 µg./m^3	- 24 hr. average not exceed 50 ppm - 1 yr. average not exceed 20 ppm
$PM_{2.5}$	- 24 hr. average not exceed 0.05 µg./m^3 - 1 yr. average not exceed 0.025 µg./m^3	-24 hr. average not exceed 25 ppm -1 yr. average not exceed 10 ppm
TSP	- 24 hr. average not exceed 0.33 µg./m^3	-

Pollutants	Department of Pollution Control Ambient air pollution standard	World Health Organization (2005)
	- 1 yr. average not exceed 0.1 μg./m^3	
noise	- maximum level not exceed 115 dBA - 24 hr. average not exceed 70 dBA -different sound level between disturb level and normal level (L90) 10 dBA	- ambient noise standard 16 hr. average 50 LAeq intermediate disturb level 55 LAeq very disturb level

In addition, the Ministry of Industry has announced the emission pollutants standard year 2006 to control the amount of pollutants emitted from the chimney of industry as shown in the table 6-3

Table 6-3: The Emission Pollutants Standard from Stationary Source of Biomass Fuel Plant

Pollutants	amount	Measurement method
1.Total suspended Particulate	320 (mg/m^3)	Follow the Determination of Particulate Emissions from Stationary sources which defined by U.S. EPA or other equivalent method
2.Sulfur dioxide	60 ppm	Follow the Determination of Hydrogen Sulfuric, Carbonyl Sulfide and Carbon Disulfide Emissions from Stationary sources which defined by U.S. EPA or other equivalent method
3.Oxide of Nitrogen	60 ppm	Follow the Determination of Nitrogen Oxide Emissions from Stationary sources which defined by U.S. EPA or other equivalent method

6.3 How to use the community development fund for sustainable development of quality of life of the community nearby the plant

The cabinet has endorsed the guideline for the community development fund establishment which is for supporting the quality of community life nearby the electricity plant sustainably development since June19, 2007

The electricity generating plant has to share the budget to the fund which the sharing amount depending on the capacity of generation. During the constructing the plant, its amount is 50,000 Baht/MW/year or not less than 500,000 Baht/year. During operating, its rate varies on the type of fuel, for biomass type, its rate is 1 Satang/unit.

The administration committee of the fund composing:

1. The represents of public which are more than 50% of the committee
2. The represent of government who is appointed by the provincial governor.
3. The represent of the electricity generating plant
4. The qualified expert

The type of fund:

Type A is for the electricity generating plant which has capacity more than $5000x10^6$ KW-hr/year or get income more than $50 x10^6$ Baht/year, and covering controlled area 5 km.

Type B is for the electricity generating plant which has capacity not exceed $5000x10^6$ KW-hr/year or get income $1x10^6 – 5 x10^6$ Baht/year, and covering controlled area 3 km.

Type C is for the electricity generating plant which has capacity not exceed$100x10^6$ KW-hr/year or get income not exceed $1x10^6$ Baht/year, and covering controlled area 1 km.

The frame of expense of fund: the community is able to expense the fund for quality of life development, public health and environment development, and for community comprehensive planning.

The Role of Public Health Official:

The health promotion and disease prevention for the public in risk area project which is endorsed by the administration committee, is possibly occurred by supporting and encouraging by the roles of Public Health Official as following;

- To suggest and recommend on the conducting the public health involved project to the administration committee.
- To support and promote to use the budget of the fund for surveillance and prevention of health impact.
- To inform the information on the situation and tendency of the health of the people living nearby the power plant.

Example: Community project format
"**The annual health check-up of the community**"

Electricity Developing Fund Type A"
Community of Moo 7, Sam Rong Nuea sub-district, Dan Sam Rong municipality, Mueang district, Samut prakarn province. Fiscal year 2012.

Title	Detail
1. Project	The Annual Health Check-up of the Community project which is participatory approved by the community on May6, 2012, and is the fifth priority.
2. Issue	☑ Health promotion ☐ Career development ☐ Agriculture development ☐ Community economics development ☐ Quality of life development ☐ Education, religion, culture, and tradition development ☐ Community and community organization development ☐ Environment conservation and restoration ☐ Emergency helping the trouble people ☐ Capacity building of the people involving the fund ☐ Others……..
3. Project rational (Describe background such as the problem, the significance, and the necessary of the budget source from the fund for conducting the project)	Since the community and the municipality are presently living in the industrial area which is polluted of the particulates, car's exhaust which is sometime exceed the standard. The community lack of green area for recreation and exercise. The people are getting risk of cardiovascular, pulmonary disease from such pollutants.
4. Objective (What else of the problems could	1) The people could be raised up on the body organs so that they could themselves protect and take care.

Title	Detail
be resolved or what else of the beneficial that the people could get…)	2) The people could be better themselves health taken care. 3) They will be health checked-up covering 12 items.
5. beneficial of the project and the output measurement	After getting the health check-up status, the further treatment and preventive action from the pollutants will be continuously conducted.
6. Target group	The people in Moo 7, 300 persons will be checked-up covering 12 items.
7. Conducting area/place place (address the name of conducting area such as the school name, the temple name, the demonstrative place etc., and identify the address of such place; Moo number, sub-district, district, province which is not the private area or is not the prohibited area such as the conservative park etc.)	The Center for Community Justice "Dan Samrong" 42/2 Dan Samrong road, Moo7, Samrong Nuea sub-district, Mueang district, Samut prakarn province
8. Duration	June9, 2012 – September10, 2012.
9. Budget	255,000 Baht from the electricity developing fund.

10. The project activities:

Activity	Procedure/Method	Duration	Budget (Baht)	Indicator
Preparation	Project communication and recruit the people to get health checking –up, coordinate the hospital and prepare snack or food for serving.		38,500	A number of the people in Moo 7 covering 300 persons
Conducting	Health check-up kick off		1,500	The people are informed their health status and further treatment or prevention.
	Samrong medicine general hospital check-up service the target 300 persons. (700 Baht each)		210,000	The people are raised up their awareness on self-care.
Report the project evaluation	Make the project evaluation report covering the results and the budget.		1,500	300 persons whose health were checked-up could recommend others to self-take care.
Project closing	Report the project		1,500	
others	Coordinating expense		2,000	

Title	Detail
11. Project proposed	☑ Health volunteer group ☐ Government ☐ The community development committee in the electricity generating plant. ☑ Other……..”the community chief of Moo7”…….
12. Project in-charge	Mr. Chalong Waisung nuen

Remark: the list of 12 items check-up;

1. General check-up by the physician covering ears, eyes, throat, nasal, mouth, teeth, heart, lymph node, skin, thyroid gland, respiratory tract.
2. Weight, height
3. Body mass index
4. Blood pressure
5. Chest x-ray
6. EKG
7. CBC
8. Blood sugar
9. Blood lipid
10. Liver function
11. Kidney function
12. Sight measurement

Bibliography

Department of Renewable Energy and Energy Conservation: 2009. The Handbook for Energy and Investing Development Series 4.

Department of pollution Control. Ambient Air Standard.[online].[Accessed on December 20, 2014]. http://www.pcd.go.th/info_serv/reg_std_airsnd01.html

National Energy Strategies and Direction: Energy Policy and Plan Bureau, 2014

Pattana Muelapruek. Environmental Health. Bangkok: The Press of Veteran Organization. 1998.

Patraporn Teaw etc.2012. The Study of Particulates pollution from Biomass and Lignite Combustion. Energy Research Bulletin, Year 9, Issue 3 (September – December)

Energy for Environment Foundation. Biomass. Bangkok: Q Print Management ltd.2006

The Report of Follow-up Prevention and Resolution Measurement of Environmental Impact, January – June 2013. Biomass Electricity Generating Plant 17 MW Project. Surin Province, Mung Charoen Biomass Company ltd.

Public Health College, Chulalongkorn University. The Final report of Public Health Impact Study from Air Pollution. Mae Mor District, Lampang Province Issue1, Summary Report for Executives. Bangkok: C.P.N. Supply.2001

The Office of Energy Regulatory Commission (2012). Community Project Example Menu.

National research council. 2009

WHO (2005). Air quality guidelines - global update 2005. [online].[accessed on December10, 2014]. http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/

WHO. (2006). Air quality guidelines global update 2005. Denmark: WHO regional office for Europe.

Appendix

List of Biomass Power Plant in Thailand (February, 2015)

Name	Province	Permission license date	Type of fuel	Capacity
Health Promotion Center 1				
PRG Crops Company ltd.	Patumthani	October 29, 2009	Biomass	9.240
Power Prospect Company ltd.	Pranakorn Sriayuthaya	November 26,2009	Biomass	9.900
Health Promotion Center 2				
True Energy Power Lopburi Company ltd.	Lopburi	May17,2010	Biomass	7.500
Ever Green Plus Company ltd.	Lopburi	April 11,2013	Biomass, woodchips, wood slab	9.800
T.N. Sugar Industry Company ltd.	Lopburi	July 24, 2012	Biomass, Bagasse, Sugarcane leaves	36.000
A-Plus Power Company ltd.	Lopburi	September30, 2014	Biomass, woodchips, wood slab, sawdust	1.894
Singburi Sugar Company ltd.	Singburi	Ahugust22, 2011	Biomass	17.000
B M P Energy (public) Company Ltd.	Chainat	April25, 2012	Biomass	9.5
Health Promotion Center 3				

Name	Province	Permission license date	Type of fuel	Capacity
BW Power Supply Company ltd.	ChachoengSao	May12, 2011	Biomass	3
National Power Plant 2 Company ltd.	ChachoengSao	March13, 2012	Biomass	10.4
National Power Plant 3 Company ltd.	ChachoengSao	March20, 2012	Biomass	10.4
National Power Plant 3 Company ltd.	ChachoengSao	March20, 2012	Biomass	36.93
National Power Plant 11 Company ltd.	Prachiburi	December17, 2009	Biomass	32.9
National Power Plant 5 Company ltd.	Prachiburi	April1, 2010	Biomass, Diesel Oil	74.68
National Power Supply (public) Company ltd.)	Prachiburi	August20, 2009	Biomass	323.6
Kaewlamduan Power Supply Company ltd.	Srakaew	December14, 2012	Biomass, woodchips, wood slab, sawdust	9.9
Sugar and Sugar cane Eastern Company ltd.	Srakaew	October10, 2013	Biomass, Bagasse, Sugarcane Leaves	32
E S Energy Company ltd.	Srakaew	November15, 2013	Biomass, woodchips, wood slab	23

Name	Province	Permission license date	Type of fuel	Capacity
New Kuang Sun Lee Sugar Company ltd.	Chonburi	October 8, 2009	Biomass	8.500
Advance Clean Power Company ltd.	Chonburi	December 28,2011	Biomass	9.9
Rayong Sugar Company ltd.	Chonburi	December17,2010	Biomass	18
Sahakarn Sugar Chonburi Company ltd.	Chonburi	April29, 2013	Biomass, Bagasse, Sugarcane Leaves	11
Suksomboon Oil Palm Company ltd.	Chonburi	February25, 2014	Biomass, Palm shell, Palm fiber, Palm brunch	2.05
Health Promotion Center 4				
H V Green Company ltd.	Karnchanaburi	February9, 1012	Biomass	1.105
Thai Karnchanaburi Power Company ltd.	Karnchanaburi	May 9,2013	Biomass, Bagasse, Sugarcane Leaves	8
Prachuab Industry Company ltd.	Karnchanaburi	March25, 2009	Biomass	11
Prachuab Industry (project 2) Company ltd.	Karnchanaburi	March13, 2014	Biomass, Bagasse, Sugarcane Leaves	16
Khonkaen Sugar Electricity Plant Company ltd.	Karnchanaburi	December27, 2010	Biomass	135
Thai Puempoon Industry Company ltd.	Karnchanaburi	July 7,2011	Biomass	25

Name	Province	Permission license date	Type of fuel	Capacity
Thai Sugar Industry Company ltd.	Karnchanaburi	October3,2012	Biomass, Bagasse, Sugarcane Leaves	19
Mitr Agricultural Industry Company ltd.	Karnchanaburi	October9, 2012	Biomass, Bagasse, Sugarcane Leaves	20.5
Thai Sugar Karnchanaburi Industry Company ltd.	Karnchanaburi	May31, 2013	Biomass, Bagasse, Sugarcane Leaves	15
Sinchaisri Company ltd.	Karnchanaburi	July24, 2014	Biomass, Rice husk, Rice straw	4.9
Thanyakit Nakornpatom Partnership (1978)	Nakornpatom	October 29, 2009	Biomass, Diesel oil	2.86
Sin Ek Panich Company ltd.	Nakornpatom	September20, 2013	Biomass, Palm shell, Rice husk	9.9
Biomass Nakornpatom Company ltd.	Nakornpatom	October 16,2014	Biomass, Diesel Oil, Rice husk, Rice straw	9.5
Rachburi Sugar Company ltd.	Rachburi	February 15,2011	Biomass	28.5
Banpong Sugar Company ltd.	Rachburi	May31,2011	Biomass	18
Siam Cellulose Company ltd.	Rachburi	November21,2014	Biomass, Black oil from pulp paper process	5
Decha Bio Green Company ltd.	Supanburi	March13, 2009	Biomass	7.5

Name	Province	Permission license date	Type of fuel	Capacity
U-thong Biomass Company ltd.	Supanburi	October8, 2009	Biomass	7.5
Kinetic Power and Energy Company ltd.	Supanburi	May18, 2011	Biomass	9
U-thong Biomass Company ltd.	Supanburi	December24, 2013	Biomass, Rice husk, Rice straw	9
Chaimongkon Refine Sugar Company ltd.	Supanburi	November 2,2011	Biomass	24
Mitrpon Bio-power Company ltd.	Supanburi	May 2,2012	Biomass	113.43
A.S.T. Palm Oil Company ltd.	Prachuab Kirikan	January21,2010	Biomass	1.5
Pranburi Sugar Industry Company ltd.	Prachuab Kirikan	September12,2011	Biomass	8
Tabsakae Clean Energy Company ltd.	Prachuab Kirikan	October17,2011	Biomass	9.4
J S Energy Company ltd.	Samutsakorn	December 3,2009	Biomass, Diesel Oil	8.54
Health Promotion Center 5				
Mitrpon Bio-power Company ltd.	Chai yapum	December1, 2012	Biomass	74.52

Name	Province	Permission license date	Type of fuel	Capacity
Advance Bio Power Company ltd.	Burirum	June25, 2009	Biomass	9.5
Satuek Biomass Company ltd.	Burirum	JUne25, 2009	Biomass	7.5
Burirum Energy Company ltd.	Burirum	April10, 2012	Biomass, Bagasse	9.9
Sriwattana Green Power Company ltd.	Burirum	September25, 2013	Biomass, Wood slab	9.9
Sricharoen Bio Power Company ltd.	Burirum	July16, 2009	Biomass, Diesel oil	3.904
Well Korat Energy Company ltd.	Burirum	December3, 2014	Biomass, woodchips, wood slab, sawdust	9.9
Burirum Power Company ltd.	Burirum	February5, 2015	Biomass, Bagasse, Sugarcane leaves	9.9
Buayai Bio Power Company ltd.	Nakorn Rachsrima	January21, 2010	Biomass	7.29
Jia Meng Company ltd.	Nakorn Rachsrima	December22, 2010	Biogas, Biomass	2.52
T R C Clean Energy Company ltd.	Nakorn Rachsrima	September5,2011	Biomass	9.9
Advance Agro Power Plant Company ltd.	Nakorn Rachsrima	December26,2012	Biomass, Wood peel from Eucalyptus, cassava root	9.9

Name	Province	Permission license date	Type of fuel	Capacity
Kornburi Sugar (Public) Company ltd.	Nakorn Rachsrima	March8,2011	Biomass	23
Kornburi Electricity Generating Plant Company ltd.	Nakorn Rachsrima	Mya17,2013	Biomass, Bagasse, Sugarcane leaves	15
Korat Industry Company ltd.	Nakorn Rachsrima	October8,2009	Biomass, Diesel Oil	44
Ang Weang Industry Company ltd.	Nakorn Rachsrima	June23, 2014	Biomass, Bagasse, Sugarcane leaves	64
Advance Agro Power Plant Company ltd.	Surin	October1, 2012	Biomass, Wood peel, wood top, branches, leaves and root of Eucalyptus, Cassava root	9.9
Mungcharoen Green Power Company ltd.	Surin	August 20,2009	Biomass, Diesel Oil	10.3
Surin Electricity Plant Company ltd.	Surin	December2,2009	Biomass	30
Mungcharoen Biomass Company ltd.	Surin	June26, 2012	Biomass, Rice straw, woodchips, wood slab	17
Health Promotion Center 6				
Alliance Clean Power Company ltd.	Nongkai	December13, 2013	Biomass, Woodchips, Cassava root	9.9

Name	Province	Permission license date	Type of fuel	Capacity
Erawan Power Company ltd.	Nong Bualampu	December9,2010	Biomass	15
Kasetpol Sugar Company ltd.	Udornthani	December22,2010	Biomass	15
Kumpawapee Sugar Company ltd.	Udornthani	January26, 2012	Biomass	19.6
T S M Power Company ltd.	Udornthani	November29,2013	Biomass, Bagasse, sugarcane leaves	30
Advance Asia Power Plant Company ltd.	Khonkaen	August24,2012	Biomass, wood peel, wood top, branches, leaves and root of Eucalyptus, Cassava root	9.9
Khonkaen Green Power Company ltd.	Khonkaen	January23, 2013	Biomass, Rice straw	9.6
Pol Power Supply Company ltd.	Khonkaen	March12,2013	Biomass, Rice husk, Rice straw	9.6
Mitrpol Bio-power (Puweang) Company ltd.	Khonkaen	October29, 2009	Biomass	50
Khonkaen Sugar Electricity Plant Company ltd.	Khonkaen	December2, 2009	Biomass	30
Phoenic Pulp and Paper (public) Company ltd.	Khonkaen	February24, 2011	Biomass	60.4

Name	Province	Permission license date	Type of fuel	Capacity
Wanhkanai Sugar Company ltd.	Mahasarakam	September28, 2011	Biomass	18
Bua Sommai Electricity Generating Plant Company ltd.	Roi-et	March 25, 2009	Biomass	9.9
Bua Somma Company ltd.	Roi-et	March 18, 2011	Biomass	6
Roi-et Green Company ltd.	Roi-et	February 10, 2012	Biomass, Diesel Oil	9.95
Sri Saengdao Bio Power Company ltd.	Roi-et	April24, 2012	Biomass, Rice husk	9.9
Advance Clean Power Company ltd.	Roi-et	May 31, 2013	Biomass, Woodchips, wood peel, sawdust	9.9
Bua Sommai Electricity Generating Plant Company ltd.	Roi-et	August6, 2009	Biomass, Diesel Oil	11.3
Kamalasai Bio Power 2010 จำกัด Company ltd.	Karasin	January26, 2012	Biomass	9.9
Mitr Karasin Sugar Company ltd.	Karasin	January 4, 2011	Biomass	39.5
Mitrpol Bio-power (Karasin) Company ltd.	Karasin	November8, 2012	Biomass, Woodchips, wood peel, sawdust, bagasse, sugarcane leaves	36.39
E-san Sugar Industry	Karasin	December6, 2013	Biomass, bagasse, sugarcane	15.484

Name	Province	Permission license date	Type of fuel	Capacity
Company ltd.			leaves	
Khonkaen Sugar Electricity Plant Company ltd.	Loi	September30,2014	Biomass, bagasse, sugarcane leaves	40
Mitrpol Bio-power (Puluang) Company ltd.	Loi	January 14, 2015	Biomass, Diesel Oil, bagasse, sugarcane leaves	67
Health Promotion Center 7				
Saharueang Company ltd.	Mukdaharn	December 9, 2010	Biomass	15
Northeast Green Energy (Thaialnd) Company ltd.	SakolNakorn	March 5, 2013	Biomass, woodchips, rice straw, rice husk	0.99
Tang Sae Yeang Green Power Company ltd.	Sri saket	December19, 2012	Biomass, rice husk, wood slab	9.5
Ubol Biogas Company ltd.	Ubolrachtanee	February25, 2011	Biomass	1.944
Kaona Power Supply Company ltd.	Ubolrachtanee	October28, 2010	Biomass	9.9
Health Promotion Center 8				
Thai seri Generating Company ltd.	Kampaengphet	October29, 2009	Biomass, Diesel Oil	6.48
Kampaengphet Electricity Generating Company ltd.	Kampaengphet	January17, 2011	Biomass	2.9
Kampaengphet Sugar Company ltd.	Kampaengphet	January7, 2011	Biomass	9

Name	Province	Permission license date	Type of fuel	Capacity
Nakornphet Sugar Company ltd.	Kampaengphet	June1, 2012	Biomass, Bagasse, Sugarcane leaves	5
Saha Green Forest Company ltd.	Kampaengphet	October29, 2012	Biomass, woodchips, cassava root, Eucalyptus slab	7.5
Tip Kampaengphet Bio Energy Company ltd.	Kampaengphet	December28, 2012	Biomass, woodchips, wood slab, sawdust, bagasse, sugarcane leaves	36
Kampaengphet Green Energy Company ltd.	Kampaengphet	June3, 2014	Biomass, rice husk, rice straw	9.9
Nongbua Green Power Company ltd.	Nakornsawan	February19, 2013	Biomass, Gasification from corn leaves, corn stem, woodchips	1
Kaset Thai International Sugar Corporation (public) Company ltd.	Nakornsawan	June13, 2013	Biomass	50
Kaset Thai International Sugar Corporation (public) Company ltd.	Nakornsawan	August14, 2012	Biomass, bagasse, sugarcane leaves	32.5
Kaset Thai Bio Power Company ltd.	Nakornsawan	March20, 2013	Biomass, bagasse, sugarcane leaves	60
Chitserm Thai Rice Mill Company ltd.	Pichitr	June14, 2012	Biomass	0.92

Name	Province	Permission license date	Type of fuel	Capacity
A.T. Bio Power Company ltd.	Pichitr	August20, 2009	Biomass, Diesel Oil	22.69
Banrai Electricity Generating Company ltd.	U-taitani	December16, 2010	Biogas, Biomass	9.9
Withai Bio Power Company ltd.	U-taitani	May16, 2012	Biomass, rice husk, cassava root, Vithai grass, bagasse	9.5
Banrai Sugar Industry Company ltd.	U-taitani	April17, 2012	Biomass	41
U-taitani Bio Energy Company ltd.	U-taitani	March5, 2014	Biomass, Bagasse, Sugarcane leaves	35
Banrai Electricity Generating (Branch 2) Company ltd.	U-taitani	May21, 2014	Biomass, Bagasse, Sugarcane leaves	27
Health Promotion Center 9				
Maesod Clean Energy Company ltd.	Tak	November22, 2010	Biomass	14.27
Pitsanulok Sugar Company ltd.	Pitsanulok	September12, 2012	Biomass, Bagasse, Sugarcane leaves	21
Pitsanulok Electricity Generating Company ltd.	Pitsanulok	September23 , 2014	Biomass, Bagasse, Sugarcane leaves	20
Thai Rung-rueang Industry Company ltd.	Petchabun	September12, 2012	Biomass, Bagasse, Sugarcane leaves	52
Thai Rung-rueang Electricity	Petchabun	September12, 2013	Biomass, Bagasse, Sugarcane	27

Name	Province	Permission license date	Type of fuel	Capacity
Generating Company ltd.			leaves	
Thip Sukhotai Bio Energy Company ltd.	Sukhotai	December22, 2011	Biomass	36
Health Promotion Center 10				
Sahacogen Green Company ltd.	Lampun	November2, 20910	Biomass	9.6
Advance Bio Asia Company ltd.	Lampang		Biomass, woodchips, wood slab, sawdust	9.9
Health Promotion Center 11				
Sap Anan Biomass Company ltd.	Chumporn	March13, 2009	Biomass	9.5
Chumporn Palm Oil Industry (public) Company ltd.	Chumporn	July20, 2011	Biomass	8.41
Natural Palm Group Company ltd.	Chumporn	May23, 2012	Biomass, Palm shell, empty bunch palm. Palm fiber	9.4
Nikom Tasae Corparative Company ltd.	Chumporn	August6, 2014	Biogas, Biomass, Diesel Oil, waste water from palm oil production plant, palm shell, palm fiber, empty bunch palm	3.05
Natural Palm Group Company ltd.	Surat Thani	March25, 2009	Biogas, Biomass	3.51

Name	Province	Permission license date	Type of fuel	Capacity
Taksin Palm (1978) Company ltd.	Surat Thani	July16, 2009	Biogas, Biomass, Diesel Oil	3.541
Tachana Palm Oil Company ltd.	Surat Thani	June2, 2010	Biomass	3.19
J R One Company ltd.	Surat Thani	July2, 2010	Biomass	1.35
Thai Talow and Oil Company ltd.	Surat Thani	April22, 2011	Biogas, Biomass	4.59
Thai Talow and Oil Company ltd.	Surat Thani	April22, 2011	Biogas, Biomass	3.128
Taksin Palm Oil (1993) Company ltd.	Surat Thani	December1, 2011	Biomass	2.795
Tachang Palm Oil Industry Company ltd.	Surat Thani	January10, 2014	Biomass, Palm shell, Palm fiber, Empty Bunch Palm	9.9
Surat Thani Green Energy Company ltd.	Surat Thani	October29, 2009	Biomass, Diesel Oil	10.2
Natural Electricity Company ltd.	Surat Thani	June25, 2014	Biomass, palm shell, palm fiber, empty bunch palm	6.5
Porpanich Rungrueang Palm Oil Company ltd.	Surat Thani	November18, 2014	Biogas, Biomass, Waste water from Palm oil production, palm shell, palm fiber, empty bunch palm	3.39

Name	Province	Permission license date	Type of fuel	Capacity
S.P.O. Agro Industry Company ltd.	Nakorn Sritammarat	May25, 2012	Biogas, Biomass, Waste water from Palm oil production, palm shell, palm fiber, empty bunch pal	9.09
Chang Raek Bio Power Company ltd.	Nakorn Sritammarat	February20, 2013	Biomass, rubber woodchips, Palm woodchips	9.5
Univanich Palm Oil (public) Company ltd.	Krabi	August6, 2009	Biogas, Biomass, Diesel Oil	5.716
Univanich Palm Oil (public) Company ltd.	Krabi	September3, 2009	Biogas, Biomass, Diesel Oil	1.982
Sricharoen Palm Oil Company ltd.	Krabi	September24, 2009	Biogas, Biomass, Diesel Oil	5.639
Saraf Energy Company ltd.	Krabi	December3, 2009	Biomass, Diesel Oil	9.94
Saha Industry Palm Oil (public) Company ltd.	Krabi	October24, 2009	Biogas, Biomass, Waste water from Palm Oil Production, Palm shell, Palm fiber, Empty bunch Palm	5.104
Health Promotion Center 12				
Yala Green Energy Company ltd.	Yala	August8, 2013	Biomass, Rubber woodchips	9.9
Gulf Yala Green Company ltd.	Yala	July16, 2009	Biomass, Diesel Oil	25.56

Name	Province	Permission license date	Type of fuel	Capacity
Eco Generation Company ltd.	Songkhla	October29, 2009	Biomass	4.8
Green Energy Company ltd.	Songkhla	December3, 2009	Biomass	9.6
A.P.K Green Energy Company ltd.	Songkhla	November1, 2013	Biomass, woodchips, wood slab, sawdust	9
Lamsoong (Thailand) (Public) Company ltd.	Trang	July16, 2009	Biogas, Biomass, Diesel Oil	3.352
Pitak Palm Oil Company ltd.	Trang	September6, 2012	Biogas, Biomass	3.343
Otago Company ltd.	Trang	February18, 2010	Biogas, Biomass, Diesel Oil	2.26
Plan Eco Energy Company ltd.	Trang	April30, 2013	Biomass, Woodchips for Gasifier	4.94
Otago Company ltd.	Trang	November15, 2013	Biomass, Waste from Palm Oil Production, Palm shell, Palm fiber, Empty bunch Palm	7.5

Source: Office of the Energy Regulatory Commission (www.erc.or.th) March, 2014

Publication Working Group

Advisory group

Director General of Department of Health	Advisor
Director General of Department of Disease Control	Advisor
Deputy Director of Department of Health (Environmental Health line)	Advisor
Deputy Director of Department of Disease Control	Advisor
Expertise of Department of Health	Advisor
Expertise of Department of Disease Control	Advisor
Director of Environmental Health Bureau	Advisor
Director of Food Sanitation and Drinking Water Bureau	Advisor
Director of Public Health Law Administration Center	Advisor
Director of Laboratory Center for Department of Health	Advisor
Director of Environmental Health and Occupational Disease Bureau, Department of Disease Control	Advisor

Working group of information proceeding, surveillance, warning, and public communication, Department of Health

1) Miss Siriwan Chantanajullaka Director of Health Impact Assessment Division	Chairperson
2) Ms. Amporn Bussarangsri Division of Health Impact Assessment	Vice chairperson
3) Mrs.Preeyanuch Buranapakdee chairperson 2 Bureau of Environmental Health	Vice
4) Ms.Dachanee Mahachanika Bureau of Environmental Health	Staff
5) Mr.Charoen Harnpanchakit Bureau of Environmental Health	Staff
6) Ms.Molruedee Treewai Bureau of Environmental Health	Staff
7) Mr.Wirote Wacharakeattisak Bureau of Food Sanitation and Drinking Water	Staff

8) Mr.Chailert Kingkaewcharoenchai Staff
Bureau of Food Sanitation and Drinking Water
9) Mr.Chirapan Phromlikitchai Staff
Bureau of Food Sanitation and Drinking Water
10) Mr.Rachapadung Damrongpingkasakul Staff
Bureau of Food Sanitation and Drinking Water
11) Mrs.Lalana Thongthae Staff
Bureau of Food Sanitation and Drinking Water
12) Mrs.Jittima Rodsawad Staff
Division of Health Impact Assessment
13) Ms.Panita Charoensuk Staff
Division of Health Impact Assessment
14) Mrs.Suwanna Jeerapokkakul Staff
Center of Public Health Law
15) Ms.Wassana Kongsuk Staff
Center of Laboratory for Department of Health
16) Ms.Benchawan Tawachasupa
Division of Health Impact Assessment Secretariat of working group
17) Ms.Worrawan Pongprasert
Division of Health Impact Assessment Secretariat assistant of working group

Working group of air pollution surveillance in the risk area Gold mining case

1) Mrs.Sukanda Padpadee Division of Health Impact Assessment, Department of Health
2) Ms.Panita Charoensuk Division of Health Impact Assessment, Department of Health
3) Mr.Nuttapon Sirilar Division of Health Impact Assessment, Department of Health
4) Ms.Lamai Chai-ngam Division of Health Impact Assessment, Department of Health
5) Ms.Natchaya Darawan Division of Health Impact Assessment, Department of Health

6) Mr.Suphat Phengphan	Bureau of Food Sanitation and Drinking Water Department of Health

Coordinator and Words proofing staff

1) Mrs.Jittima Rodsawad	Division of Health Impact Assessment, Department of Health
2) Ms.Worrawan Pongprasert	Division of Health Impact Assessment, Department of Health
3) Ms.Pratum Sedajit	Division of Health Impact Assessment, Department of Health
4) Ms.Issaraporn Somsuay	Division of Health Impact Assessment, Department of Health
5) Ms.Anong Thonguamyai	Division of Health Impact Assessment, Department of Health
6) Ms.Ladda Pimjan	Division of Health Impact Assessment, Department of Health

Health Impact assessment Division
Department of Health, Ministry of Public Health
Tiwanon Road, Nonthaburi 11000, Thailand.
Tel : (662) 590 4190 Fax : (662) 590 4356
Website : http://hia.anamai.moph.go.th