

Application of renewable energy such as solar and wind should be promoted according to emission free of greenhouse gas. Advanced developing country like Thailand may have to limit the amount of greenhouse gas emission in the very near future.

Yearly average solar radiation in Thailand is approximately $17 \text{ MJ/m}^2\text{-day}$ of which 50% is diffuse radiation with small variation of solar radiation during each season. Potential application of solar energy are water heating, water distillation, drying, direct energy conversion via photovoltaics aiming at the application on lighting, battery charging, water pumping, telecommunication, etc.

Solar water heating has been commercialized for more than 25 years, mostly used in houses and isolated hotels and resorts. Drying and distillation have not been used widely due to high investment cost.

Electricity generation by photovoltaics is approximately five times compared to conventional thermal power plant. Therefore, the application is limited to isolated area. Up to present, there are about 6 MW of photovoltaics installed in Thailand, mostly for lighting, battery charging, water pumping and telecommunication. In the future, supplemented electricity generation via photovoltaic system may be widely accepted if cost is significantly reduced.

Average wind velocity is relatively low in Thailand. Therefore, it is not much interested in generating electricity by windmill with the present technology, except in some areas where wind velocity is high enough. However, windmill is appropriate for water pumping and its application is extensive in some areas of rice cultivation and salt production in Thailand.

Introduction

According to greenhouse gas problem, solar and wind, some forms of renewable energy, are gaining interest and potential for the development of society and economic. Thailand is situated near the equator with hot and humid climate. Yearly average solar radiation is approximately $17 \text{ MJ/m}^2\text{-day}$ of which 50% is diffuse radiation with low variation of solar radiation during each season. Due to high fraction of diffuse radiation, concentrating solar collector is not very appropriate. Wind energy has no great potential in Thailand due to low wind speed, 6-11 km/h

including calm period and 9-15 km/h excluding calm period. There are some areas such as coastal and mountain areas that may have higher wind speed. (NRCT, 1997 a)

Utilization of solar energy may be divided into two forms as follows:

1. Thermal application

Potential for thermal applications of solar energy are such as water heating at low (<100°C) and medium (100-300°C) temperatures, drying, distillation, generation of electricity or mechanical work, refrigeration, etc. (NRCT, 1997b).

2. Direct conversion of solar radiation into electricity by photovoltaics

At present, production capacity of photovoltaics all over the world is higher than 100 MW per year (NRCT, 1997c). Mostly is produced in the forms of single crystal and polycrystal of silicon. Some are in amorphous form. There are extensive works of research and development on multi-junction, thin-film and other semiconductor materials for improving efficiency.

Utilization of wind energy can be divided into three forms: 1) for water pumping with low head (<2m) and medium head, 2) for electricity generation and 3) for air ventilation via the top of the roof of building (NRCT, 1997d).

Utilization of solar and wind energy with some applications is now widely practiced in some countries. Examples are as follows:

- Solar water heating for domestic use, large building such as hotel and hospital.
- Solar drying of agricultural products.
- Solar water distillation for isolated areas.
- Photovoltaics for telecommunication and isolated villages.
- Windmill for electricity generation in windy areas.

Status of Solar and Wind Energy in Thailand

1. Database

Database for solar and wind energy available in Thailand is relatively good. Solar map was produced three times, in 1976, 1984 and 1999. However, this information is mostly limited to global solar radiation. For wind energy, wind map was produced in 1984 using data during the years 1966-1972. Presentation includes wind speed including and excluding calm periods.

2. Solar thermal processes

Solar water heater is relatively popular in some countries such as Australia, China, Greece, Israel, etc. Though it has been commercializing in Thailand for more than 25 years, the number of utilization is still limited. This is due to high initial cost and low quality of fabrication and services of some companies. Application of solar

water heating in industry has not been accepted yet due to high initial cost compared to conventional fuel used in industry.

There have been several projects of research, development and demonstration on drying of agricultural products for small and medium scale industries as well as for agricultural group. With the financial support for the first investment, solar dryers especially for drying fruit and vegetable with high value added are now limited acceptance. However, true commercialization of solar dryer has not yet existed in Thailand.

The research and development works on water distillation, steam generation, refrigeration, water pumping and natural air ventilation in building have been available, but these technologies have not yet been accepted or commercialized.

3. Photovoltaics

Electricity generation by photovoltaics is approximately five times compared to conventional thermal power plant. Therefore, the application is limited to isolated area. Up to present, there are about 6 MW of photovoltaics installed in Thailand of which 85% belong to government agency, 1% belong to university and 14% belong to private sector. Most of the applications are for lighting, battery charging, water pumping and telecommunication.

There are three factories in collaboration with foreign companies that fabricate photovoltaics in Thailand. The factories import most of the parts and just fabricate locally. Total production capacity is 3 MW per year.

In Thailand, there are research and development works on production of single crystal and polycrystal of silicon as well as on the application of solar cell for lighting, battery charging, water pumping and telecommunication.

In the future, supplemented electricity generation via photovoltaic system may be well accepted if cost is significantly reduced, perhaps in the time frame of 25 years.

4. Wind energy

Application of windmill for water pumping is extensive in some areas of rice cultivation and salt production in Thailand. Elevation head is normally less than 2 m. Some application for water pumping with medium head is in limited practice. Several units of windmill connected to grid for generating electricity were installed by Electricity Generation Authority of Thailand. Total capacity is 192 kW. (DEDP, 1998) Application of windmill for air ventilation from shed and building is relatively popular.

Average wind velocity is relatively low in Thailand. Therefore, it is not much interested in generating electricity by windmill with the present technology, except in some areas where wind velocity is high enough.

In 1998, total production capacity of electricity generation system is 14300.9 MW while installed capacity is 18423.4 MW. The production capacity is 4.2% less compared to that of the year 1997. Total production of electrical energy in 1998 is 90068.9 million kW/h which is 3.4% less compared to the year 1997. It is noticed that the installed capacity from power plants of geothermal, solar and wind energy is 1.1 MW and produced electrical energy of 1.8 million kW.h in 1998.

Recommendation for Research, Development and Demonstration

1. Policy recommendation

- To support research, development and demonstration on solar and wind energy with close collaboration with private sector, aiming at producing prototype and processes that have good potential for commercialization or for upgrading quality of life.
- To support establishing standard for solar equipment and solar energy test center.
- To promote government agency, private sector and people to understand the benefit of using renewable energy, based on the concept of sustainable development of society and economic, reduction of environmental pollution and greenhouse gas from using fossil fuel, and saving of foreign currency from importing fossil fuel.

2. Suggested projects on research, development and demonstration

Projects on research, development and demonstration of solar and wind energy should be in close collaboration with private sector if possible. Examples of recommended projects are as follows:

- To support research and development on photovoltaics such as silicon extraction and production of materials for photovoltaic industry. Care should be given to the pollution from production processes.
- To support research and development on photovoltaic system such as battery, AC/DC converter.
- To support research, development and demonstration on the utilization of photovoltaic system such as battery charging and lighting in isolated villages; and electricity generation by photovoltaics with grid connected roof top (limited numbers).
- To support establishing standard test center for solar equipment based on the concept of consortium from several agencies.
- To support development of solar water heater in order to upgrade product quality of local company.
- To support development and demonstration on solar drying of agricultural products with high value added.
- To support establishing standard for solar equipment.
- To support policy research on renewable energy.
- To promote educating people to understand benefit from using renewable energy.

Several recommended projects as mentioned above could be in collaboration with GMS countries. In addition, some projects below could be effectively proceeded in a short time.

- Higher education for master's and doctoral degrees in the fields of energy and environment related to energy issue. Examples of academic institutes that have international programs and may be interested in collaboration with GMS countries are as follows:
 1. Joint Graduate School on Energy and Environment, King Mongkut's University of Technology Thonburi.
 2. Sirindhorn International Institute of Technology.
 3. Solar Energy Research and Training Center, Naresuan University.
- Extension on solar map for GMS countries.

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