Available online at www.sciencedirect.com

SciVerse ScienceDirect

Energy Procedia 9 (2011) 351 – 358

Energy Procedia

9th Eco-Energy and Materials Science and Engineering Symposium

Energy utilization and the status of sustainable energy in Union of Myanmar

Wint Wint Kyaw, Sukruedee Sukchai*, Nipon Ketjoy and Sahataya Ladpala

School of Renewable Energy Technology, Naresuan University, Tambon Thapoh, Amphur Muang, Phitsanulok 65000, Thailand

Abstract

Sustainable energy has turned into one of the most promising ways to handle the challenges of energy demand problems of numerous consumers worldwide. Myanmar's energy consumption mainly depends upon traditional energy such as fuel wood, charcoal and biomass. The government had laid the energy policy guidelines and emphasized in renewable energy resources to replace traditional energy types. Although domestic conventional energy sources such as oil and natural gas have been increasing a little bit through discoveries and development, these does not satisfy the demand of the country. In this paper, the energy utilization and the present sustainable energy status are mentioned. Following that, completed projects by each sector are provided. The future plan for energy conservation is finally highlighted.

Selection and/or peer-review under responsibility of CEO of Sustainable Energy System,
Rajamangala University of Technology Thanyaburi (RMUTT).

Keywords: energy policy; energy conservation; sustainable energy; success projects in Myanmar; future plan.

1. Introduction

The geographical location of Myanmar is between Latitudes 9°58' N and 28°31' N and Longitudes 92°10' E and 101°11' E. Population of the country is estimated at 51.6 million in 2007 [1] and Myanma's population rate is increasing steadily at annual growth rate 1.84% according to the data from Ministry of Foreign Affairs, Myanmar. Population in rural areas is 65% of the total population in Myanmar.

* Corresponding author. Tel.: +66 815325590; fax: +66 055 963 182.
E-mail address: sukruedeen@nu.ac.th.

doi:10.1016/j.egypro.2011.09.038

1.1. Energy demand

In 2005-2006, final energy demand in Myanmar depended for 77% upon traditional energy sources such as fuel wood, charcoal and biomass, while 23% was contributed by commercial energy such as: oil (12%), electricity (4.5%), natural gas (4%) and coal (1.9%). Households (76%), transport (10%), industry (8.3%) and agriculture (2%) by each sector are consuming the energy.

1.2. Institutional framework

The Ministry of Energy (MOE), that has the main responsibility to carry out Exploration and Production of Crude Oil and Natural Gas, Refining, Manufacturing of Petrochemicals and Transportation, Distribution of Petroleum Products, is in charge of Oil and Gas sector and comprises such as Energy Planning Department (EPD), Myanma Oil and Gas Enterpirse (MOGE), Myanma Petrochemical Enterprise (MPE) and Myanma Petroleum Products Enterprise (MPPE). Ministry of Electric Power (1) and (2) which consists Department of Electric Power (DEP) and Myanma Electric Power Enterprise (MEPE) is responsible for planning, generation and distribution of electricity through out the country. Moreover, Ministry of Forestry, Ministry of Mines and Ministry of Science and Technology share the responsible on aspects of energy management of biomass, coal and renewable sources respectively.

Table 1. Primary energy consumption (Kilotonne of oil equivalent KTOE).

	2004_05	2005_06	2006_07	2007_08
Primary energy consumption	13113	12705	14238	14889
Crude oil and petroleum products	1957	1756	1904	1789
Natural gas	1508	1305	1511	1721
Coal and lignite	196	85	501	558
Hydro	926	988	1277	1541
Biomass (Wood)	8526	8561	9045	9280

2. Status of Sustainable Energy

2.1. Solar energy

Due to the geographical position of Myanmar, most Myanmar territories posses an abundant and reliable solar supply all year round. Hence, to face the urgent electrification problem of rural consumers spread throughout Myanmar, our government is trying to promote PV system especially in rural areas. Through her rural electrification program, some of government health centers, water supply systems and photovoltaic powered village in remotest areas where grid electricity is inaccessible are being installed with PV systems, basically for lighting and for health services and to improve the socio-economic standards of living of people working there. As an initial step to demonstrate the Photovoltaic Power System for remote villages, some equipment has been installed under the "Technical Cooperation among Developing Countries Programme". Pilot project under the "Solar Photovoltaic Battery Charging Community Enterprise" financed by Energy Services and Income Generating Opportunities for the Poor (Project "ENSIGN") in collaboration with Yoma Bank and Energy Planning Department (EPD) of the Ministry of Energy and Research works under the "Demonstrative Research on a Photovoltaic Power Generation System in Myanmar" in cooperation between New Energy and Industrial Technology

Development Organization (NEDO) of Japan and Department of Electric Power of Ministry of Electric Power were carried out. Similarly, Solar Power Village Electrification Scheme was implemented and Research and Development works on prototypes of solar equipment were performed by Myanma Scientific and Technological Research Department (MSTRD). At the present, research activities are on going in the use of Photovoltaic Power supply system for household purpose. Most Myanmar territories have high solar potential. Potential available solar energy of Myanmar is around 51973-8 Tera Watt-hour per year[3].

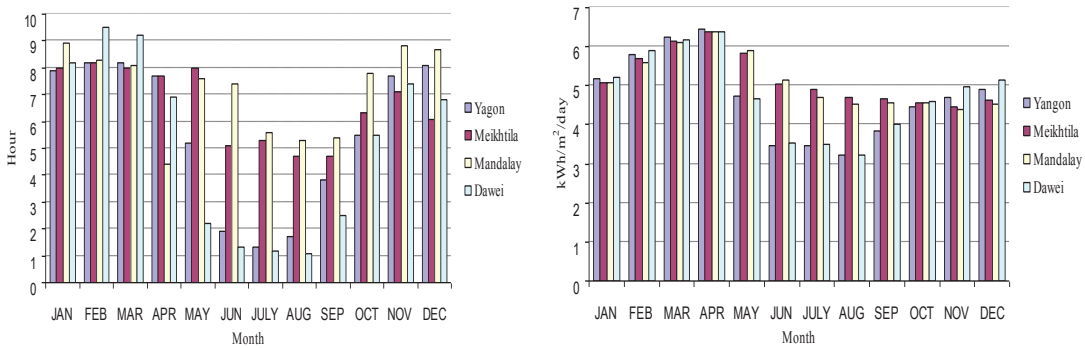

Fig. 1. (a) Average sunshine hours of selected cities; (b) Average solar radiation of selected cities.

Ministry of Science and Technology has played an important role in the research and development of PV cell and PV system. The different categories of PV systems with their capacities as well as installed sites are listed in the following table.

Table 2. Photovoltaic power applications in Myanmar.

PV system	Installed site	Capacity (*kW*)
Water pumping	Natha-myaing village	3.6
Water pumping	Yanmyoaung Village	40
VAST station	Mogok	1.8
Radio telephone post	Myitkyina	3.0
Water pumping (through the country)	Water resources department	40
Battery charging station	Pale, Thongwa Township	0.45
Solar refrigerators	Ministry of Health	50
Health centers in rural areas	Ministry of Health	15
PV generator in hybrid system	Chaung Tha Village	80
Private own	Various companies	250
Other utilizations		50

Presently, there are more than three local companies such as Earth Renewable Energy Solutions, Myanmar Eco Solutions, Myanmar Solar Energy System and Earth Computer System, manufacturing of PV systems with technological backup from foreign companies. Many kinds of PV modules imported from Thailand, China, Singapore and Japan are available in Myanmar PV market. In Myanmar market, solar electric power systems, remote home power systems, solar water pumping systems, solar outdoor

lighting systems, photovoltaic systems, photovoltaic module mounting systems are available. Market potential of PV modules in Myanmar is starting too high especially in household applications. Most of PV projects are conducted by government organizations.

2.2. Hydro energy

Myanmar is topographically endowed with abundant hydropower resources due to numerous river systems that occurred throughout the country. The World Bank estimates a figure of more than 100,000 MW out of which MEPE has identified 267 sites with a total generating capacity of 39,624 MW. Existing hydro power stations contribute only 320 MW and hence only 1% of the total has been utilized. Available hydro resources in each state and division are listed in the following table.

Table 3. Medium and large hydro power plants in Myanmar.

Installed site	Capacity (*MW*)
BHP 1	168
BHP 2	28
Kinda	56
Sedawgyi	25
Zawgyi 1	18
Zawgyi 2	12
Zaungtu	20
Thaphanseik	30
Paunglang	280
Mone	75
Yenwe	25
Khabaung	30
Shwe Li	600
Keng Tawn	54
Yeywa	592.5

Realizing the effects of power shortage on the society as a whole, the government has launched large scale projects to fulfill the needs of a growing 50 millions plus population. It is envisaged that another 2,000 MW can be realized from large scale projects in the next five years. One of the projects that are underway is the Paung Laung Hydel Scheme which is located 14 miles east of Pyinmana in Mandalay Division. The 430 feet high dam will have a storage capacity of 560,000 acre-feet of water with a total installed turbine capacity of 280 MW. Power generation is slated to start in December 2003. Paung Laung is known as the biggest infrastructure project ever carried out in the whole of Myanmar.

2.3. Wind energy

Wind power generation technology has been introduced in Myanmar since 1997. This was mainly attributed to field test works by New and Industrial Development Organization (NEDO) of Japan. As in solar energy, due to expensive initial cost, wind energy is in the research and development phase. Wind energy is only implemented as an experimental phase. Wind energy is abundantly available in the hilly regions of Chin and Shan States, western part, costal region and some central parts of Myanmar. Wind

energy of 360.1 TWh per year is potentially available.

Table 4. Yearly average wind velocity in selected cities.

Location	Wind velocity (*m/sec*)
Bago	1.1
Dawei	0.7
Haka	4.0
Hpa-an	1.9
Homalin	1.6
Kyaukphyu	1.9
Loikaw	1.7
Lashio	0.3
Myitkyina	1.3
Mandalay	2.3
Meikhtila	4.8
Monywa	2.4
Magway	1.5
Mawlamying	2.3
Pathein	2.2
Sitthway	6.7
Yangon	2.5

Department of Electric Power DEP and MEPE of Ministry of Electric Power in cooperation with New and Industrial Development Organization (NEDO) of Japan constructed Meteorological Observation Stations and installed Wind and Solar measuring equipments at some sites. They constructed a hybrid system with solar energy at Chaungthar, west coast, and Myanmar. In this system, the wind turbine generates 40 kW and PV systems generation facilities is 80 kW. The population of this village is 6,325. This system can support 1,307 households, one high school, two monasteries, and one small health center with 16 beds, one police station and one post office.

2.4. Biomass energy

Myanmar has fairly large availability of biomass energy sources. It can be utilized in two forms; first one is traditional form whose biomass energy utilization is mostly applied by domestic sectors and small scale commercial sectors by direct combustion with rather lower efficiency and second one is modern form whose energy utilization, biomass energies are utilized by newly developed biomass energy conversion technologies in the form of liquid, gas and electricity such by producing bio-diesel and bio-gas. Wood fuel is the main source of domestic energy in Myanmar. During 1988-89, the wood fuel consumption was about 80.46 percent of the total primary energy consumption and gradually decreased to 64.07 percent. The development of biomass energy utilization can be considered from it sources and technologies used for its transformation and utilization.

The Government had launched a program to propagate the biogas utilization since 1980 and in 1983. A total of 867 floating type biogas plant, family size digesters have been constructed and utilized in 134

townships in all 14 states and divisions with highest figure in central Myanmar Region where fuel wood was becoming scarce. Nowadays, the biogas technology in Myanmar has been rapidly and widely accepted particularly in both large and small-sized livestock farms chiefly.

For the period 2001-2005, two fixed dome type biogas plants with 50 m^3 volume had been constructed from local available materials. This system was promoted by Yangon Technological University under the MOST and utilized since the beginning of 2003 in Panan and Pankkque villages, Kyauk Se Districit, Mandalay Division. Total estimated cost for a 50 m^3 in size, MMO model Fixed Dome Type Biogas Plant is about USD 2000 including the cost of 25 H.P, 15 kVA engine and other accessories for lighting. It can support 300 houses in a village.

At the end of year 2004, MOST constructed 35 numbers of electricity producing plants by biogas from cow dung for community size in Mandalay, Sagaing and Magway Divisions. Nowadays, more than thirty numbers of Fixed Dome Type biogas plants are under constructions.

In 2006, Rice Husk Gasifier for rural electrification Project was manufactured by Myanmar Inventors' Cooperatives Society (MICS) which is operated in Lin Tha Village, Thandwe Township, Rakhine State. This project was won the 2006 ASEAN Energy Award from ASEAN Center for Energy (ACE). A 50 kW biomass gasifier-engine-generator system to produce electricity was constructed and commissioned in Dagaoondaing Village, Twantay Township. This project is from a grant from Thai Government. The system consists of biomass hopper, gasifier, producer gas cooling and cleaning devices, engine and generator with a control box. The system is housed under 56 m^2 building that is partitioned into operation area, control room and fuel storage room.

Table 5. Specification of rice husk gasifier to supply electrification.

Type of porject	Specifications
Power output	Engine output 60 hp
	Generator output 30 kW
Investment cost in US$	Building cost _ 2,500
	Gasfier unit _ 3,750
	Gas engine _ 1,250
	Electricity main and distribution system _ 4,583
	Installation and overhead cost _ 2,000
Generated energy	Electricity
Energy sale income in US$	Operation time 17 hrs/day (12 hr ricemilling + 5 hr lighting)

2.5. Tidal energy

Although Myanmar has more than 2,800 km of coastline with numerous small creeks, tidal energy in Myanmar is very initial stage and studies are being made to utilize the tidal energy. As the power generations have all along been based on hydropower and gas based generation, considerations have never been made to utilize tidal power for generating electricity. As the demand for electricity has rapidly increased, studies are being conducted for tidal energy. Myanmar Engineering Society (MES) provided technical services for feasibility study, design and supervision especially to the rural areas where are far from grid lines.

One of completed tidal Energy projects is situated in Kanbalar village, Ayeyarwaddy Division. This village is far about 150 km from grid line. A small earth filled type dam was constructed across the branch creek. Damn height is approximately 3 m and length is 10 m. Wooden open channel 0.35 m high

0.35 m breath 8 m length was connected to turbine casing through outlet gate. Draft tube has been installed at the outlet of turbine. During actual performance, because of variation in tide level, for 6 hrs the consumption is only ½ of available discharge. That leads to possibility of running 10 numbers of turbine parallel. The generating hours daily with high and low tide. As there occur two tides everyday, for generating 6 hrs for each tide come to 12 hrs per day [2].

2.6. Geothermal

Myanmar is one of the numerous geothermal resources that could be represented as an additional source of energy to fulfill its future energy requirement. A total of 93 geothermal locations have been recorded and identified throughout the country. Out of the 93 geothermal sites, 43 of them were investigations had been made by Myanma Oil and Gas Enterprise (MOGE) of the Ministry of Energy and Myanma Electric Power Enterprise (MEPE) of the Ministry of Electric Power in cooperation with Electric Power Development Co., Ltd. (EPDC) of Japan, Unocal of United States and Caithness Resources Inc of United States. Water samples of hot springs were taken and chemical analysis, X-ray diffraction analysis were performed.

3. Energy Policy and Strategy Plans

Myanmar's energy policies and strategies have expressed efforts to provide sufficient energy resources for the country's development need. Ministry of Energy in accordance with the guidance of the Government had established energy polices and strategies and measure and frame work for all economic and social development issue and agenda.

The main objectives of the policy are:

- To utilize optimum amount of energy efficiently and to save non renewable energy sources
- To increase the production level of existing energy sources and at the same time to update the unsuppressed energy demand.

Due to the rapid growth of population of Myanmar, the energy conservation and improvement of efficiency of equipments and technologies are essential. In order to achieve such energy development objectives, the following programme are taken into account:

- Integrated Energy Planning and Policy
- Energy Development Options
- Energy System Diversification
- Energy Interconnection (Electricity, Natural Gas, Petroleum Products)
- Renewable Energy Development Technologies
- Rural Energy Supply
- Energy Pricing System
- Private sector participation in Energy Development Programme.

The Government's policies are focusing within the natural resources to manage environment and strengthen the science and technology. Consequently, each sector of sustainable energy has it own key issues which are to be taken into account for implementation of future development.

In hydroelectricity sector, some projects are planned to be constructed for export to neighboring countries such as Thailand and India. The Government issued the targets for hydropower sector are:

- To reduce the gap between demand and supply
- To have more input in terms of financial resources, equipment, machineries and facilities
- To improve technology and management systems
- To promote private participation
- To have more conducive terms and conditions to attract more foreign direct investment
- To formulate appropriate pricing mechanism.

Up to now, the concrete policy on promoting renewable energy and efficiency are stated by the Government. Although renewable energy has many environment benefits, the costs are still high compared with the costs of using commercial energy, especially fossil fuels. Consequently, the government has to take the lead in promoting it, using financial support from the regional organizations like ASEAN Centre of Energy, NEDO, NGOs, DEDE from Thailand and BIMSTEC. Key issues in the renewable energy sectors are as follows:

- To have adequate information on each and every type of renewable energy sources of the country
- To encourage more inter-Ministries and inter-departmental interaction and cooperation
- To promote private participation in the development programme.
- To define and specify energy policy incorporating renewable energy.
- Energy Policy and Strategy Plans.

4. Conclusion

Renewable energy (RE) that is energy from sustainable sources is the best way to meet the challenges of the energy demand growth in 21st century. As a result of energy planning and concentrating on sustainable sources, economic and social development of country will be more streamlined.

Acknowledgements

The author would like to express her special sincere gratitude for her parents for encouragement throughout her life. She would like to thanks to all teachers especially Dr.Sukruedee Sukchai and Assist.Prof.Dr-Ing. Nipon Ketjoy, for their continuous supports and their advices.

References

[1] Thet Thet Han Yee, Solar energy potential and applications in Myanmar, Proceeding of world academy of science, engineering and technology volume 32, August 2008 ISSN 2070-3740.

[2] U Win Khaing, Renewable energy and rural development in Myanmar.

[3] U Maung Maung Myint, ASEM Ministerial Conference on Energy Security, Chapman and Hall, Landon; 18th June 2009.