Small Hydropower Development At Existing Irrigation Dams For Clean And Renewable Energy In Thailand

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Abstract:

Kingdom of Thailand is a country in Southeast Asia. The Thai government has the policy to increase the renewable energy resources. Therefore, the Power Development Plan of Thailand (PDP 2004) was set the criteria that the construction of the new power plants using fossil fuels i.e. oil, natural gas, coal was required to supply another 5% capacity of the power plants under the Renewable Portfolio Standard (RPS). According to the PDP 2004, the Electricity Generating Authority of Thailand (EGAT) planned to construct 4 new power plants with the total capacity of 2,800 MW during 2008 - 2010. Therefore, the RPS such as the small hydropower, biomass, wind, solar, etc. was required at least 140 MW. There are more than 4,000 existing irrigation dams / reservoirs in Thailand belonging to the Royal Irrigation Department (RID). Only few of them have been installed with the hydropower plants. The hydropower development at the irrigation dams was considered not only to increase the efficiency of utilization of the water but also to meet the requirement of RPS. Six existing and under construction dams of RID were studied and proposed by EGAT to develop the small hydropower projects with the total installed capacity of 78.7 MW, namely Chao Phraya (2 x 6 MW), Naresuan (8 MW), Mae Klong (2 x 6 MW), Pasak Jolasid (6.7 MW), Khun Dan Prakarnchon (10 MW) and Khwae Noi (2 x 15 MW). Naresuan Dam is an example of six mentioned dams, which was commenced operation in 1980. It is the most important irrigation diversion dam in the Nan river basin, in the northern region of Thailand. Although the available head is about 6.0 m, the large released water to downstream can be installed 1 unit of Bulb Turbine with the installed capacity of 8 MW and the annual generating energy of 42 GWh. This project is fully supported for construction by the concerned people around the project site because they can use the water discharging from the powerhouse easier than the previous condition. According to the Memorandum of Understanding (MOU) between EGAT and RID for the cooperation to develop six hydropower projects at the irrigation dams, the energy benefit generated from the mentioned projects will be shared to RID due to the utilization of the water for the power generation. It is the new approach to develop the hydropower projects at the irrigation dams and it is also the first time to develop hydropower for RPS in Thailand. The Cabinet Members approved the renewable energy development projects on October 30, 2007 comprising six small hydropower projects with the total installed capacity of 78.7 MW, the solar power of 1 MW and the wind power of 2 MW. Most of them are under construction, only some projects are in bid evaluation periods. Six small hydropower projects are the pilot projects for the clean and renewable energy development at

the exiting irrigation dams in Thailand and it is expected to be the best example to develop the renewable energy resources of the country in the future.

Key words: Hydropower, irrigation, dams, renewable energy

1. Introduction

Kingdom of Thailand is a country in Southeast Asia. The fossil fuel resources are limited and inadequate to satisfy the energy demand of the country. Therefore, Thailand has to depend on the imported energy from foreign sources, which causes a considerable loss of foreign currency. The renewable energy development will help reduce not only the energy supply burden but also the import of non-renewable energy. In addition, renewable energy will help reduce the environmental impacts resulting from energy development and utilization. It also causes less emission of carbon dioxide, the greenhouse gas causing the climate change. Hydropower is the clean type of the renewable energy resources. The constructions of new hydropower dams are limited due to the environmental problem. There are more than 4,000 existing irrigation dams, which are owned by the Royal Irrigation Department (RID). Only few irrigation dams have been installed with the hydropower plants. Several irrigation dams were studied by the Electricity Generating Authority of Thailand (EGAT) for adding the hydropower plants. The hydropower development at the irrigation dams was considered not only to increase the efficient of utilization of the water but also to meet the requirement of the Renewable Portfolio Standard (RPS).

2. Renewable Portfolio Standard (RPS) in Thailand

A Renewable Portfolio Standard (RPS) is a requirement on electric utilities and other electric suppliers to supply a minimum percentage or amount of their load with eligible sources of renewable energy. Establishing the RPS ensures that a certain amount of the energy generated in the electric power system comes from renewable sources such as solar power, wind power, biopower, hydropower, etc. The RPS is becoming popular, especially in the United States of America.

The Thai government has the policy to increase the renewable energy resources and try to establish the regulation or legal enforcement on the Renewable Portfolio Standard (RPS) for the new power plants. Therefore, the Power Development Plan of Thailand (PDP 2004) was set the criteria that the construction of new power plants using fossil fuel i.e. natural gas, coal, etc. was required to supply another 5% capacity of the power plants from the renewable resources under the RPS.

EGAT planned to construct 4 new power plants with the total installed capacity of 2,800 MW during 2008 - 2010. Therefore, the renewable energy resources such as biomass, wind, solar, hydropower, etc. was required at least 140 MW. EGAT submitted the Power Development Plan of the Renewable Portfolio Standard (RPS) for New Power Plants of EGAT during 2008 - 2010 to the Ministry of Energy for approval. They comprised 6 hydropower projects with the total installed capacity of 78.7 MW, solar power of 1 MW, wind power of 2 MW. For the remaining renewable power (58.3 MW) such as garbage power, biomass power, etc., EGAT will buy the energy from the Small Power Producers (SPP) instead of constructing the power plants by itself. It is the first time of EGAT and Thailand to develop the renewable energy resources according to the RPS. The Cabinet Members approved the renewable energy development projects on October 30, 2007. Most of them are under construction, only some projects are in bid evaluation periods.

3. Hydropower Development at Existing Irrigation Dams

There are a lot of existing irrigation dams / reservoirs of RID designed and constructed for irrigation, flood control, etc. Six existing and under construction dams of RID were studied and proposed by EGAT to develop the small hydropower projects with the total installed capacity of 78.7 MW, namely Chao Phraya (2 x 6 MW), Naresuan (8 MW), Mae Klong (2 x 6 MW), Pasak Jolasid (6.7 MW), Khun Dan Prakarnchon (10 MW) and Khwae Noi (2 x 15 MW). The locations of all projects are shown in Figure 1. The general project descriptions are summarized in Table 1. The plant factors of the mentioned projects vary from 32 to 70 %., which are rather high. The average production cost of six small hydropower projects is about 5.0 US Cent / kWh (3.6 - 7.0 US Cent / kWh), which is lower than the production cost of solar power (59.4 US Cent / kWh) and wind power (20.4 US Cent / kWh) in Thailand.

According to the Memorandum of Understanding (MOU) between EGAT and RID for the cooperation to develop six hydropower projects at the irrigation dams, the energy benefit generated from the mentioned projects will be shared to RID due to the utilization of the water for the power generation. It is the new approach to develop the hydropower projects at the irrigation dams.

4. Naresuan Hydropower Project

Naresuan Dam is an example of six mentioned dams. It is the most important irrigation diversion dam in the Nan river basin, in Phitsanulok Province, about 410 km north of Bangkok, which was constructed by RID and commenced operation in 1980. It annually diverts 852 million m^3 of water to the Phitsanulok Irrigation Area and also releases 4,779 million m^3 of flow to downstream, to the Chao Phraya river basin. The diversion dam is the reinforced concrete structure for 5 spillway gates with the height of 7.60 m and the width of 12.50 m each. The closure dam is an earthfill type with the height of 16 m and the crest length of 180 m. The proposed powerhouse is located at the right abutment of the closure dam. It is designed as an indoor type with the reinforced concrete structure for 1 unit of Pit or Bulb turbine. The installed capacity is 8 MW and the average annual energy generated is about 43 GWh. This project is fully supported for construction by the concerned people around the project site because they can use the water discharging from the powerhouse easier than the previous condition.

Figure 2 shows the Longitudinal Section of Powerhouse of Naresuan Hydropower Project.

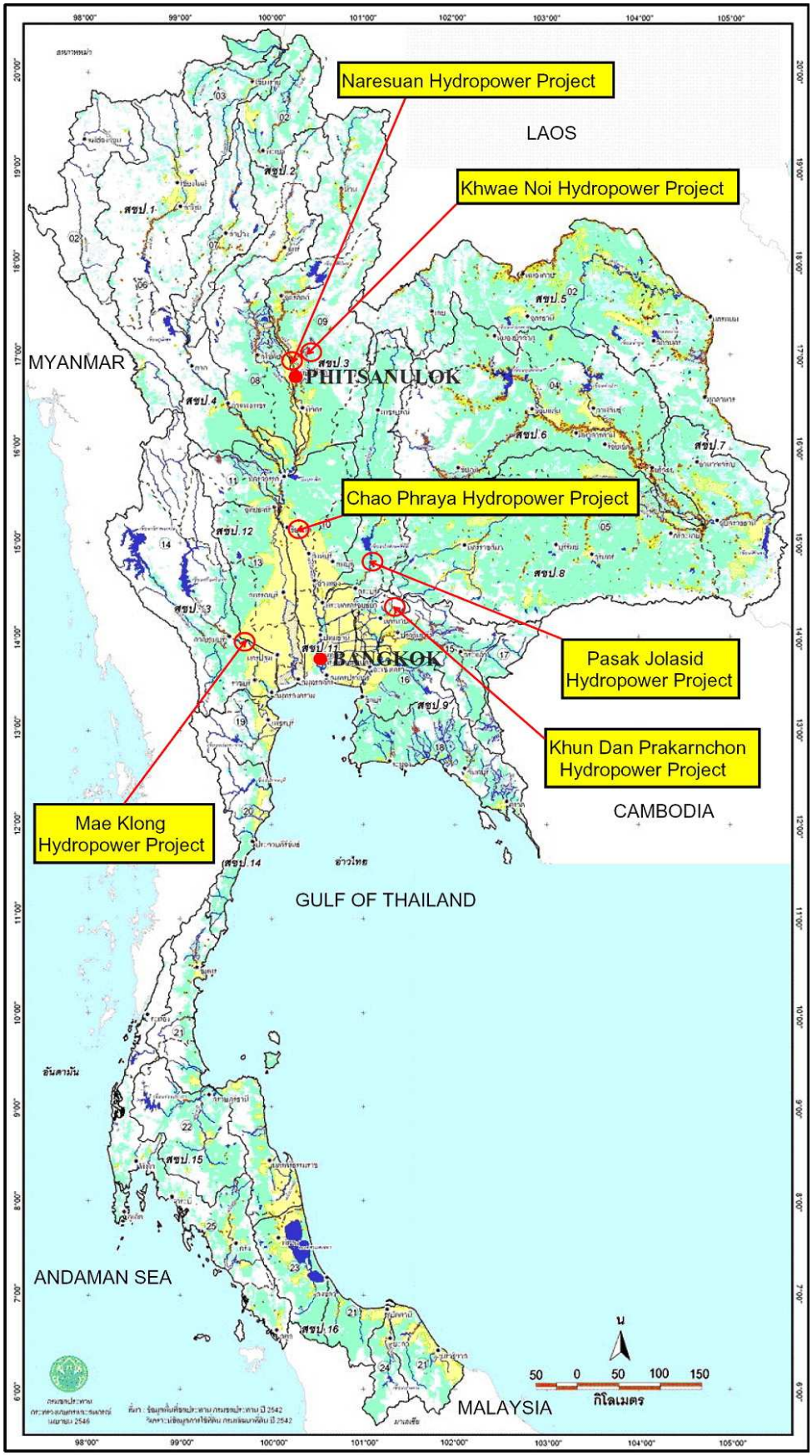

Figure 1 Location Map of Hydropower Projects at Existing Irrigation Dams in Thailand

Table 1 Summary of General Project Descriptions

Description	Unit	Project Name					
		Pasak Jolasid	Khun Dan Prakarnchon	Chao Phraya	Naresuan	Mae Klong	Khwae Noi
1. Existing Dam/ Reservoir							
1.1 River Name	-	Pasak	Khlong Tha Dan	Chao Phraya	Nan	Mae Klong	Khwae Noi
1.2 Purpose	-	Irrigation, Flood Control	Irrigation, Flood Control	Irrigation, Navigation	Irrigation	Irrigation, Navigation	Irrigation, Flood Control
1.3 Completed in	-	1999	2005	1957	1980	1970	Feb. 2009
1.4 Catchment Area	km^2	14,520	194	119,000	19,549	25,590	4,254
1.5 Average Annual Inflow	Mm^3	2,400	337	21,254	5,626	15,381	1,449
1.6 Effective Storage Capacity	Mm^3	782	220	145	8	8	733
1.7 Dam							
Type	-	Earthfill	RCC	Earthfill	Earthfill	Earthfill	CFR
Height	m	31.5	95	16	16	13	75
Crest Length	m	4,860	2,600	264	180	300	681
2. Proposed Hydropower Development							
2.1 Approach Channel							
Bottom Width	m	-	-	19-52	20	15	-
Length	m	-	-	270	290	650	-
2.2 Penstock	m						
Diameter	m	3.0	2.0	-			3.7-2.3
Length		287	50	-			117
2.3 Powerhouse	-						
Type		Semi Outdoor	Indoor	Indoor	Indoor	Indoor	Indoor
2.4 Tailrace Channel	m						
Bottom Width	m	8.0	7.5	18-75	25-70	38	15.5
Length		155	17	1,139	4,700	60	140
2.5 Power Generation Facilities							
Installed Capacity	MW	1 x 6.7	1 x 10	2 x 6	1 x 8	2 x 6	2 x 15
Turbine Type	-	S	Horizontal Francis	Pit or Bulb	Pit or Bulb	Pit or Bulb	Vertical Francis
Design Head	m	13.5	66.16	7.00	6.00	9.00	50.14
Unit Design Discharge	m^3/s	55.00	18.20	99.50	154.84	77.42	35.67
2.6 Average Annual Energy	GWh	35	28	62	43	74	147
2.7 Plant Factor	%	59	32	59	61	70	56
2.8 Production Cost (Exchange Rate: 1 USD = 35 THB)	US Cent/ kWh	4.3	5.8	6.3	7.0	5.3	3.6

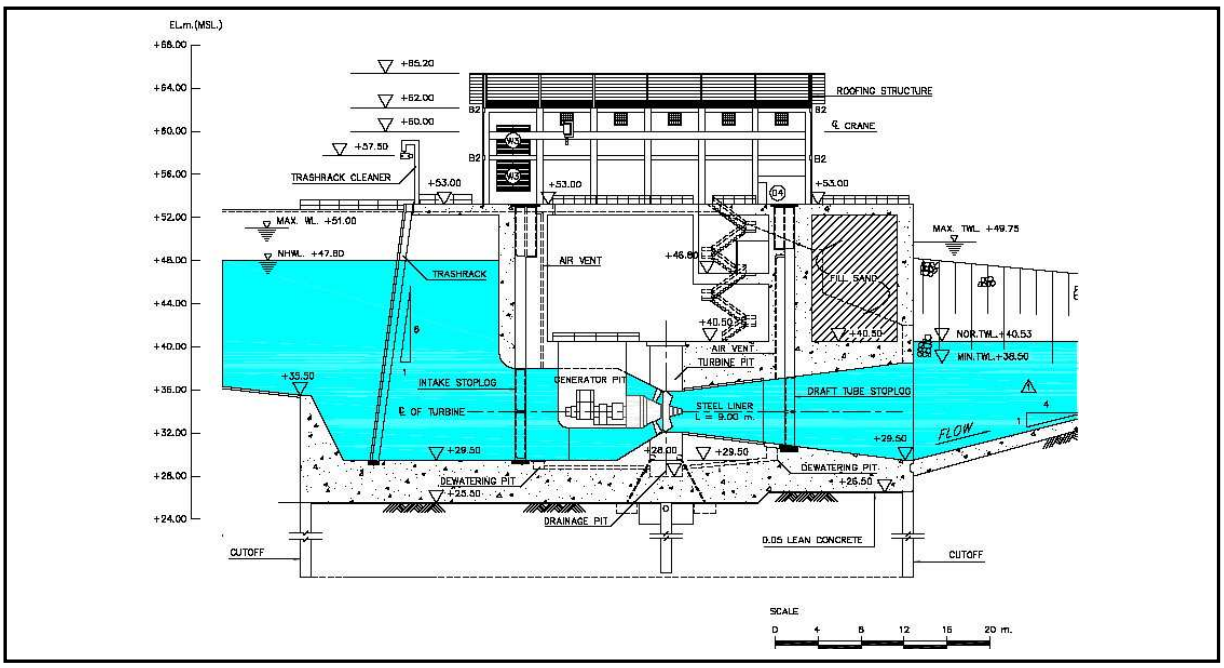

Figure 2 Longitudinal Section of Powerhouse of Naresuan Hydropower Project

5. Conclusion and Recommendations

The hydropower development at the irrigation dams is considered not only to utilize the existing water resources as the renewable energy resources for the country but also to achieve the value added to the investment. Six small hydropower projects are the pilot projects for the clean and renewable energy development at the existing irrigation dams in Thailand and it is expected to be the best example to develop the renewable energy resources of the country in the future.

Acknowledgment

The authors would like to express the sincere thanks to the Royal Irrigation Department (RID) for the kind cooperation of the study and the implementation of all projects.

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