Chapter 6

Power Exchange through the Transmission Highway

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Chapter 6

Power Exchange through the Transmission Highway

6.1 Exported Power Generation from the Lao PDR through the Transmission Highway

6.1.1 Power generation in the Lao PDR exported through candidate cross-border interconnections

The electric energy to be transmitted from the Lao PDR through the new interconnections is from the increase in energy export volume from the domestic power grid and new export-dedicated IPPs of the country. In addition, the rise in energy import from Thailand into the domestic power grid of the Lao PDR during the dry season is also expected.

6.1.2 Increase in export from the domestic power system of the Lao PDR

During the rainy season, the power generators in the domestic power grid of the Lao PDR produce a surplus of electric power. However, the capacity of the interconnections with Thailand is insufficient to transmit all the surplus power. When interconnections (1) and (3) with Thailand (Table 5.1) operate, the interconnection capacity will expand, and the amount of surplus power exported to Thailand from domestic power supply generators will increase. This increase is calculated from Lao PDR's power supply and demand balance and factored into the rise in the country's hydropower generation. Interconnection line (4) will only transmit electricity from the export-dedicated IPPs.

During the dry season, the power output of hydropower plants in the domestic power grid of the Lao PDR declines, requiring imports from Thailand. Although building a new thermal power plant to secure electric power for the dry season is possible, the amount of electric power imported from Thailand through new interconnection lines in (1) and (4) is estimated to be the amount of electric power that can secure the power supply in the dry season.

Table 6-1 Increase in Imports from Thailand to the Domestic Power Grid of the Lao PDR (Annual) (Unit: GWh)

	2030	2035
Import from Thailand due to existing interconnected capacity	780	1,742
Imports from Thailand by expanding the interconnection (+1000MW*)	780	4,224
Increase in imports from Thailand	0	2,482

*MK. Pakbeng vacancy and the increase in interconnection capacity due to the linkage between the vicinity of 230 kV Vientiane and Thailand
Source: Authors.

6.1.3 New IPPs for exporting

Table 6-2 lists the export-dedicated IPPs in the Lao PDR to Thailand. Existing plants are (1), (2), (7), (8), and (14), and (13) Xepien–Xenamnoy hydropower plant is under construction in southern Lao PDR. The planned (9) MK. Pakbeng hydropower plant in the north and the hydropower plants in Sekong province in the south of (10) to (12) are expected to account for the increase in Lao's hydropower in 2030. IPPs (10) to (12) are expected to be transmitted to Thailand by the export-dedicated lines under construction at the (13) Xepien–Xenamnoy hydropower station.

Table 6-2 Export-dedicated IPPs in the Lao PDR to Thailand

Power Plant	MW	Type.	COD	Status	Remarks
Theun-Hinboun	440.0	Reservoir	1998	existing	existing export-dedicated line
Nam Theun 2	1,000.0	Reservoir	2009	existing	existing export-dedicated line
Nam Ngum 2	615.0	Reservoir	2010	existing	Existing export-dedicated lines (Nabong substation)
Nam Ngum 3	480.0	Reservoir	2020	under construction	Existing export-dedicated lines (Nabong substation)
Nam Ngiep 1	294.0	Reservoir	2019	existing	Existing export-dedicated lines (Nabong substation)
Nam Theun 1	520.0	Reservoir	2022	under construction	Existing export-dedicated lines (Nabong substation)
Hongsa Lignite (T)	1,778.0	Thermal	2015	existing	Existing export-dedicated line
MK. Xayaboury	1,225.0	Run of river	2019	existing	Existing export-dedicated line
MK. Pakbeng	798.0	Run of river			Planned export-dedicated lines (including part of Table 5-1 (1))
Sekong 5	330.0	Reservoir			
Xekong 4A	175.0	Reservoir			
Xekong 4B	165.0	Reservoir			
Xepien - Xenamnoy	370.0	Reservoir	2019	under construction	Export-dedicated lines under construction (including part of Table 5-1 (4))
Houay Ho	150.0	Reservoir			Existing export-dedicated line to be returned from IPP to Lao PDR with 2029 BOT deadline

BOT = build-operate-transfer
Source: Authors.

In addition to the above, the wind power station in Attapeu province, which was considered for Viet Nam, was expected to be used for wind farms.

6.1.4 IPPs in the Lao PDR for exporting to Thailand and Viet Nam

Table 6.3 shows the IPPs in the Lao PDR to be exported by candidate interconnections.

Table 6-3 IPPs in the Lao PDR Exported by Candidate Cross-Border Interconnections

Power Station	Rated Capacity [MW]	Annual Generation [GWh/year]
MK. Pakbeng	798	4,169
Sekong 5	330	1,613
Xekong 4A	175	781
Xekong 4B	165	749
Xepien - Xenamnoy (e) ***	370	1,794
Wind power in Attapeu	600	1,505
Total	**2,438**	**10,611**

*** Existing contracts
Source: Authors.

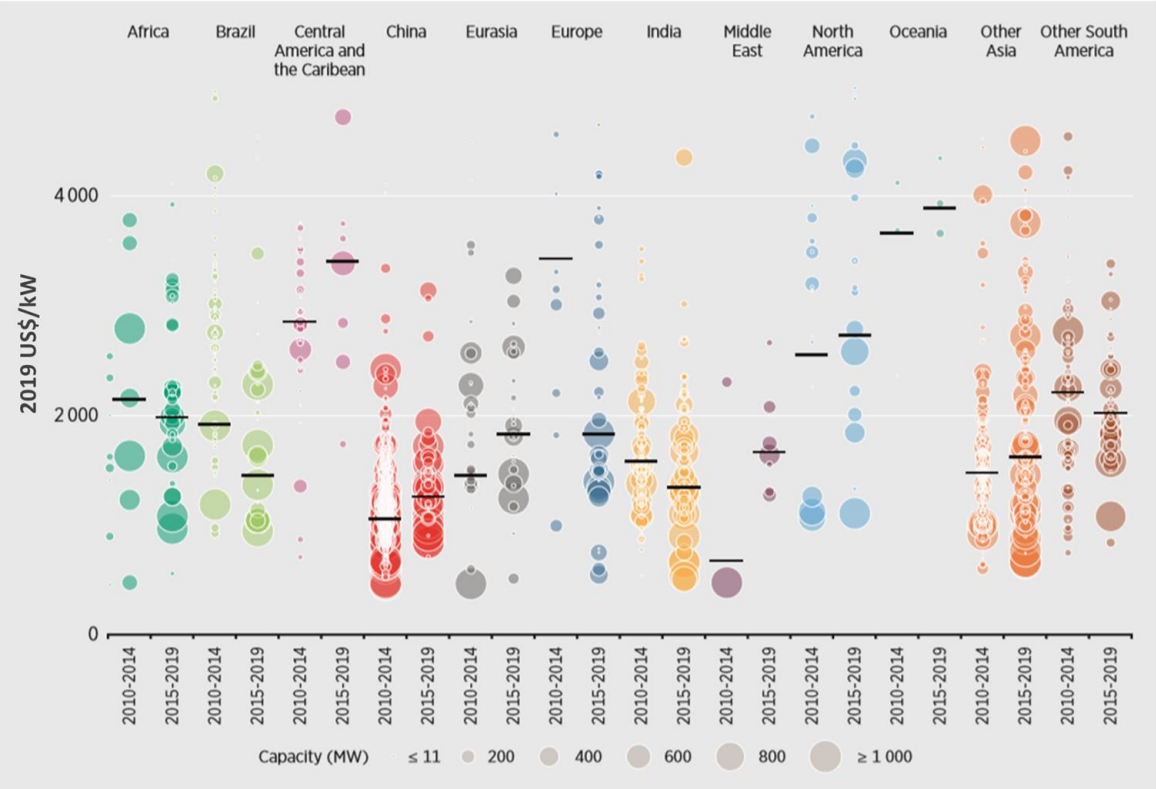
6.1.5 Assumptions for installation cost estimation of new power stations

According to IRENA (2019), the total installed cost varies from region to region. The total installed hydropower costs are highest in Oceania, Central America, and the Caribbean, while lowest in China and India (Figure 6-1). The IRENA study divided total installed costs in Asia amongst China, India, and others. Since the development of hydropower assumed in this survey is a plan in the Lao PDR to calculate the construction cost of the hydropower plant, this survey referred to the cost of China, which is US$1,264/kW.

On the other hand, the total installed costs for onshore wind are highest in Other Asia, Middle East and Africa, Europe, Central America and the Caribbean, South America (excluding Brazil), and Oceania. Brazil, China, and India have more mature markets and lower cost structures than their neighbours (Table 6-4). Similar to hydropower, to calculate the construction cost of the onshore wind power plant, this survey referred to the cost of China, which is US$1,223/kW.

Table 6-5 shows the cost estimate for each new power station. The total installation cost of new IPPs is US$4,016 million.

Figure 6-1 Total Installed Cost Ranges and Capacity Weighted Averages for Large Hydropower Projects, by Country and Region



Source: IRENA (2019).

Table 6-4 Total Installed Cost Ranges and Weighted Averages for Onshore Wind Projects, by Country and Region, 2010 and 2019

	2010			2019		
	5th percentile	Weighted average	95th percentile	5th percentile	Weighted average	95th percentile
	(2019 US$/kW)					
Africa	2,226	2,291	3,196	1,448	1,952	2,189
Other Asia	1,829	2,501	2,762	1,392	2,368	3,709
Central America and the Caribbean	2,497	2,664	2,787	1,737	1,737	1,737
Eurasia	2,284	2,432	2,501	1,277	1,633	2,035
Europe	1,575	2,405	3,602	1,071	1,800	2,233
North America	1,594	2,407	3,696	1,099	1,636	2,162
Oceania	2,993	3,501	3,882	1,157	1,555	1,788
Other South America	2,399	2,644	2,729	1,123	1,718	2,270
Brazil	2,252	2,539	2,603	1,224	1,559	2,061
China	1,173	1,491	2,038	1,115	1,223	1,340
India	1,013	1,412	1,941	1,039	1,055	1,082

Source: IRENA (2019).

Table 6-5 Installation Cost of New IPPs

Power Station	Rated Capacity [MW]	Installation cost [mil. US$]
MK. Pakbeng	798	1,009
Xekong 5	330	417
Xekong 4A	175	221
Xekong 4B	165	209
Xepien - Xenamnoy (e) ***	370	468
Wind power in Attapeu	600	734
Total	**2,438**	**3,057**

*** Existing contracts.
IPP = independent power producer.
Source: Authors.

6.2 Power Exchange Settings

Table 6-6 shows the power exchange settings for study analysis.

Table 6-6 Power Exchange Settings for Study Analysis (GWh/year)

Power Station and Power Exchange	2030	2035	Type	Power generation	Power receiving
Increase in exports from Lao PDR to Thailand	2,563	1,404	Hydropower	Lao PDR	Thailand
Increase in imports from Thailand to Lao PDR	0	2,482	Thermal power	Thailand	Lao PDR
MK. Pakbeng	4,169	4,169	Hydropower	Lao PDR	Thailand
Xekong 5	1,613	1,613	Hydropower	Lao PDR	Viet Nam
Xekong 4A	781	781	Hydropower	Lao PDR	Viet Nam
Xekong 4B	749	749	Hydropower	Lao PDR	Viet Nam
Xepien - Xenamnoy ***	1,794	1,794	Hydropower	Lao PDR	Thailand
Wind power in Attapeu	1,505	1,505	Wind power	Lao PDR	Viet Nam
Increase in export from Thailand to Myanmar	6,000	6,000	Import from Lao PDR	Thailand	Myanmar
Increase in export from Thailand to Cambodia	2,000	2,000	Import from Lao PDR	Thailand	Cambodia

*** Existing contracts.
Source: Authors.

Table 6-7 lists the power sources that will be transmitted by candidate cross-border interconnections.

Table 6-7 Power Sources for Candidate Cross-Border Interconnections

	Section.	Independent Power Plant (IPP)	Power Sources
(1)	MK. Pakbeng – (Mae Moh–Tha Tako)	MK. Pakbeng	(Rainy seasons) Increase in exports to Thailand from domestic power grid of Lao PDR x 1/2 (Dry seasons) Increase in imports to domestic power grid of Lao PDR Lao from Thailand x 1/2
(2)	(Mae Moh–Tha Tako) – Mawlamyaing		Export from Thailand to Myanmar
(3)	Vientiane–Bunkan		(Rainy seasons) Increase in exports to Thailand from domestic power grid of Lao PDR x 1/2 (Dry seasons) Increase in imports to domestic power grid of Lao PDR Lao from Thailand x 1/2
(4)	Xekong–Roi Et	Xepien–Xenamnoy	
(8)	Chaiyaphum–Banteay Meanchey		Export from Thailand to Cambodia
(9)	Thanh My–Xekong	Wind power in Attapeu, Xekong 5, 4A, 4B	

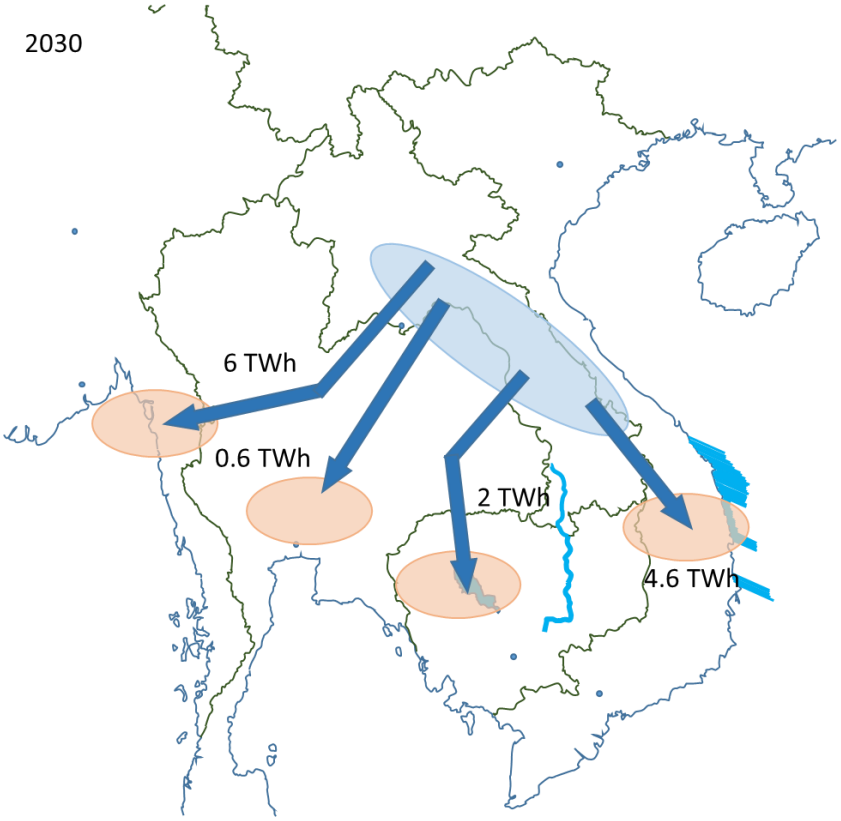
Source: Authors.

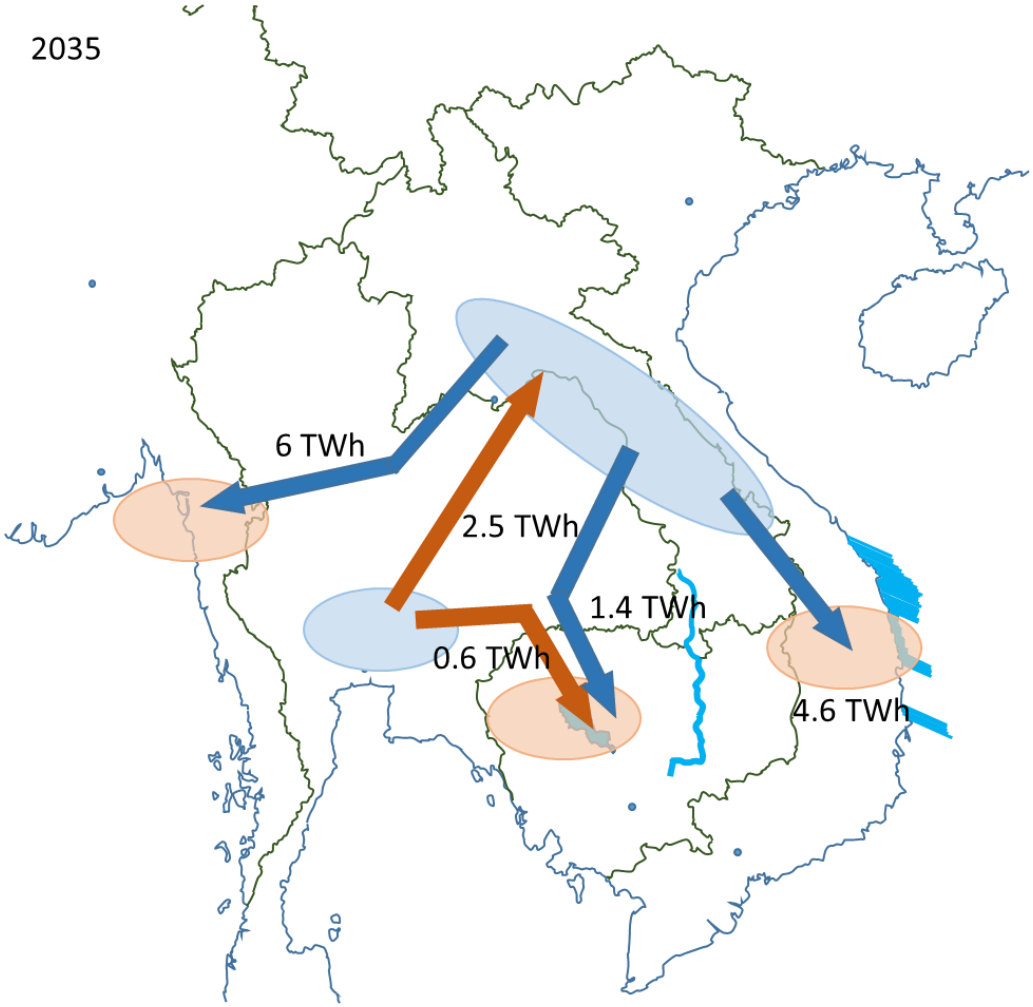
6.3 .Expected Power Trade

Figure 6-2 shows the expected power trade amongst ACMECS countries. The country with increased energy generated is the sending end of the flow, and the country with decreased energy generated is the receiving end of the flow. Here, the power flow assumptions did not include existing power trade but assumed the amount of power flow for which new power trades are expected.

The Lao PDR could export additional power energy to Cambodia, Myanmar, Thailand, and Viet Nam. The Lao PDR exports 6 TWh of power energy to Myanmar via Thailand, 0.6 TWh to Thailand, 2 TWh to Cambodia via Thailand, and 4.6 TWh to Viet Nam in 2030. The power demand in the Lao PDR increases, and power trade condition changes from 2030 to 2035. The Lao PDR exports 6 TWh of power energy to Myanmar via Thailand, 1.4 TWh to Cambodia via Thailand, and 4.6 TWh to Viet Nam, while Thailand exports 2.5 TWh to the Lao PDR and 0.6 TWh to Cambodia in 2035.

Figure 6-2 Expected Power Trade





Source: Authors.

6.4 Changes in the Amount of Power Generation in Each Country through the Transmission Highway

The changes in the amount of electricity generated in each country due to the power trade are compared with each country's supply and demand balance in the energy outlook (ERIA, 2019).

Some of the new hydropower plants shown in Table 6-2 already seem to be included in the 2030 and 2035 hydropower plants in the energy outlook (ERIA, 2019). Still, no breakdown is available, so the increase in the amount of energy generated by hydropower plants in the Lao PDR from the original figures is not known. However, changes in the amount of energy generated by thermal power plants in Cambodia, Myanmar, Thailand, and Viet Nam can be considered changes from the original figures.

In Cambodia, the power demands are about 20 TWh in 2030 and 27 TWh in 2035. According to discussions with the MME in working group meetings, the power imports account for less than 10% of power generation in terms of energy security. Thus, the electricity exports to Cambodia are assumed to be 2 TWh: 0.5 TWh of imported energy for reduced thermal power generation, and the remaining 1.5 TWh is supplied to domestic power demand to contribute to the electricity access in 2030. Then, half of the imported energy is for reduced thermal power generation, and the remaining half is used for electricity access in 2035.

In Myanmar, the power demand is about 36 TWh in 2030 and 46 TWh in 2035. Since the electricity access ratio is still low, this study set the amount of imported energy at 6 TWh, accounting for about 17% of total power demand in 2030 and about 13% in 2035. Half of the imported energy is used to reduce thermal power generation, and the remaining half is supplied to domestic power demand to contribute to electricity access.

Table 6-8 Energy Outlook and Changes in Power Generation by Using the Candidate Cross-Border Interconnections in Different Countries

2030		Lao PDR	Thailand	Myanmar	Viet Nam	Cambodia
Primary energy supply (Import) (TWh)						
	Original	-35.14	61.91	0.00	5.97	1.82
	Scenario	-13.20	0.60	6.00	4.60	2.00
Final energy consumption						
Final energy consumption		7.11	273.88	36.29	374.95	19.73
				3.00		1.50
Total		42.32	237.18	40.33	398.90	19.05
Power generation output (TWh)						
Coal		20.71	38.11	14.54	253.42	6.87
				-3.00	-4.60	-0.50
				11.54	248.82	6.37
				-20.6%	-1.8%	-7.3%
Oil		0.00	0.62	0.00	0.00	0.00
Natural gas	Original	0.00	150.58	9.30	85.00	2.42
	Scenario		-2.60			
			147.98			
			-1.7%			
Hydro	Original	21.61	13.24	13.37	60.11	9.55
	Scenario	11.70				
Others		0.00	34.63	3.13	0.38	0.21
	Scenario	1.50				
Power generation input (MTOE)						
Coal	Original	5.09	9.18	3.29	59.21	1.64
	Scenario			-0.68	-1.07	-0.12
				2.61	58.14	1.52
				-20.6%	-1.8%	-7.3%
Oil		0.00	0.14	0.00	0.00	0.00
Natural gas	Original	0.00	27.01	2.00	14.28	0.43
	Scenario		-0.47			
			26.54			
			-1.7%			

	2035	Lao PDR	Thailand	Myanmar	Viet Nam	Cambodia
Primary energy supply (Import) (TWh)						
	Original	-33.50	88.93	0.00	5.97	1.82
	Scenario	-9.60	-3.10	6.00	4.60	2.00
Final energy						
Final energy consumption		8.71	312.15	45.67	441.53	26.79
				3.00		1.00
Total		42.32	251.27	50.48	469.84	26.57
Power generation output (TWh)						
Coal		20.71	49.01	17.91	313.14	9.82
	Original			-3.00	-4.60	-1.00
	Scenario			14.91	308.54	8.82
				-16.8%	-1.5%	-10.2%
Oil		0.00	1.80	0.00	0.00	0.00
Natural gas	Original	0.00	145.81	12.30	96.72	3.15
	Scenario		3.10			
			148.91			
			2.1%			
Hydro	Original	21.61	14.29	16.43	59.60	13.05
	Scenario	8.10				
Others	Original	0.00	40.35	3.84	0.37	0.56
	Scenario	1.50				
Power generation input (MTOE)						
Coal	Original	5.09	11.55	4.05	71.99	2.22
	Scenario			-0.68	-1.06	-0.23
				3.37	70.93	1.99
				-16.8%	-1.5%	-10.2%
Oil		0.00	0.40	0.00	0.00	0.00
Natural gas	Original	0.00	26.16	2.64	16.12	1.25
	Scenario		0.56			
			26.72			
			2.1%			

Source: ERIA (2019), modified by the author.

Table 6-9 shows the summary of changes in power generation by using the candidate cross-border interconnections in different countries under the above conditions, assuming the power trade of hydro and wind power generation in the Lao PDR.

Table 6-9 Summary of Changes in Power Generation by Using the Candidate Cross-Border Interconnections in Different Countries

	Countries	Energy outlook (TWh)	Fuel type	Changes (TWh)	Study case (TWh)	Change Ratios (%)
2030	Thailand	150.58	Natural gas	-2.6	147.98	-1.7
	Myanmar	14.54	Coal	-3	11.54	-20.6
	Viet Nam	253.42	Coal	-4.6	248.82	-1.8
	Cambodia	6.87	Coal	-0.5	6.37	-7.3
2035	Thailand	145.81	Natural gas	3.1	148.81	2.1
	Myanmar	17.91	Coal	-3	14.91	-16.8
	Viet Nam	313.14	Coal	-4.6	308.54	-1.5
	Cambodia	9.82	Coal	-1	8.82	-10.2

Source: Authors.

In Thailand and Viet Nam, the amount of energy generated by the original thermal power plants is large, and the change is only a small percentage. In Myanmar, the scale of demand is small, and the change is close to 20% of the total amount of energy generated by the coal-fired power plants in the country.