Chapter 7

Cost-Benefit Analysis of the Transmission Highway

December 2021

This chapter should be cited as
Study Team (2021), 'Cost-Benefit Analysis of the Transmission Highway', in Kimura, Shigeru and K. Ueda (eds.), *Feasibility Study on the Transmission Highway in ACMECS.* ERIA Research Project Report FY2021 No. 17, Jakarta: ERIA, pp.87-102.

Chapter 7

Cost–Benefit Analysis of the Transmission Highway

This chapter calculates the economic and social benefits of the candidate cross-border interconnections proposed in the previous chapter.

7.1 Assumptions of Benefit Analysis

The study assumed the following in calculating the benefits of the candidate cross-border interconnections:

1) Power flow through candidate cross-border interconnections

- The amount of power flow is the main criterion for calculating benefits. The power flows of the candidate cross-border interconnections were based on the results from the previous chapter.
- The amount of electricity exports to Myanmar is 6 TWh/year, of which 50%, 3 TWh/year, was used for reduced thermal power generation, and the remaining 3 TWh/year was used for electricity access.
- The amount of electricity exports to Cambodia is 2 TWh/year. However, according to discussions with the MME during working group meetings, the power imports account for less than 10% of power generation in terms of energy security. Thus, 0.5 TWh/year of 2 TWh/year will be used to reduce thermal power generation, and the remaining 1.5 TWh/year will be used for electricity access before 2035. Then, 1.0 TWh/year of 2 TWh/year will be used for reduced thermal power generation, and the remaining 1.0 TWh/year will be used for electricity access after 2035.

2) Fuel cost reduction

- The unit fuel cost of natural gas was calculated by using the natural gas consumption and fuel utilisation cost in the EGAT *Annual Report 2018*. It uses the unit cost of US$8.33/MBTU (Mega British Thermal Unit).

Table 7-1 Unit Cost of Natural Gas

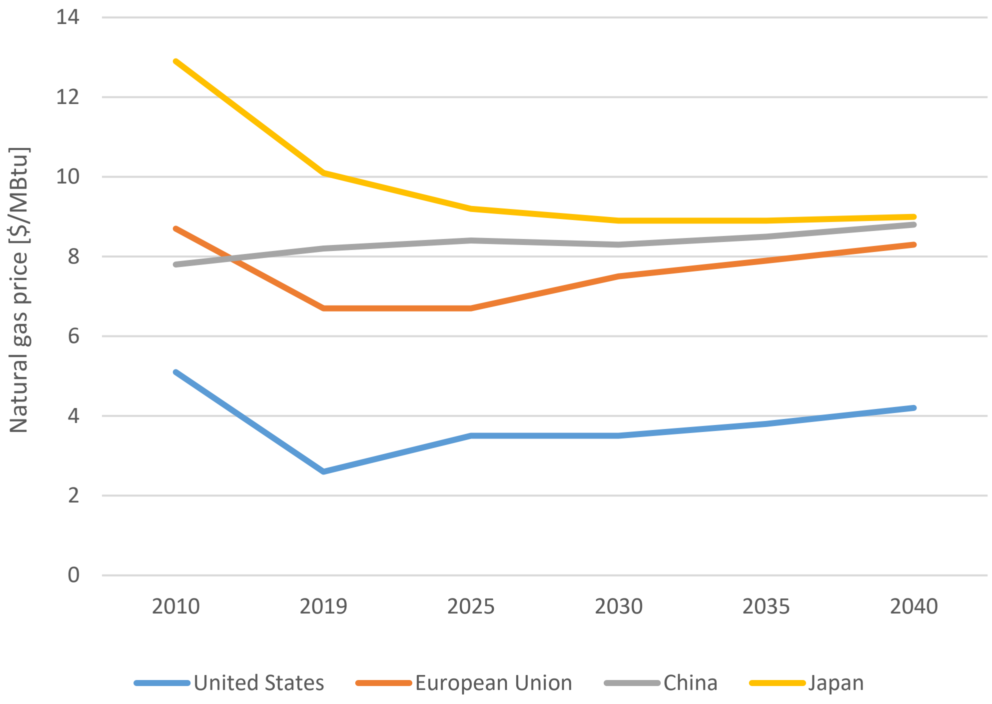
Fuel type	Fuel consumption (MBTU)	Fuel cost (million baht)	Unit cost (baht/MBTU)	Unit cost (US$/MBTU)
Natural gas	383.91	99,896.12	260.21	8.33

MBTU = Mega British Thermal Unit.
Source: EGAT (2018).

- The study used the Indonesian free-on-board (FOB) coal price of US$77.9/tonne, which is the average price in 2019, to calculate the fuel cost reduction of coal-fired power.

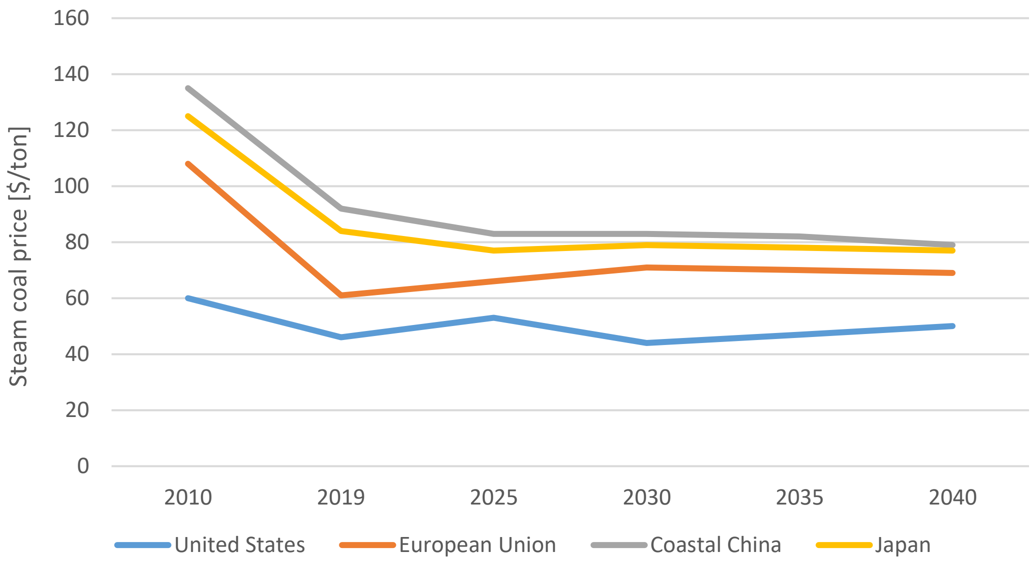
The future fuel unit cost was estimated based on future fuel prices described in the IEA's data (Figures 7-1 and 7-2). This study referred to the trend of China's future price scenario for the future price calculation.

Figure 7-1 Trend of Natural Gas Price



Source: IEA, Report Extract Macro Drivers, https://www.iea.org/reports/world-energy-model/macro-drivers (accessed 3 February 2021), modified by the author.

Figure 7-2 Trend of Coal Price



Source: IEA, Report Extract Macro Drivers, https://www.iea.org/reports/world-energy-model/macro-drivers (accessed 3 February 2021), modified by the author.

3) Reduction in new investment of thermal power plant

If thermal power generation can be reduced by importing electricity from neighbouring countries, new investment in thermal power plants can be reduced. This study analyses the decrease in new investment in thermal power plants due to power imports under the following conditions.

- **Table 7-2 assumes the installation cost of each type of thermal power plant.**

Table 7-2 Unit Installation Cost of Thermal Power Plant

Fuel type	Unit installation cost (US$/kW)
Coal (SC)	1,600
Natural gas (CCGT)	700

SC = supercritical, CCGT = combined cycle gas turbine.
Source: IEA (2015).

- **The assumptions of the capacity factor of each type of thermal power plant are shown in Table 7-3.**

Table 7-3 Capacity Factor of Each Type of Thermal Power Plant

Fuel type	Capacity Factor [%]
Coal	0.85
Natural gas (GT)	0.85

GT = gas turbine.
Source: Timilsina (2020).

4) CO_2 emission reduction and carbon pricing

Greenhouse gas (GHG) emissions, including CO_2, have become a global issue. To address this global challenge, 196 parties adopted the Paris Agreement at COP21 in 2015. The Paris Agreement is a legally binding international treaty on climate change. Its goal is to limit global warming to well below 2, preferably 1.5, degrees Celsius than pre-industrial levels. Countries aim to reach global peaking of GHG emissions as soon as possible to achieve a climate-neutral world by mid-century to achieve this long-term temperature goal.[3]

As of September 2017, all AMSs had signed and ratified the Paris Agreement, joining the global cooperative effort to mitigate and adapt to climate change. As the heart of the Paris Agreement, the nationally determined contributions (NDCs) chronicle the climate strategy of each party to the agreement in reducing GHG emissions, including associated policies, financial measures, and progress towards achieving the targets. Most AMSs have transformed their intended nationally determined contributions into NDCs by ratifying them (Yurnaidia et al., 2021).

---

[3] UNFCCC, The Paris Agreement, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (accessed 12 January 2021).

At present, the proportion of 'energy-derived CO_2' emitted from fuel combustion and the use of supplied electricity and heat are high in many countries. As mentioned in the previous chapter, the ratios of thermal power to total installed capacity are the highest in all ACMECS countries except the Lao PDR. If Lao PDR's hydropower can be utilised through the Transmission Highway, it will be possible to reduce the amount of thermal power generation in each country, thus contributing to reduced CO_2 emissions. Therefore, this study analysed the CO_2 emission reduction by utilising the Transmission Highway.

CO_2 emissions from electricity generation vary by type of fuel/energy source and by type and efficiency of electric power plants. The amount of CO_2 produced per kWh during any time will vary according to the sources of electricity supplied to the electric power grid during that time. Therefore, electricity-related CO_2 emissions and CO_2 emission factors will change hourly, daily, monthly, and annually. The US Energy Information Administration (EIA) reported on US electric utility and independent power electricity generation and resulting CO_2 emissions by fuel in 2019 (Table 7-4). This study uses the emission factor of 1.0 × 10-4 metric tonnes CO_2/kWh for coal-fired thermal power and 0.41 × 10-4 metric tonnes CO_2/kWh for natural gas thermal power.[4]

Table 7-4 US Electric Utility and Independent Power Electricity Generation and Resulting CO_2 Emissions, by Fuel, in 2019

Fuel type	Electricity generation [GWh]	CO_2 emissions [million metric tons]	CO_2 emissions factor [metric tons CO_2/kWh]
Coal	947,891	952	1.00 x 10-3
Natural gas	1,358,047	560	0.41 x 10-3
Petroleum	15,471	15	0.97 x 10-3

Source: EIA data, modified by the author.

This study also analysed the benefits of 'carbon pricing', a market-based strategy for lowering GHG emissions. Its purpose is to set a monetary value on carbon emissions so that the costs of climate change impacts and opportunities for low-carbon energy options are better reflected in our production and consumption choices.

According to the World Bank (2021), 61 carbon pricing initiatives are now in place or scheduled for implementation. These comprise 31 emissions trading systems (ETSs) and 30 carbon taxes, covering 12 gigatons of CO_2 equivalent ($GtCO_2e$) or about 22% of global GHG emissions. In ACMECS countries, Thailand and Viet Nam are also considering ETS or carbon tax.

The High-Level Commission on Carbon Prices estimated that carbon prices of at least US\$40–80/tCO_2 by 2020 and US\$50–100/tCO_2 by 2030 are required to reduce emissions cost-effectively in line with the temperature goals of the Paris Agreement. However, as of today, less than 5% of GHG emissions currently covered by a carbon price are within this range, with about half of covered emissions priced

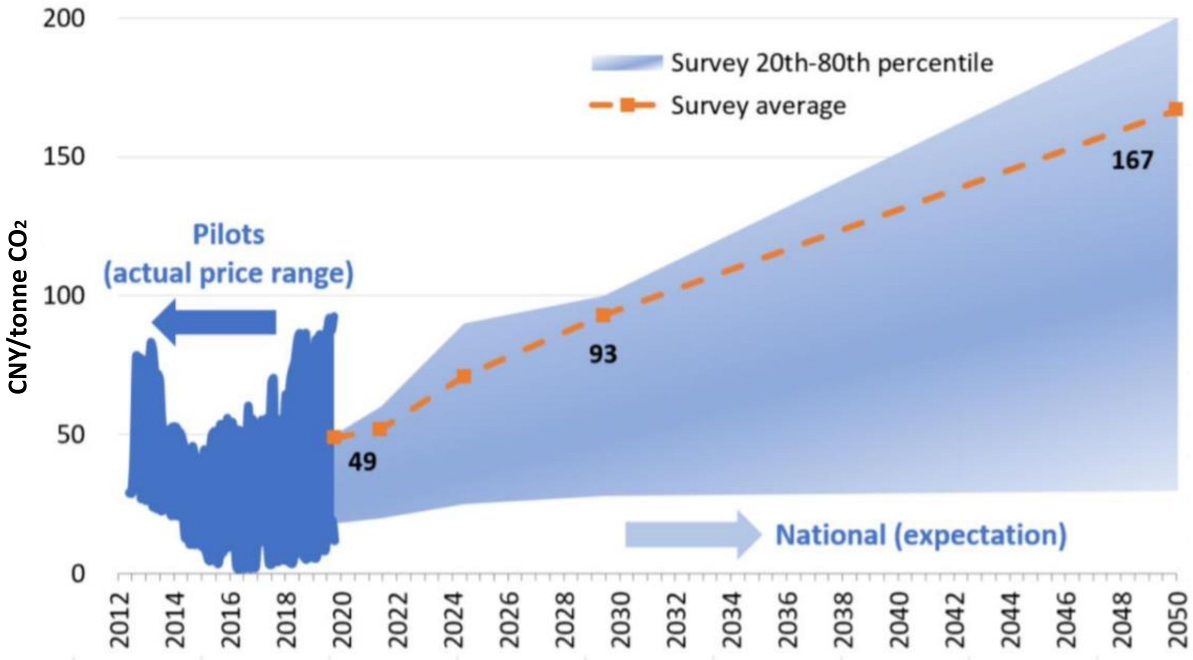
---

[4] EIA, https://www.eia.gov/tools/faqs/faq.php?id=74&t=11 (accessed 11 January 2021).

at less than US$10/$tCO_2e$. The International Monetary Fund calculates the global average carbon price to be only US$2/$tCO_2$. (World Bank, 2021)

The China Carbon Forum implemented the 2020 China Carbon Pricing Survey in July–August 2020, obtaining expectations about the future of carbon pricing in China from hundreds of stakeholders. They asked for stakeholders' carbon price expectations to mid-century to understand how carbon pricing may play a role in China's mid- to long-term decarbonisation strategy. According to this survey, the average price expectation in the national carbon market starts at CNY49/tonne in 2020, rising to CNY71/tonne in 2025, CNY93/tonne by 2030, and CNY167/tonne by 2050 (Figure 7-3). However, as in most carbon markets, the actual price levels remain highly uncertain, especially in the more distant future (Slater et al., 2020).

Figure 7-3 Range of Prices in the Pilot Systems to-date, and Estimated Prices in China



Source: Slater et al. (2020).

Since there are no carbon pricing initiatives in ACMECS countries, this study referred to this carbon pricing estimation in China to calculate the benefit of reduced CO_2 emissions. The carbon price converted by the average value of the Chinese yuan and the US dollar in 2020 (CNY1.0 = US$0.145) is shown in Table 7-5.

Table 7-5 Average Carbon Price Estimation in China

	Carbon price (CNY/tonne)	Carbon Price (US$/tonne)
2020	49	7.1
2025	71	10.3
2030	93	13.5
2050	167	24.2

Source: Slater et al. (2020), modified by the author.

5) Impact of electricity access on GDP in Myanmar and Cambodia

- This study referred to the following data from ERIA's *Energy Outlook* report (ERIA, 2019) to calculate the impact of electricity access on GDP in Myanmar and Cambodia.
  - GDP
  - GDP per capita
  - Electricity consumption
  - Population
- According to The Rockefeller Foundation[5], electricity access can increase household per capita income by 39% in Africa. Since the per capita income in Africa is the same as in Myanmar and Cambodia, this study uses this percentage to calculate the impact on GDP.
- Utilise 3 TWh/year out of 6 TWh/year of electricity exports to Myanmar for electricity access.
- Utilise 1.5 TWh/year before 2035 and 1 TWh/year out of 2 TWh/year after 2035 out of 2 TWh/year to Myanmar for electricity access.

6) Wheeling charge

Wheeling charge is the price power network users pay transmission asset owners and operators to use their assets (Energy & Environment, 2015). Generally, a power producer such as an IPP pays a usage fee to transmission asset owners and operators to supply electricity to the purchaser. The wheeling charges should reflect the full costs (fixed and variable) to the transmission owner to provide the necessary transmission infrastructure and services. This could include capital cost, asset depreciation, O&M costs, and any associated losses. In addition, the wheeling charge also needs to consider both the physical and commercial aspects of power transmission. Some key aspects to be considered in a basic arrangement are summarised as follows:

- amount of wheeling capacity
- time duration of the transmission
- grid or country entry and exit points
- metering of actual power flows
- agreed balancing procedures (to be used if a counterparty fails or is unable to honour the agreed transaction volumes)
- how to handle transmission losses
- an agreement on managing taxation of cross-border trades.

This methodology can cover both long-term bilateral trading agreements and short-term trading (IEA, 2019).

As mentioned, the wheeling charge depends on the conditions of each transmission line; thus, the wheeling charge should be fixed through careful discussion. JICA, in 2017, surveyed the South African Power Pool (SAPP). The study was conducted to follow up the 5th Tokyo International Conference on African Development. The study reviewed power system

---

[5] The Rockefeller Foundation, https://www.rockefellerfoundation.org/blog/access-to-electricity-is-critical-to-africas-growth/ (accessed 15 October 2020).

development plans, such as the existing master plans and relevant information, found and prioritised issues and projects comprehensively to realise a power pool as part of the strategic master plan formation for the Southern African region. According to this study, the wheeling charge for 92 routes of transmission lines in SAPP was listed, and the price range was 0.004–0.685 cents/kWh in 2016. The wheeling charge in SAPP was calculated based on:

- The available capacity calculation for power trade on all transmission systems in SAPP
- Usage charge calculation in each transmission facility with their book values
- Summation of charges on transmission facilities for all routes.

SAPP charges are very low because the book value of existing power transmission facilities is low. In other words, power transmission facilities are considerably old. Therefore, the wheeling charge may sharply rise in the future as new transmission lines are built (JICA, 2017).

This study analysed the income from wheeling charges through cost–benefit analysis. The unit price of wheeling charge should be set to calculate income. Since this study assumed the construction of new cross-border interconnections between ACMECS countries, it is appropriate to set the unit price of wheeling charge higher than the case of SAPP at least. Based on the above, this study roughly conducted a benefit analysis assuming a 1 cent/kWh unit price for all candidate cross-border interconnections. Since the distance and construction cost of the cross-border interconnections are different, the wheeling charges should be decided for each cross-border interconnection in actual operation.

7) Calculation Period

The calculation period was assumed to be 25 years, the same as the period for calculating the construction cost.

8) Net Present Value (NPV)

To account for the time value of money, the yearly net benefit was discounted and then summed to see how the present value of the benefit compares to the other. The formulation of NPV is expressed in Equation (2).

$$NPV = \sum_{n=0}^{N} \frac{B_n - C_n}{(1+r)^n} \qquad (2)$$

Where:

N: calculation period

n: point in time (n = 0 means present)

B: is benefits gained by cross-border interconnections

C: cost incurred by cross-border interconnections

r: discount rate

9) Internal Rate of Return (IRR)

The IRR is the discount rate that forces the expected cash flows to equal the initial cash flow. This is equivalent to forcing the NPV to equal zero. The IRR is an estimate of the project's rate of return. If this return exceeds the cost of funds used to finance the project, then the difference benefits the firm's stockholders. On the other hand, if the IRR is less than the cost of capital, stockholders must make up for the shortfall. .

To calculate the IRR, begin with Equation (2) for the NPV, replace *r* in the denominator with *IRR* and choose a value of *r* so that the NPV equals zero. This transforms Equation (2) into Equation (3), the one used to find the IRR (Brigham and Ehrhardt, 2010).

$$NPV = \sum_{n=0}^{N} \frac{CF}{(1+IRR)^n} = 0 \qquad (3)$$

Where:

CF: Cash flow

IRR: Internal rate of return

Based on the above assumptions, the benefits of each interconnection will be calculated in the following sections.

7.2 Fuel Cost Reduction of Thermal Power Plants

Many benefits can be obtained by power trade through cross-border interconnections. One of them is fuel cost reduction of the thermal power plant as an economic benefit. The summary of fuel cost reduction is shown in Table 7-6. The results of fuel cost reductions for 25 years are US$1,569 million in Thailand; US$2,614 million in Viet Nam; US$1,667 million in Myanmar; and US$448 million in Cambodia. The total fuel cost reduction is expected to be US$6,298 million.

Table 7-6 Fuel Cost Reduction of Thermal Power Plant in Each Country

Country	Thermal power generation reduction (GWh)			Fuel type	Fuel Cost Reduction (mil. US$)		
	2030	2035	25 years		2030	2035	25 years
Thailand	-2,600	0	-26,000	Natural gas	156.0	0	1,569
Viet Nam	-4,600	-4,600	-115,000	Coal	107.9	104.9	2,614
Myanmar	-3,000	-3,000	-75,000	Coal	68.2	67.3	1,667
Cambodia	-500	-1000	-20,000	Coal	12.0	22.4	448
Total	**-10,700**	**-8,600**	**-236,000**		**344.0**	**194.6**	**6,298**

Source: Authors.

7.3 Reduction in New Investment of Thermal Power Plants

Power imports from neighbouring countries may reduce fuel costs of, and investment in, thermal power plants. Reduced new investment in thermal power plants also has economic benefits.

Table 7-7 summarises the reduction in the new investment of thermal power plants. In Thailand, the reduction in new generation capacity is 349 MW, about 0.6% of the total installed capacity in 2030, while that for natural gas power plants is about US$244 million. In Myanmar, the reduction in new generation capacity is 403 MW, about 3.4% of the total installed capacity in 2030. The reduction in new investment of coal power plants is about US$645 million. In Viet Nam, the reduction in new generation capacity is 618 MW, about 0.4% of the total installed capacity in 2030, while that for coal power plants is about US$989 million. In Cambodia, the reduction in new generation capacity is 134 MW, about 0.8% of the total installed capacity in 2030, and that for coal power plants is approximately US$215 million. The total capacity and total installation costs that can be reduced are 1,504 MW and US$2,093 million, respectively. Therefore, we can expect that power trade though transmission highway contributes to reduced new investment of thermal power plants.

Table 7-7 Reduction in New Investment of Thermal Power Plant

Country	Thermal power generation reduction (GWh)			Fuel type	Fuel Cost Reduction (mil. US$)		
	2030	2035	25 years		2030	2035	25 years
Thailand	-2,600	0	-26,000	Natural gas	156.0	0	1,569
Viet Nam	-4,600	-4,600	-115,000	Coal	107.9	104.9	2,614
Myanmar	-3,000	-3,000	-75,000	Coal	68.2	67.3	1,667
Cambodia	-500	-1000	-20,000	Coal	12.0	22.4	448
Total	**-10,700**	**-8,600**	**-236,000**		**344.0**	**194.6**	**6,298**

Source: Authors.

7.4 CO2 Emission Reduction and Carbon Pricing

CO_2 emission will decrease due to reduced thermal power generation. This result is calculated as a social benefit. The CO_2 emission reduction in each country is shown in Table 7-8. We expect that CO_2 emission reduction for 25 years are 3 Mt-C in Thailand, 31 Mt-C in Viet Nam, 21 Mt-C in Myanmar, and 5 Mt-C in Cambodia. The total CO_2 emission reduction is expected to be 60 Mt-C.

Table 7-8 CO_2 Emission Reduction in Each Country

Country	Thermal power generation reduction (GWh)			Fuel type	Fuel Cost Reduction (mil. US$)		
	2030	2035	25 years		2030	2035	25 years
Thailand	-2,600	0	-26,000	Natural gas	156.0	0	1,569
Viet Nam	-4,600	-4,600	-115,000	Coal	107.9	104.9	2,614
Myanmar	-3,000	-3,000	-75,000	Coal	68.2	67.3	1,667
Cambodia	-500	-1000	-20,000	Coal	12.0	22.4	448
Total	**-10,700**	**-8,600**	**-236,000**		**344.0**	**194.6**	**6,298**

Source: Authors.

Table 7-9 shows the benefits of carbon pricing in each country based on CO_2 emission reductions. We expect that the benefits of carbon pricing for 25 years to be US$46.2 million in Thailand; US$1,984.1 million in Viet Nam; US$1,294.1 million in Myanmar; and US$365.7 million in Cambodia. Thus, the total benefits of carbon pricing are expected to be US$3,690.2 million.

Here, to date, ACMECS countries have not yet introduced a carbon pricing incentive. However, this result shows the feasibility of introducing carbon pricing incentives to ACMECS countries. Therefore, we can expect the Transmission Highway to contribute greatly to global GHG emission issues.

Table 7-9 Benefits of Carbon Pricing

Country	Carbon price (million US$)		
	2030	2035	25 years
Thailand	3.9	0	46.2
Viet Nam	62.3	74.7	1,984.2
Myanmar	40.6	48.7	1,294.1
Cambodia	13.5	16.2	365.7
Total	**120.4**	**139.6**	**3,690.2**

Source: Authors.

7.5 Improvement of GDP

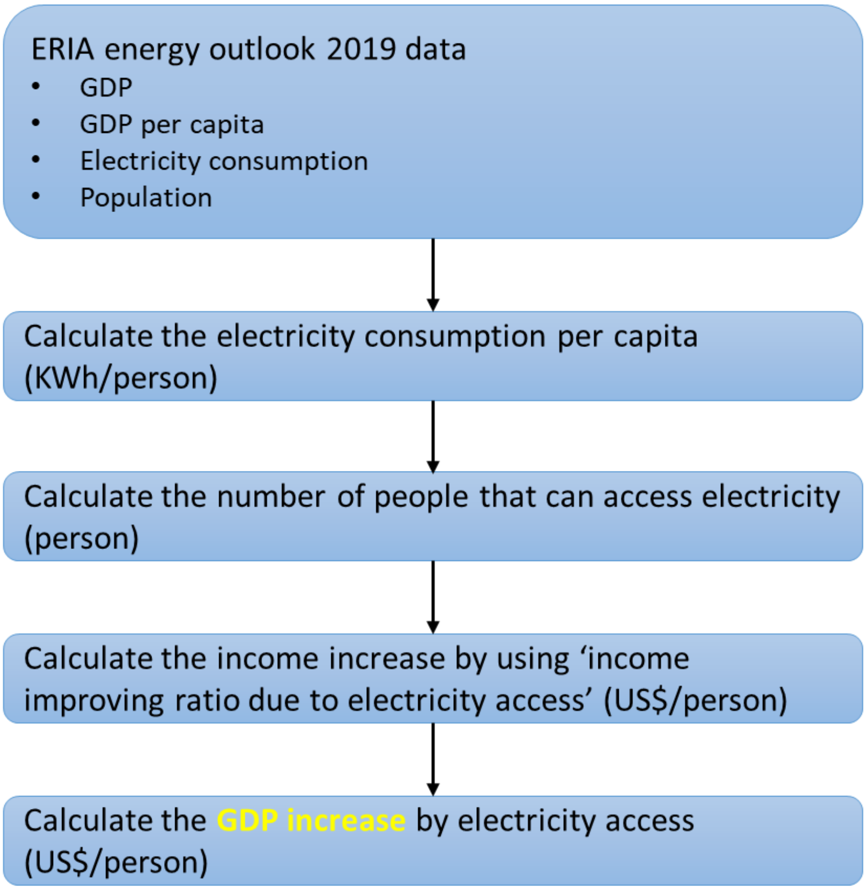
Electricity access results in many benefits. Businesses can operate at higher productivity levels; farmers can run cleaner irrigation systems and processing machines, improving their yields and, thus, their incomes.

This study referred to the following data from ERIA's Energy Outlook report (ERIA, 2019). To calculate the impact on GDP:

- **GDP**
- **GDP per capita**
- **Electricity consumption**
- **Population**

Figure 7-4 shows the simple calculation flow of impact on GDP by electricity access.

Figure 7-4 Simple Calculation Flow of Impact on the GDP, by Electricity Access



Source: Authors.

7.5.1 Myanmar

Myanmar has achieved 50% of nationwide electricity access in 2019, however, electricity access level is still low. Table 7-10 shows the assumption of calculation data in Myanmar.

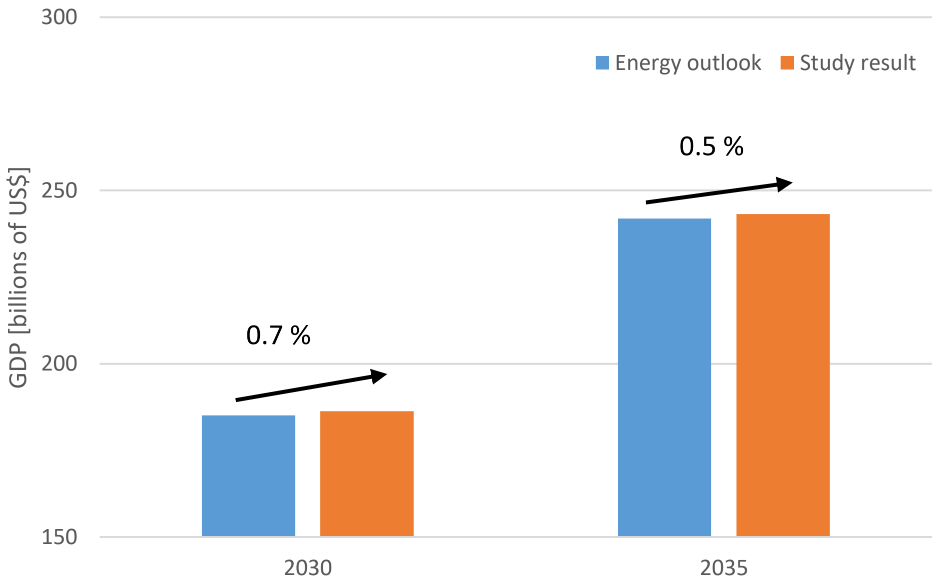
Table 7-10 Assumptions of Calculation Data in Myanmar

Item	2030	2035
GDP (billions of 2010 US dollars)	185	242
GDP per capita (thousands of 2010 USD/person)	3.12	3.96
Electricity Consumption (TWh)	36.29	45.67
Population (millions of people)	59.26	61.12
Imported electricity for electricity access (TWh)	3.0	3.0
Average number of people per household (people)	4.8	4.8
Income improving ratio per capita by electricity access	**8.1 %**	**8.1 %**

Source: Authors.

Based on the above calculation flow, GDP improvement through electricity access in Myanmar was calculated (Figure 7-5). Using electricity imports from Thailand for electricity access will improve GDP by 0.7% in 2030 and 0.5% in 2035, respectively (ERIA, 2019).

Figure 7-5 GDP Improvement in Myanmar, by Electricity Access



Source: Authors.

7.5.2 Cambodia

Electricity access in Cambodia was about 74.7% of villages and 58.2% of households in 2017, still low at those levels. Similar to Myanmar's calculation, data from ERIA's energy outlook report was used.

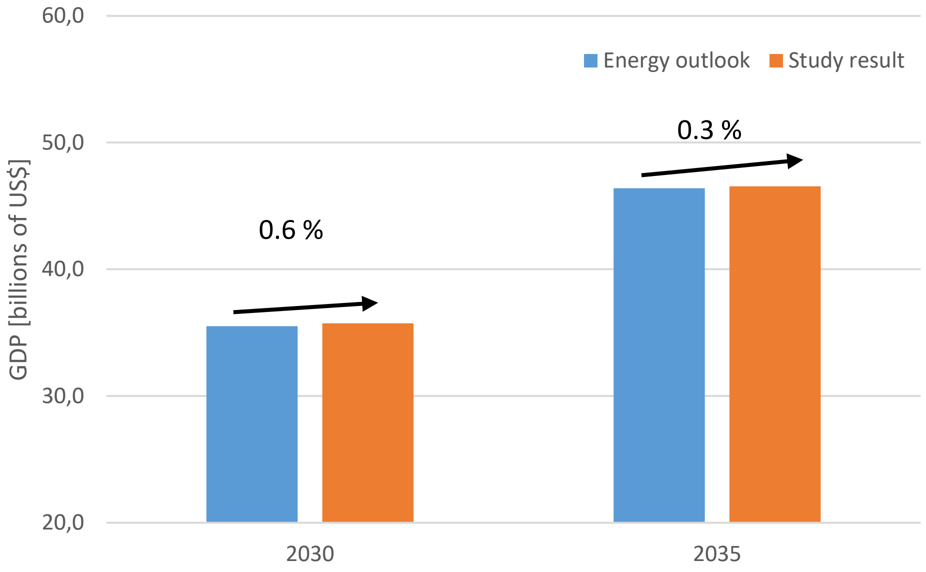
Table 7-11 Assumptions of Calculation Data in Cambodia

Item	2030	2035
GDP (billions of 2010 US dollars)	35.50	46.40
GDP per capita (thousands of 2010 USD/person)	1.83	2.22
Electricity Consumption (TWh)	19.73	26.79
Population (millions of people)	19.40	20.90
Imported electricity for electricity access (TWh)	1.5	1.0
Average number of people per household (people)	4.6	4.6
Income improving ratio per capita by electricity access	**8.5 %**	**8.5 %**

Source: Authors.

Based on the above calculation flow, GDP improvement through electricity access in Cambodia was calculated (Figure 7-6). Using electricity imports from the Lao PDR through Thailand to make electricity accessible will improve GDP by 0.6% in 2030 and 0.3% in 2035, respectively (ERIA, 2019).

Figure 7-6 GDP Improvement in Cambodia, by Electricity Access



Source: Authors.

7.6 Income from Wheeling Charge

The Income from the wheeling charge of each cross-border interconnection is shown in Table 7-12. This study assumes that the wheeling charges are the same for all candidate cross-border interconnections. Therefore, the larger the amount of power trade, the larger the income. The income from the wheeling charge for 25 years in each candidate cross-border interconnection ranged from US$446 million to US$1,500. The total income from the wheeling charge is expected to be US$5,545 million.

Table 7-12 Income from Wheeling Charge of Each Cross-Border Interconnection

Section	Amount of power exchange (GWh)			Income from wheeling charge (mil. US$)		
	2030	2035	25 years	2030	2035	25 years
(1) 500 kV MK. Pakbeng – (Mae Moh – Tha Tako)	5,450	6,112	148,828	54.5	61.1	1,488
(2) 500 kV (Mae Moh – Tha Tako) – Mawlamyaing	6,000	6,000	150,000	60.0	60.0	1,500
(3) 230 kV Laos Vientiane – Thailand Bunkan	1,281	1,943	44,603	12.8	19.4	446
(4) 500 kV Xekong – Roi Et	1,794	1,794	44,850	17.9	17.9	449
(8) 500 kV Chaiyaphum – Banteay Meanchey	2,000	2,000	50.000	46.5	46.5	500
(9) 500 kV Thanh My – Xekong	4,648	4,648	116,200	20.0	20.0	1,162
Total	**21,173**	**22,497**	**554,481**	**211.7**	**225.0**	**5,545**

Source: Authors.

7.7 Financial Indicators

The study analysed the benefits of the candidate transmission lines in the previous section. In this section, the study analyses the financial internal rate of return (FIRR), economic internal rate of return (EIRR), and the NPV of the Transmission Highway.

The assumptions used to calculate the FIRR, EIRR, and NPV for the Transmission Highway are as follows:.

1) FIRR

- The calculation period was set to 25 years
- The costs for FIRR calculation were assumed as follows:
  - The total construction cost of candidate cross-border interconnections (excluding the domestic transmission lines in Thailand)
  - O&M cost for each year is 3% of the total construction cost
- The benefits for FIRR calculation were assumed as follows:
  - Wheeling charge of candidate cross-border interconnections
- NPV was evaluated at 8% and 10% discount rate

2) EIRR

- The calculation period was set to 25 years
- The costs for EIRR calculation were assumed as follows:
  - The total construction cost of candidate cross-border interconnections (excluding the domestic transmission lines in Thailand)
  - The total construction cost of new power stations
  - O&M cost for each year is 3% of the total construction cost
- The benefits for EIRR calculation were assumed as follows:
  - Wheeling charge of candidate cross-border interconnections
  - Fuel cost reduction of thermal power plant
  - Reduction in new investments for thermal power
  - CO_2 emission reduction (carbon pricing)
- NPV was evaluated at 8% and 10% of the discount rate

The result of FIRR, 15.9%, is shown in Table 7-13. In the case of a discount rate of 8%, the estimated NPV for the Transmission Highway is US$859 million, with a payback period of 8.9 years. For a discount rate of 10%, the NPV is US$557 million with a payback period of 10.1 years.

Amongst the five ACMECS countries, Myanmar's long-term interest rate is as high as 9.5%, but FIRR is higher than that. In addition, the NPV is also positive (> 0). Therefore, the Transmission Highway has sufficient financial feasibility.

Table 7-13 FIRR of Transmission Highway

Financial indicators	
FIRR	15.9%
NPV (million US$) (Discount rate: 8%)	859
Payback period in years (Discount rate: 8%)	8.9 years
NPV (million US$) (Discount rate: 10%)	557
Payback period in years (Discount rate: 10%)	10.1 years

Source: Authors.

The EIRR is shown in Table 7-14. The EIRR is 13.9%. For a discount rate of 8%, the estimated NPV for the Transmission Highway is US$2,170 million, with a payback period of 9.9 years. For a discount rate of 10%, the NPV is US$1,249 million, with a payback period of 11.9 years.

According to ADB, the general criterion for accepting a project is achieving a positive economic net present value discounted at the minimum required EIRR or achieving the minimum required EIRR. ADB adopted 9% as the minimum required EIRR (ADB, 2017). The EIRR of the Transmission Highway is higher than 9% of the standard adopted by ADB; the NPV is also positive (> 0). Therefore, the Transmission Highway is also economically feasible.

Table 7-14 EIRR of Transmission Highway

Financial indicators	
EIRR	13.9%
NPV (million US$) (Discount rate: 8%)	2,170
Payback period in years (Discount rate: 8%)	9.9 years
NPV (million US$) (Discount rate: 10%)	1,249
Payback period in years (Discount rate: 10%)	11.9 years

Source: Authors.