Identifying Factors for Promoting Renewable Energy Projects through the Clean Development Mechanism in China, India and ASEAN Countries

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Abstract

This study analysed the greenhouse gas (GHG) abatement cost of renewable energy projects developed through the Clean Development Mechanism (CDM) in China, India and ASEAN countries. The results from this study show that the average abatement cost for all renewable energy technology including biomass, hydro, wind and solar renewable energy in ASEAN countries was the highest among these three countries due to the absence of a "scale of economy," lower penetration rate of new technology such as PV and wind power, and lower magnitude of grid emission factors. To encourage the implementation of renewable energy in ASEAN countries towards a decarbonised economy, the following research topics could be examined in the future. First, it will be necessary to analyse the "learning curve" for new types of technology, i.e., PV and wind power technology. Second, effective mitigation mechanisms and incentives need to be examined because as the results of this study imply, the magnitude of grid emission factors could affect the abatement cost and business conditions for investments in renewable energies through mitigation mechanisms. Lastly, it is important to discuss the overall policy arrangements since ASEAN countries implement not only feed-in-tariffs for renewable energy, but also subsidies for fossil fuels, which provide some advantages to fossil-fuel power plants and affect estimations of CO_2 abatement costs. Apparently, climate policies interact so closely with energy policies that it is worth proposing comprehensive climate and energy policies with analytical insights into energy-related technologies and policies in ASEAN countries.

Key words: abatement cost, ASEAN, China, India, renewable energy, scale of economy

1. Introduction

In December 2015, the Conference of Parties (COP) adopted the Paris Agreement to strengthen the global response to the threat of climate change, aiming to keep the global temperature rise this century to well within two degrees Celsius over pre-industrial levels. The Paris Agreement requires all countries including developing countries to make their best efforts to implement mitigation actions through nationally determined contributions (NDCs).

Among the developing countries, China and India emitted 9.1 billion tonnes and 2.0 billion tonnes of CO_2, respectively, from fossil fuel combustion in 2014, accounting for 34% of the world's total CO_2 emissions from fossil fuel combustion in 2015. Also, among the Association of Southeast Asian Nations (ASEAN) countries, Indonesia, Thailand, and Malaysia had GHG emissions positioned within world's top 30 (World Bank, 2015). Furthermore, the final energy consumption of the whole ASEAN region is expected to increase by 2.2% per annum, which indicates an increase from 549 Mtoe in 2011 to 1,004 Mtoe in 2035. The Asian Development Bank (ADB) (2013) has forecasted the amount of electricity generation to increase to 1,879 TWh in 2035 from 696 TWh in 2011, which indicates a 4.2% annual increase. In particular, it is expected that the use of coal will increase in Viet Nam, the Philippines and Lao PDR which have not used fossil fuels as electricity sources in the past (ADB, 2013). Therefore, it is important to take the best actions for mitigation in the electricity sector, especially in ASEAN countries, in order to achieve the ultimate goal of the Paris Agreement.

Until the end of the first commitment period of the Kyoto Protocol in 2012, the Clean Development Mechanism (CDM), which is a baseline and credit

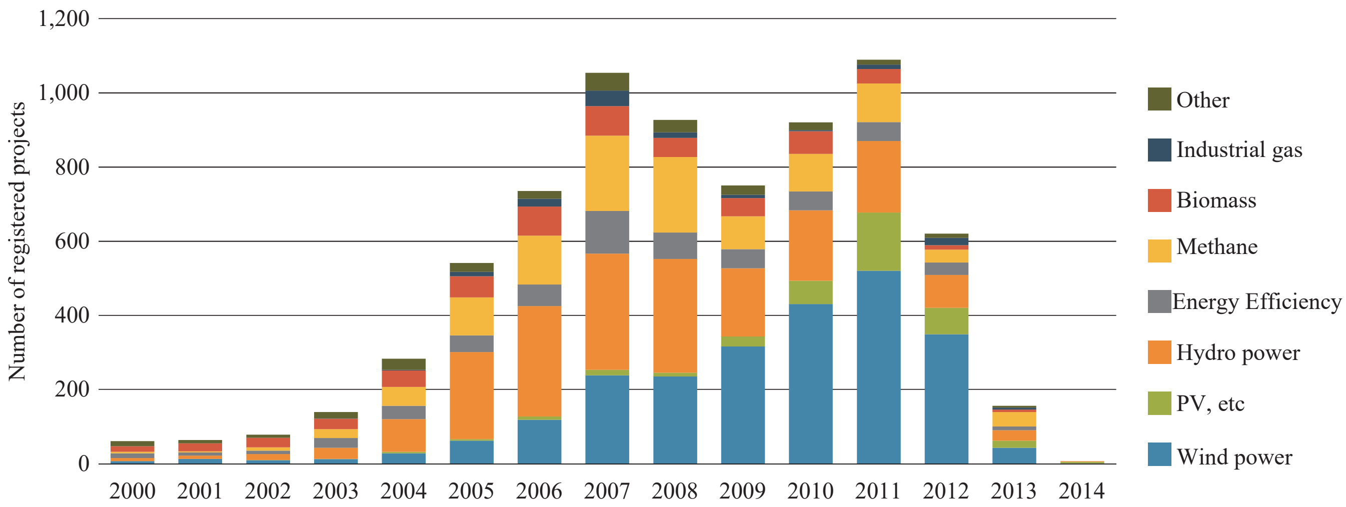

Fig. 1 Annual estimated emission reductions through CDM project activities, categorised by project type and project starting date. Source: author, based on IGES (2014).

mechanism in developing countries authorised under the Kyoto Protocol, provided significant incentives to promote mitigation measures in developing countries. By the end of May 2014, the CDM had registered 7,490 projects and issued 1.5 billion tons of certified emission reductions (CERs) (IGES, 2016).

Figure 1 illustrates trends of annually estimated emission reductions through CDM projects. As shown in Fig. 1, project developers promoted energy efficiency CDM projects mainly for waste heat recovery, hydropower generation, methane recovery and avoidance, and fossil fuel substitution by using biomass and industrial gases such as HFC and N_2O from 2004 to 2007. From 2007 onwards, registration of those project types has become less active, while renewable energy project types such as wind power and photovoltaic power have increased. As a result, renewable energy projects accounted for 64% of the total registered projects that had been developed by 2014. In particular, China and India hosted 60% and 27% of those renewable energy projects, respectively. This indicates that China and India hosted 38% and 17%, respectively, of all CDM projects. This result can be explained by looking at the business incentives for CDM project developers. In other words, most project developers were interested in a project that would bring a higher profit, or in a country where the business market could be expected to expand. Regarding the attractiveness of the investment for host countries, Jung (2006) evaluated the potential of CDM project formulations from three aspects: reduction potential in each country, institutional framework in host countries, and investment in climate change. Among Asian countries, Jung (2006) concluded the assessment for China, India, Thailand, Indonesia, Mongolia and Malaysia was "very attractive" or "attractive." Oleschak & Springer (2011) also evaluated the attractiveness of project investments in the host countries from three aspects: the institutional framework for the Kyoto

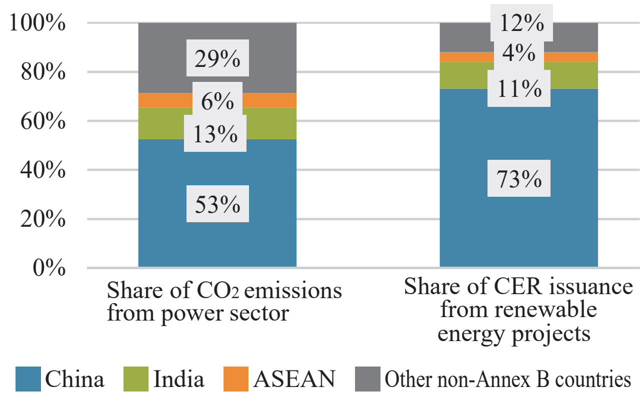

Fig. 2 CO_2 emissions in the electricity sector and CER issuance status of renewable energy projects.
Source: author, based on IEA (2014a), IGES(2016).

Mechanism, legal regulations in host countries, and economic activity. As a result, India was evaluated as the most attractive country for investment by project developers, with China in second place. Winkelman and Moore (2011) also state that total GHG emissions, the emission intensity of the economy, domestic human capital and increased electricity demand are important factors in hosting a CDM project.

Indeed, ASEAN countries including Indonesia, Thailand and Viet Nam have a high potential to host a considerable number of CDM projects because those countries have sufficient institutional capacity and a huge potential for GHG emissions reduction owing to the rapid increase in economic activity. However, as Fig. 2 shows, CERs in the electricity sector have not been issued there in contrast to India and China when it comes to considering the ASEAN countries' share of CO_2 emissions in the power sector. A possilble factor hindering the development of CDM projects in those countries could be high GHG abatement and transaction costs in ASEAN countries since, generally speaking, the cost issue is one of the major concerns for CDM project developers. This study, however, focuses solely on analysing GHG abatement costs because the transaction costs for renewable energy projects account for only 14.4% of the total (Michaelowa & Jotzo, 2003).

As shown in Equation (1), the CO_2 abatement cost per ton can be calculated by dividing the abatement cost by the amount of emission reductions (Rahman *et al.,* 2009). The abatement cost is defined as the difference between the baseline cost and the project cost, and emission reduction is identified by the difference between baseline emissions and project emissions.

$$\text{Average GHG emission abatement cost} = \frac{\textit{Project cost-Baseline cost}}{\textit{Baseline emissoin-Project emission}} \quad (1)$$

The cost of a CDM project consists of investment costs and operating costs for the project. The baseline cost is defined as the cost of generating electricity using conventional power plants that would be operated in the absence of the CDM. For a renewable energy project, the baseline cost is defined as the selling price of electricity (Rahman *et al.,* 2012). The effect of technological innovation can also be considered, in which the cost of GHG reduction falls in proportion to the decrease in the cost of the project. (Lantz *et al.,* 2012; IEA, 2014b).

A review of past studies reveals that there are few studies analysing the CO_2 abatement costs using data from actual projects in China, India and ASEAN countries. Rahman *et al*. (2012) calculated the GHG abatement cost for all CDM projects that had been registered up to 2011 in Annex B countries but which did not have any focus on ASEAN countries. Simon *et al*. (2016) investigated the abatement cost structure of CDM projects in India. Therefore, this study analyses the reasons ASEAN countries failed to harness a considerable number of CDM projects compared to their mitigation potentials, from the two perspectives of "scale of economy," which causes the average cost of producing something to fall as the volume of its output increases, and renewable energy technology type. The discussion section analyses possible impact by level of grid emission factors.

Section 2 introduces data preparation for project costs and abatement costs. Section 3 discusses the analytical approach, Section 4 describes the analytical results, Section 5 draws conclusions and discusses them, and Section 6 remarks on prospects for further studies.

2. Data

This study developed data for analysing CO_2 abatement costs for renewable energy projects under the CDM, based on the information used in the investment analysis to demonstrate additionality. This information is provided in the project design documents (PDDs) for each renewable energy project. In a review of existing literature, Rahman *et al*. (2012) define the abatement cost as the difference between the project cost and baseline cost, charged for supplying the same amount of electricity in the absence of the renewable energy technology proposed under the CDM. In particular, Castro and Michaelowa (2010) and Wetzelaer and Linden (2007) define the baseline cost as the net present value of electricity sales, and the project cost as the net present value consisting of investment costs and operation costs. When project developers calculate the net present value, they can usually use the discount rate as a value for their business. Therefore, this study follows the same approach to identifying the abatement cost of CDM projects using the benchmark rate as shown in Equation (2). GHG emission reductions are referred to by the numbers described in each PDD. Using the project period outlined in the PDDs, emission reductions during the assessment period are calculated using Equation (3). The duration used in evaluating the net present value is same as the project period for each project.

$$AC_i = I + \sum_{t=1}^{n} \frac{OMC_{i,t}}{(1+r)^t} + \sum_{t=1}^{n} \frac{FC_{i,t}}{(1+r)^t} + \sum_{t=1}^{n} \frac{OTC_{i,t}}{(1+r)^t} - \sum_{t=1}^{n} \frac{IE_{i,t}}{(1+r)^t} \quad (2)$$

$$ER = Annual\ emission\ reduction\ \times n \quad (3)$$

where "t" denotes the year of the project activity starting date, "n" represents the project period, "i" denotes i_{th} project serial number, and "r" indicates the discount rate defined by the value of the benchmark described in the PDDs. "AC_i" represents the net present value of GHG abatement costs without social costs for project i. "$OMC_{i,t}$" denotes the operation cost of project i at time t, "$FC_{i,t}$" represents the fuel costs of project i at time t, "$OTC_{i,t}$" represents other costs of project i at time t, such as water usage rights and insurance. "$IE_{i,t}$" represents income from electricity sales of project i at time t.

For projects which do not provide a benchmark value, this study uses the lending interest rate given by the World Bank (2015). To collect cost data, this study examines each PDD that is made available on the UNFCCC website. Since the PDDs provide cost data using several currencies, this study unified all the cost data into USD for the year 2013 using the exchange rate and consumer price index provided by the World Bank (2015). Table 1 summarises the basic statistics for all the data.

"Abatement Cost" indicates the GHG abatement cost. "Abatement" denotes the amount of emission reduction during the project period. "Biomass," "pv_ solar" and "wind" represent the dummy variables of biomass power, PV or solar power and wind power projects, respectively. The numbers for 2006 to 2012 denote the dummy variables for each year. "Project Duration" indicates project operation period. "India" and "ASEAN" denote the country dummy variables.

Table 1 Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Abatement Cost	3381	15.4	1.32	2.6	20.1
Abatement (Log)	3842	14.1	1.11	10.0	18.3
biomass	3895	0.1	0.23	0.0	1.0
pv_solar	3895	0.0	0.19	0.0	1.0
wind	3895	0.5	0.50	0.0	1.0
2006	3895	0.1	0.29	0.0	1.0
2007	3895	0.1	0.33	0.0	1.0
2008	3895	0.1	0.33	0.0	1.0
2009	3895	0.1	0.33	0.0	1.0
2010	3895	0.2	0.36	0.0	1.0
2011	3895	0.2	0.39	0.0	1.0
2012	3895	0.1	0.31	0.0	1.0
Project Duration (Log)	3895	3.1	0.19	1.9	3.9
India	3895	0.2	0.40	0.0	1.0
ASEAN	3895	0.1	0.27	0.0	1.0

3. Methodology

The cost function for emissions abatement through CDM refers to existing studies on pollution abatement costs. Hartman *et al*. (1997), Goldar*, et al*. (2001), and Rahman *et al*. (2012) note that the abatement costs of projects under pollution control can be explained by the first and second powers of emission reduction of pollutants as shown in Equations (4) and (5). If the coefficient of the second power of emission reductions is negative, the result can imply that the abatement cost has a scale of economy.

$$\ln(AC_i) = \alpha + \beta \ln(A_i) + \sigma X_i + \varepsilon_i \quad (4)$$

$$\ln(AC_i) = \alpha + \beta \ln(A_i) + \gamma[\ln(A_i)]^2 + \sigma X_i + \varepsilon_i \quad (5)$$

where "ACi" denotes the abatment cost (USD) derived by Equation (2), "Ai" represents the amount of emission reduction during the project period (tCO_2), "Xi" denotes explanatory variables and "ε_i" denotes the error term.

4. Estimation Results for Abatement Costs in China, India and ASEAN Countries

Table 2 presents the estimation results of this study. Model 1 shows the results for all of the countries including China, India and ASEAN countries. The coefficient of abatement is positive at a significance level of 1% while the coefficient of squared abatement is negative at a significance level of 5%. This result implies that abatement costs in all of the countries have a scale of economy. All the models include the dummy variables of project types, which enable us to discuss the impact of cost increases compared to the base project. Hydropower is selected as the base project because it is the only the type of renewable energy technology that is widely implemented across the regions in this study. Regarding abatement cost differences by project type, abatement costs for biomass power, PV and solar thermal power (hereinafter, solar) and wind power CDM projects are around 30%, 16% and 64% higher than the cost of hydropower projects, respectively. Considering the effect of the project starting year, the abatement cost has increased over the years. Looking at the country's effect on CO_2 abatement costs, the abatement cost of a CDM project in India is 12−16% higher than in China. On the other hand, the abatement cost in ASEAN is estimated to be 47−48% lower than in China. This result is consistent with the consequences of investment in CDM projects, whereby China and India host a large number of CDM projects and ASEAN countries have had less investment through the CDM despite their mitigation potential as discussed in Section 1.

Models 2, 3 and 4 show the country-specific results. For China, the coefficient of abatement in Model 2.1 is estimated to be 0.745 at a 1% significance level. In Model 2.2, however, the coefficient of abatement and squared abatement are not significant. This result implies that renewable energy projects in the CDM did not have a scale of economy. The cost of biomass, solar and wind power projects in China are 103−106%, 181−183% and 71−73% higher than the cost of hydropower projects, respectively. The abatement costs of renewable energy projects have been continuously increasing over the years.

For India, the coefficient of abatement in Model 3.1 is estimated to be 0.985 at a 1% significance level. Also, in Model 3.2 the coefficient of abatement is 1.941 at 1% significance levels while the coefficient of squared abatement is −0.036 at 5% significance levels. This result implies that renewable energy projects in India have a scale of economy effect. The cost of biomass power is 52−55% lower than the cost of hydropower plants, while the cost of solar and wind power plants are 97−100 and 42% higher than the cost of hydropower plants, respectively. Regarding the dummy variable of a project's starting year, variables for 2007, 2008 and 2011 are positively significant. The weak trend of increasing CO_2 abatement costs as years pass is consistent with past studies conducted by Simon *et al*. (2016)

Regarding ASEAN countries, the results do not indicate a scale of economy effect. This can be seen in in Model 4.2, where neither the coefficients of abatement nor squared abatement are significant. Compared to the results in China and India, the abatement costs of solar and wind power plants in ASEAN countries are more than 200% higher compared to the cost of hydropower plants. This result implies that solar and wind power in ASEAN countries are still much more costly than conventional renewable technology such as hydropower and biomass power. Unlike the results for China and

Table 2 Estimation results for all countries and by country.

Abatement Cost (Log)	ALL (Model 1)		CHINA (Model 2)		INDIA (Model 3)		ASEAN (Model 4)	
	Model 1.1	Model 1.2	Model 2.1	Model 2.2	Model 3.1	Model 3.2	Model 4.1	Model 4.2
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Abatement (Log)	0.868 ***	1.446 ***	0.745 ***	0.081	0.985 ***	1.941 ***	0.933 ***	1.006
	(0.02)	(0.23)	(0.03)	(0.48)	(0.03)	(0.39)	(0.05)	(0.81)
Squared Abatement (Log)	-	−0.021 **	-	0.023	-	−0.036 **	-	−0.003
		(0.01)		(0.02)		(0.02)		(0.03)
Renewable Energy Dummies:								
biomass	0.312 ***	0.294 ***	1.026 ***	1.055 ***	−0.518 ***	−0.545 ***	−0.040	−0.043
	(0.10)	(0.10)	(0.08)	(0.08)	(0.14)	(0.14)	(0.46)	(0.47)
pv & solar	1.630 ***	1.609 ***	1.834 ***	1.811 ***	0.995 ***	0.974 ***	2.183 ***	2.182 ***
	(0.17)	(0.17)	(0.27)	(0.28)	(0.28)	(0.27)	(0.26)	(0.26)
wind	0.642 ***	0.642 ***	0.706 ***	0.733 ***	0.417 ***	0.415 ***	2.069 ***	2.064 ***
	(0.04)	(0.04)	(0.05)	(0.05)	(0.13)	(0.13)	(0.26)	(0.27)
Project's Start Year:								
2006	0.112	0.108	0.077	0.080	0.291	0.293	−0.170	−0.169
	(0.09)	(0.09)	(0.10)	(0.10)	(0.21)	(0.21)	(0.44)	(0.44)
2007	0.183 **	0.182 **	0.141	0.141	0.380 **	0.401 **	−0.193	−0.192
	(0.08)	(0.08)	(0.10)	(0.10)	(0.19)	(0.19)	(0.43)	(0.43)
2008	0.228 ***	0.232 ***	0.202 **	0.197 **	0.444 **	0.477 **	−0.055	−0.055
	(0.08)	(0.08)	(0.09)	(0.09)	(0.18)	(0.19)	(0.51)	(0.51)
2009	0.337 ***	0.346 ***	0.497 ***	0.495 ***	0.259	0.283	−0.135	−0.135
	(0.08)	(0.08)	(0.09)	(0.09)	(0.18)	(0.18)	(0.46)	(0.46)
2010	0.410 ***	0.410 ***	0.516 ***	0.515 ***	0.327 *	0.339 *	−0.015	−0.014
	(0.08)	(0.08)	(0.09)	(0.09)	(0.19)	(0.19)	(0.41)	(0.41)
2011	0.442 ***	0.436 ***	0.485 ***	0.487 ***	0.557 ***	0.574 ***	−0.221	−0.221
	(0.08)	(0.08)	(0.08)	(0.08)	(0.19)	(0.19)	(0.44)	(0.44)
2012 and After	0.348 ***	0.341 ***	0.430 ***	0.429 ***	0.186	0.208	−0.141	−0.142
	(0.09)	(0.09)	(0.09)	(0.09)	(0.21)	(0.21)	(0.47)	(0.48)
Project Duration (Log)	−0.390 ***	−0.336 **	0.214	0.217	−1.340 ***	−1.277 ***	−0.302	−0.306
	(0.14)	(0.15)	(0.18)	(0.18)	(0.31)	(0.32)	(0.38)	(0.40)
India	−0.161 ***	−0.118 **	-	-	-	-	-	-
	(0.05)	(0.06)						
ASEAN	0.478 ***	0.472 ***	-	-	-	-	-	-
	(0.07)	(0.07)						
_cons	3.699 ***	−0.524	3.510 ***	8.366 **	5.130 ***	−1.287	3.337 **	2.828
	(0.39)	(1.75)	(0.45)	(3.55)	(1.06)	(3.01)	(1.31)	(5.35)
Number of obs.	3,360		2,403		697		260	
Adjusted R2	0.61	0.61	0.52	0.52	0.61	0.61	0.62	0.61

Note: Each model shows the results both with and without the variable of Squared Abatement (Log). For all models, the base technology is hydropower. For Models 1.1 and 1.2, the base country is China.

India, none of the year variables of ASEAN countries were significant, meaning that the abatement costs in ASEAN countries have not increased over the years.

5. Discussion and Limitations of This Study

As discussed above, mitigation by renewable energy projects under the CDM was higher than the costs in China and India. Three reasons can be considered for this result. First, scale of economy could have resulted in the lower CO_2 abatement costs of renewable energy projects in India. Indeed, India has the lowest average abatement cost for the whole country among the three groups. On the other hand, only the coefficients of abatement are significant for China and ASEAN counties. Furthermore, while China's coefficient is 0.745, the coefficient of ASEAN is 0.955 which implies that abatement costs increase in proportion to increased abatement. This result could indicate that CDM project developers in ASEAN countries have been unable to benefit from scale of economy.

Second, the incremental cost of ASEAN's wind and PV technology compared to hydropower plants is larger than that of the incremental costs in China and India. The results from our empirical model show that the cost of wind power technology in India is only 42% higher than the cost of hydropower plants. On the contrary, the cost of wind technology in ASEAN countries is 207% greater than the cost of hydropower plants. Similarly, the cost of solar technology in ASEAN countries is higher than the cost in China and India. This result could be explained by the fact that CDM project developers have implemented a large number of solar and wind power projects in these two countries. In fact, China had hosted 1,427 wind power projects and 118 solar projects by 2014. India had hosted 570 wind power projects and 20 solar projects by 2014. Therefore, China and India could benefit from the "learning curve" from such technological innovation, which has contributed to a reduction in the initial cost of renewable energy technologies.

Third, the grid emission factor of ASEAN countries is lower than those in India and China. In fact, the baseline emissions of renewable energy projects which displace electricity from electricity grids are obtained by multiplying the amount of electricity generation (MWh) by the grid emission factor (tCO_2/MWh). For example, the average grid emission factors in China and India are 0.90 tCO_2/MWh and 0.88 tCO_2/MWh, respectively, which are higher than those of other CDM project host countries according to data from IGES (2015). On the other hand, the grid emission factors of Indonesia, Viet Nam and Thailand are 0.76 tCO_2/MWh, 0.56 tCO_2/MWh and 0.55 tCO_2/ MWh, respectively, which are mid or lower level among the host countries. The differences in grid emission factors among China, India and ASEAN countries mean that CDM project developers in China and India gain 1.6 times the CERs compared to ASEAN countries even though they generate the same amount of electricity by renewable energy. Thus, even if the power generation costs per kilowatt hour are at the same level among those countries, CO_2 abatement costs from renewable energy are not uniform owing to differences in GHG emission reductions. While the magnitude of grid emission factors could have a significant impact on the abatement costs of renewable energy, there is no sophisticated method for identifying grid emission factors, and in fact there is room for improvement. In fact, Hawkes (2014) pointed out that quantification of CO_2 emissions from electricity use is usually accomplished using short-run emission factors, but these short-run factors do not take account of structural changes in power systems. He also suggested that long-run marginal emission factors need to be analysed to quantify CO_2 emissions. In particular, although the “tool to calculate the emission factor for an electricity system” (UNFCCC, 2013) takes into account structural changes in the electricity system, it does not consider how the newly-built or avoided power stations would have operated in the absence of the CDM. Harmsen and Graus (2013) pointed out that an average CO_2 intensity approach cannot be used to estimate future electricity savings in situations where the change in both electricity generation and the emission intensity occur simultaneously. In this case, they recommend applying a marginal CO_2 intensity approach with a scenario-based analysis.

Indeed, the result of our model also supports the fact that ASEAN countries have enormous potential to implement renewable energy because the abatement costs using renewable energy technology in China and India have increased over the years while the cost in ASEAN countries has not increased. Also, as discussed above, if the project costs of renewable energy decrease further owing to the scale of economy, or methods for identifying CO_2 emission reduction from electricity use are improved to take into account possible increases of fossil-fuel power plants, then the abatement costs of renewable energy in ASEAN countries would decrease.

6. Prospects for Climate and Renewable Energy Policies in ASEAN Countries

In this concluding section, this study identifies possible research topics to be examined in the future. First, it would be interesting to examine the learning effect or learning curve of a new type of technology, e.g., PV and wind power technology. As predicted by various research (Taylor, *et al*., 2015), the levelised cost of electricity (LCOE) for that technology would be lower than for conventional power plants. However, there are still few studies on how technology has been developed using actual data.

Second, an effective mitigation mechanism that provides appropriate incentives in line with long-term emission reduction goals needs to be examined. The results of this study imply that the degree of the grid emission factor could affect the abatement cost advantage. The limitation of current grid emission factors, however, is that they can only reflect historical CO_2 emissions or short-term trends in electricity sectors as discussed in Section 5. The number of fossil fuel-fired power plants, including coal-fired power technology, however, is expected to increase in ASEAN countries. In this case, the mitigation impact by renewable energy could be higher if it takes into account long-term energy forecasts. Therefore, an appropriate method that promotes renewable energy technology at an early stage as possible needs to be considered to fulfill the two-degree target, which is the ultimate objective of the Paris Agreement.

Third, it is necessary to discuss a comprehensive policy framework. In order to calculate CO_2 abatement costs in this study, the abatement cost was defined as the difference between project and baseline costs. The baseline cost was determined by the electricity sales, consisting of electricity generation and tariffs. In fact, those elements could be affected by certain energy policy interventions. For example, if a government implemented feed-in tariffs, the baseline cost would increase. As a consequence, the abatement cost would decrease. On the other hand, some ASEAN countries have introduced fossil fuel subsidies for energy, especially for oil prices. In this case, the fuel cost for electricity generation is lower than that of business-as-usual. As a consequence, the electricity price is lower than the normal level, and tariffs for electricity also decrease. In this case, though, abatement costs increase.

Above all, the mitigation costs of renewable energy depend on the level of technology development, the design of mitigation mechanisms and incentives, and policy arrangements. Renewable energy for ASEAN countries, however, is critical for achieving a decarbonising society, so the development of these technologies should be constantly promoted with stable policy support. For that reason, a policy proposal based on analytical policy research and fundamental policy discussion would have a significant impact on promotion of steady mitigation actions in ASEAN countries.

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