Study on Pathways to Low Carbon and Efficiency in ASEAN

Final Report

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Acronyms

ASEAN	Association of Southeast Asian Nations
BAU	Business As Usual
BOT	Build Operate Transfer
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
DEN	Dewan Energi Nasional
EE	Energy Efficiency
EPIRA	Electric Power Industry Reform Act
EVN	Electricity of Vietnam
FIT	Feed-In Tariffs
GDP	Gross Domestic Product
GHG	Green House Gas
GW(h)	Gigawatt (Hour)
IEA	International Energy Agency
IEEJ	Institute of Energy Economics Japan
IMF	International Monetary Fund
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
kW(h)	Kilowatt (Hour)
LNG	Liquefied Natural Gas
MEMR	Ministry of Energy and Mineral Resources
MW(h)	Megawatt (Hour)
NOx	Nitrogen Oxide
O&M	Operations and Maintenance
OPEX	Operational Expenditure
PLN	Perusahaan Listrik Negara
PM	Particulate Matter
PPA	Power Purchase Agreement
RE	Renewable Energy
SO_2	Sulfur Dioxide
tCO_2e	(Tons of) Carbon Dioxide (Equivalent)
TW(h)	Terawatt (Hour)
USD	United States Dollar

VIP	Vietnam, Indonesia, and the Philippines
WACC	Weighted Average Cost of Capital
WESM	Wholesale Electricity Spot Market

1 Overview

The Japan International Cooperation Agency (JICA) hired Castalia to assess pathways to low carbon and efficiency for electricity supply in the region of the Association of Southeast Asian Nations (ASEAN), with a focus on Vietnam, Indonesia, and the Philippines (the 'VIP countries'). To assess pathways to low carbon and efficiency, this assignment evaluates existing and proposed low carbon policies in the VIP countries (shown in Appendix A) based on their impact on the following five Policy Goals for the countries' power sectors: affordability, reliability, economic efficiency, widespread access, and sustainability.

The Institute of Energy Economics Japan (IEEJ), also hired by JICA for this assignment, built a power sector model that projects electricity demand and supply in the VIP countries to years 2030 and 2050. The model's demand-supply projections are carried out under different scenarios to show the effect of various low carbon policies on the Policy Goals. The assumptions that IEEJ used for generation technology are shown in Appendix B.

This Final Report assesses the results of IEEJ's modeling to suggest how VIP countries (as well as other countries in ASEAN) could attain reliable, low-cost power through win-win policies that strike a balance between low carbon and efficiency. This Final Report draws on the discussions held during the ASEAN Symposium of 13 December 2013 in Tokyo, and the consultation trip to the VIP countries from 24 to 28 February 2014.

Below we define Policy Goals (Section 1.1), and present our key findings (Section 1.2).

1.1 Defining Policy Goals

For purposes of our analysis, Policy Goals are defined as follows:

- **Affordability**: electricity supply that (i) for consumers, is low cost and fair under a distributional point of view, and (ii) for governments, has a reasonable fiscal impact. Affordability of electricity can be measured in terms of cost (USD) per kilowatt hour (kWh); the distributional fairness can be measured in terms of the share of income represented by electricity expenditure
- **Reliability**: electricity supply that, considering international best practices, is subject to interruptions that are reasonable in duration and frequency. Including intermittent RE, which can compromise reliability, is a key component of many low carbon policies in the VIP countries. Therefore, to measure impact of low carbon policies on reliability, one can consider any additional cost for maintaining reliability when adding intermittent renewable energy (RE)
- **Economic efficiency** (in the rest of this report, 'efficiency'): electricity supply that meets demand while consuming the minimum amount of inputs. Technical energy efficiency (reducing technical losses in generation and transmission; and reducing energy intensity on the demand side) is an important component of economic efficiency. However, economic efficiency considers a broader scope of inputs, including fuel, capital, and operations & maintenance (O&M). Therefore, efficient electricity minimizes resources used and maximizes the economic benefit of using those resources. On a national scale, efficient electricity helps reduce the amount of electricity required to generate a unit of Gross Domestic Product (GDP), reducing the energy elasticity ratio

- **Widespread availability**: the degree to which the majority of businesses and households has access to electricity services. This can be measured in terms of the percentage of consumers that has access to electricity supply through grid-connection, or off-grid solutions such as mini-grids or distributed generation

- **Sustainability**: electricity supply that over time does not do economic damage to society or the local and global environment. In economic terms, sustainability means that the marginal cost of damage done to the environment by pollution from the power sector is less than the marginal benefit society gains by the use of the electricity. Furthermore, marginal cost and marginal benefit are weighted based on when their impacts will occur using a discount rate. This means that pollution generated today that will have costs that are not realized until a later date are not considered as costly as pollution generated today that will have immediate impacts. In the power sector, one can measure sustainability in terms of recovery factors; emissions of local air pollutants (tons of sulfur dioxide, SO_2; nitrogen oxides, NOx; or particulate matter, PM) per unit of electricity supplied (kWh); or global greenhouse gases (GHGs) (tons of CO_2 equivalent, tCO_2e) per unit of electricity supplied (kWh).

1.2 Key Findings for Pathways to Low Carbon and Efficiency

In our analysis we find that:

- **ASEAN countries are signing up for low carbon policies** (Section 2)—in particular Feed-In Tariffs (FITs), portfolio standards, GHG emissions reduction targets, and energy efficiency (EE) targets

- **Low carbon policies have benefits** (Section 3)—they increase uptake of RE generation, and reduce GHG emissions

- **However, IEEJ's modeling suggests that low carbon policies can have unexpected consequences** (Section 4)—they can increase electricity costs more than anticipated, creating additional burdens on the finances of governments or on ratepayers. Furthermore, subsidies create tradeoffs between affordability on one side, and efficiency, sustainability, and widespread access on the other. Finally, low carbon policies can lead to inconsistent results

- **Fortunately, IEEJ's modeling shows that there also are several win-win policies that ASEAN countries can pursue** (Section 5)—these are policies that reduce GHG emissions while also reducing the overall cost of electricity supply: phasing out tariff subsidies, supporting EE on both the demand and the supply side, allowing trade of fossil fuels, and seeking international funding for GHG reductions. VIP countries are already pursuing several of these policies

- **Countries can achieve low carbon and low cost by encouraging efficiency in changing policy contexts** (Section 6)—benefits of efficiency are clear. How these can best be achieved critically depends on broader policy choices. More confidence to investors can attract larger, efficient generation. Gradual introduction of cost-reflective tariffs can help efficiency in both generation and consumption. Concessional finance can help efficient generation choices happen.

The boxes below summarize key features of VIP countries, and their power markets.

Box 1.1: Vietnam

Vietnam has the smallest population and the lowest GDP per capita of the VIP countries. Vietnam has a population of 87.8 million. GDP per capita was estimated at USD1,896 in 2013. However, the country has gone through a period of strong growth, with growth rates averaging 7.2 percent between 2000 and 2010. According to the IMF, economic growth is going to slow down and average 5.5 percent between 2013 and 2018.

In 2012, the most important sector of the country's economy was services, with a contribution to GDP of 41.7 percent, followed by agriculture with 19.7 percent, manufacturing with 17.4 percent, and natural resources with 14 percent. The contribution of agriculture to GDP halved over the last 15 years, and Vietnam has built globally competitive industries such as textiles, footwear, and tourism.

Vietnam is an oil producing country with an output of 348,000 barrels per day, and a reserve of 4.4 billion barrels. The country is currently self-sufficient in coal and natural gas production. However, it is likely that Vietnam will eventually start importing LNG and coal, given its current reserves and growing demand.

Electricity demand and supply

Power demand and supply are growing rapidly in Vietnam. Between 2000 and 2012, demand increased more than fivefold, from 22TWh to 117TWh; high demand growth rates are expected to continue. Demand has outstripped supply despite annual capacity additions of 1,600MW per year since 2000. For example, measures to restrict power use were imposed in various regions in 2013. The Ministry of Industry and Trade projects that demand will increase by 14-16 percent until 2015, and by 11-12 percent between 2016 and 2020.

Government plans call for a total installed capacity of 146.8GW by 2030. Coal will play an increasing role and provide up to 50 percent of capacity in 2030. In addition, nuclear power generation is expected to be commissioned in 2020. The investment need for the power sector from 2011 to 2020 is estimated at a total of USD124 billion, of which approximately two thirds for generation.

Electricity Supply in Vietnam

	Natural gas	Hydro	Coal	Oil	Biofuels	Wind	Imports
Supply (percent)	41.7	28.6	20.1	4.6	0.1	0.1	4.9
Efficiency (percent)	49.1		35.0	32.2			

Source: International Energy Agency (2011) and IEEJ (2013)

Electricity market design

With the approval of the Electricity Law in 2004, Vietnam set the stage for a gradual liberalization of its power market. In 2009, Vietnam started moving towards a competitive generation market. The start of a wholesale competitive market is planned for 2014, and the final move towards a retail market is expected to take place in 2022.

In 2011, the state-owned utility Vietnam Electricity (EVN) and its subsidiaries owned 68 percent of installed capacity, and Independent Power Producers (IPPs) and build-operate-transfer (BOTs) accounted for the remaining 32 percent. As of 2014, the country had only licensed four foreign-invested BOT power projects.

In 2013, the average power tariff in Vietnam was USD0.72 per kWh, the lowest in the ASEAN region. Coal subsidies for power generation were USD2.9 billion in 2011. Low prices represent an entry barrier for foreign investors in the country's power sector.

Sources: **See Appendix C**

Box 1.2: Indonesia

Indonesia has the largest economy and population of the three VIP countries. In 2013, its GDP was USD867 billion. Indonesia has a population of 240 million spread over 922 different islands. GDP per capita was about USD3500 in 2013. Between 2000 and 2012, GDP grew by 5.3 percent on average, fuelled by an expanding service sector and growing private consumption. In 2012, the services sector was the largest in the country's economy, with a GDP share of 38.6 percent, followed by manufacturing with 23.9 percent. Agriculture contributed 14.4 percent in 2012.

Indonesia is endowed with oil, natural gas, and coal. Oil production reached 918,000 barrels per day in 2012, and reserves are estimated at 3.7 billion barrels. Coal and gas are important export commodities. In 2011, Indonesia overtook Australia as the world's largest coal exporter, and exported 300 million tons; the country produces roughly five times its consumption. Natural gas production has grown two percent per year over the last decade, but growing domestic demand is expected to impact exports.

Electricity demand and supply

Electricity demand has steadily increased in recent years. Since 2001, demand for electricity recorded an average annual growth rate of 6.8 percent. Demand growth has been driven by increasing consumption in the commercial sector, which registered growth rates of 9.5 percent. Underinvestment in new capacity has led to regular blackouts. The average duration of blackouts was 3.8 hours in 2009.

Demand projections foresee further growth. The Master Plan of Electricity Supply projects that power generation will increase to 358TWh in 2020, from 182TWh in 2011. Even if the country's renewable energy targets are met, fossil fuel capacity to generate more than 100TWh per year will be needed. Government plans require total investment for the power sector of USD99.6 billion between 2015 and 2021—75 percent of which will be invested in expanding generation capacity. IPPs are expected to contribute 56 percent of this investment.

Electricity Supply in Indonesia

	Coal	Oil	Natural Gas	Hydro	Geothermal	Biofuels	Solar PV
Supply (percent)	44.4	23.2	20.3	6.8	5.1	0.1	0.0
Efficiency (percent)	31.8	35.2	38.7				

Source: International Energy Agency (2011) and IEEJ (2013)

Electricity market design

Indonesia is moving toward a competitive power market. It started to deregulate power generation in 1995. The share of the state-owned utility, PLN, in generation assets decreased from 80 percent of generation capacity in 2004 to 73 percent in 2012.

Power tariffs in Indonesia have gradually increased, but are still subsidized by the Government. In 2012, tariffs were 20 percent higher than in 2005. However, the price increases could not offset rising input costs. The average tariff for businesses was USD0.103 per kWh, and that for residential customers USD0.067 per kWh. Production costs were about USD0.13 per kWh in 2012. In 2011, the Government spent USD5.6 billion to finance the cost gap.

Sources: **See Appendix C**

Box 1.3: The Philippines

The Philippines has a population of almost 100 million, similar to Vietnam, and was the slowest growing VIP economy in recent years. Since 2000, average GDP growth rate was 4.7 percent. The country was affected by the global crisis in 2008, with growth rates of 4.2 percent that year, and 1.5 percent in 2009. However, the economy has since recovered and recorded a growth rate of 6.8 percent in 2012 and 2013. GDP per capita for the year 2013 was estimated at USD2,792.

The Philippines has a strong services sector that accounts for 57.1 percent of GDP. Manufacturing and agriculture contribute 20.5 percent and 11.8 percent, respectively. The recent growth has been attributed to a variety of factors, such as strong domestic consumption financed by remittances, and sectors such as the call center industry and electronics.

The Philippines is the only VIP country without significant primary energy resources. Oil production is only 32,000 barrels per day. Furthermore, the Philippines is a net coal importer. Also, in the absence of new discoveries, it will be difficult to maintain gas production levels in the Philippines due to decreasing production at Malampaya, the main field.

Electricity demand and supply

Electricity demand in the Philippines grew less than in Vietnam and Indonesia. From 2005-2012, the average annual growth rate of electricity demand was 3.9 percent. Most demand is distributed between the three main grids in Luzon, Visayas, and Mindanao. Currently, a 400MW transmission line connects the Luzon and Visayas grids. Further interconnections are planned.

The Government expects that demand will more than double and reach 149TWh by 2030. Additional capacity of 11,400MW is needed to generate enough electricity during peak hours. Investment required amounts to USD17-25 billion, assuming a range of USD1,500-2000 per KW for capital costs.

Electricity Supply in the Philippines

	Coal	Natural Gas	Geothermal	Hydro	Oil	Biofuels	Wind	Waste	Solar PV
Supply (percent)	36.6	29.8	14.4	14.0	4.9	0.1	0.1	0.1	0.0
Efficiency (percent)	35.2	56.7		36.7					

Source: International Energy Agency (2011) and IEEJ (2013)

Electricity market design

The privatization process in the power market started with the Electricity Power Industry Reform Act (EPIRA) in 2001. The share of generation capacity held by the National Power Corporation decreased to 13.5 percent in 2013. Since 2012, the grid is operated under a concession agreement by a Chinese-Philippine joint venture. The retail distribution market is served by 20 private companies.

A wholesale market for electricity started in the Luzon grid in 2006. However, only a fraction of electricity is bought on the spot market. 87 percent of wholesale electricity was sold through bilateral contracts in December 2013. In 2014, the Department of Energy issued a decree that allows the operator to administer the spot market price. In case of price spikes, the market operator can set prices on the basis of a 30 days historical average.

Power is not subsidized in the Philippines. The average generation cost was about USD0.063per kWh in 2012, and the average wholesale price was USD0.112 per kWh for the same year.

Source: **See Appendix C**

2 ASEAN Countries Are Signing Up for Low Carbon Policies

There are four key types of low carbon policies in ASEAN countries. 'Key' policies are those that have been implemented in at least two of the three VIP countries, are widespread (or widely being considered) in the ASEAN region, and are likely to have a significant impact on the electricity sector over the medium to long term:

- **Feed-In Tariffs**—these offer RE generators long-term contracts to purchase their electricity at a pre-determined price, usually (but not necessarily) at a premium over the avoided cost of power (Section 2.1)
- **Portfolio standards**—these consist of a regulatory mandate to increase or decrease the share of electricity from specific technologies (for example, coal, natural gas, hydro, and other renewables) to meet a predetermined percentage of supply (Section 2.2)
- **GHG emissions reduction targets**—these are proposed reductions in tons of carbon dioxide equivalent (tCO_2e) compared to a baseline year or a reference case scenario (Section 2.3)
- **EE targets**—these are objectives to reduce by some percentage the amount of electricity required for a given output; that is, achieving the same level of economic output with a lower amount of inputs (Section 2.4).

The remainder of this section presents these policies in greater detail for the VIP countries.

Other policies in force or under consideration in VIP countries are not low carbon, but have important impacts on low carbon goals—particularly those concerning energy trade and subsidies. Vietnam maintains a coal price subsidy for the electricity sector; and Indonesia has proposed limiting energy exports and restricting them for domestic energy use. On the other hand, Vietnam has considered allowing the cost of coal for electricity generation to rise to world market levels; and Indonesia has proposed to allow tariffs to rise to economic levels.

The full list of policies reviewed in our assignment is contained in Appendix A. The list is the result of consultations with JICA and IEEJ, online research, and in-person consultations held with key stakeholders in each VIP country throughout 2013.

2.1 Feed-In Tariffs

All three VIP countries have adopted FITs, summarized in Table 2.1 below:

- In **Vietnam**, the Government has set the FITs for biomass and wind based on the estimated cost of supplying electricity with those technologies. The FIT for any other RE technology is based on the avoided cost of electricity for the system
- In **the Philippines**, the FITs are based on the cost to build, interconnect to the grid, and operate new RE plants (focusing on biomass, hydro, wind, and solar)
- In **Indonesia**, the FIT scheme consists of price ranges by technology. The ranges are set based on a combination of the cost per kWh for each RE technology and the avoided cost of the electricity grid. Avoided costs differ depending on which grid a plant is considered for, and the voltage at which a plant is interconnected.

Table 2.1: Feed-In Tariffs for RE (USD per kWh)

	Vietnam	The Philippines	Indonesia
Biomass	0.056	0.15	0.106-0.1872
Hydro	-	0.13	0.056-0.13
Geothermal	-	-	0.10-0.13
Landfill gas to energy	-	-	0.11-0.155
Waste to energy	-	-	0.09-0.15
Wind	0.087	0.19	-
Solar	-	0.22	-
Other, or general RE	0.056	-	0.0713-0.1637

Source: Governments of Vietnam, the Philippines, and Indonesia

2.2 Portfolio Standards

All VIP countries have adopted portfolio standards. The portfolio standards in the Philippines are explicitly for increasing the share of RE or low carbon energy in their generation mix by 2020 or 2030. However, in Indonesia and Vietnam the portfolio standards cover targets for low carbon energy as well as targets for conventional generation—including oil, coal, natural gas, and nuclear. As a result, the portfolio standards impact on GHG emissions is uncertain. Table 2.2 below shows targets in each country for increasing the share of RE or low carbon energy in their generation mix by 2020 or 2030.

Table 2.2: Portfolio Standards (percent of electricity supply)

	Vietnam		The Philippines		Indonesia	
Year	**2020**	**2030**	**2020**	**2030**	**2020**	**2030**
Hydro	19.6	9.3		7		
Geothermal				8	>5	
Biomass					>5	
Natural Gas					<30	
Other RE	4.5	6		1	>5	

Source: Governments of Vietnam, the Philippines, and Indonesia

The countries' portfolio standards are based on the following policy documents (see Appendix A for more detailed references):

- **Vietnam**: the Power Development Plan of 2011
- **The Philippines**: the proposed Green Growth Scenario presented to IEEJ in June 2012. More aggressive portfolio standards have been proposed in the National Renewable Energy Program of 2011. However, the final renewable portfolio standards called for under the Renewable Energy Act of 2008 (which

originally established the National Renewable Energy Program) have not yet been finalized

- **Indonesia**: Presidential Regulation No. 5/2006. More aggressive portfolio standards have been proposed by the National Energy Council (DEN). DEN's portfolio standards are currently under consideration in Parliament.

Despite efforts to integrate low-emissions generation, VIP countries recognize that high-emissions technologies will remain a substantial part of their energy mix—making the case for increasing the efficiency of these technologies, as explained further below (see Section 5.2.2 and Section 6.1). Removing high-emission technologies would be very expensive for VIP countries. For example, IEEJ conducted an analysis of what it would cost to ban new investments in coal-fired generation, the most emissions-intensive generation source. The analysis found that doing so would raise the cost of electricity per kWh in 2030 by USD0.03 in Vietnam, USD0.03 in Indonesia, and USD0.02 in the Philippines compared to the reference scenario.

2.3 GHG Emissions Reduction Targets

Vietnam and Indonesia have chosen to pursue GHG emissions reductions targets, shown in Table 2.3 below. In Vietnam, the reductions are compared to the base year of 2010. In Indonesia, the reductions are based on a reference or 'business as usual' (BAU) case. The Government of the Philippines has decided not to adopt a GHG emissions reduction target.

Table 2.3: GHG Emissions Reduction Targets (percent)

	Vietnam (vs. 2010 base year)		Indonesia (vs. BAU)	
Year	**2020**	**2030**	**2020**	**2030**
Voluntary Reduction (a)	10	20	26	-
International Support (b)	10	10	15	-
Total (a + b)	20	30	41	-

Source: Governments of Vietnam, the Philippines, and Indonesia

As shown in the table, Vietnam and Indonesia have stated that they will take responsibility for a voluntary reduction of GHG emissions; and request international assistance for additional reductions.

2.4 Energy Efficiency Targets

All three VIP countries have adopted EE targets:

- **Vietnam**—nationwide EE savings of 5-8 percent by 2015
- **Indonesia**—nationwide reduction of energy intensity per unit of GDP by one percent per year until year 2025
- **The Philippines**—nationwide EE savings of 10 percent by 2030.

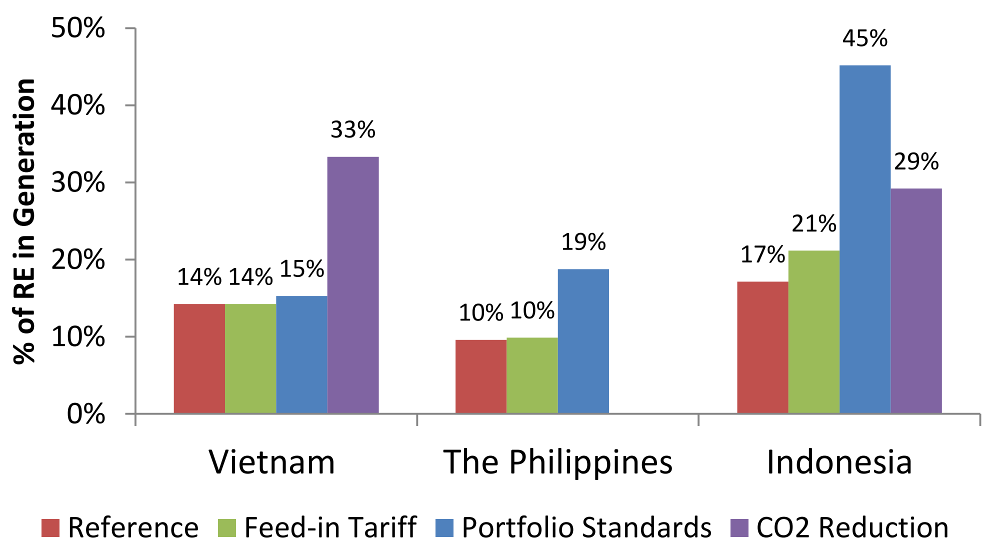
3 Low Carbon Policies Have Benefits

Low carbon policies increase penetration of RE generation (Section 3.1). This means cleaner power generation options that use primary sources found within a country—which contributes to greater energy security. Low carbon policies also reduce GHG emissions (Section 3.2).

3.1 Low Carbon Policies Increase Penetration of Renewables

Figure 3.1 below shows the impact FITs and portfolio standards have on the share of RE generation in total supply compared to the reference case in Vietnam, the Philippines, and Indonesia. It also shows the impact of GHG emissions reduction targets in Indonesia and Vietnam (the Philippines does not have GHG emissions reductions policy). Results shown below are for year 2030.

Figure 3.1: Increased Penetration of RE from Low Carbon Policies, 2030 (percent)



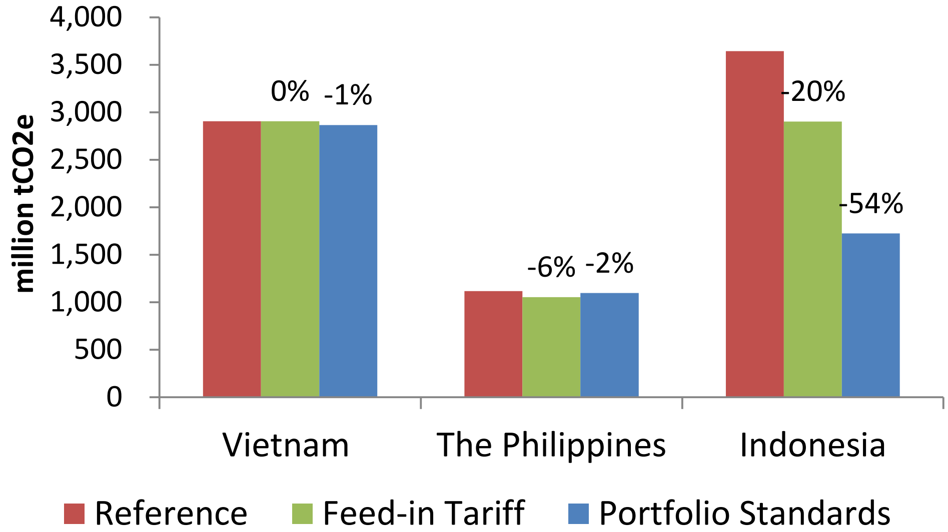
Source: Elaboration based on IEEJ modeling

RE generation options included (among them, hydro) are selected in IEEJ's model on a least cost basis, under the constraints that each low carbon policy places on a country's electricity sector development. The figure shows that FITs in Vietnam and the Philippines have a limited impact on RE penetration—suggesting that they might not provide sufficient incentive for RE. In Indonesia, penetration of RE is greater than targets set in the country's portfolio standard because the portfolio standards are minimum amounts—solving for least cost, greater amounts would actually be dispatched. Finally, GHG reduction targets mobilize large amounts of RE in Vietnam and Indonesia.

3.2 Low Carbon Policies Reduce GHG Emissions

Figure 3.2 shows the extent to which FITs and portfolio standards reduce GHG emissions in the VIP Countries (GHG emissions reductions targets reduce CO_2 emissions by definition.) The model's readout is shown for year 2050.

Figure 3.2: GHG Emissions from Low Carbon Policies, 2050 (million tCO_2e)



Source: Elaboration based on IEEJ modeling

The figure above suggests that the FIT and portfolio standards policies of Vietnam and the Philippines would not have a significant impact on GHG reductions compared to what would happen under the reference scenario. However, in Indonesia the FIT and the Portfolio Standard are aggressive enough to make a significant difference in GHG emissions.

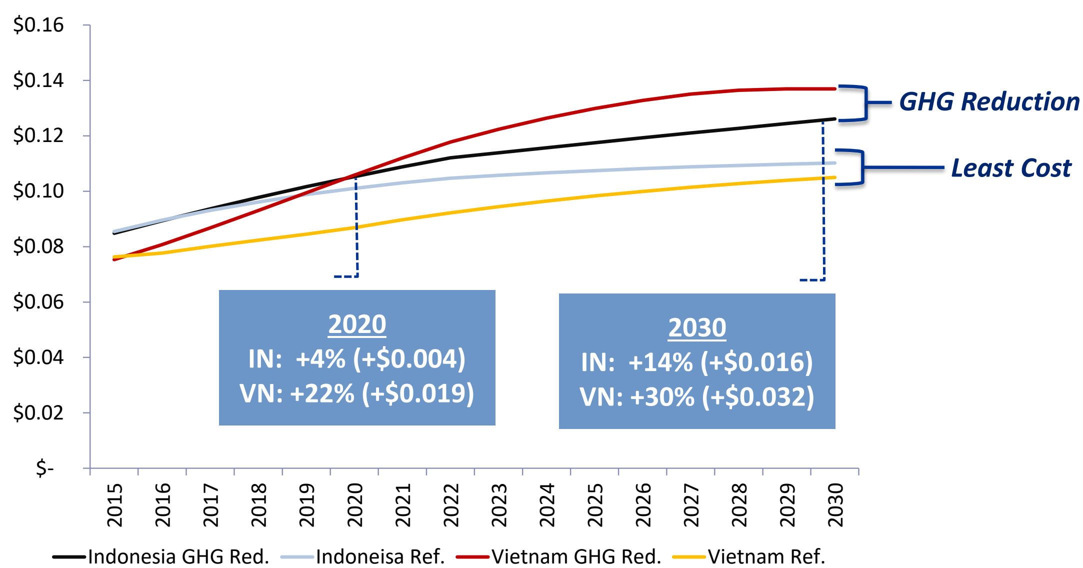
4 Low Carbon Policies Can Have Unexpected Consequences

Low carbon policies can have unintended—or, as put during the ASEAN Symposium in December 2013, unexpected consequences. They can raise electricity costs (Section 4.1). Intuitively, most people are likely to imagine that low carbon policies may produce some increase in costs. However, not all may appreciate just how much, perhaps with a tendency to underestimate. Intermittent renewable technologies might further increase cost due to additional investments needed for reliability. Higher costs must be paid by someone: governments, when the price of power is subsidized; or ratepayers, when prices reflect costs (Section 4.2). Tradeoffs between affordability and other Policy Goals of efficiency, sustainability, and widespread access can result from subsidies (Section 4.3). Finally, low carbon policy frameworks may lead to inconsistent results (Section 4.4).

4.1 Low Carbon Policies Lead to Higher Cost of Electricity

Low carbon policies increase the cost of electricity by encouraging generation options that are not least cost. For example, as shown in Figure 4.1 below, IEEJ's modeling suggests that GHG emissions reduction targets would increase the cost of electricity by four percent in Indonesia and 22 percent in Vietnam by year 2020, and by 14 percent in Indonesia and 30 percent in Vietnam by year 2030. Interestingly, one observes a significant difference in 2030 despite Indonesia's target being set for 2020. This is likely due to a 'lock-in effect' of building more expensive generation to meet the 2020 target.

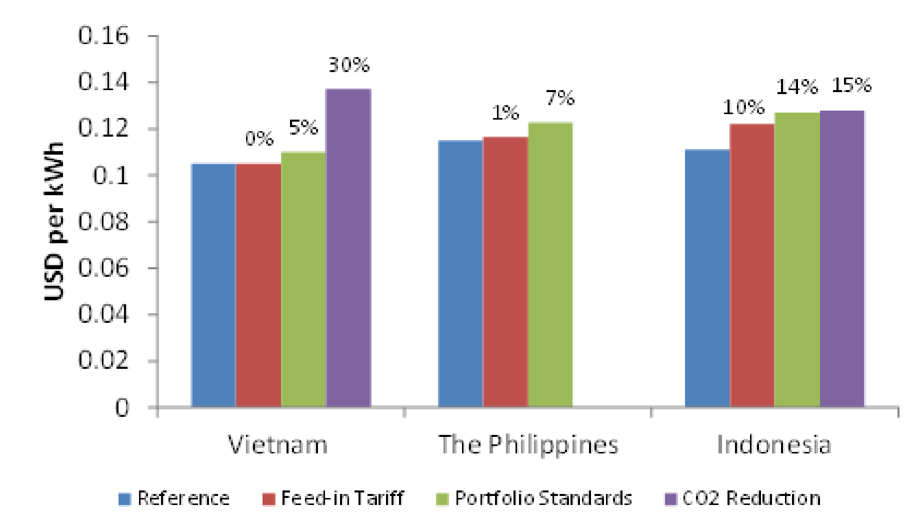
Figure 4.1: Average Cost of Supply, Indonesia and Vietnam, 2015-2030 (USD per kWh)



Source: Elaboration based on IEEJ modeling

IEEJ's modeling results suggest that GHG emissions reduction targets, FITs, and portfolio standards increase the cost of electricity compared to the reference case in each of the three VIP countries, as shown in Figure 4.2 below. FITs that are set at a cost higher than avoided cost will increase the cost of electricity. (In Vietnam, only the FIT for wind is set at a value higher than avoided cost—hence the small increase in cost shown in the figure.) GHG emissions reductions targets that require a higher share of lower carbon, higher cost generation options increase the cost of electricity. The same happens with portfolio standards.

Figure 4.2: Impact of Key Low Carbon Policies on Electricity Costs (USD per kWh)



Source: Elaboration based on IEEJ modeling

Increased generation from clean but intermittent technologies might increase the cost of reliability. Additional investment could be required in backup and standby generation, or in grid strengthening. Detailed studies on grid integration and transmission reinforcement can adequately assess costs and benefits of increased penetration of intermittent renewables.

4.2 Low Carbon Policies Reduce Affordability as Governments or Businesses Pay for Higher Costs

In countries where the cost of electricity reflects cost of service, such as the Philippines, the extra cost of low carbon policies will be passed to ratepayers through higher tariffs. Higher tariffs will negatively impact the competitiveness of businesses—particularly industries for which the cost of power represents a high share of total operating costs. If countries like Indonesia and Vietnam were to allow tariffs to rise to cost-reflective levels, ratepayers would bear a combined increase from low carbon policies and phase-out of tariff subsidies.

In countries that subsidize the cost of electricity, such as Indonesia and Vietnam, the extra electricity cost added by low carbon policies that increase the cost of supplying power will be borne by the government. If the increase in cost is too high, the strain on public finances may be too much for a government to sustain, particularly considering other Policy Goals.

Whether it is ratepayers or governments paying, a key determinant of higher costs is cost of capital, which can end up encouraging inefficient investments. Higher cost of capital will result where there is increased risk, real or perceived—including for some newer, cleaner technologies that international private financiers may be less familiar with. Development financiers are more familiar with newer, cleaner technologies, and are willing and able to provide financing on concessional terms. Local banks and businesses in ASEAN are increasingly proving more willing to take on risk.

4.3 Subsidies Create Tradeoffs between Affordability and Other Policy Goals of Efficiency, Sustainability, and Widespread Access

Sound economics is critical to correctly assessing, and effectively pursuing a balanced mix of Policy Goals. However, subsidies bring distortions that create tradeoffs other than the one between low carbon and affordability, making it difficult to identify any win-win policy options that there may be.

Subsidies help affordability for customers, but they are a disincentive to efficiency. With subsidies, households and businesses are less inclined to invest to use energy more efficiently, or conserve it. Investments in more reliable, efficient generation may be delayed or not made for lack of cost recovery. Inefficient, high-emission generation technology may be chosen if there are direct or indirect subsidies to supply, such as coal export restrictions.

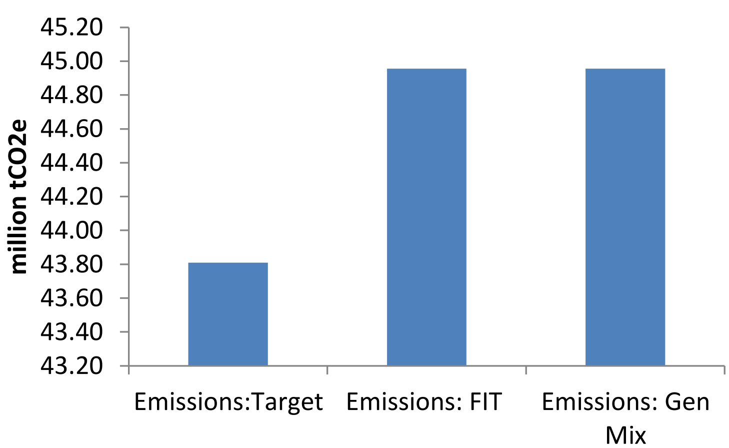
In turn, inefficiency lowers the sustainability of a country's power sector. More electricity is consumed than what would be efficient; and it is generated with less efficient technology. Distorted prices may lead to uneconomic damage for society and the environment: increased emissions of pollutants, uneconomic depletion of countries' natural resources, and increased emissions of global GHGs.

Finally, subsidies can jeopardize the goal of more widespread access. Government resources may be too limited to sustain subsidies as well as fund electrification initiatives. Private investments for increasing electrification will be discouraged by lack of cost recovery tariffs.

4.4 Low Carbon Policies Can Have Inconsistent Results

Low carbon policies that have the same objectives of lower GHG emissions and higher RE penetration, but different mechanisms for arriving at those goals, may lead to inconsistent results. This inconsistency may be due to the fact that different low carbon policies may be issued at different points in time—but it should be considered if a country wants a coherent policy framework. Figure 4.3 shows an example for Indonesia.

Figure 4.3: GHG Emissions in Indonesia, 2020 (million tCO_2e)



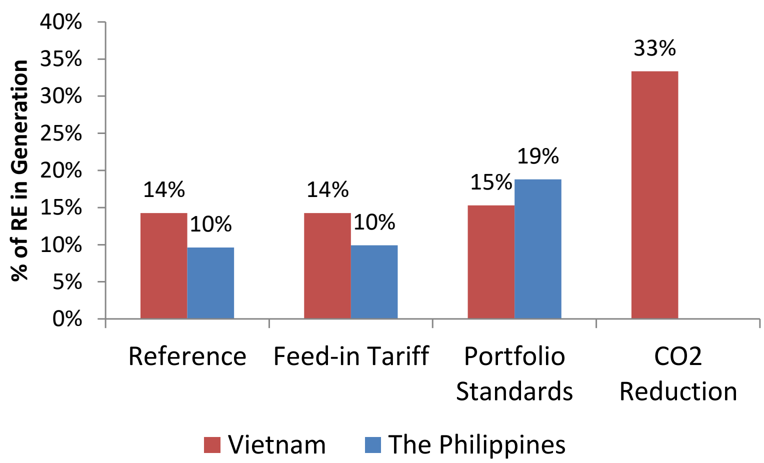
Source: Elaboration based on IEEJ modeling

In the Indonesia example illustrated above, FITs may be an insufficient incentive to ensure that enough RE is built to meet GHG reduction targets; and desired generation mix targets may not reduce CO_2 sufficiently to meet those targets either. We use Indonesia as an example, because the Philippines does not have an explicit GHG emissions reduction target.

Figure 4.4 and Figure 4.5 use examples for Vietnam and the Philippines to show each country's specific approach to FITs and portfolio standards can lead to different outcomes:

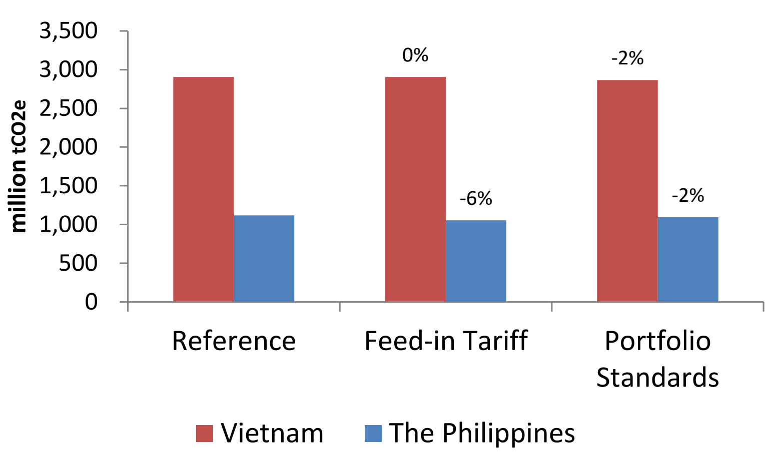
- Modeling results suggest that FITs and portfolio standards would have no appreciable impact on share of RE generation or GHG emissions in Vietnam
- In the Philippines, FITs would have virtually no impact on share of RE in generation, but some impact on GHG emissions; while portfolio standards would increase RE by nine percent, and have a negligible impact on GHG emissions.

Figure 4.4: Share of RE Generation in Vietnam and the Philippines, 2030 (percent)



Source: Elaboration based on IEEJ modeling

Figure 4.5: GHG Emissions in Vietnam and the Philippines, 2050 (million tCO_2e)



Source: Elaboration based on IEEJ modeling

Inconsistencies between different policies can create an investment environment that financiers perceive as riskier. This can increase cost of capital and encourage inefficient investments, as discussed above.

5 Countries Can Pursue Win-Win Policies for Low Carbon and Efficiency

Fortunately, there are several win-win policies that governments of ASEAN can pursue—and in some cases VIP countries are already doing so. These policies achieve lower GHG emissions, but without increasing electricity costs. In fact, they decrease costs. Preliminary modeling results of IEEJ suggest that phasing out tariff subsidies (Section 5.1), supporting EE (Section 5.2), allowing energy trade (Section 5.3), and seeking international support for GHG emissions reductions (Section 5.4) are win-win policies.

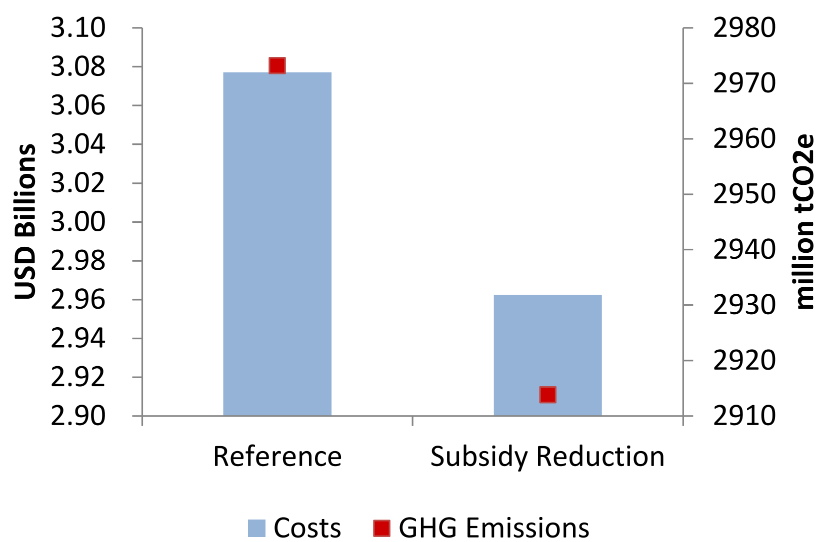
5.1 Phasing Out Tariff Subsidies Is a Win-Win Policy

Phasing out tariff subsidies reduces demand for electricity, because consumers are price sensitive. Consumers will seek ways to reduce electricity use while still producing the same amount of economic output through energy conservation (avoiding unproductive use of energy); as well as through EE investments (reducing energy intensity—the amount of energy required to produce one unit of output; or, conversely, increasing productivity).

This results in a win-win effect, as shown in the example in Figure 5.1 below for Indonesia:

- Reduced cost of electricity for the country as a whole
- Lower GHG emissions.

Figure 5.1: Cumulative Cost of Electricity (USD Billion) and GHG emissions (million tCO_2e) in Indonesia under Subsidy Reduction, 2050



Source: Elaboration based on IEEJ modeling

Note: the figure only models an energy conservation effect (modeling of EE effects is shown in Section 5.2 below)

These results are a win-win because in IEEJ's model they happen while GDP increases at the same rate as in the reference case. This example shows how economic efficiency (fewer inputs relative to outputs) can be consistent with low carbon objectives.

Higher tariffs that reflect costs will increase electricity costs for individual customers. However, the overall cost of supply for the country as a whole will decrease because cost-reflective tariffs will incentivize investments in efficiency. In demand side efficiency, as consumers react to prices through energy conservation and efficiency;[1] and in supply side efficiency, as generators are able to recover new investments. (The next section deals with demand and supply-side efficiency in greater detail.)

Social objectives are very important, and should be kept in mind when thinking about reducing subsidies. Fortunately, the two things are compatible. Pursuing both at the same time makes economic sense:

- In customer categories with very low consumption, such as lifeline tariff customers, demand is likely to be inelastic. Increasing tariffs for these customers would not increase energy conservation or EE
- However, in other customer classes demand will be elastic. Increasing energy conservation and EE through subsidy reduction is likely to work for higher tariff categories.

Correct price signals will be very important for businesses and higher-income households. Such price signals may determine if a business decides whether or not to make an EE investment, depending on whether that investment saves them money given the electricity prices that apply. Targeted lifeline tariffs, just for those who really need them, can be put in place at the same time. Society can be better off under both aspects.

5.2 Supporting Energy Efficiency Is a Win-Win Policy

Supporting EE is a win-win policy on both the demand side and the supply side.

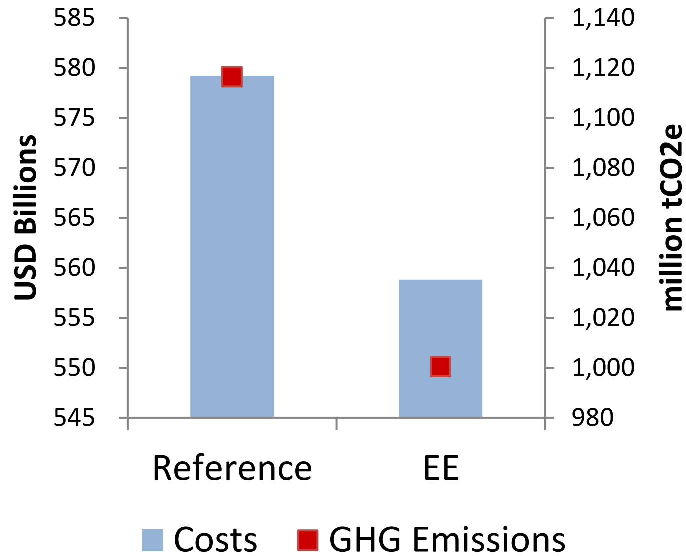
5.2.1 Demand-side energy efficiency

On the **demand side**, many EE investments represent least cost 'negawatt hour' (kilowatt hour saved) measures that generate good savings with quick payback periods while reducing GHG emissions. Assuming that, on average, a package of EE measures would require a cost of USD0.05 per negawatt hour, Figure 5.2 shows how the EE target in the Philippines would not impose additional cost of supply. In fact, it would reduce it, and as such could be considered an integral part of a least cost demand-supply balance. At the same time, the EE target would achieve lower GHG emissions.

IEEJ's modeling of EE effects keeps the same GDP growth as in the reference case, as for modeling the effects of phasing out subsidies discussed above. This means that there is no *absolute* reduction in demand—instead, there is a *relative* reduction in demand as economies grow at the same pace, but requiring less inputs, and therefore more efficiently. This is another example of achieving economic efficiency at the same time as low carbon objectives.

1 See for example Jan Cornille, Samuel Frankhauser, The energy intensity of transition countries, Energy Economics, May 2004, http://www.sciencedirect.com/science/article/pii/S0140988304000234; and Leiming Hang, Meizeng Tu, The impacts of energy prices on energy intensity: evidence from China, Energy Policy, May 2007 http://www.sciencedirect.com/science/article/pii/S0301421506004137 (accessed on 1 February 2014).

Figure 5.2: Cumulative Cost of Electricity (USD Billion) and GHG emissions (million tCO_2e) in the Philippines, 2050



Source: Elaboration based on IEEJ modeling; investment costs of EE assumed at USD0.05 per kWh saved, based on estimates from Castalia studies globally

EE can have a 'rebound effect' embedded in increasing demand: as ratepayers can consume more efficiently, they will also consume more. A rebound effect does not contradict EE, because efficiency is a relative concept of fewer inputs for the same outputs (or, conversely, more outputs from the same inputs). Greater consumption is good, because it brings more welfare and economic growth, as long as it happens as efficiently as possible and is not simply more unproductive consumption.

Importantly, only EE of the four key policy types can be combined with other policies in IEEJ's model. EE targets combined with FITs, portfolio standards, and GHG emissions reduction targets can help reduce GHG emissions at an even lower cost for each scenario, as shown in the example of Vietnam in Table 5.1.

Table 5.1: Cumulative Cost of Electricity (USD Million) and GHG Emissions (million tCO_2e) with and without EE, Vietnam 2050

	Feed-In Tariff		Portfolio Standards		Emissions Reduction Target	
	w/o EE	w/EE	w/o EE	w/EE	w/o EE	w/EE
Cumulative Cost (USD Million)	1,601,700	1,261,300	1,551,100	1,151,300	1,695,800	1,176,400
GHG Emissions (Million tCO_2e)	2,905	1,880	2,866	1,750	1,647	1,181

Source: IEEJ Analysis

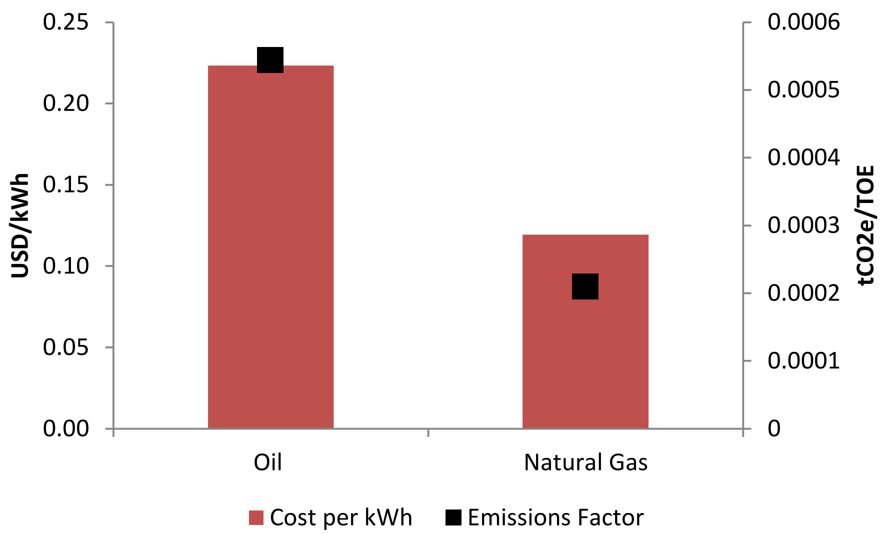
5.2.2 Supply-side energy efficiency

Also on the **supply side** increasing EE can reduce the cost of electricity while reducing GHG emissions. In Section 6, we show in detail how supply side efficiency can contribute to lower costs and GHG emissions.

An interesting example of this in the VIP countries is replacing oil-fired generation with natural gas fired generation. Natural gas can closely follow load, and is the cheapest technology for load following. Natural gas requires large investments that have sometimes prevented its use in the past; however, lower costs may justify expanding the use of natural gas to cover all shoulder and peak generation as well as potentially some base load.

Figure 5.3 below compares the cost of generation (USD per kWh) and emissions factor (tCO_2e per tons of oil equivalent used) for oil fired generation and natural gas generation.

Figure 5.3: Cost and Emissions of Natural Gas Compared to Oil Fired Generation



Source: Elaboration based on IEEJ modeling

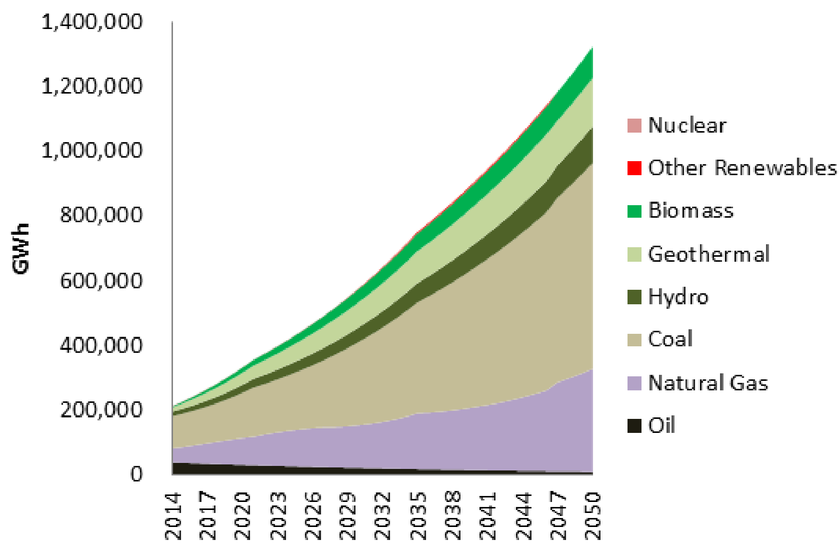
Assumptions: Oil-fired plant with installed capital cost of USD900 per kilowatt, fuel cost of USD0.187 per kWh, and other operating costs of USD0.03 per kWh; Combined Cycle Gas Turbine (CCGT) with installed capital cost of USD940 per kilowatt, fuel cost of USD0.104 per kWh, and other operating costs of USD0.01 per kWh

IEEJ's model recognizes the potential gains from replacing oil fired generation with natural gas, and recommends doing so—for example, in Indonesia and the Philippines as shown in Figure 5.4 and Figure 5.5 below, respectively. In 2012, oil fired generation represented 23 per cent of electricity generation in Indonesia and 10 per cent in the Philippines, with installed capacity of 5.7GW and 1.1GW respectively. The figures below show how the model gradually removes oil-fired generation in both countries and replaces it with state of the art combined cycle gas turbine (CCGT) generation technology.

IEEJ's model suggests that replacing oil fired generation with CCGT generation using natural gas would require an investment of USD5.37 billion in Indonesia and 1.07 billion in the Philippines.

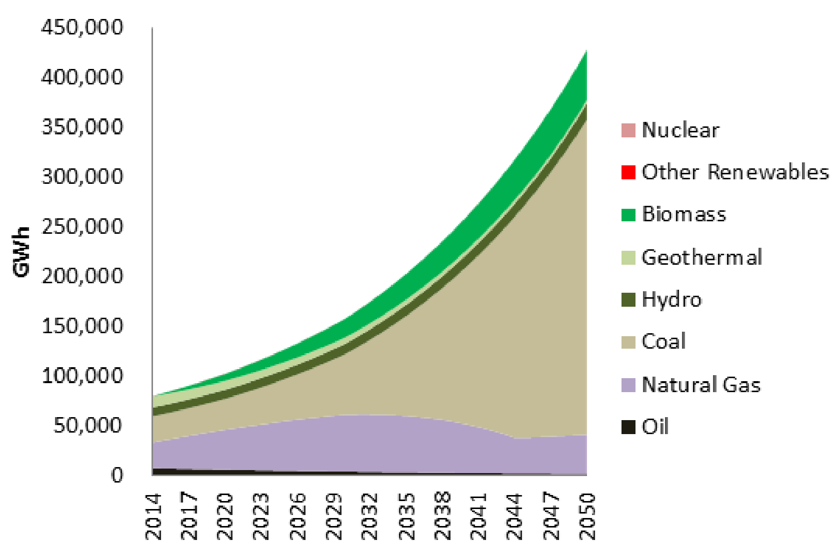
Getting financing on good terms is critical to making these efficient investments. Development financing can play an important role—but (as discussed further in Section 6) also policy choices on how a power market should function, and where tariff levels should be, are key to increase investor certainty, reduce risks, and reduce cost of capital.

Figure 5.4: Electricity Supply by Fuel Source in Indonesia, 2014-2050 (GWh)



Source: IEEJ

Figure 5.5: : Electricity Supply by Fuel Source in the Philippines, 2014-2050 (GWh)



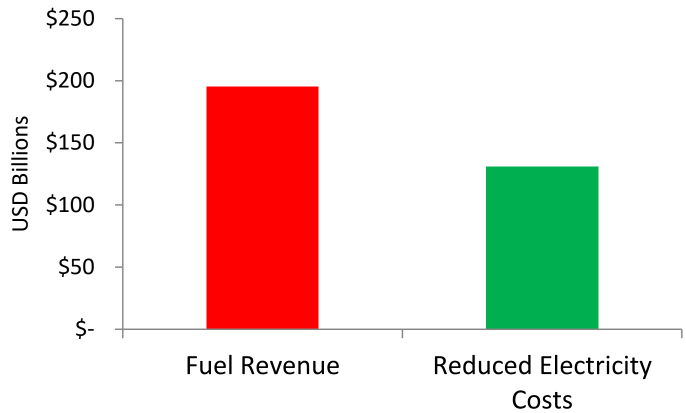
Source: IEEJ

Apart from natural gas generation, investing in efficiency can also make other higher-emission generation technologies more economical and sustainable. Even coal generation can be made more efficient and, to some extent, cleaner.

5.3 Allowing Energy Trade Is a Win-Win Policy

IEEJ's modeling results suggest that allowing energy trade maximizes the amount of value that a national economy may receive for its resources. Individual market participants may benefit from energy trade restrictions; however, a country as a whole is likely to lose value from them. Figure 5.6 compares benefits and costs of allowing exports of coal and natural gas in Indonesia, the only VIP country with a proposed coal or gas export restriction. The country would give up some reduction in cost of electricity supply. However, that would be more than made up for by increased revenues from exporting those fuels at world market prices.

Figure 5.6: Coal and Natural Gas Exports in Indonesia: Benefits and Costs, 2050 (USD Billion)

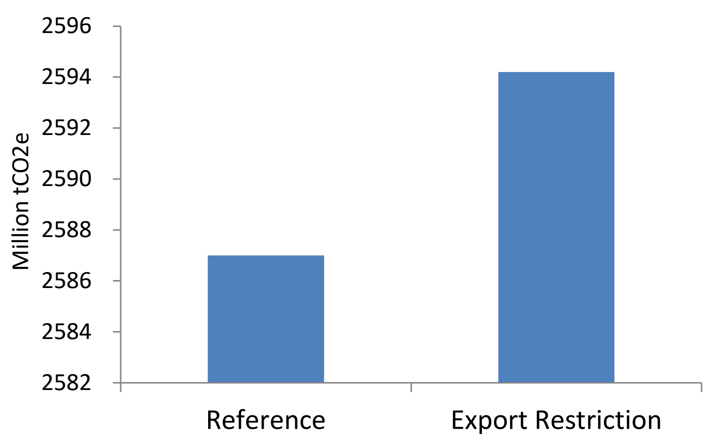


Source: Elaboration based on IEEJ modeling

Note: 'Reduced Electricity Costs' are intended as those given up by allowing exports of coal and natural gas

Figure 5.7 below shows that GHG emissions from the country would be higher with the export restrictions than without them.

Figure 5.7: Coal, NG Exports in Indonesia: GHG Emissions (Million tCO_2e)



Source: Elaboration based on IEEJ modeling

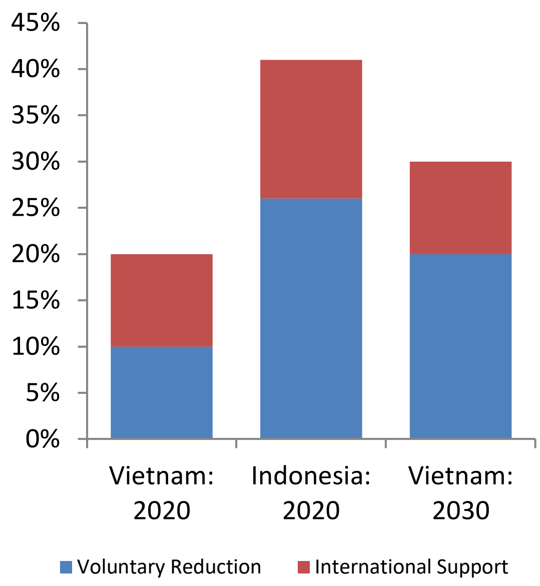
5.4 Seeking International Support for GHG Reductions Is a Win-Win Policy

As shown in Figure 5.8 below, Vietnam and Indonesia are already distinguishing between the GHG emissions reductions they intend to achieve with their own resources, and those for which they intend to request donor support.

That is a well-advised approach, and one that could be further improved by economic analysis. Emerging economies should identify the amount of GHG emissions reductions that they can achieve economically with least-cost technologies on the demand and supply side; and ask that the international community pay for GHG emissions reductions that are not economically viable.

Development financing can play an important role in providing lower cost capital to foster investments in clean energy that create the global public good of lower GHG emissions, and generally to more efficient generation.

Figure 5.8: GHG Emission Reductions Targets, Vietnam and Indonesia (percent)



Source: Governments of Vietnam and Indonesia

This approach would benefit countries and donors alike:

- **From the perspective of a developing country**, knowing which clean energy technologies save costs in addition to saving GHG emissions would benefit the world while achieving sustainable economic growth in-country
- **From the perspective of donors**, knowing which clean energy technologies they should support, and by how much, minimizes what they would spend (as it would allow identifying a viability gap to cover), and also increases the likelihood that they will actually provide funding (as it would provide a sound economic justification for it).

A least-cost approach is vital for assessing all technology options. It allows countries to rank and prioritize options based on their economic viability. The challenge of climate change is such that good economics is more important than ever. There are some economically viable renewable options in several countries, and perhaps their number will increase if their cost drops. Since resources are scarce, countries will benefit from knowing what to prioritize—avoiding spending scarce resources on options that cost too much, and that take money away from the better ones.

6 Achieving Low Carbon and Efficiency in a Changing Policy Context

Achieving a good balance of Policy Goals requires that a market incentivize efficient supply and use of power. Efficient power markets will deliver reliable electricity at the lowest feasible cost, and encourage end-users to use electricity as efficiently as possible; in many cases, this will also lower emissions (Section 6.1). To achieve a low cost, low carbon power sector, policy choices on market structure and tariffs are key to aligning incentives correctly for generators and consumers (Section 6.2). Lower capital costs supported by concessional financing can help efficient choices in generation happen (Section 6.3).

6.1 Efficiency Can Lower Costs and Emissions

Investing in high efficiency generation plants that use natural gas or coal and energy efficient technology for end-users will lower costs and emissions in the electricity sector. Analysis conducted by IEEJ suggests that switching to high efficiency generation will have economic benefits in almost all cases (Section 6.1.1). Furthermore, encouraging increased uptake of energy efficient equipment by end-users will add to the benefits of efficient generation (Section 6.1.2).

6.1.1 Efficient generation can lower costs and emissions

For our analysis, we consider a low efficiency, medium efficiency, and high efficiency scenario. In all three VIP countries, the medium efficiency scenario will lower costs, and the high efficiency scenario lowers costs in Vietnam and the Philippines. The table below shows the assumptions used for coal and natural gas generation in each scenario.

Table 6.1: Assumptions for Low, Medium, and High Efficiency Generation

	Capacity	Lifetime	Capacity Factor	Thermal Efficiency	Installed Capital Cost
Unit	MW	Years	%	%	USD/kW
Coal: Low Efficiency	500	35	80	35	1441
Coal: Medium Efficiency	1,000	35	80	40	1590
Coal: High Efficiency	1,000	35	80	45	1892
Natural Gas: Low Efficiency	300	25	80	45	718
Natural Gas: Medium Efficiency	700	25	80	50	847
Natural Gas: High Efficiency	1,000	25	80	60	1164

Source: IEEJ Analysis

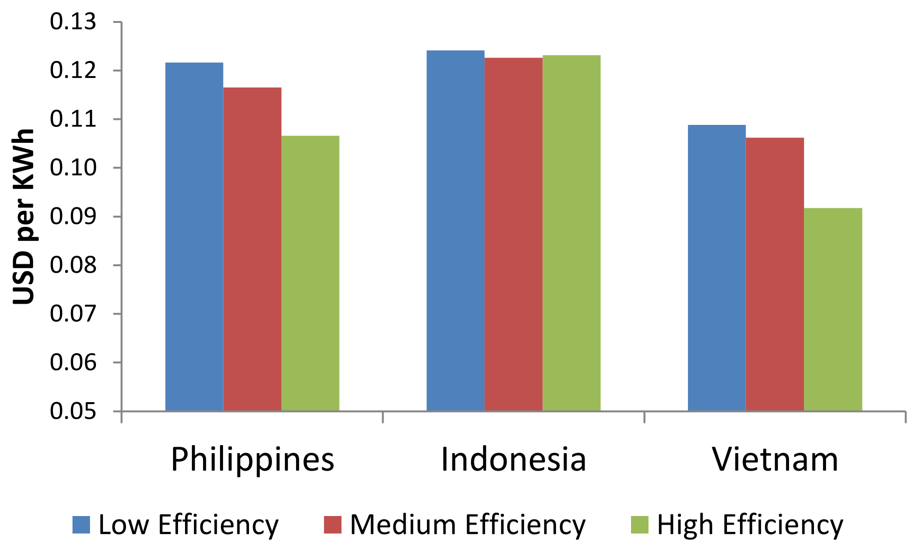
The table above shows that higher efficiency plants have higher capital costs. The relationship between capital costs and efficiency is established by IEEJ through analysis of costs and efficiency of existing generating units worldwide as reported by the International Energy Agency (IEA).[2]

2 IEA. "Projected Costs of Generating Electricity." 2010. OECD.

High efficiency plants can lower the cost of electricity supply

More capital intensive, higher efficiency plants save money over the life of the investment by saving on fuel costs. Natural gas plants can lower costs by providing efficient shoulder and peaking capacity. Efficient coal plants can deliver lower cost base load power.

Figure 6.1: Cost of Supply for Generation Efficiency Scenarios, 2030 (USD per kWh)



Source: Elaboration based on IEEJ modeling

The figure above shows that investing in higher efficiency plants reduces the cost of supplying power in every scenario except for the high efficiency scenario in Indonesia. This is due to lower cost fuel available in Indonesia—however, in the next section we argue how even this apparently disappointing result can represent a success in terms of lower cost of emissions reductions.

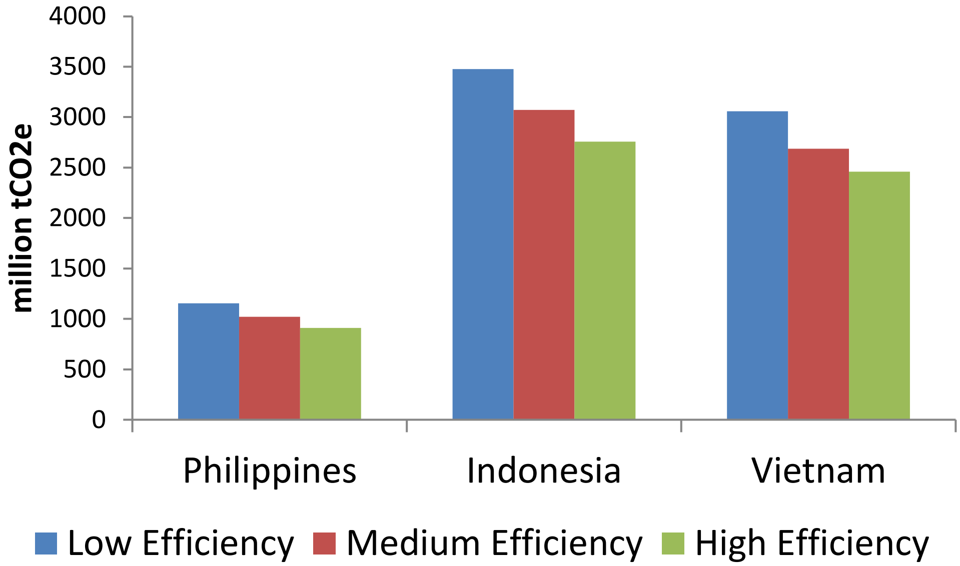
Fuel prices are a key determinant of the benefits of higher efficiency generation units. Higher cost, higher efficiency plants are economically justified when fuel savings offset higher capital costs. Therefore, higher fuel prices enhance the economic viability of high efficiency plants by increasing the value of fuel saved. Low fuel prices have the opposite effect, as is the case in Indonesia.

High efficiency plants can lower GHG emissions

Encouraging higher efficiency generation is a win-win policy because it will lower carbon emissions while lowering costs. The figure below shows how carbon emissions will fall as efficiency increases in all VIP countries.

From this perspective, even the cost of service result shown above for Indonesia can be seen as a success. Even higher efficiency coal can reduce emissions without increasing costs. Figure 6.2 shows greater emissions reductions with higher efficiency generation, and Figure 6.1 shows that these are obtained without increases in cost of service. Replacing standard efficiency with higher efficiency coal generation represents an even larger carbon emissions reduction opportunity than replacing oil with natural gas, because coal makes up a far larger share of generation mix than oil.

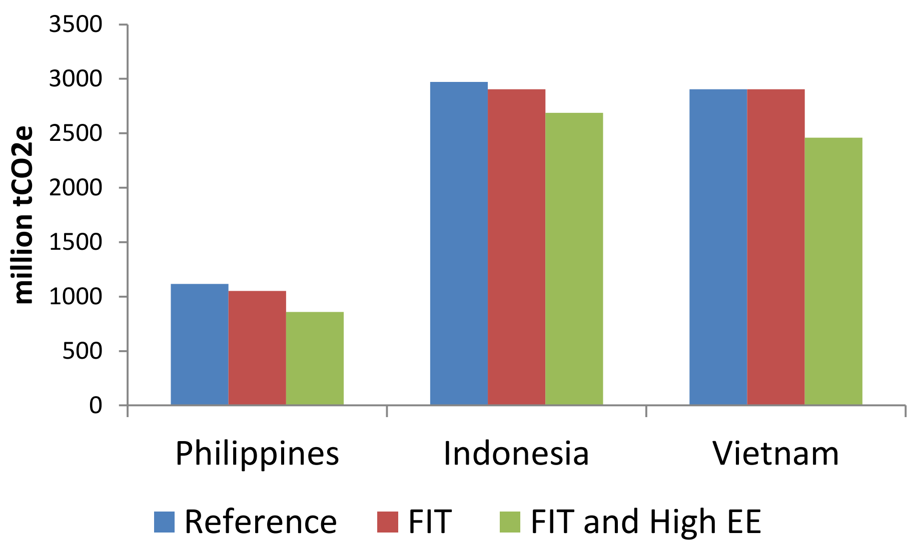
Figure 6.2: Cumulative Emissions to 2050 under Generation Efficiency Scenarios (million tCO_2e)



Source: Elaboration based on IEEJ modeling

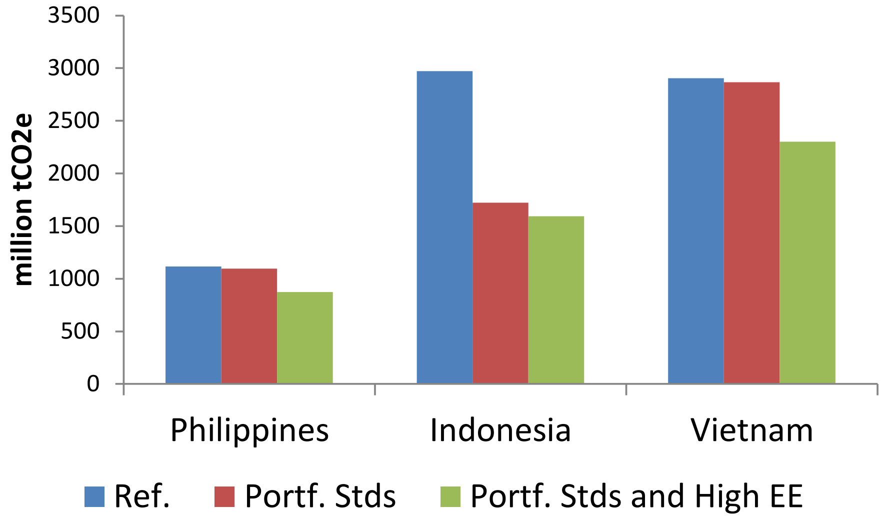
Furthermore, combining higher efficiency generation with low carbon policies will lower emissions more than the low carbon policies on their own. The figures below show how adding high efficiency generation to the FIT scenario and the portfolio standards scenario will in almost all cases lower emissions.

Figure 6.3: Emissions for FIT Combined with High Efficiency Generation (million tCO_2e)



Source: Elaboration based on IEEJ modeling

Figure 6.4: Emissions for Portfolio Standards Combined with High Efficiency Generation (million tCO_2e)

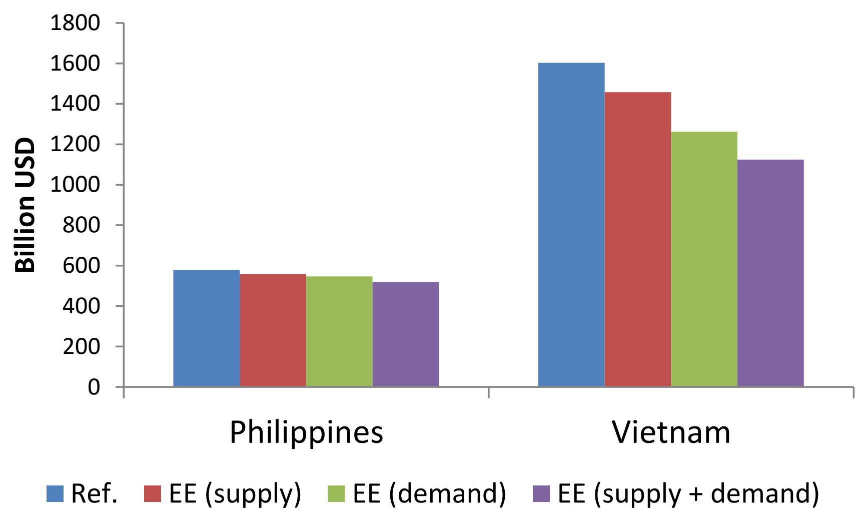


Source: Elaboration based on IEEJ modeling

6.1.2 Energy efficient technology for consumers lowers costs and emissions

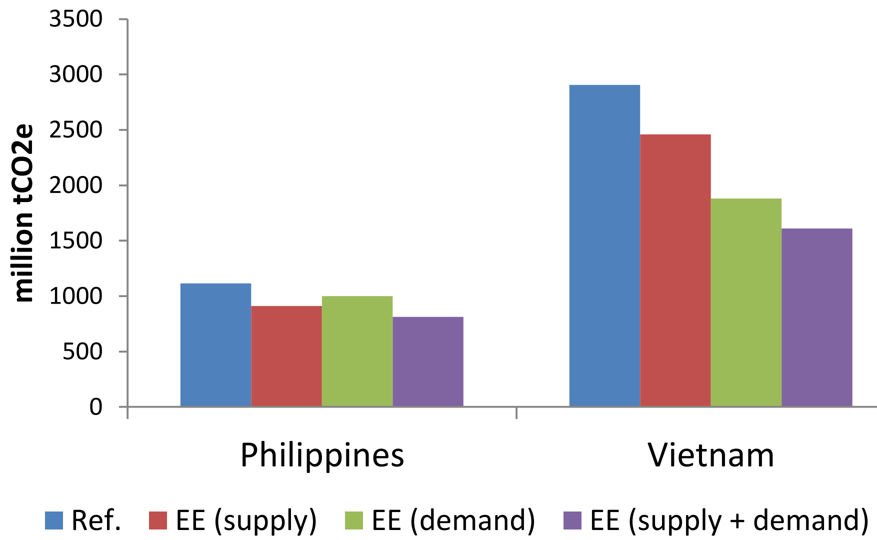
IEEJ's analysis suggests that energy efficient technology for end-users can play an important role in reducing costs and emissions in the VIP countries. Further, increasing uptake of EE technology on the demand side can add to the benefits gained by EE power supply. The figures below show the impact of increasing uptake of EE in supply and demand in Vietnam and the Philippines—the VIP countries that have specific policies for doing so. Results are shown for demand and supply side EE separately, and combined.

Figure 6.5: Cost of Power Supply to 2050 with Increased Efficiency (Billion USD)



Source: Elaboration based on IEEJ modeling

Figure 6.6: GHG Emissions to 2050 with Increased Efficiency (million tCO_2e)



Source: Elaboration based on IEEJ modeling

6.2 Policy Choices on Market Models and Tariffs Are Key to Ensure Efficiency

As shown above, the benefits of efficiency cannot be overstated—but what is the best way to achieve it? This section explores market models and tariff subsidies as the two broader power sector matters that can play a large role in attracting efficient investments in generation and consumption of electricity:

- Investors need to be confident that they will be able to recover the cost of their investment in larger, more efficient, and more capital intensive plants. Large infrastructure investments needed to support efficient generation, such as LNG facilities, also require investor certainty—which the public sector is uniquely positioned to provide. The VIP countries' recent experience suggests that there is no need to rush to a full reform for a wholesale market; a country like Vietnam would benefit from consolidating its current phase of reform, making the single buyer model work, before moving on (Section 6.2.1)
- Tariffs at cost-recovery levels are useful for encouraging efficiency on the consumption and generation sides. On the consumption side, cost-recovery tariffs can increase end-users' certainty that their energy savings justify the cost of investing in energy efficient equipment and measures. On the generation side, they improve the attractiveness of investing in higher efficiency supply. However, countries should exercise caution when raising tariffs. A dramatic, sudden rise may hurt competitiveness of businesses, as well as low income households (Section 6.2.2).

6.2.1 Providing Confidence to Attract Large Investments in Generation

As VIP countries advance in their market reforms, they should consider how to align incentives for making efficient generation happen, and bring low costs and emissions.

The Philippines should find ways to provide greater certainty for large, efficient generation

Countries' recent experience in bringing larger and more efficient generation units to the market provides useful insight. In the past decade, Vietnam and Indonesia have done so. However, since enacting EPIRA the Philippines has not. The table below compares the five largest additions to Vietnam's generating park in the last two years with those in Visayas and Luzon (where the Wholesale Electricity Spot Market (WESM) is in place) in the Philippines over the last ten years.

Table 6.2: Recent Additions to the Power Grids of Vietnam and the Philippines

Name	Year	Technology	Installed Capacity
Vietnam			
Son La #5,6	2012	Hydro	800
Vung Ang I #2	2013	Coal	600
Mao Khe #1,2	2013	Coal	440
Dong Nai #1,2	2012	Hydro	340
Quang Ninh	2012	Coal	300
The Philippines			
APEC	2006	Coal	50
Bangui Wind Power	2013	Wind	33
CIP II	2013	Diesel	21.3
First Farmers Biomass Cogen	2006	Biomass	21
Green Future	2013	Biomass	19.8

Source: Government of Vietnam, Department of Energy of the Philippines

In the last two years alone, Vietnam has had greater success adding larger and more efficient generation units than the Philippines has had in the last decade. In addition, Indonesia is set to commission ten coal plants with an average capacity of 240MW.[3]

These data suggest that under EPIRA investors have been hesitant to build large, efficient plants to meet demand at least cost. This may have happened because of limited certainty in cost recovery, which in turn may have contributed to increased risk, higher returns, and the high tariffs that are a general concern in the country.

Distortions that have affected the market include an absence of long term capacity contracts or traditional power purchase agreements (PPAs) and poor financial health of off-takers. Instead of PPAs, generators and distribution companies purchase electricity through contracts for differences and in the spot market. At present, 89 percent of electricity is purchased through contracts for differences. Although the requirement to purchase 10 percent of electricity through the spot market has expired in Luzon, distribution utilities still

3 Azwar, A. "Fast-tracked power plant building program way behind schedule." The Jakarta Post, February 13, 2013 Accessed on January 15,2014 at: http://www.thejakartapost.com/news/2013/02/13/fast-tracked-power-plant-building-program-way-behind-schedule.html

purchase about 11 percent of their electricity on the spot market.[4] Poor financial health of electrical cooperatives, the key off-takers in the Philippine energy market, makes it difficult for generators to be certain that contracts for differences will be honored.

The Philippines will need stronger policy action and coordination to invest in a LNG terminal that would supply the high efficiency natural gas power plants that the modeling exercise recommends. Under EPIRA there is no policy apparatus for the Philippines' Department of Energy to turn 'plans into plants.' All investment decisions are left to the private sector, including investment decisions on natural gas infrastructure. The Philippines' only significant natural gas field is the Camago-Malampaya field, which supplies 1,500MW of gas-fired generation in Batangas. This field is expected to be exhausted in 17-23 years, as it contains between 2.5-3.5 cubic feet of natural gas and it is producing 146 billion cubic feet of natural gas per year.[5] According to the Philippine Department of Energy, once the Malampaya field is exhausted additional "gas-fired power plants (…) require additional gas discoveries or importation of LNG."[6]

The Philippines has had some recent success increasing the size and efficiency of committed investments, as a couple of larger plants have reached financial close;[7] and one may argue that the market is beginning to function as intended. However, EPIRA has been in effect for over a decade now. It has been a long and costly transition for households and businesses.

The Philippines should seek to ensure that recent successes can continue to be replicated by preserving and enhancing competition and engineering mechanisms that will strengthen long term contracts in the eyes of investors.

The Philippines should consider how to put in place mechanisms that ensure reasonable certainty to generation investors about prices and quantities over the life of the plant. Such mechanisms should build on the Philippines' competitive market, rather than try to reverse the country's reforms: the problem is likely to be in how the market structure works rather than in the chosen market structure per se. Long term power purchase agreements are provided in the Philippines to renewables that are not least cost and do not provide firm power. High-efficiency conventional generation that is least cost and provides firm power would deserve better. New Zealand, Thailand, Brazil, and Singapore may offer useful examples for further study about how to make a competitive wholesale market work as intended, eliminating distortions that lead to a sub-optimal energy mix.

Indonesia and Vietnam's government-backed utilities have provided investor certainty

Arguably, Indonesia and Vietnam have been able to successfully contract large quantities of generation at scale because their utilities are directed and backed by government. PLN's status as the state-sanctioned electric monopoly allows it broad discretion to set its own emissions reductions targets and pursue its own generation mix targets. PLN consults with

4 "Monthly Summary Reports." WESM. Accessed on January 30, 2014 at: http://www.wesm.ph/inner.php/downloads/monthly_summary_reports/page/2

5 "Malampaya Deep Water Gas to Power Project." Department of Energy of the Philippines. Accessed on February 20, 2014 at: http://www.doe.gov.ph/microsites/ngmd%20website/malampaya_history.pdf

6 Balce, G,. Pablico, E. "Report on Philippine Natural Gas Resources: Maximizing their Potential." Department of Energy of the Philippines. Accessed on February 20, 2014 at:http://www.doe.gov.ph/fossil-fuels/natural-gas/356-reports-natgas-01

7 Petilla, Jericho. "Investment Opportunities in the Philippine Energy Sector." October 2013 Symposium for Investment for Energy Sector in the Philippines. Accessed on January 31, 2014 at: http://eneken.ieej.or.jp/data/5228.pdf

the Ministry of Energy and Mineral Resources (MEMR). However, ultimately it is responsible for determining its generation mix. Vietnam's Government can achieve its generation mix targets and contract for large generation units by directing EVN to tender for the required capacity.

Indonesia should achieve greater certainty in its policy framework to avoid jeopardizing investor security

A clear and coherent policy framework in Indonesia would allow maximizing the benefits of procuring large investments in power generation, building on successes of the Fast Track Programs . The country is in the process of finalizing a new Energy Policy that is expected provide clearer priorities for the energy sector (as of early March 2014, the new Policy has been approved by Parliament, and is awaiting Presidential signature to be issued as Presidential Decree).

PLN's independence also makes it able to resist the policies and mandates of the Government. This can cause confusion for investors—paradoxically, one of PLN's strengths that allows it to make investment decisions more freely can also be a hindrance to investment.

Despite success achieved, a lack of coordination has harmed Indonesia's ability to procure large, efficient generation in the past when ministries responsible for land acquisition and environmental permitting did not adequately coordinate with PLN.[8]

Vietnam should consolidate the gains from its current stage of market reform before moving ahead with further reforms

Vietnam has reformed its power sector to allow for competition in generation. And under this market structure, it has successfully attracted large investments.

Given the Philippines' experience of a long and costly transition to a wholesale power market, Vietnam would be well advised to consider carefully at what speed it wants to proceed on its reform path. Consolidating gains from the current phase of competitive generation, making it work as well as possible, is likely to benefit the country. Conversely, moving too quickly to the next phase of reform, before the market is really ready for it, is likely to put those gains at risk.

6.2.2 Carefully phasing in cost-reflective tariffs to encourage efficiency

Removing electricity tariff subsidies is a key element of aligning incentives. Indonesia and Vietnam are in the process of doing so:

- In Indonesia, PLN is open to raising the tariff to cost-recovery levels provided that Parliament support it. The Government of Indonesia spends a large share of its budget on electricity subsidies. According to the PLN statistics, the average cost of electricity generation in 2012 was about USD0.13 per kWh.[9] The average tariff was USD0.07 per kWh. After the Constitutional Court repealed Law No.20 of 2002 on Electricity, the People's Consultative Assembly passed Law Number 30 of 2009 Concerning Electricity. Article 34 (part two) states that the "The

8 Inajima, T., Urabe, E. and Wulandari, F. "J-Power, Partners Delat $4 Billion Indonesia Power Plant." Bloomberg News. October 4, 2013 Accessed January 19, 2014 at: http://www.bloomberg.com/news/2013-10-04/j-power-partners-delay-4-billion-indonesia-coal-power-plant.html

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competent Government shall set consumer power tariffs upon consent of the House of Representatives of the Republic of Indonesia." This effectively gives the People's Consultative Assembly final authority over tariffs

- Vietnam has confirmed that it will allow electricity tariffs to float. However, the target is just USD0.08-0.09 per kWh by 2020, while the electricity price in 2011 was around USD0.06 per kWh. USD0.06 is lower than the estimated long run marginal cost of USD0.095 per kWh.[10] Power producers argue that allowing the tariff to rise is necessary to attract additional investment in power production[11]; however, local industries are concerned about the tariff increase, and are pushing back against efforts to raise it.[12]

In countries where tariffs are subsidized, raising tariffs would help electric utilities earn enough revenue to cover the costs of investments; more cost reflective tariffs would also reduce the distortion of an artificially low elasticity of generation choices to cost of fuels (such as in the case of subsidized coal). Reducing subsidies would also incentivize electricity consumers to invest in energy efficiency, and conserve energy—while lowering GHG emissions. Furthermore, lowering energy subsidies would reduce the fiscal burden on governments, freeing up funds for other energy sector goals such as widespread availability (for example, building on Indonesia's success in electrification to further increase the rate from the current level of about 80 percent).

However, countries considering raising tariffs should weigh tradeoffs carefully, as this may also cause concern among households, businesses, and foreign direct investors in countries where tariffs are raised. In Vietnam and Indonesia, key industries rely on lower power costs to remain competitive. As a result, they are resistant to raising electricity tariffs, and might reconsider investment decisions if tariffs rise.

6.3 Providing concessional finance to help efficient generation choices happen

Relatively high capital costs linked to low investor confidence and high perceived risk may hurt more capital intensive and efficient generation choices. Conversely, as VIP countries advance in their market reforms and build confidence to lower perceived investment risks, more capital intensive and efficient generation choices will be more likely to happen.

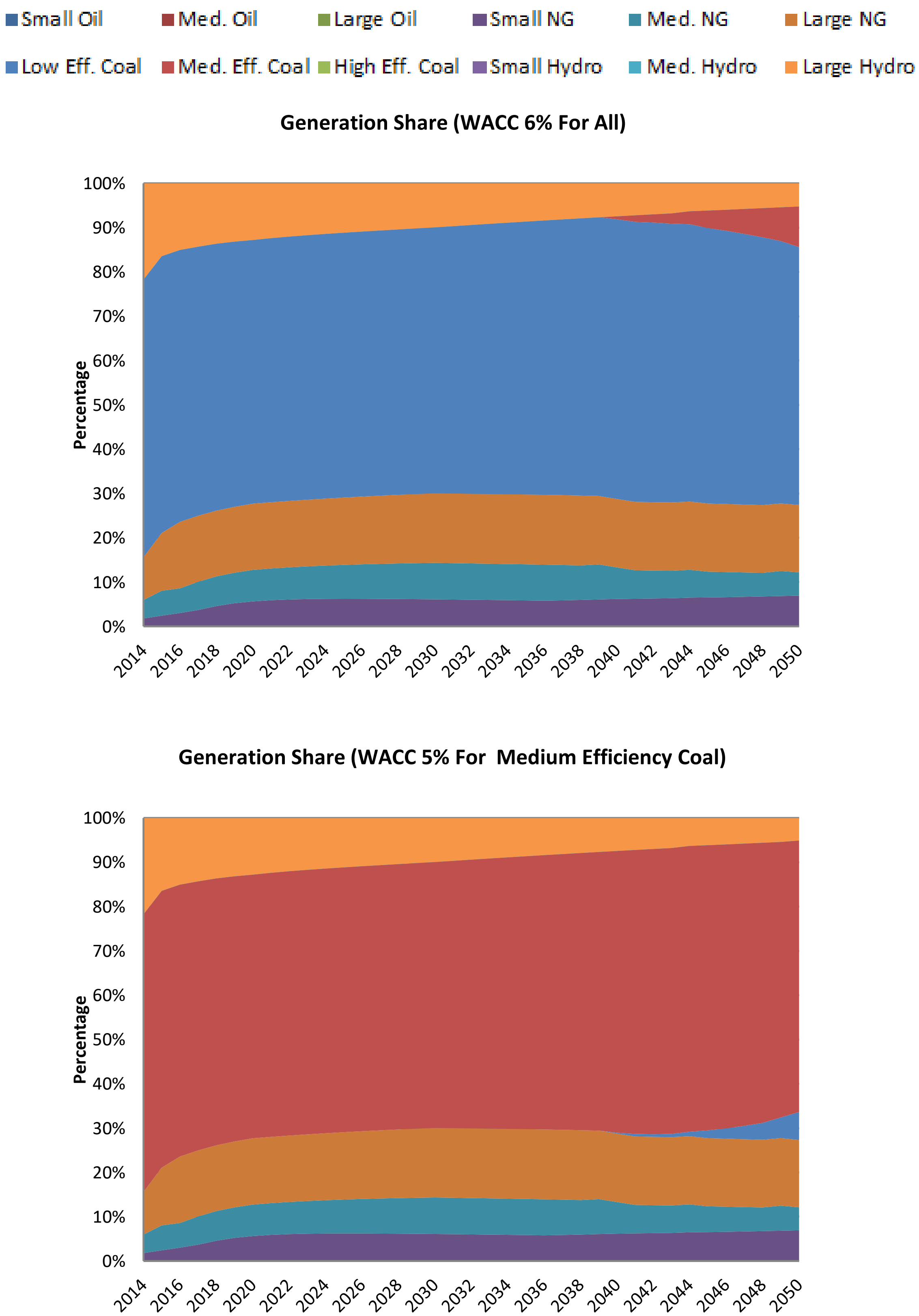
Concessional finance can play a key role to ensure that the most efficient generation options happen. The figures below from IEEJ's modeling for Vietnam show how lowering the Weighted Average Cost of Capital (WACC) from an overall level of 6 percent to lower levels for more efficient coal can bump up higher-efficiency generation options. With a 5 percent WACC, medium efficiency coal moves up in the merit order above standard efficiency coal; and with a 4.5 percent WACC, high efficiency coal becomes the least cost option.

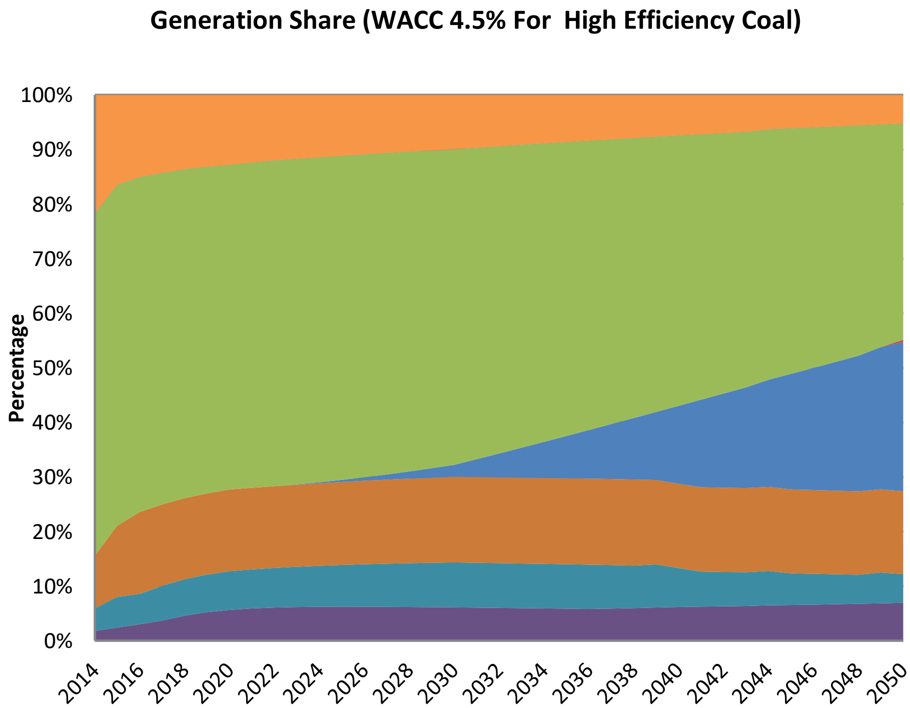
10 Nguyen, Q. K. (2012), 'Cambodia's Electricity Sector in the Context of Regional Electricity Market Integration' in Wu, Y., X. Shi, and F. Kimura (eds.), Energy Market Integration in East Asia: Theories, Electricity Sector and Subsidies, ERIA Research Project Report 2011-17, Jakarta: ERIA, pp.253-267.

11 "Vietnam Faces Growing Threat of Power Blackouts." Bloomber News. 05/12/2013 Accessed on March 12, 2014 at: http://www.bloomberg.com/news/2013-12-05/vietnam-faces-growing-threat-of-power-blackouts-southeast-asia.html

12 "Vietnam electrify rate hike worries businesses." Asia News Network. 07/04/2012 accessed on March 12, 2014 at: http://www.asianewsnet.net/news-32917.html

Figure 6.7: Share of Higher Efficiency Coal under Different Capital Cost Scenarios, Vietnam




Generation Share (WACC 4.5% For High Efficiency Coal)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050

Source: IEEJ

7 Conclusion

This study suggests that there are win-win scenarios for VIP countries to pursue pathways to low carbon and efficiency. The key policies that are worthwhile pursuing are:

- More cost reflective tariffs, carefully introduced—these will incentivize generators to invest, and consumers to use electricity prudently and efficiently
- Supply side energy efficiency—this will lower the cost of electricity and emissions
- Demand side energy efficiency—this will lower demand, reduce emissions, and save money
- Supporting investor confidence—this will lower perceived risk, and in turn reduce costs thanks to lower cost of capital.

Other policy scenarios are not win-win: for example, GHG emissions reductions targets are likely to increase costs; FIT policies may raise costs and have limited impact on carbon emissions.

VIP countries like others in ASEAN would be well advised to focus on win-win options; and pursue options that are not win-win only if they are convinced that these create net economic benefits to the country—and seeking international donor support.

Finally, the timing and sequencing of reforms are likely to be key factors for success. Each step in reform should be taken when it can really benefit a country—the experience of the Philippines can provide a useful example for Vietnam and other countries in ASEAN. And reform should follow a critical path, enacting 'enabling' reforms first—critically, putting in place more cost-reflective tariffs before any success can be expected from efforts for greater efficiency.

Appendix A: Low Carbon Policies Reviewed for Vietnam, Indonesia, and the Philippines

A.1 Vietnam

Name of Policy	Description of Policy	Instructions to Modelers
Reevaluating Coal Price Distortion	Policy to increase the cost of coal supplied by the state coal company, Vinacomin, to EVN to 100 percent of Vinacomin's production cost Currently, the coal price is equal to about 85 percent of Vinacomin's production cost. From now until early 2014, it will be increased to be equal to cost recovery level	1) Specify coal price of 85 percent of Vinacomin's production cost for BAU scenario 2) Specify coal price of 100 percent of Vinacomin's production cost to model policy 3)Specify coal price at world prices to show the implicit subsidy of Vinacomin selling coal to EVN at productions cost
Decision No. 1393/QD-TTg: Green Growth Strategy	Policy that sets energy sector GHG emissions reduction targets compared to BAU: • 2011-2020: 10-20 percent; the voluntary reduction will be 10 percent, and 10 percent is dependent on international support • 2020-2030: 20-30 percent; voluntary reduction will be approximately 20 percent, and 10 percent is dependent on international support	1) Include constraint in model that can reduce GHG emissions resulting from power generation by a specific percentage by a specific target date 2) Set GHG emissions constraint to zero to create a BAU scenario 3) Set GHG emissions constraint to between 15 and 20 percent for 2020 and between 20 and 30 percent by 2030 to model policy
Decision 1474/QD-TTg: National Action Plan on Climate Change in the period 2012-2020	Policy that sets energy sector GHG emissions reduction targets of eight percent by 2020 compared to the base year of 2005	1) Include constraint in model that can reduce GHG emissions resulting from power generation by a specific percentage by a specific target date 2) Obtain information about electricity generation mix in 2005. Apply standard emissions factors for each plant in the 2005 energy generation mix to calculate 2005 baseline. 3) Set GHG emissions constraint to eight percent less than emissions in 2005
Decision 1208/QD-TTg: Master Plan for	Policy that establishes portfolio standards for 2020 and 2030. The requires that generation in 2020 and 2030 be:	Include constraint in model to force the model to change the total electricity supply mix to include a

Name of Policy	Description of Policy	Instructions to Modelers
Power Development 2011 - 2020 with Vision to 2030	• Hydro: 19.6%; 9.3% • Coal: 46.8%;56.4% • NG: 24.0%:14.4% • RE: 4.5%; 6.0% • Nuclear:2.1%; 10.1% • Import: 3.0%; 4.9% RE targets of 4.5 percent of consumption in 2020 and 6 percent in 2030	specified percentage of MWh from RE despite potentially higher cost. Constraint should still ensure that lower cost RE will be used first
Decision No. 1955/QD-TTg: Nuclear Power Development	Policy that calls for commissioning the first nuclear generator by 2020. The policy also requires that nuclear power account for about 15-20 percent of the total energy consumption by 2050	1) Include nuclear generation options among candidate plant 2) Include constraint in model to force the model to change the total electricity supply mix to include a specified percentage of nuclear power 3) Set constraint to 15-20 percent nuclear power
Decision No. 18/2008/QD-BCT: Avoided Cost Tariff Act Regulation	Policy that sets FITs for RE at avoided cost. In 2012, the average avoided cost tariff was USD0.056	Model avoided costs of providing electricity using conventional and renewable generation options for each year the model will consider. Offer this as FIT.
Decision No. 37/2011/QD-TTg: Vietnam Wind FIT	Policy that sets FIT of USD0.087/kWh for wind energy. The FIT will be offered under a PPA that must have a term of 20 years	Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model.
Biomass Feed-In Tariff	Proposed policy that sets a FIT for combined heat and power (CHP) from biomass of USD0.056 per kWh	Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model.
Decree 75/2011/ND-CP : Investment Credits and Export Credits for RE Projects	Policy establishes that RE projects will be entitled to state investment credits with interest rates equivalent to a five-year Vietnamese government bond plus 1 percent and a term of 12 years	1) Include a variable to apply a different discount rate to RE candidate plant that is equivalent to the five year Vietnamese bond rate plus one percent 2) Lower the discount rate for RE generation options to the cost of a five-year government bond plus 1 percent

Name of Policy	Description of Policy	Instructions to Modelers
Decision 79/2007/QD-TTg: Vietnam National Target Energy Efficiency Program	Policy that promotes EE in target sectors—industrial, commercial, residential, and transport—to achieve nationwide energy efficiency savings of 5-8 percent by 2015 compared to forecast energy demand in the national electricity development plan period 2011 - 2020	Reduce variable for total demand by 5-8 percent by 2015 compared to BAU

A.2 Indonesia

Name of Policy	Description of Policy	Instructions to Modelers
Presidential Regulation No. 5/2006	Policy that establishes a target energy mix for 2020 of: • Oil <20% • Gas <30% • Coal <33% • Biofuel >5% • Geothermal >5% • RE >5% • Liquefied Coal >2%	Include constraint in model to force the model to change the total electricity supply mix to include a specified percentage of MWh from each candidate plant fuel type despite higher costs. The percentage of each candidate plant fuel type for the electricity sector should reflect a percentage that will allow Indonesia to achieve its overall targets for the energy sector
DEN (National Energy Council) Draft Energy Policy: High RE Energy Mix Targets	Policy that establishes a target energy mix of: • Gas: 20 percent by 2025; and 14 percent by 2050 • Oil: 23 percent by 2025; 16 percent by 2050 • Coal: 30 percent by 2025; 30 percent by 2050 • RE: 26 percent by 2025; 39 percent by 2050	Include constraint in model to force the model to change the total electricity supply mix to include a specified percentage of each candidate plant fuel type despite higher costs. The percentage of each candidate plant fuel type for the electricity sector should reflect a percentage that will allow Indonesia to achieve its overall targets for the energy sector.
Energy Law (No. 30. 2007): Electricity Tariff Subsidy Reduction	Policy that calls for reducing across-the-board subsidies until tariffs reflect the economic price of electricity	1) Include in the model a relationship between tariff price increases and reduced demand 2) Assume that demand is reduced equivalent in relation to the rise in tariffs
MEMR—Regulation No. 04 of 2012: Feed-In Tariff	Policy that establishes FITs for various RE generation candidate plant under 10 MW based on the avoided cost of the grid in which it is introduced:	Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model

Name of Policy	Description of Policy	Instructions to Modelers
	• RE: USD0.0713-0.1637 (expected to work for wind, solar) • Biomass: USD0.106-0.1872 • Waste to energy: USD0.09-0.15 • Hydro: USD0.056-0.13	
MEMR— Regulation No. 22 of 2012 Geothermal FiT(under review)	Policy that establishes a geothermal feed-in tariff of between USD0.10 and USD0.185 depending on both the location and voltage connection (medium or high) of the geothermal generation asset. The regulation does not contain a limit on installed capacity for each installation	Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model
MEMR—Regulation No. 17 (2013): Solar Energy Auction Program	Policy that allows PLN to auction off up to 172.5MW of installed solar capacity to candidate solar project developers to bid at a discount to the state-set top price of USD0.25 per kWh. Winning bids will sign 20-year contracts to sell power to state utility	1) Model the cost of candidate solar PV plants 2) Assume that candidate solar PV plant the cost of which is less thantUSD0.25 per kWh will have their bids accepted starting with the least expensive bid until the maximum installed capacity of 172.5 MW is reached
MEMR—Regulation No. 19 of 2013: Landfill Gas to Energy	Policy that establishes a feed-in tariff of between USD0.125 and USD0.155 for Landfill Gas to Energy (LFGTE) under 10 MW based on zero waste technology and between USD0.11 and USD0.14 for LFGTE under 10 MW based on sanitary landfill technology. For each technology the lower FIT is for installation interconnected to medium voltage connections and the higher tariff is for installations interconnected to low voltage connections	Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model
International Interconnection	Policy that calls for establishing interconnection between Sumatra and Malaysian Peninsula and between Kalimantan and Serawak	1) Research the average cost of generation in the Malaysian Peninsula and Serawak 2) Include generation from Serawak and the Malaysian peninsula as candidate plants in the energy mix of Sumatra and Kalimantan
Domestic Interconnection	Policy that call for improving the Java-Sumatra interconnection	Consider candidate plant in Sumatra, Java, and Bali as eligible for meeting the electricity needs of Sumatra, Java, and Bali
DEN Proposed Coal and Gas Export Restrictions	Policy that calls on the Government to limit gas and coal exports in order to preserve them for long term domestic use. However, the details of how exports would be limited have not been made available	1) Model allows changing cost of coal and gas if export restrictions are imposed 2) Allow for several scenarios of coal and gas export

Name of Policy	Description of Policy	Instructions to Modelers
		restriction. • A severe export restriction scenario should allow for coal prices to fall close to the short run marginal cost of coal and gas production in the short to medium term—defined as the length of the average investment in coal mine or gas field. In the long term, coal and gas prices should rise to the long run marginal cost of coal production in Indonesia. • A limited export restriction scenario should allow for coal and gas prices to fall slightly below the global market price and remain there for the period of the simulation
DEN Proposed GHG Reductions	Policy that establishes a GHG emissions reduction target of 26 percent by 2020 compared to a BAU scenario. According to the MEMR this requires a 30 million tCO2e reduction from the electricity sector.	1) Include constraint in model that can reduce GHG emissions resulting from power generation by a specific percentage by a specific target date 2) Set GHG emissions constraint to zero to create a BAU scenario 3) Set GHG emissions constraint to 26 percent for 2020
Presidential Regulation No. 61 of 2011—approval of Nationally Appropriate Mitigation Actions	Policy that reaffirms the government's GHG emissions reduction target of 26 percent for the energy sector by 2020 compared to a BAU scenario. Furthermore, the policy calls for an additional 15 percent reduction from the energy sector to be funded with international support under the NAMAs framework. To achieve the additional reductions in the electricity sector, this regulation calls for constructing: • **Micro Hydro**: 46.17MW between 2010 and 2014 and 84.23MW between 2015 2020 • **Mini Hydro Power**: 182MW between 2010 and 2014 and 510MW between 2015 and 2020 • **Solar PV**: 102MW between 2010 and 2014 and 510MW between 2015 and 2020 • **Biomass Power Plant**: 0.4MW between 2010 and 2014 and	Include constraint in model to force the model to change the total electricity supply mix to include a specified MW from each candidate plant fuel type by the specified year despite higher costs

Name of Policy	Description of Policy	Instructions to Modelers
	16.5MW between 2015 and 2020	
Government Regulation No.70/2009—Energy Efficiency	Policy that aims to reduce energy intensity of Indonesia's economy by one percent a year until 2025 by promoting energy efficiency and conservation. The policy calls for labelling energy efficiency technologies, providing incentives for energy conservation and mandatory energy efficiency improvements for large users	Adjust the electricity demand function to reduce energy intensity per unit of GDP by one percent per year until 2025

A.3 The Philippines

Name of Policy	Description of Policy	Instructions to Modelers
Draft Renewable Portfolio Standards Policy, August 2013 (at least three year transition period is envisioned before implementation)	Each market supplier (distribution utilities, retail electricity suppliers) will be given a different target, based on its electricity supply portfolio. RPS target expected to increase by 1 percent annually. Renewable Energy Certificates can be bought to meet shortfalls. DoE will grant exceptions for meeting targets, if lack of RE capacity or available supply on market. Eligible technologies include: biomass, waste-to-energy, wind energy, solar energy, run-of-river hydro, ocean energy, hybrid systems, impounding hydropower that meet international standards, geothermal	Include constraint in model to force the model to change the total electricity supply mix to include a specified percentage of MWh from RE despite potentially higher cost. Constraint should still ensure that lower cost RE will be used first
Approved Feed-in Tariff Policy, July 2012	FITs currently determined based on total average costs of building, operating and connecting "new" RE plants to the grid. In 2012, run-of-river hydropower (USD0.13/KWh), biomass (USD0.15/KWh), wind (USD0.19/KWh), solar (USD 0.22/KWh). Ocean eligible but FIT rate not set (can assume higher than solar). FITs lowered if actual installed capacity per technology exceeds expected amount. A uniform "FIT-all" tariff applied to electricity consumers, based on per kWh consumption. By 2030, FIT targets are run-of-river hydro: 250MW, biomass: 250MW, wind: 200MW, solar: 50MW, Ocean: 10MW	1) Calculate value of subsidy compared to average cost of generation and apply value to reduce the cost of RE in the model. 2) Include the option to drop FITs, and revert to least cost generation if/when generation mix reaches target capacity: By 2030, FIT targets are run-of-river hydro: 250MW, biomass: 250MW, wind: 200MW, solar: 50MW, Ocean: 10MW
Labeling and Standardization Program and Minimum Energy Performance	Policy to label the energy efficiency performance of home appliances including refrigerators and freezers, air conditioning window units, CFLs, linear fluorescent lamps, washers, dryers, and audio-video equipment—such as televisions and stereos. This measure alone expected to reduce cumulative energy consumption between 2010 and	Reduce variable for total demand by 4-5 percent or 150.3TWh between 2010 and 2030

Name of Policy	Description of Policy	Instructions to Modelers
Standards (these programs part of Comprehensive National Energy Efficiency and Conservation Program (NEECP), 2004)	2030 by 150.3 TWh, which forms roughly 45 percent of Philippines' goal of achieving total energy savings of 10 percent by 2030	
Proposed Mindanao and Visayas (Leyte-Mindanao Interconnection Project), 500MW capacity, March 2013	Visayas and Luzon are already connected (total capacity 1240 MW). Interconnection infrastructure is proposed between Mindanao and Visayas, including a 455km overhead line and a 23km submarine cable. Initial investment projected to be USD300 million, but feasibility studies (USD2 million costs) pending	1) Consider candidate plant in Visayas, Luzon, and Mindanao as eligible for meeting the electricity needs of all three grids 2) Link higher total generation costs (more expensive peaker) plants to tariffs to show increase
Increasing Share of Natural Gas in Energy Mix	Expanded use of natural gas in electric generation as well as industrial estates, households, and transport; including consideration of pipeline construction and LNG import facilities	Increase the share of natural gas in the electricity generation mix
Energy Efficient Transport	Policy to encourage energy efficient transport that utilizes electricity from the electric grid (for example, mass transit and e-trikes)	Increase electricity demand as a result of increased demand for electric vehicle charging and demand for electricity to power mass transit
Building Energy Efficiency Standards	Policy to improve energy efficiency in buildings by imposing energy efficiency standards.	Reduce electricity demand from commercial buildings by 10 percent to account for improved energy efficiency.
Distributed Generation in Off-Grid Areas	Electricity Regulatory Commission (ERC) will allow a 50 percent subsidy on cost of generation for all renewable energy in all off-grid areas—defined to include Mindanao until 2018	Allow for RE to receive 150 percent of the long run marginal cost of generation in all off-grid areas

Appendix B: IEEJ Modeling Assumptions

Plant	Fuel	Initial Fuel Prices	Capacity	Life	Max Operating	Min Operating	Thermal Efficiency	CAPEX	WACC	OPEX (Non-fuel)	Emission Factor
		USD/toe	GW	Years	Hours/Year	Hours/Year	(*11630kWh/toe)	USD/kW	USD	USD/kWh	tCO_2 e/toe
OL1	Oil	782.00	0.01	20	7000.00	0.00	0.30	500.00	0.06	0.0260	0.7900
OL2	Oil	782.00	0.02	20	7000.00	0.00	0.35	800.00	0.06	0.0260	0.7900
OL3	Oil	782.00	0.05	20	7000.00	0.00	0.36	900.00	0.06	0.0260	0.7900
NG1	Gas	709.98	0.30	25	7000.00	1000.00	0.45	718.00	0.06	0.0075	0.5800
NG2	Gas	709.98	0.70	25	7000.00	1000.00	0.50	847.00	0.06	0.0065	0.5800
NG3	Gas	709.98	1.00	25	7000.00	1000.00	0.60	1164.00	0.06	0.0055	0.5800
CL1	Coal	82.26	0.50	35	7000.00	3000.00	0.35	1441.00	0.06	0.0060	1.0400
CL2	Coal	82.26	1.00	35	7000.00	3000.00	0.40	1590.00	0.06	0.0060	1.0400
CL3	Coal	82.26	1.00	35	7000.00	3000.00	0.45	1892.00	0.06	0.0060	1.0400
HY1	Hydro	0.00	0.01	30	4380.00	0.00	1.00	2000.00	0.06	0.0041	0.0000
HY2	Hydro	0.00	0.02	30	4380.00	0.00	1.00	1600.00	0.06	0.0041	0.0000
HY3	Hydro	0.00	0.10	30	4380.00	0.00	1.00	1000.00	0.06	0.0041	0.0000
GE1	Geothermal	0.00	0.05	30	6132.00	3000.00	1.00	7000.00	0.06	0.0180	0.0000
GE2	Geothermal	0.00	0.10	30	6132.00	3000.00	1.00	5000.00	0.06	0.0180	0.0000

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