Chapter 4

Strategy Proposals for Renewable Energy Development

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Chapter 4

Strategy Proposals for Renewable Energy Development

The Alternative Policy Scenarios (APSs), as noted earlier, were developed based on the accessible potential and ability of exploiting all types of RE for power generation with the assumption that additional policies will be implemented. Results show that the renewable energy (RE) resources could be exploited to contribute 14.1% of the total power production in 2040.

These outputs also depend on prioritised least-cost RE technology options. The strategy for RE development aimed at achieving the RE target and plan of action for Viet Nam is based on these assumptions – accessible RE resources, the adoption of least-cost technology, and the presence of supporting policies.

1. Prioritised Renewable Energy Technology Options

A total of five RE technologies are proposed in APSs for power generation, which will achieve the share of RE at 12.7% of total power generation output by 2030, and 14.1% by 2040. However, not all five RE technologies could be feasible because of low economic return and high greenhouse gas (GHG) abatement costs. The prioritised RE technology options are selected to achieve the targets of RE development based on co-benefit analysis to ensure balancing between the costs of GHG abatement and benefits of sustainable development of the country.

In this study, a Co-Benefits Based Approach (Dubash, et al., 2013), based on Multi-Criteria Analysis (MCA) will be used to evaluate the prioritised technology options when there are multiple important objectives. This method provides a clear and transparent process to guide decision-making based on criteria balanced for GHG abatement costs and benefits for sustainable development, as specified in each option.

1.1. Cost–benefit analysis

Investment for RE development will bring benefits to society, environment, and economy. This section focuses on the cost–benefit of RE technologies for power generation based on basic assumptions and input data.

i. Basic assumptions

Data on economic and technical specifications of each RE technology option were taken from published data, research results, and implemented relevant projects.

In the electricity generation module, data on power capacity, process efficiencies, capital cost, and operations and maintenance (O&M) costs were taken from the PDP VII of Viet Nam.

In other modules (such as natural gas production, oil refining, crude oil production, and coal production), the capacity data and other data on process efficiencies, capital costs, O&M costs, and others were referred to the PDP VII and other studies or overseas data.

The data on economic and technical specifications of each RE were referred from Vietnam's Intended Nationally Determined Contributions for Energy and Transport Sectors (Bao et al., 2015).

It is assumed that all RE technologies could replace coal-fired power thermal plants. The fuels used for these power plants include both domestic and imported coals. The cost of domestic coal is US$45 per tonne while the cost of imported coal is US$96/tonne.

Coal-fired thermal power plant's efficiency is 35% and maximum capacity factor (MCF) is 80%.[7]The investment costs for coal power plants are US$1,300/kW and the O&M costs are US$45.5/kW, with additional variable O&M costs of US$4.5/MWh. The lifespan of coal-fired thermal power plants is expected to be 30 years.

The environmental externality costs are also included in each scenario. Estimation of external costs of electricity generation requires complex databases and integration of simulated models, and externality-related studies.

Viet Nam so far has not officially carried out any study on the external costs associated with electricity generation. Due to a lack of sufficient data and evaluations to calculate externality costs in the power sector, external costs factors are extrapolated from other relevant studies in China, including nitrogen oxides (NO_x), sulphur dioxide (SO_2), and particulate matter (PM10), in which the cost of NOx is US$1,328/tonne, SO_2 is US$2,047/tonne, and PM10 is US$1,460/tonne (Nguyen-Trinh and Ha-Duong, 2015).

There are several estimates of the external costs of carbon dioxide (CO_2) emissions. The average cost of CO_2 control used by the European Commission is US$19/tonne). Some studies on these issues in China estimate the costs of CO_2 at US$50/tonne. Clean Development Mechanism projects use damage costs of US$7/tonne, which are based on the monetary benefits that power producers could earn if they reduced CO_2 emission during electricity-generating activities. For historical and near-term calculations, this value is acceptable and quite useful for both power producers and energy policymakers. In long-term projections, the average CO_2 control cost of US$20/tonne would be used (Nguyen-Trinh and Ha-Duong, 2015).

ii. Specific input data and results

Based on the assumptions above and the following input data for specific RE technology and the application of a 5% discount rate, the cost–benefit of each RE technology compared to BAU were calculated as follows:

Small hydropower plants

[7] MCF referred to as the maximum availability of a process is the ratio of the maximum energy produced to what would have been produced if the process ran at full capacity for a given period (expressed as a percentage).

It is assumed that the capacity of small hydropower plants (SHP) could reach 4,600 MW by 2030 and 5,600 MW by 2040, replacing coal power plants.

The MCF of SHPs is 40%. The investment cost for SHP is US$1,700/kW and the O&M cost is estimated at US$42.0/kW with additional variable O&M costs of US$2.5/MWh. The lifespan of SHP is 25 years.

Coal-fired thermal power plant's efficiency is 35% and MCF is 80%. The investment cost for coal power plants is US$1,300/kW and the O&M cost is US$45.5/kW, with additional variable O&M cost of US$4.5/MWh. The fuel cost for coal-fired thermal power is US$45/tonne. The lifespan of coal-fired thermal power plants is expected to be 30 years.

Based on the input data above, the cost–benefit of SHP compared to the BAU is calculated. All incremental costs relative to the BAU are shown as positive values, while benefits are shown as negative values.

Results show that the total social costs (including investment cost and O&M costs) for developing SHP plants are approximately US$2.04 billion, resulting in social benefits[8] of US$3.25 billion, with the majority accounted for by reduced fuel imports (US$1.75 billion) and environmental externalities (US$1.31 billion). Therefore, the net social benefits amount toUS$1.21 billion.

Table 35: Social Costs – Small Hydro Scenario Differences vs. BAU

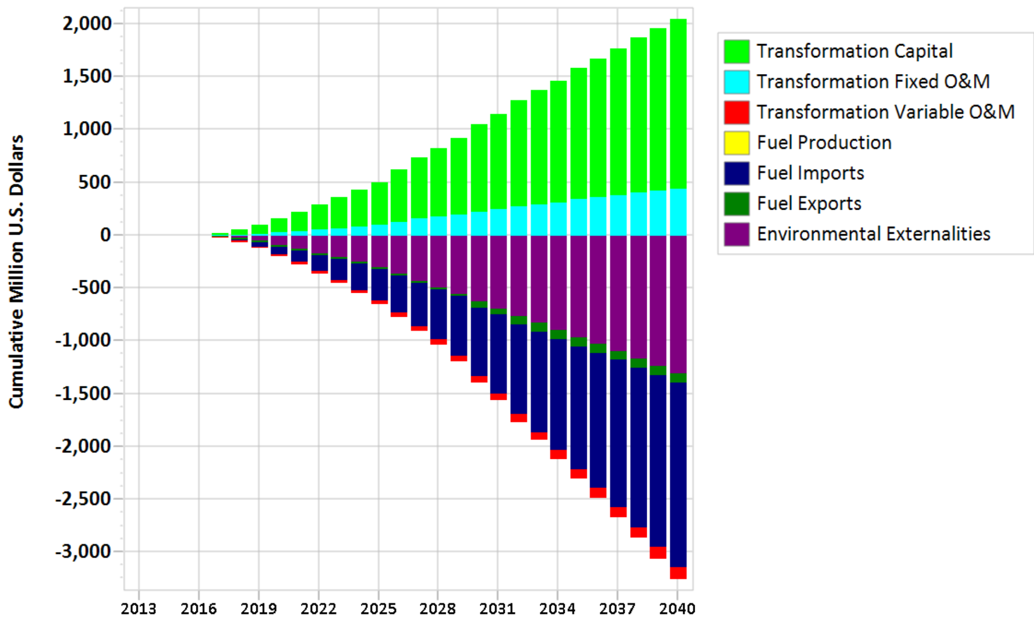
Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	157.0	499.0	1,048.3	1,578.2	2,041.3
Transformation capital	125.4	398.6	818.8	1,233.5	1,600.1
Transformation fixed O&M	31.6	100.4	229.5	344.6	441.2
Benefits	-191.3	-644.9	-1,392.3	-2,299.7	-3,250.0
Fuel production	-0.0	-0.1	-0.2	-0.2	-0.2
Fuel exports	-17.4	-17.4	-56.6	-84.1	-84.1
Fuel imports	-72.2	-297.8	-653.3	-1,167.1	-1,749.8
Transformation variable O&M	-8.0	-25.9	-51.1	-77.3	-104.2
Environmental externalities	-93.6	-303.7	-631.1	-970.9	-1,311.7
Total	**-34.3**	**-145.8**	**-344.0**	**-721.5**	**-1,208.8**

Source: Calculation results derived from LEAP model.

[8] Benefits are shown as negative values, while costs are shown as positive values.

Figure 16: Social Costs – Small Hydropower Scenario Differences vs. BAU



BAU = business-as-usual.
Source: Calculation results derived from LEAP model.

Biomass power plants

The assumption is that Viet Nam's biomass power capacity could reach 1,600 MW by 2030 and 4,000 MW by 2040 to replace coal power plants.

The efficiency of biomass power is 31.5% and MCF is 60%. The investment cost for biomass power plants is US$1,800/kW and the O&M cost is US$70/kW, with additional variable O&M costs of US$6.7/MWh. The fuel cost for biomass thermal power is US$25/toe. The lifespan of biomass power plants is assumed to be 30 years.

Results show that the total social costs (including investment cost, O&M costs, fuel production, and export) for developing biomass power plants are approximately US$1.68 billion, resulting in social benefits of US$3.41 million, with the majority accounted for by reduced fuel imports (US$2.23 billion) and environmental externalities (US$1.19 billion). Therefore, the net social benefits amount to US$1.73 billion.

This biomass power scenario requires more fuels, such as diesel and residual oil for power generation, to meet the peak power requirement resulting in the reduction of the amount of oil products for export of US$85.4 million compared with BAU scenario in terms of costs.

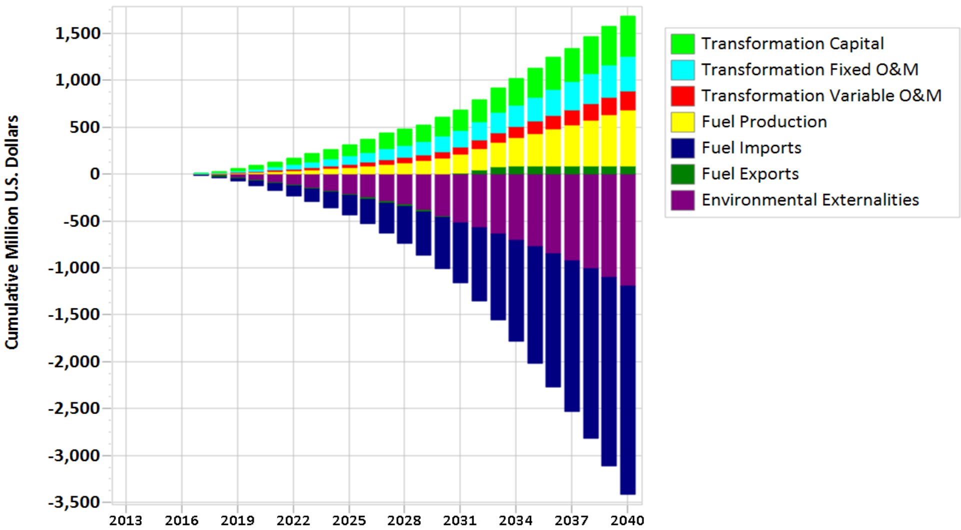
Table 36: Social Costs – Biomass Power Scenario Differences vs. BAU

Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	81.2	302.7	600.6	1,132.3	1,683.7
Transformation capital	36.5	121.4	209.7	314.2	429.0
Transformation fixed O&M	26.2	88.0	161.2	255.7	369.1
Transformation variable O&M	9.9	33.4	70.2	128.8	198.9
Fuel production	19.4	70.7	170.3	348.1	601.3
Fuel exports	-10.8	-10.8	-10.8	85.4	85.4
Benefits	-111.4	-427.0	-999.5	-2,017.0	-3,414.9
Fuel imports	-49.0	-212.7	-548.6	-1,244.2	-2,225.1
Environmental externalities	-62.4	-214.3	-450.9	-772.8	-1,189.8
Total	**-30.1**	**-124.3**	**-398.9**	**-884.7**	**-1,731.2**

BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Figure 17: Social Costs – Biomass Power Scenario Differences vs BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Wind power plants

It is assumed that wind power plants could reach 5,000 MW by 2030 and 10,000 MW by 2040 to replace imported coal power plants.

Wind power farms have an average load factor of approximately 25%. The investment costs for wind power farms are US$2,000 per kW and the O&M costs are US$ 40 per kW, with additional variable O&M costs of US$5.0 per MWh. The lifespan of wind power plants is 20 years.

Results show that the total social costs (including investment cost and O&M costs) for developing wind power plants are approximately US$5.57 billion, resulting in social benefits of US$3.96 million, with the majority accounted for by reduced fuel imports (US$2.36 billion) and environmental externalities (US$-1.59 billion). Therefore, the net social cost is US$1.61 billion.

Table 37: Social Costs – Wind Power Scenario Differences vs. BAU

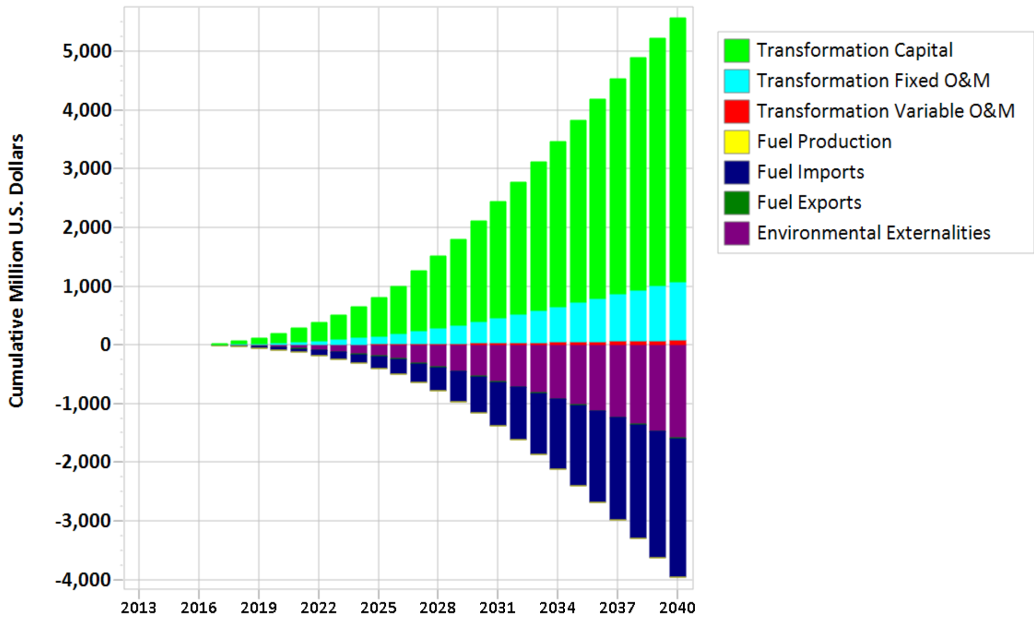
Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	186.8	802.7	2,111.8	3,821.2	5,565.8
Transformation capital	152.7	654.2	1,714.0	3,100.1	4,493.3
Transformation fixed O&M	31.5	137.3	369.9	670.3	998.8
Transformation variable O&M	2.6	11.3	27.9	50.7	73.7
Benefits	-85.3	-399.5	-1,164.7	-2,399.1	-3,957.7
Fuel production	0.0	-0.1	-0.1	-0.2	-0.3
Fuel exports	-6.7	-6.7	-6.7	-6.7	-6.7
Fuel imports	-35.0	-198.5	-619.3	-1,368.1	-2,361.1
Environmental externalities	-43.5	-194.2	-538.5	-1,024.0	-1,589.7
Total	**101.6**	**403.2**	**947.1**	**1,422.1**	**1,608.1**

BAU = business-as-usual, O&M = operations and maintenance.

Source: Calculation results derived from LEAP model.

Figure 18: Social Costs– Wind Power Scenario Differences vs BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Solar photovoltaic power plants

It is assumed that the total installed capacity of grid-connected PV power plants will reach 10,000 MW in 2030 and 16,000 MW in 2040 to replace imported coal power plants.

The MCF of PV power plants is 15%. PV power plants require capital investments of US$3,500/kW in 2013 (which is expected to decline to US$1,000/kW in 2040), and O&M costs of US$35/MW. The lifespan of grid-connected PV systems is around 25 years.

Results show that the total social costs (including investment cost, O&M costs, and fuel export) for developing solar PV power plants are approximately US$6,316.0 million, resulting in social benefits of US$5.28 billion, with the majority accounted for by reduced fuel imports (US$3,552.1 million) and environmental externalities (US$1.35 billion). Therefore, the net social cost is US$1.04 billion.

This solar PV scenario requires more fuel, such as diesel and residual oil, for power generation to meet the peak power requirement resulting in the reduction of oil products for export (or US$772.1 million in terms of money) compared with BAU scenario.

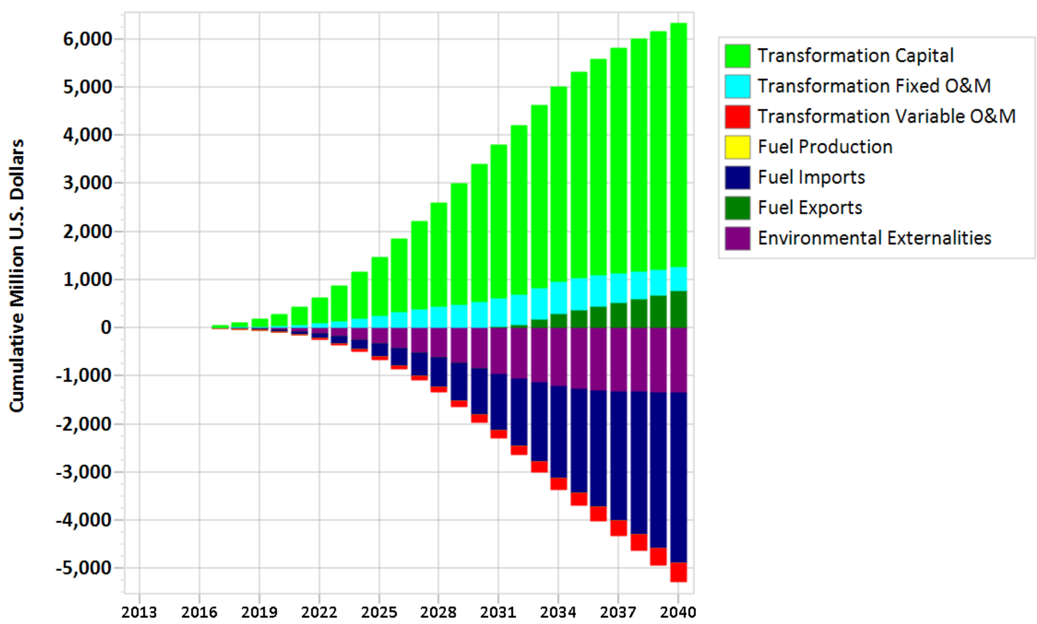
Table 38: Social Costs – Solar Photovoltaic Scenario Differences vs. BAU

Unit: Discounted 2013 cumulative US$ million

	2020	2025	2030	2035	2040
Costs	261.0	1,463.0	3,391.5	5,311.9	6,316.0
Transformation capital	223.2	1,214.0	2,849.6	4,281.4	5,058.9
Transformation fixed O&M	38.6	249.8	542.7	659.2	485.1
Fuel exports	-0.7	-0.7	-0.7	371.4	772.1
Benefits	-94.1	-658.0	-1,961.1	-3,695.3	-5,278.7
Transformation variable O&M	-7.2	-47.2	-138.0	-254.5	-372.8
Fuel production	0.0	-0.1	-0.1	-0.1	0.0
Fuel imports	-36.5	-274.9	-967.8	-2,158.3	-3,552.1
Environmental externalities	-50.5	-335.8	-855.2	-1,282.4	-1,353.9
Total	**166.9**	**805.1**	**1,430.4**	**1,616.6**	**1,037.3**

BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Figure 19: Social Costs– Solar Photovoltaic Scenario Differences vs. BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

Biogas power plants

It is assumed that the total installed capacity of biogas power plants could reach 150 MW in 2030 and 200 MW in 2040 replacing imported coal power plants.

The energy efficiency for biogas power generation is 32% and the MCF of biogas power plants is 50%. These plants have an average investment cost of US$820/kW and O&M costs of US$115/kW, with an added variable O&M cost of US$0.1/MWh. The lifespan of biogas power plants is approximately 20 years.

The average cost of a biogas digester with a volume of 10m^3 is US$580 and the annual average production capacity is about 1,200m^3/year. The investment cost is approximately US$900/toe/year (with heat value of biogas of 5,380 kcal/m^3). The O&M costs are estimated at 3% of the investment cost, or US$27/toe/year. The lifespan of biogas digester is approximately 10 years.

Results show that the total social costs (including investment cost and fixed O&M cost) for developing biogas power plants are approximately US$254.0 million, resulting in social benefits of US$282.3 million, with the majority accounted for by reduced fuel imports (US$161.8 million) and environmental externalities (US$101.3 million). Therefore, the net social benefits amount to US$28.3 million.

Table 39: Social Costs – Biogas Power Scenario Differences vs BAU

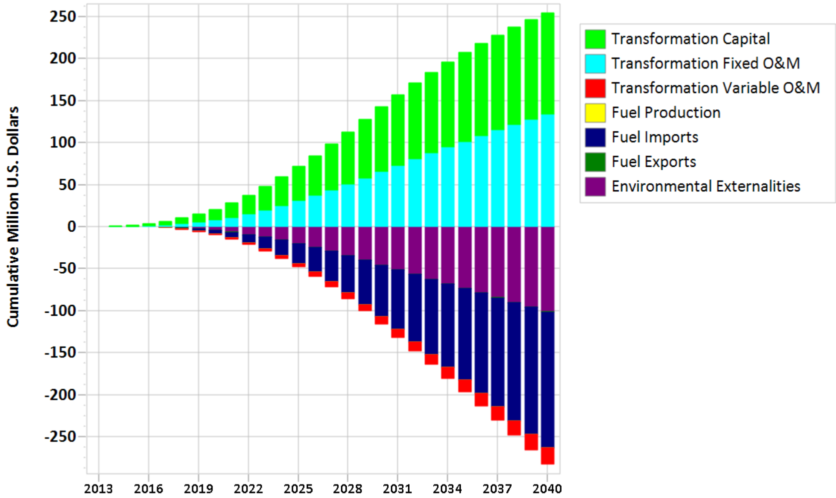
Unit: Discounted 2013 cumulative US$ million

	2015	2020	2025	2030	2035	2040
Costs	**1.92**	**20.68**	**71.30**	**142.56**	**206.93**	**253.99**
Transformation capital	1.55	13.02	40.60	77.09	105.56	120.21
Transformation fixed O&M	0.37	7.66	30.70	65.47	101.37	133.78
Benefits	**0.00**	**-9.84**	**-48.20**	**-116.06**	**-196.80**	**-282.30**
Transformation variable O&M	0.00	-0.88	-4.06	-9.00	-14.19	-19.10
Fuel production	0.00	0.00	-0.01	-0.01	-0.01	-0.02
Fuel imports	0.00	-4.56	-23.92	-61.25	-109.11	-161.78
Fuel exports	0.00	-0.09	-0.09	-0.09	-0.09	-0.09
Environmental externalities	0.00	-4.31	-20.12	-45.70	-73.39	-101.32
Total	**1.92**	**10.83**	**23.10**	**26.51**	**10.13**	**-28.32**

BAU = business-as-usual, O&M = operations and maintenance.

Source: Calculation results derived from LEAP model.

Figure 20: Social Costs – Biogas Power Scenario Differences vs. BAU



BAU = business-as-usual, O&M = operations and maintenance.
Source: Calculation results derived from LEAP model.

1.2. GHG abatement costs of RE technologies

The overall cost of reducing GHG emissions and the total cumulative GHG emissions avoided by each RE scenario are summarised in Table 40.

Table 40: Mitigation Potentials and Costs

Units: 2013 US$ million

	Solar PV	Biogas	Wind	Small Hydro	Biomass
Transformation	5,171.2	234.9	5,565.8	1,937.0	997.0
- Electricity generation	5,171.2	90.7	5,565.8	1,937.0	997.0
- Biogas production	-	144.2	-	-	-
Resources	-2,780.0	-161.9	-2,368.1	-1,834.1	-1,538.4
- Production	-0.0	-0.0	-0.3	-0.2	601.3
- Imports	-3,552.1	-161.8	-2,361.1	-1,749.8	-2,225.1
- Exports	772.1	-0.1	-6.7	-84.1	85.4
Environmental externalities	-1,353.9	-101.3	-1,589.7	-1,311.7	-1,189.8
Net present value	1,037.3	-28.3	1,608.1	-1,208.8	-1,731.2
GHG savings (million tonnes CO_2e)	147.5	9.5	175.2	129.3	143.9
Cost of avoiding GHGs (US$/tonne CO_2e)	7.0	-3.0	9.2	-9.3	-12.0

CO_2e = carbon dioxide equivalent, GHG = greenhouse gas, PV = photovoltaic.
Source: Calculation results derived from LEAP model.

From the above results, some comments could be drawn, as follows:

- The RE technologies used for power generation lead to savings in GHG emissions ranging from 9.5 million to 175.2 million tonnes of CO_2 equivalent. Similarly, the incremental costs vary from -US$1.73 billion to US$ 1.61 billion.
- Environmental externalities or externality costs contributed significantly to making RE technologies feasible in terms of economics and costs of GHG reduction.
- Three of five technologies can be implemented at negative incremental costs. Biomass power technology replacing coal power plants is most cost-effective in reducing GHG emissions, followed by SHP and biogas power technologies. Solar PV power, followed by wind power plants, has the highest incremental cost due to high investment costs.

1.3. Selection of prioritised RE technologies

1.3.1. Methodology for selection

As noted earlier, the MCA method was used to evaluate the prioritised technology options based on criteria that reflect the objectives of RE development, GHG reduction, and sustainable development.

The process of selecting prioritised technology options was implemented with the following steps:

- Identify the criteria and sub-criteria for the selection of priority technologies based on the context and information available in Viet Nam.
- Prepare the information sheets for each RE technology option to support the selection.
- Describe the expected performance of each option and score the option against each criterion.
- Assign weights for each of the criteria to reflect their relative importance to the decision.
- Combine the weights and scores for each of the options to derive the overall value.
- Examine the results.

An effective approach to carry out the MCA method for the selection of prioritised technology options is to use a facilitated workshop with participants chosen to represent all the key perspectives on the issues.

First, the information sheets, including criteria and sub-criteria for the selection of prioritised RE technologies, were prepared by a technical group.

The rating scores through the MCA process is made by using the following rating scheme:

1 – Faintly desirable

2 – Fairly desirable

3 – Moderately desirable

4 – Very desirable

5 – Extremely desirable

The meeting was organised by the Institute of Energy (IE) to select the prioritised technology options, with 15 participants who are RE experts, economists, and managers from IE.

Participants were introduced to the purpose of the selection, information on RE technologies, and the method of scoring and weighting each criterion.

The scores were approved at a rate from 1 to 5 and assessed by the values associated with the consequences of each option for each criterion.

The weights were to be measured on a scale from 0 to 1. The rating weights were derived individually through a process of evaluating the important levels of each criterion and then compared in a group discussion to finally determine the weight for the criterion.

Criteria for selecting priority technologies

The following were the major criteria, which were discussed and adopted by the stakeholders:

Table 41: Criteria for Selecting Priority Technologies

<table>
<tr><th colspan="2">Multiple Benefits</th><th>Specifications</th><th>Weights</th></tr>
<tr><td rowspan="2">GHG emission reduction</td><td>GHG reduction potential</td><td>Options with large enough abatement potential to have a significant mitigation impact on the sector or at national levels.</td><td rowspan="2">0.25</td></tr>
<tr><td>Abatement cost</td><td>Options should have low abatement costs to attain feasibility in investment.</td></tr>
<tr><td colspan="2">Alignment with government priorities</td><td>Options should conform to the national strategies, sectoral development, priorities, and plans.</td><td>0.2</td></tr>
<tr><td rowspan="2">Economic benefits</td><td>Economic development</td><td>Contribute to economic development by developing new industries, creating investment environment, building and maintaining infrastructure, reducing costs, and opening more opportunities for business.</td><td rowspan="2">0.18</td></tr>
<tr><td>Increased energy security</td><td>Reduced energy imports (or dependence from the outside) will contribute to a stable and sustainable economic development.</td></tr>
<tr><td rowspan="2">Social benefits</td><td>Creation of new jobs</td><td>Create work opportunities and improve incomes.</td><td rowspan="2">0.17</td></tr>
<tr><td>Health conditions</td><td>Improve health conditions.</td></tr>
<tr><td rowspan="2">Local environmental benefits</td><td>Air quality</td><td>Reduce concentration of toxic gases and dust.</td><td rowspan="2">0.2</td></tr>
<tr><td>Other benefits (Biodiversity, land and water quality)</td><td>Ensure the quality of land and water.
Ensure the natural balance and ecosystem (such as river basins, forests, etc.)</td></tr>
</table>

GHG = greenhouse gas.

Source: Authors, compiled from various sources.

1.4. Result of the selection of prioritised RE technologies

The results of assessment and making scores for each technology by each criterion are presented in Table 42.

Table 42: Result of Selection for Prioritised RE Technologies

Option	GHG emission reduction	Alignment with government priorities	Economic benefits	Social benefits	Local Environ-mental benefits	Total
Small hydropower	1.25	0.60	0.72	0.51	0.40	3.48
Biomass power	1.25	0.80	0.72	0.51	0.40	3.68
Wind power	0.75	1.00	0.72	0.51	1.0	3.98
Solar PV	0.75	1.00	0.54	0.51	1.00	3.80
Biogas power	0.50	0.60	0.54	0.68	0.80	3.12

GHG = greenhouse gas, PV = photovoltaic, RE = renewable energy.

Source: Result from IE's group meeting.

From the above results of assessment for prioritising RE technology options, some comments could be drawn, as follows:

- Wind power is the first priority with its highest score of 3.98 point, followed by solar PV (3.8 point). Both technologies got high scores on environment benefits and in the country's development priorities (see Annex 2).
- Biomass and SHP are the third and fourth priorities with 3.68 and 3.48 points, respectively, because these technologies got high scores on GHG emission reduction potential.
- Biogas power got the lowest score at 3.12 point due to its low potential in GHG emission reduction and low economic benefits.
- All RE technologies were prioritised with different ranges for development to achieve the RE development targets, feasibility in investments, and in reducing GHG emissions.

2. Proposals on Strategy for RE Development

2.1. Targets of RE development

i. General target

The general target of RE development is to achieve 14% of RE in total power generation output by 2040.

ii. Specific targets

Specific targets are set for each RE technology based on assumptions made in the above APSs. The specific targets for each RE technology are arranged from higher to lower priority in the following:

Wind power technology

- By 2030: Installation capacity of wind power will reach 5,000 MW.
- By 2040: Installation capacity of wind power will reach 10,000 MW.

Solar PV power technology

- By 2030: Installation capacity of solar PV will reach 10,000 MW.
- By 2040: Installation capacity of solar PV will reach 16,000 MW.

Biomass power technology

- By 2030: Installation capacity of biomass power will reach 1,600 MW.
- By 2040: Installation capacity of biomass power will reach 4,000 MW.

Small hydropower technology

- By 2030: Installation capacity of SHP will reach 4,600 MW.
- By 2040: Installation capacity of SHP will reach 5,600 MW.

Biogas power technology

- By 2030: Installation capacity of biogas power will reach 150 MW.
- By 2040: Installation capacity of biogas power will reach 200 MW.

2.2. Proposed action plans to implement RE development targets

i. Identify the barriers to RE development

Although Viet Nam is endowed with RE resources, investment in RE technology is still insignificant. There are many barriers to large-scale development of RE technologies. These barriers were identified in several presentations and workshops, and interviews with stakeholders (IISD, 2012). The major barriers are summarised and presented as follows:

Economic barriers

- The investment cost of RE projects is higher than conventional energy projects.
- Longer payback period and lower rate of return.
- Low electricity tariffs exist due to the indirect subsidies available to power production from natural gas and coal, hence, making RE power difficult to compete with other conventional power plants.

Technical and human-capacity barriers

- Weakly developed supply chains and a lack of energy service provision, and O&M of RE equipment.
- Domestic technologies have not been developed and most of RE technologies are imported.
- Lack of specialised consultants, technical knowledge, and skills to implement RE projects.

Financial barriers

- Limited and unattractive feed-in tariffs (FIT) for RE in Viet Nam (currently available only for small hydro, wind power, and biomass, and these are considerably lower than in neighbouring countries).
- Limited finance is available from international financial institutions but depends on the project’s feasibility.
- Lack of a sustainable mechanism to provide subsidy for RE projects.
- Difficulties in accessing financial resources from commercial banks due to a low rate of return.

Regulatory, legal, and institutional barriers

- Lack of regulation and clear procedures for planning, installing, connecting, and operating RE power projects.
- Inadequate policies and mechanisms to support RE projects.
- Cumbersome requirements for establishing plans for RE development.
- Information barriers.
- Lack of data on RE resources making it difficult for planning programs and projects.
- Lack of information on RE technologies and of service providers.

ii. Prepare roadmap action plans

To achieve the RE development target, a roadmap action plan is proposed to address the existing barriers. This requires the following actions for stakeholders:

- Government will act as a market enabler to encourage the economic organisations to participate in RE development and utilisation. Government will also protect the legal rights and interests of developers and users.
- The Ministry of Industry and Trade (MOIT) is to represent the state in elaborating the policies, regulations, and institutional arrangements to support and promote RE development.
- The Ministry of Planning and Investment will take the lead role in allocating funds for RE promotion and for research and development.
- The Ministry of Finance is responsible for fiscal incentives and energy tariff policies.
- The Ministry of Natural Resources and Environment is responsible for issues on environmental regulation and standards.
- The Ministry of Construction is responsible for national building standards and RE-related technologies.
- The Ministry of Education and Training is responsible for technical and capacity-building activities on RE technologies.
- The General Directorate of Energy under MOIT is responsible for implementing state management on RE. The Electricity of Viet Nam (EVN) implements policies and regulations in installing, connecting, and operating RE power projects.

The following action plans are proposed to remove the barriers and support RE development:

Table 43: Proposed Roadmap and Action Plan

Measures	Activity	Responsibility	Time Frame
Supportive policies	Set up effective policies on investment incentives.	MOIT (GED), MOF	2017–2025
	Set in place support systems to encourage no-regret and low abatement cost measures.	MOIT (GED), MPI	2017–2025
	Encourage and promote the development of a biomass fuel market.	MOIT (GED)	2017–2025
	Implement environmental regulation in the farms to encourage the use of biogas plants.	MONRE, MOIT	2017–2020
	Develop testing and standards of technology, such as biomass boilers, biogas systems etc. to improve the reliability of the technologies.	MOIT (GED)	2017–2020
Technical and human capacity building	Facilitate the training and education on the technology, form groups of technicians, and share experiences with international experts.	MOIT, MOET	2017–2025
	Develop business skills among appropriate groups to enable efficient preparation and implementation of RE projects.	MOIT, MOET	2017–2020
	Develop infrastructure and maintenance services.	MPI, MOIT	2017–2030
Regulation and institution	Develop regulations and clear procedures for planning, installing, connecting, and operating RE power projects.	MOIT (EVN)	2017–2020
	Develop institutional and legal framework to support RE projects.	MOIT (GED)	2017–2020
Information	Develop an information collection system on data of RE resources, technologies, and prices.	MOIT (GED)	2017–2030
	Build a communication system to provide sufficient and updated information to stakeholders.	MOIT (GED)	2017–2030

GED - General Energy Department, MOIT =Ministry of Industry and Trade, MPI = Ministry of Planning and Investment, MONRE = Ministry of Natural Resources and Environment, RE = renewable energy.
Source: Authors, compiled from various sources.

2.3. Proposals on policy and institutional framework for RE development

i. Proposals on policy and institutional framework

From the above analysis of the status of policies and of Viet Nam's institutional framework, this study suggests a move forward to implement an action plan through the following measures:

Develop comprehensive legal framework for RE development

- In the short term, it is necessary to revise the current legal system to ensure the preparation of investment incentives that are transparent and easy to understand. Revise also the current prices that EVN offers – notably FITs for wind power and SHP – and establish FITs for biomass and biogas power plants.
- In the long term, Viet Nam should consider revising the law on RE development. The revised law should provide adequate regulatory foundations for electricity market competition, product quality and standardisation, investment incentives, fiscal incentives, procedures for establishing and operating RE projects, power purchase tariffs, small power purchase agreements, and so on. The law should also provide for the establishment of a Renewable Energy Development Fund that supports all types of RE technologies including biogas, solar energy, and biofuels.

Initiate institutional arrangements

- The role and responsibility of ministries on state management of RE should be regulated by the law in which the MOIT has a decisive role in all RE issues with the support and assistance of other ministries.
- Under MOIT, the New and Renewable Energy Department should be assigned as focal point on national management of RE. This department will act on behalf of the government in RE promotion activities, such as setting up subsidy mechanisms, planning, arranging fund, and managing RE projects.
- The EVN should move forward quickly to enable the evolution of a competitive power market that treats all investors equally and allows investment incentives to work.

Establish a Renewable Energy Development Fund

- The aim of the Renewable Energy Development Fund is to support activities such as the conduct of surveys and assessments of RE resources and building data information systems; research and development and setting up standards; facilitate training and education; and offer subsidies to domestic manufacturers to improve the product quality.
- The fund's activity mechanism is not for profit and will be established by the MOIT and the Ministry of Finance.

- Contributions to the fund will come from royalties collected for the exploitation of natural resource, carbon taxation, or external costs of fossil fuel–based electricity generation outputs.