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# Potentials and opportunities for low carbon energy transition in Vietnam: A policy analysis

Caitlin Shem[a], Yeliz Simsek[a,b], Ursula Fuentes Hutfilter[a,c], Tania Urmee[a,*;]

[a] School of Engineering and Information Technology, Murdoch University, Western Australia, Australia
[b] Department of Mechanical and Metallurgical Engineering, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Santiago, Chile
[c] Climate Analytics Australia, Perth, Western Australia, Australia

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ABSTRACT

This paper intends to synthesis the status quo and projected energy situation for Vietnam, as one of the fastest growing energy economies among the Association of South East Asian Nations (ASEAN). Focus is drawn towards the existing policy landscape's ability to foster low carbon development progression as an alternative to the existing fossil fuel driven economy, while also aligning with achievement of Sustainable Development Goals (SDGs) for the nation. Effectiveness of Vietnam's policy portfolio for fostering low carbon development was informed via a systematic literature review and Multi Criteria Decision Analysis (MCDA). This was founded upon six developed criteria, informed from the literature review. The results were presented and analyzed via chronological and hierarchical policy taxonomies. Findings indicate that to support a pathway towards low carbon development, policies need to include mechanisms that favor Renewable Energy technology and also foster the mobilization of private investment or international cooperation. The research also indicates a significant connection between clean energy sector progression and achievement of relevant SDGs. Such a correlation should heighten the priority of energy sector actions, such as policy mechanisms and outcomes, not only quantitative targets.

## 1. Introduction

As of October 28, 2018, 181 countries out of 197 countries ratified the Paris Agreement. This landmark agreement calls for strong reduction in greenhouse gas emissions to achieve the objectives of holding global average temperature increase to well below 2 °C and limit it to 1.5 °C above preindustrial levels. A core element to achieve this objective is the Nationally Determined Contributions (NDC) submitted by countries that are parties to the Paris Agreement. The Intergovernmental Panel on Climate Change (IPCC) in its latest assessment report on 1.5 °C pathways, identifies the need to decarbonize energy systems, phase out coal for power generation by 2050, and scale up the share of renewable energy as key mitigation strategies to achieve the Long-term temperature goal (LTTG) of the Paris Agreement.

South East Asia (SEA) is at a cross road regarding decisions related to the extension of the energy supply system (Fuentes et al., 2018). The Association of South East Asian Nations (ASEAN n.d.) are at various stages of economic development and have different energy resource endowments and consumption patterns. The ASEAN region has experienced large energy demand growth, increasing by 60% over the past 15 years (IEA, 2017).

Vietnam is considered one of the fastest growing economies among SEA and is also an energy-intensive economy (MOIT and DEA, 2017). It has experienced strong economic growth over the last decade. NDC targets for the country include a reduction of 8% GHG emissions compared to Business as Usual (BAU) by 2030, with a conditional clause of 25% reduction in GHG emissions with international support (UNFCCC, 2019, n.d). Vietnam's efforts will focus on adaptation and mitigation efforts, including energy efficiency opportunities, uptake of renewable energy resources (MOIT and DEA, 2017) and increased governance of considerable energy-using sectors (Vieria, 2017). In addition to the NDC, Vietnam has defined targets for energy efficiency and renewable energy. Vietnam is very vulnerable to climate change impacts and has an aspirational goal of supplying 100% of its power with renewable energy, as part of a commitment by the Climate Vulnerable Forum countries.

Currently, Vietnam relies on an energy mix from oil, coal, natural gas and hydropower, with the coal portion expected to increase (IEA, 2017). Further, in recent years Vietnam has been pushed from being an energy exporter to an importer (ADB, 2016), influencing the country's

* Corresponding author. School of Engineering and Information Technology, Australia.
*E-mail address:* T.Urmee@murdoch.edu.au (T. Urmee).

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energy security. The Vietnam Government recognize 'economic growth needs to go hand in hand with sustainable development' (MOIT and DEA, 2017). In the past 30 years, Vietnam has progressed from a developing to an emerging middle economy, shifting energy requirements and the resource makeup for the country. With rapid economic growth; poverty, eradication, access to essential services and infrastructure have improved; however, many challenges remain, including for the energy sector (World Bank, 2018b). Therefore, this research intends to identify, 'How does the existing energy related policy suite address successful implementation and resulting impact for progress towards a low carbon society?'.

This paper aims to synthesis Vietnam's current energy situation and existing policy landscape and identify policy implementation and resulting impact to drive low carbon development progression, achievement of Sustainable Development Goals (SDG) and provide benefits to both the nation's economy and environment. The objectives of this research are as follows:

- ✓ Identify and demonstrate the existing energy regulatory framework and policy landscape for Vietnam
- ✓ Understand the progress of Vietnam's National Determined Contribution (NDC), SDGs and implications for renewable energy (RE) and in turn a low carbon society
- ✓ Identify challenges and barriers for increased RE and lower emissions in Vietnam
- ✓ Develop criteria to evaluate policy effectiveness and determine levels of implementation success and resulting impact for low carbon progress in Vietnam
- ✓ Apply Multi-Criteria Decision Analysis (MCDA) methods and develop policy taxonomy

The five purposes relevance for synthesizing Vietnam's current energy situation and existing policy landscape can be considered linearly. Initially the objectives of identification and understanding of existing regulatory and policy information and information on challenges and barriers allowed for an informed baseline. Thus allowing weighted criteria development based on literature findings and limitations to evaluate Vietnam's low carbon progress from existing policy effectiveness and implementation success. The MCDA method was chosen as it allowed for a collaborative synthesis of multiple desktop literature sources connected to the criteria developed. The MCDA was supported by policy taxonomy, allowing for a visual aid to display the outcomes reached in this study.

The paper is organized as follows: Section 1 is an introduction to the paper, providing a background, aims and objectives, relevance of the research and the scope. Section 2 is a comprehensive look into Vietnam's energy situation, including the status quo, projections for the nation's energy system, renewable sources and potential. Section 3 provides the methodology applied: systematic review for energy policy and policy analysis including MCDA and policy taxonomy. Section 4 presents results including results of energy policy review, analysis of existing policies and their effectiveness to date, including the results of MCDA and policy taxonomy. Section 5 is the discussion section which contains interpretation and significance of findings. Section 6 is the conclusion and recommendations from the analysis and further research proposed.

## 2. Literature review: Vietnam's energy system status quo

This section outlines Vietnams' energy system status quo and projections to 2030 and in some cases, 2040, considering fuel mix, electricity and key demand sectors along with energy security and access for the country.

As recently as 2013, Vietnam was self-sufficient for energy needs (IRENA, 2018a). However, with economic growth and increased energy demands the country shifted from a net exporter to net importer in 2015, a total of 5% energy demand (APERC, 2016; MOIT and DEA, 2017, Vieweg et al., 2017). It is suggested that increased energy demand will, in turn, escalate the import share of total primary energy from coal and oil above 50% as soon as 2030 (MOIT and DEA, 2017; IRENA, 2018a). Vietnam has domestic reserves of fossil fuels and renewable resources; however, rapid exploitation of these energy reserves is occurring with growing demand for fuel supplies (IRENA, 2018a). The current known extent of domestic coal resources is likely to be depleted within the next 70 years (MOIT and DEA, 2017), mature oil field productions have declining outputs (IRENA, 2018a) and natural gas production is plateauing (ACE, 2015).

Within the ASEAN region, Vietnam has one of the highest recorded and predicated GHG emissions growth rates (MOIT and DEA, 2017) and the energy sector is responsible for half of these emissions (Vieweg et al., 2017). Increases are attributed to rapid economic growth for the country, where most significant energy sources have shifted from traditional biofuels and hydropower towards an energy mix relying heavily upon fossil fuels (ECA, 2016; MOIT and DEA, 2017).

Vietnam's current energy fuel mix includes fossil fuel resources of coal, crude oil, natural gas and renewable resources of biomass and hydropower (MOIT and DEA, 2017, Vieweg et al., 2017). Fossil fuel resources dominate energy supply and demand for the country, while renewable resources make up a very small portion (ADB, 2016; Khoung, 2017). In 2015, Total Primary Energy Supply (TPES) and final demand equated to 70588 and 54080 kilotons of oil equivalent (KTOE) respectively. Commercial sectors are responsible for the majority share, 75.5% and non-commercial 24.5% (MOIT and DEA, 2017).

The Business as Usual (BAU) scenarios to 2035 project total final energy demand (TFED) to increase by 2.5 times from 2015 with an annual growth of 4.7%. The key demand sectors of industry and transport are likely to experience the greatest energy demand increase at 5% and 7% annual growth rates respectively (MOIT and DEA, 2017). The 2030 GHG emissions estimate are 787.4 MtCO2e, tripling since 2010, 246.8 MtCO2e (Vieweg et al., 2017), which would exceed Vietnam's NDC, unconditional (724.4 MtCO2e) and conditional (590.5 MtCO2e) (UNFCCC, 2019, n.d). Total Primary Energy Share (TPES) as fuel mix in current and projected scenarios are presented in Fig. 1. With increasing energy demand to 2035, fossil fuel dominance is the predicted trajectory, even in a "High Renewable Energy Scenario".

The critical demand sectors of industry and transport are projected to rely on coal and oil, while traditionally prominent resources such as hydropower capabilities will begin to decline in their share with growth demand (MOIT and DEA, 2017). For all identified projected scenarios, coal has a consistently high influence within the fuel mix, ranging from 34% to 47% of TPES, which is greater than the 33% share in 2015. Oils influence is around a 20% or higher share for most scenarios, however, the APEC BAU scenario is the only case where the TPES is a 6% share in 2020 and decreases to 3% share by 2030. The low oil supply appears to be replaced by an increase in gas supply, which is more significant in the APEC BAU scenario, higher than a 30% share by 2040 while, other scenarios indicate a lower share.

Also, the greatest renewable energy potentials for Vietnam exist from small hydro, wind and solar, along with contributions from biomass, biogas, geothermal and solid wastes as shown in Table 1. Depending on these huge RE potential, significant amount of renewable sources in projected scenarios are considered.

TPES of non-renewable and renewable sources in current and projected scenarios are shown in Fig. 2. TPES for RE sources (other than large hydropower) increase between 10 and 21% across the scenarios, which is considered a significant influence to current RE targets.

The most ambitious TPES for fuel mix is the 2025 IRENA (RE Map), which has approximately a 60:40, split, non-renewable and renewable sources respectively. Further, it is based upon a range of RE sources, including wind and solar power contributing large shares of the TPES, along with the national grid interconnection capacity increasing with time (IRENA and ACE, 2016).

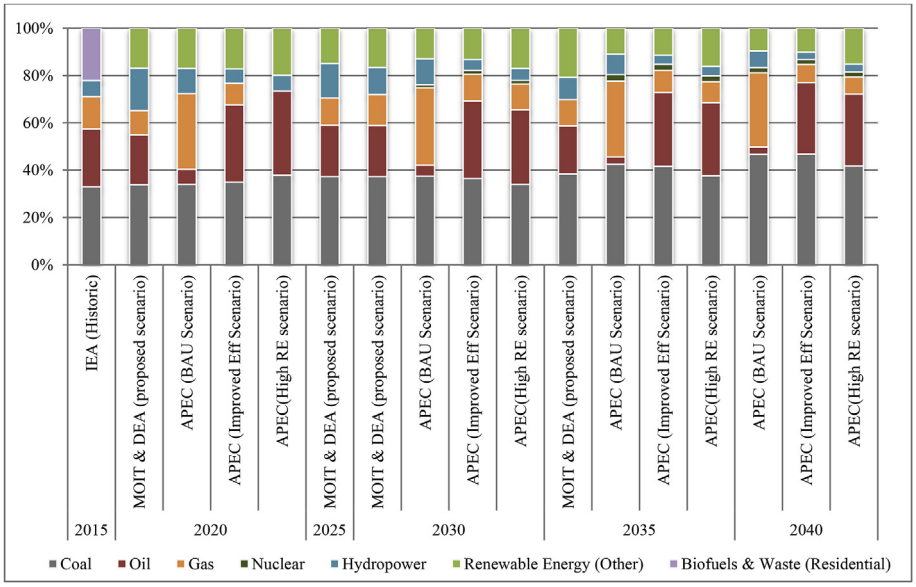


**Fig. 1.** TPES: Fuel mix - current and projected scenarios. Sources: collated from (IEA, 2015; APERC, 2016; MOIT and DEA, 2017).

RE electricity generation projections appear to decrease over time, in terms of share, from 31.8% (2020) to 23% (2030), however, in absolute terms, this corresponds to an increase from 84 to 132 TWh. Over the coming years, hydropower (large scale) will decrease its share due to exploitation (Blume, 2018). Fig. 3 shows that decreasing hydropower (large scale) will reduce the percentage of RE in the mix for an undefined period as other RE sources come into play. By 2030 it is projected that of the 23% RE for electricity generation, 15.5% will be hydro, 2.1% wind, 2.1% biomass and 3.3% solar (APERC, 2016).

Historical and projected TPED for key sectors are presented in Fig. 4. Vietnam's industrial sector is the largest energy consumer, responsible for more than half of Vietnams annual energy usage (IRENA, 2018a; Perera, 2018). Fuel resources utilized to meet industrial energy demands include coal (greater than 40%), electricity (greater than 25%) and bioenergy (approximately 16%) (IRENA, 2018a). The commercial and residential sectors equated for approximately 30% of energy use in 2015 (MOIT and DEA, 2017). As energy use has increased for this sector the share of resource consumption has shifted from biomass (wood, agricultural by-products and animal waste) to electricity (MOIT and DEA, 2017; IRENA, 2018a). Transportation equates for approximately 23% of energy use (ADB, 2016; MOIT and DEA, 2017). Fuel sources are majority petroleum based (road transport), where the demand is increasing with urbanization, economic and population growth (IRENA, 2018a).

Electricity access is available to 100% of the population, which reached 94.57 million in 2016 (World Bank, 2018a), meanwhile clean fuel and technology for cooking was only accessible to 50% of the population in 2014 (SEforALL, 2017). The majority of Vietnam has been electrified since 2014 (Banerjee et al., 2017) with the predominant production sources being gas, coal and hydropower (ACE, 2017, Vieweg et al., 2017). Total electricity demand in 2015 was 143.7 Terawatt hours (TWh) (Vieweg et al., 2017), with hydropower responsible for greater than half of the demand, just shy of 90 TWh (IRENA, 2018a). As shown in Fig. 5, electricity demand is predicted to grow by 8% annually to 2035 (MOIT and DEA, 2017), totalling 572–632 TWh by 2030 (Vieweg et al., 2017).

## 3. Methodology

The methodology in this paper is based on a comprehensive review of energy policy and policy analysis with multi-criteria decision method as outlined in Fig. 6 and each step are explained in further detail within the following sections.

### 3.1. Comprehensive review of energy policy

The energy policy review is the initial step, where data was collected and collated for further policy analysis. Firstly, a comprehensive review of Vietnam's status quo of policy and targets as an ASEAN country was undertaken. To create a reputable, reliable and valid review the widely applied method of systematic review was utilized to provide insight from existing resources of Vietnam's energy situation. Sources were identified via databases including Science Direct and Research Gate and open access search engines including Google and Google Scholar. As many international organisation reports were part of the review, open access searches often returned results of more significant interest and relevance.

Two key screening criteria to refine the direction of a systemic review, maintain relevance and limit an exhaustive search over the project lifespan were: the qualitative review could include references from the year 2000 onwards, and the quantitative review could include references from the year 2010 onwards (where possible). References were included that offered relevant quantitative or qualitative information relating to the study aims. The majority of sources were international organisation reports, Vietnamese Government-related documents and news articles. For the status quo literature review, limited database and

**Table 1**
Renewable energy potential TPES.

| | Wind (MW) | Hydro (small) (MW) | Biomass (MW) | Biogas (MW) | Solid Wastes (MW) | Solar (kWh/m2/day) | Geothermal (MW) | Tidal (MW) |
|---|---|---|---|---|---|---|---|---|
| **Potential** | 8000 (or 6 m/s) | > 7000 | > 2000 | > 100 | > 320 | 4–5 | 340–400 | 100–200 |
| **Current** | 180 | 1914 | 352 | > 1.6 | 2.4 | 4 MW | 0 | 0 |

Sources: (GIZ, 2016; Journet, 2018):

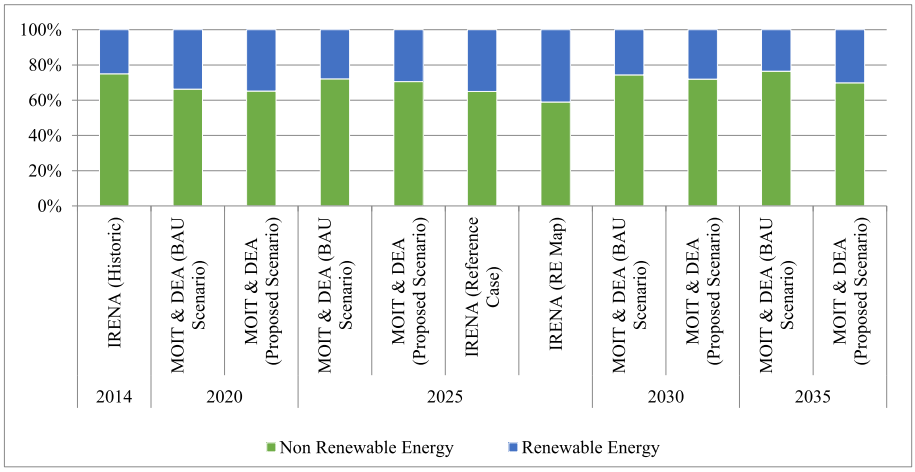


**Fig. 2.** TPES Non-Renewable V's Renewable sources - current and projected scenarios. Sources: collated from (IRENA and ACE, 2016; MOIT and DEA, 2017) (Large Hydropower is not shown as part of Renewable energy).

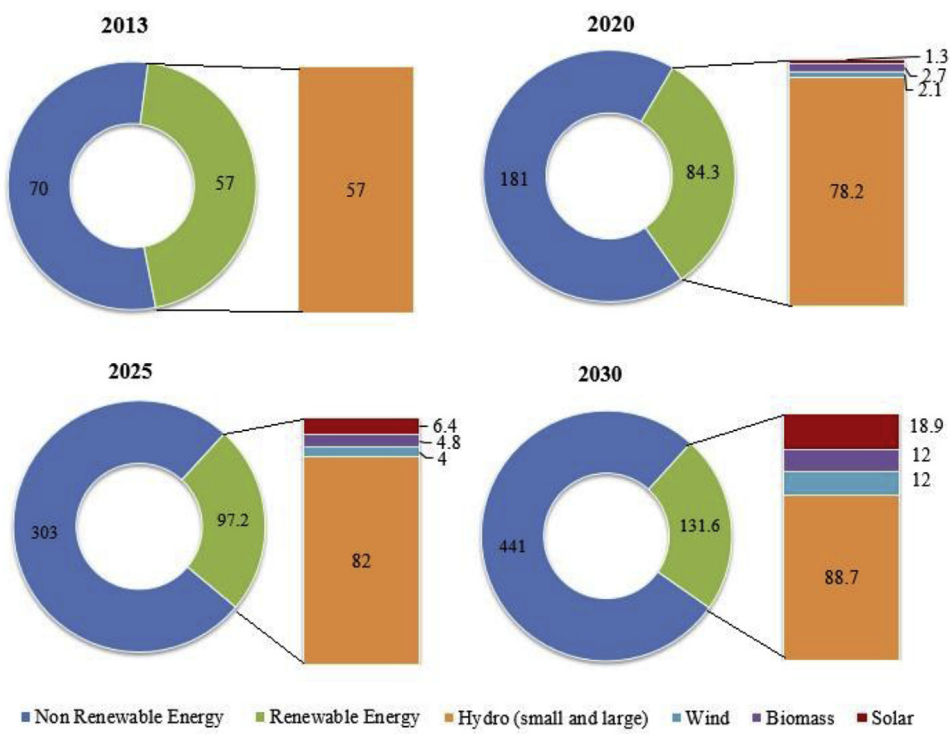


**Fig. 3.** Projected electricity generations from RE technologies. (The unit of numbers: TWh)
Sources: collated from (ACE, 2016; APERC, 2016).

peer-reviewed articles were included based on the nature of review and information available. Information from selected sources was tabulated with the collective focus of the energy system.

The pathway towards low carbon development, policy and targets the status quo, gaps and barriers, policy timeline, summary of significant policies, and criteria to be used in the MCDA are the outputs of the comprehensive energy policy review.

### 3.2. Policy analysis with multi-criteria decision method

As a key outcomes of the comprehensive review, we identify a knowledge gap in policy effectiveness and understanding the implementation status of existing energy-related policies. Based on this outcome, we realized a policy analysis in this study, using a multi-criteria decision method and policy taxonomy to analyze Vietnam's energy-related policy suite.

#### 3.2.1. Multi-criteria decision method (MCDM)

MCDM is a policy analysis tool which can be utilized with qualitative raw data or published literature for comparison of actions or solutions based on criteria or policies (JRC, 2007). MCDM was selected for policy analysis as a way to quantify the qualitative information obtained on each energy-related policy status while undertaking the policy review. Further, MCDA is an approach that allows for an overall preferential ordering based on a set of techniques (DCLG, 2009), which would, in turn, allow for a hierarchal rating of policy implementation based on a set of criteria. According to Polatidis et. al (2006), multi-criteria decision analysis (MCDA) techniques provides a reliable methodology which can rank alternative in the presence of numerous objectives and constraints (Polatidis, et al. 2006). Compared to single

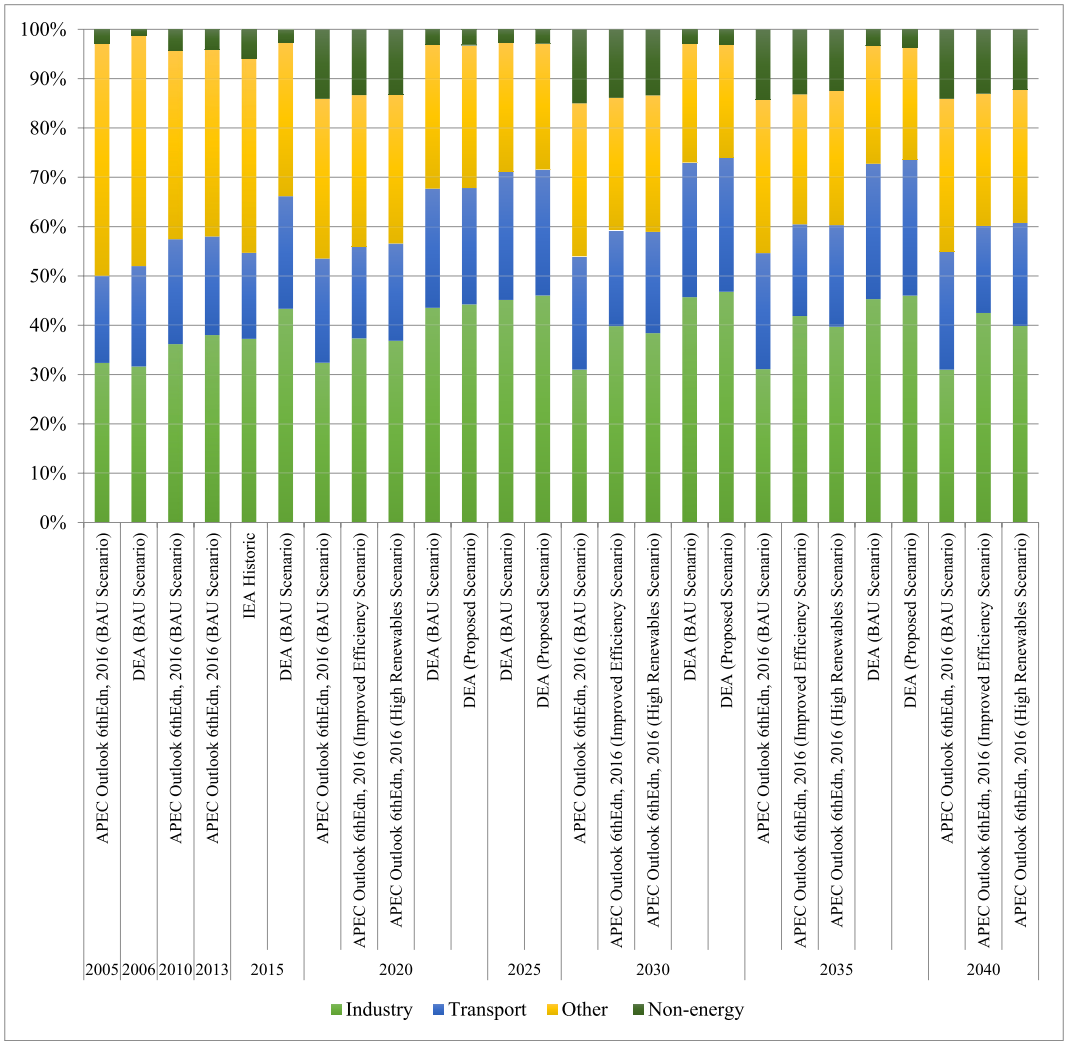

**Fig. 4.** TPED for key sectors - historical and projected. Sources: collated from (APERC, 2016; IRENA and ACE, 2016; MOIT and DEA, 2017).

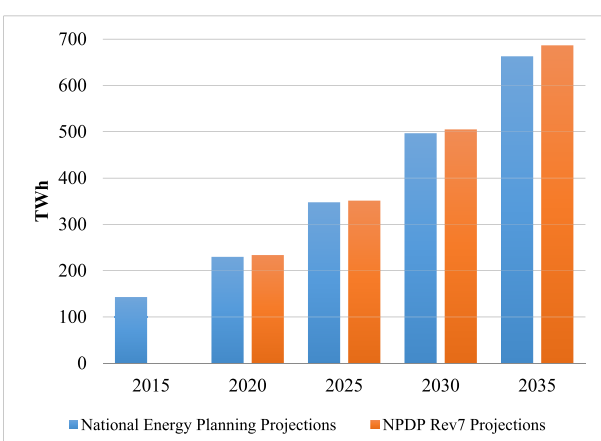

**Fig. 5.** Projected electricity demand. Sources: collated from (ACE, 2016; MOIT and DEA, 2017).

criteria approaches aimed at identifying the most efficient options at a low cost, MCDA gives the opportunity to factor in many constraints together.

The most commonly used multi criteria decision methods are analytical hierarchy process (AHP), weighted sum method (WSM), preference ranking organisation method for enrichment evaluation (PROMETHEE), the elimination and choice translating reality (ELECTRE), the technique for order preference by similarity to ideal solutions (TOPSIS) and, multi-attribute utility theory (MAUT) (Simsek et al., 2018). MCDM is used for energy policy analysis in many studies. Li et al. (2019) presented an analysis using AHP and VIKOR method (Li et al., 2019) to evaluate energy policy in China. In this research, weighted sum method was utilized due to having wide range application area and providing a simple and very flexible model.

Based on the framework provided by (DCLG, 2009) the following steps were undertaken to conduct the WSM-MCDM:

- ➢ *Identified the options to be appraised:* The options for appraisal were relevant energy-related policies sourced throughout the review of energy policy. The options included a total of 26 policies, standards and regulations, implemented between 2005 and 2017 as mentioned in section 4.3.
- ➢ *Identified objectives and criteria:* Criteria were identified from the literature review to inform the direction of policy analysis. When considering criteria, the objective to be reflected within each option was effectiveness to measure implementation and resulting impact of the energy-related policies for Vietnam's context. Six criteria were selected as shown in Table 2 for criteria options and their respective justification. The criteria act as pillars, which guide as a justification for the level of implementation and resulting impacts achieved by policies within the energy sector to date.
- ➢ Evaluated options (via scoring): Each policy was evaluated against

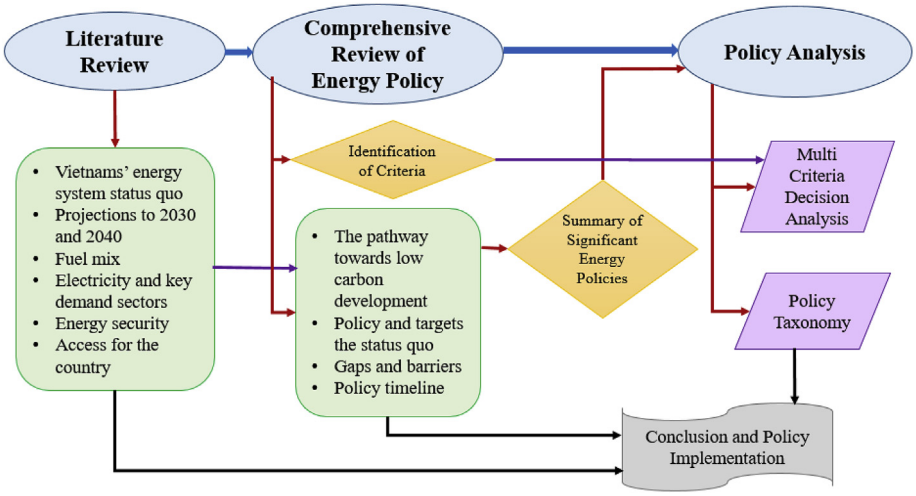


**Fig. 6.** Methodology flow chart.

the six criteria using a scoring system, derived from a scale of one (low) to five (high), to quantify the progress of each criterion for the respective policy. Fig. 7 outlines the scoring scale; a 'high' preferred value was the ideal situation for all six criteria being considered.

- ➢ Assigned weightings to criteria: Along with scoring each policy, a weighting was given to each criterion to reflect the relative importance to the decision (DCLG, 2009). Weightings were assigned based on a total allocation of 100%. The breakdown is provided in Fig. 8. The majority of the criteria were weighted similarly with a share of 15% each, as Vietnam's energy sector is still gaining momentum towards clean energy options and an interplay of factors is important in the developmental progress. Criterion three and criterion six were weighted slightly higher, at 20% each, as an increase in favourable technological factors should foster the economic and social factors for transition to effective policy mechanisms, along with successful implementation being significant to progression and transition.
- ➢ Calculated the overall value (score + weight): An overall value was then applied to each policy by adding the assigned score and weight together. This step, created a hierarchy (DCLG, 2009) to examine the implementation and resulting impact status of each policy.
- ➢ Examination of results: Results were examined based on calculated overall scores and subjective knowledge gained throughout the review process, where policy taxonomies were generated to inform recommendations for Vietnam's policy effectiveness and future perspective

### 3.2.2. Policy taxonomy

The policy taxonomy. Which justifies a level of policy implementation with a qualitative perspective, was presented as a heat map, to create a visual means of representing the outcomes of the MCDM. It allowed for a simple interface to view the MCDM policy analysis results, along with informing on the recommendation. Heat maps can be displayed in many ways; however, the common factor is the 'use of colour to communicate relationships between data values'. The colours derived for this heat map were based on the hierarchical ranking of the overall value produced for each policy (option) produced by the MCDM. Ten colours have been applied to the data, with each colour covering ten units out of 100. The relationship between heat map colour, hierarchical ranking (0–100) and justification is displayed in Table 3, the higher the number, the more effective the implementation and resulting impact status for the Vietnam energy context to date.

It is important to note that the policy taxonomy descriptors have been formulated based on the overall scores attributed to each policy, considering the secondary data reviewed and the interpreted context of Vietnam's energy situation.

## 4. Results

In this section, the results of policy review and MCDA are presented under the sub-sections: the pathway towards low carbon development, policy and targets status quo, gaps and barriers, policy timeline, significant energy-related policy, the effectiveness of current policy.

**Table 2**
Criteria developed for MCDM.

| | | |
|---|---|---|
| Criterion 1 | Ability to Measure impact | • Informs on the ability to access qualitative or quantitative progress of an implemented policy.<br>• Note: policies need to have been active for a minimum of 2 years to assess the impact (1). |
| Criterion 2 | Relevance to Reduce Emission from Energy Sector | • Contributes to NDC targets along with energy efficiency and RE goals.<br>• Contributes to SDG progress such as climate (SDG 13), health and wellbeing (SDG 3) and energy (SDG 7). |
| Criterion 3 | Relevance to Increase RE Technology | • Contributes to RE technology targets set out in NEDS, NPDP VII, REDS.<br>• Progress towards a greater mix of renewables will aid in achieving the United Nations SDGs (2). |
| Criterion 4 | Mobilization of Private Investment or International Cooperation | • Without private investment or international cooperation, many barriers will remain in place, slowing Vietnam's progression for policy implementation and in turn cleaner energy sources. |
| Criterion 5 | Quantitative Targets Included | • Tangible outcomes set by the Government.<br>• Creates a timeframe.<br>• Encourages deployment of policy mechanisms to influence targets, i.e. SPPAs, FITs, tax reliefs. |
| Criterion 6 | Ease of Implementation | • Is policy implementation straightforward?<br>• The ease of implementation influences the impact of a policy. |

Sources: (1) (ACE, 2016), (2) (IRENA, 2018a).

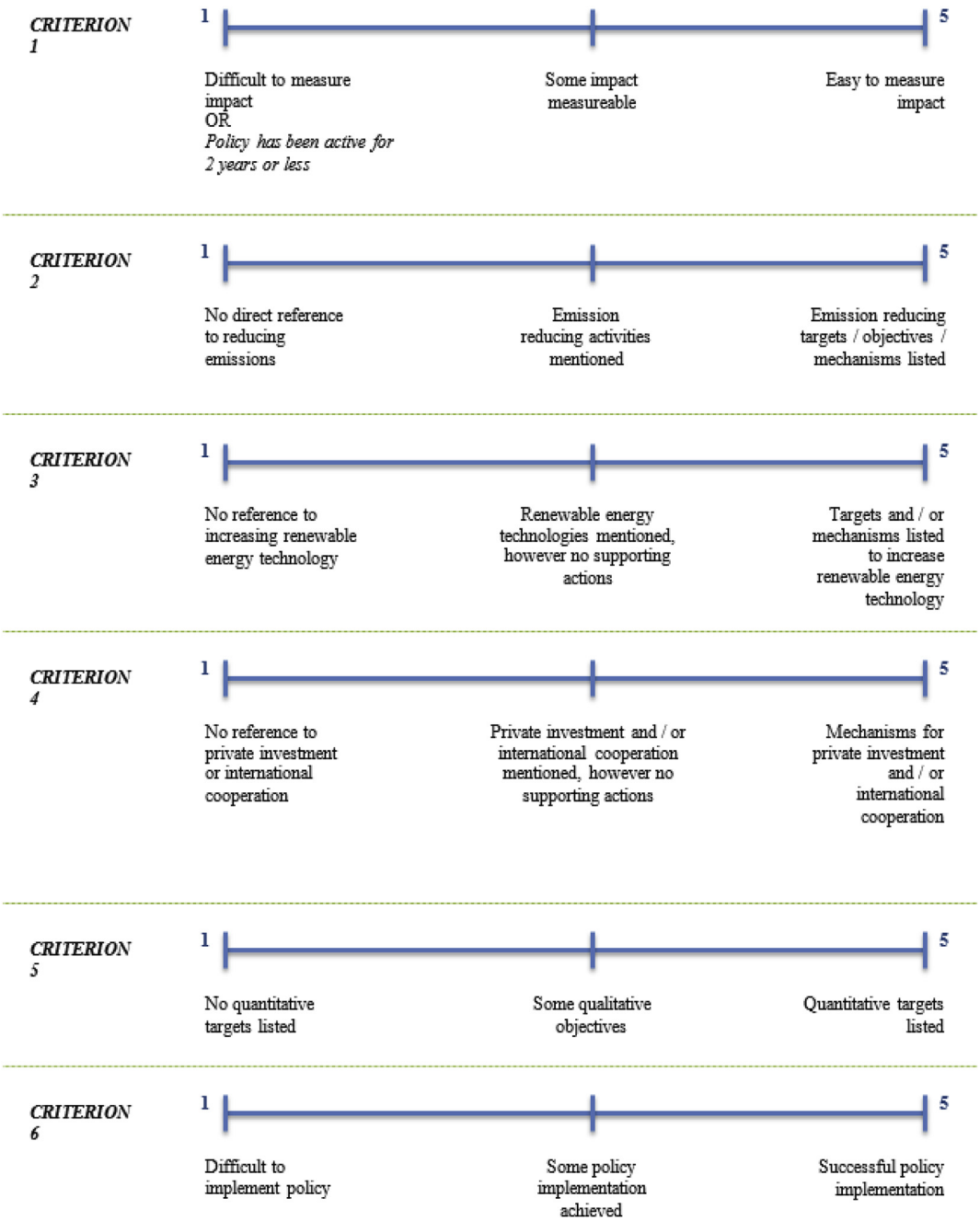


**Fig. 7.** The scoring scale for evaluated options.

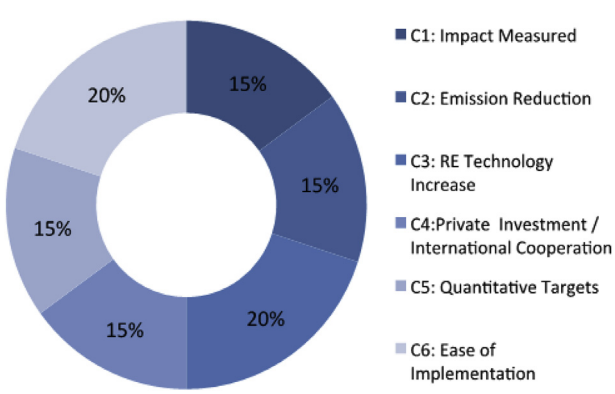


**Fig. 8.** Criteria weights.

### *4.1. The pathway towards low carbon development: Paris Agreement and SDGs*

In order to meet NDC targets and transition to a pathway consistent with the Paris Agreement Long-term temperature goal, Vietnam will need to engage externally with international partners, while also focusing internally on completing phase 2 of the power sector reform, implementing and enforcing policies, relevant mechanisms and also pursuing change from the largest energy user sectors. Fig. 9 indicates some of the potential actions and approaches that have or could be considered as Vietnam transitions its energy sector.

Considering the key demand sectors, some fuel switching to biofuel was introduced in January 2018, in line with the Biofuel Blending Mandate 2013; however, with minimal success to date due to low competitiveness with fossil fuel options and behaviour perceptions

**Table 3**
Policy taxonomy descriptions (based on criteria development).

| RANKING | HEAT MAP COLOUR | DESCRIPTION |
|---|---|---|
| *0 - 10* | | ▪ The measured impact is difficult and/or some recently activated policies and/or policy amended/out-dated<br>▪ Includes no direct reference to emission reduction and/or increase in RE technologies<br>▪ No reference for private investment and/or international cooperation<br>▪ No quantitative targets are included<br>▪ Difficult to 'no' known implementation achieved |
| *10 - 20* | | ▪ The measured impact is difficult and/or some recently activated policies<br>▪ Includes no direct reference to emission reduction and/or increase in RE technologies<br>▪ No reference for private investment and/or international cooperation<br>▪ No quantitative targets are included<br>▪ Difficult to 'no' known implementation achieved |
| *20 - 30* | | ▪ The measured impact is difficult and/or some recently activated policies<br>▪ Includes no direct reference to some activities for emission reduction and/or increase in RE technologies with no supporting actions<br>▪ No reference for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets may be included<br>▪ Difficult to 'no' known implementation achieved |
| *30 – 40* | | ▪ The measured impact is difficult and/or some recently activated policies<br>▪ Includes non-direct reference to some activities for emission reduction and/or increase in RE technologies with no supporting actions<br>▪ No reference for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets may be included<br>▪ Little implementation achieved |
| *40 - 50* | | ▪ The measured impact is difficult and/or some recently activated policies<br>▪ Includes activities for emission reduction and/or increase in RE technologies with minimal to some evidence of supporting actions<br>▪ Some reference to private investment and/or international cooperation<br>▪ No quantitative targets included<br>▪ Little implementation achieved |

(*continued on next page*)

**Table 3** (*continued*)

| | | |
|---|---|---|
| ***50 – 60*** | | ▪ Measured impact: difficult to some (case by case)<br>▪ Includes activities for emission reduction and/or increase in RE technologies with minimal to some evidence of supporting actions<br>▪ Little to no reference for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets may be included<br>▪ Little implementation achieved |
| ***60 – 70*** | | ▪ Measured impact: difficult to some (case by case)<br>▪ Includes activities for emission reduction and/or increase in RE technologies with minimal to some evidence of supporting actions (at a minimum)<br>▪ May includes mechanisms for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets may be included<br>▪ Some implementation achieved |
| ***70 - 80*** | | ▪ Some impact can be measured (at a minimum)<br>▪ Includes activities for emission reduction and/or increase in RE technologies with minimal to some evidence of supporting actions (at a minimum)<br>▪ Includes mechanisms for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets may be included<br>▪ Some implementation achieved (at a minimum) |
| ***80 - 90*** | | ▪ Some impact can be measured (at a minimum)<br>▪ Includes targets and/or mechanisms for emission reduction and/or increase in RE technologies<br>▪ Includes mechanisms for private investment and/or international cooperation<br>▪ Qualitative and/or quantitative targets included<br>▪ Some implementation achieved (at a minimum) |
| ***90 - 100*** | | ▪ Easy to measure the impact<br>▪ Emission reduction and increase in RE technology listed and supported with actions<br>▪ Mechanisms for private investment and/or international cooperation<br>▪ Quantitative targets listed<br>▪ Successful implementation achieved |

towards the biofuel option (Sapp, 2017). RE integration relies on incentives and financial mechanisms being in place for the different technologies, along with competitive prices and international support. While the power sector reform is a necessary internal action to keep moving the country into a more competitive model, in turn increasing renewable technology integration.

While developments are occurring, energy efficiency can curb existing emissions through physical and behavioural changes. Much of this knowledge may be acquired through the assistance of international expertise. To move forward and meet the Paris Agreement, the majority of approaches mentioned experience interplay, with reliance's upon one another to obtain meaningful change. Critical drivers for moving forward will also include the realization of ongoing government and international support, as 'a lack of technical and financial capacities to plan and implement, along with high-quality information pose challenges to effective private and non-private sectors' (Vieweg et al., 2017).

Energy access via electrification was achieved for the nation in 2016 (World Bank, 2017), satisfying SDG 7.1. Meanwhile clean fuel and technology for cooking was only accessible to 50% of the population in 2014 (SEforALL, 2017). Since 2010, access gains have mainly been driven by non-governmental organizations with some support from the

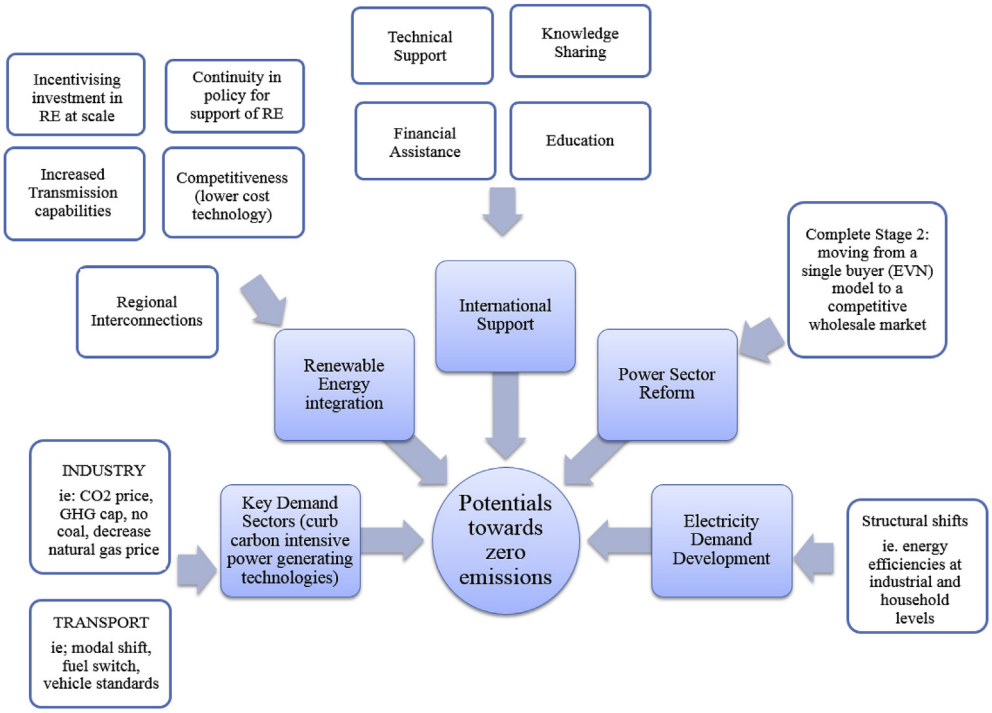


**Fig. 9.** Potential contributions towards low carbon development. Sources: collated from (Vieweg et al., 2017; Vitina et al., 2017; Pranadi, 2018).

Government, such as price stabilization for LPG (IBRD and World Bank, 2018).

Progress towards a greater mix of renewables will aid in achieving not only energy-related SDGs but also SDGs for poverty alleviation, health, water, nutrition, cities and climate (IRENA, 2018a). Energy has a role in fostering growth and socio-economic development. A successful decentralized biogas programme in rural locations outlines economic, climate change, health and food security benefits. Such a programme ran over a 14-year period with the deployment of 250,000 biodigesters achieved:

- Economic benefits: household energy cost savings, increased lighting and heating, decreased GHG emissions, fulltime employment and up-skilling;
- Health benefits: improved waste management, air quality and kitchen cleanliness; and
- Food security: Farmyard manure to increase crop yield.

The majority of decentralized examples throughout ASEAN depict a supply chain dominated by domestic inputs. For instance, this Vietnam biogas project involved some imported inputs for design; however, materials, construction and usage was mainly from domestic sources. As such a formal and informal economy were created, in turn, increasing livelihood benefits for the local community. Transition to RE options strengthens rural and community level growth, in turn supporting SDGs. However, a transition of this nature brings significant financial costs. It is unclear if the Vietnam Government has adequately projected for such a transition in their forward estimates or in partnerships with commercial organizations or other governments.

### 4.2. Policy and targets the status quo

Energy policy has been a response to economic growth and in turn increased supply since the 1990s, where government bodies, public utilities, such as the Vietnam Electricity Network (EVN) and private consumers collaborated, deploying mechanisms and incentives for load shedding (Banerjee et al., 2017). Despite active energy policy, one of the barriers preventing renewable energy growth is the low electricity and coal prices for the country that hinders a competitive market for more sustainable options (Vieweg et al., 2017). Further fossil fuel subsidies exist; however, only until 2020, with the intention of transitioning to cleaner fuel types and in turn reducing GHG emissions, especially for industrial purposes. VNNews (2018) indicates that the removal of fossil fuel subsidies will have minimal impact, one of the reasons being that fossil fuel subsidies are for oil and gas, however not for coal. It is likely that a shift to coal will be seen before clean energy options are considered widely (VNNews, 2018).

Vietnam is committed to the Paris Agreement with NDC for GHG emission reduction via adaptation and mitigation. The mitigation component of the NDC includes unconditional and conditional contributions, reducing GHG emissions by 8% below BAU by 2030 with the potential to increase to 25% given sufficient international support (UNFCCC, 2019, n.d).

Key strategies for energy and climate change include the National Energy Development Strategy to 2020 with a vision to 2050 (NEDS), the Vietnam Green Growth Strategy for the Period 2011–2020 with a vision to 2050 (VGGS) supported by the national Green Growth Action Plan (GGAP), the National Power Development Plan VII (NPDP VII) and the RE Development Strategy 2016–2030 with outlook until 2050 (REDS).

Some of Vietnam's current energy policies and respective targets are considered over four key categories, including:

a) Climate Change – reduce GHG emissions 8% below BAU by 2030, and 25% with international support;
b) Efficiency – reduce Total Final Energy Consumption (TFEC) by 8% in 2020 from BAU. Reduce the energy intensity of energy-intensive industries by 10% by 2020;
c) Electrification – Universal electrification by 2020; and
d) Renewables – Increase power generation capacity to 12.5% by 2025 (excluding hydro) and 21% by 2030 (IEA, 2017).

A status overview for each of the four categories is provided in Table A1 in Appendix A.

Vietnam's energy policy repertoire includes qualitative targets and quantitative objectives for Climate Change, Efficiency, Electrification and Renewables ranging from 2020 to 2050. Tariffs are commonly applied to renewable technologies and projects, such as FITs. Incentives are offered that include reduced fees on land and import tax exemptions. Further, financing support, via state investment credits and favourable interest rates and regulations for permits and licensing are also current mechanisms supporting energy policy.

In evaluation of Vietnam's energy policy status quo significant consideration has been applied to 'the most central policies, such as REDS, NPDP VII, the regulations on electricity selling tariffs and Standardized Power Purchasing Agreement (SPPA) for RE-based power projects, which have all been recent developments, promulgated between 2014 and 2016' (ACE, 2016). The following considers Vietnam's energy policy interplay and quantitative consistency from a status quo perspective for each of the four categories: climate change, efficiency, electrification and renewables.

#### 4.2.1. Climate change

The Climate Change targets for GHG emission reductions were established as part of the (UNFCCC, 2019, n.d), with a conditional and unconditional objective dependent on external support. The Vietnamese Government BAU projection to 2030 is an increase of GHG emissions to 787 MtCO2e (Vieweg et al., 2017). This BAU trajectory and the NDC targets (conditional and unconditional) are all greater than the quantitative amounts projected by recent institutional reports.

The projections alone Fig. 10, indicate that Vietnam can achieve GHG emission reductions that will meet and exceed the proposed NDC targets under a reference case or proposed scenario by MOIT & DEA or IRENA. The available scenario projections all follow a similar trajectory for GHG emissions from 2020 to 2035; however, GHG emission amounts vary. The projections indicate a GHG reduction range of 45%–57% less than the Government BAU, while the NDC conditional objective is only aiming for a 25% decrease. Successful reduction of GHG emissions needs to be driven through changes within energy sector efficiencies and RE development (MOIT and DEA, 2017, Vieweg et al., 2017). The ambitious proposed scenarios from institute reports rely heavily upon the weight of policy change and development applied and achieved by their respective forecasting.

The projections quantitative optimism does not appear to be consistent for all sources. Currently, the targets for efficiency and RE growth do not appear to be attainable within the set time frame, which in turn has a domino effect for climate change target. Further, there is an indication that Vietnam will require external funding support for more than half of the climate change actions necessary to reach target levels of GHG emissions (UNFCCC, 2019, n.d).

Policy framework for implementation of NDC measures includes federal laws that consider the environment, climate change and energy efficiency along with strategies such as National Climate Change Strategy 2011 and the VGGS, 2012 (UNFCCC, 2019, n.d). It is projected that by 2030 the energy sector will be responsible for even more GHG emissions than currently, with a share of 81% (Vieweg et al., 2017). Considering quantitative capacity, the climate change policies for GHG emission reductions appear progressive and have similar objectives; however, rely on substantial interplay with targets and policy outcomes for increased efficiencies, renewable development and international or private sector financial support.

Objectives appear to be similar to the policies that relate closely to climate change, with the main focus towards GHG emission reduction; however, the relationship and level of interplay is difficult to measure. There are some policy instruments, such as NAMAs, financial support, and mechanisms within the transport and building sectors in place, which ideally will aid in lowering GHG emissions; however, substantial or quantitative change cannot be gauged through available sources.

#### 4.2.2. Efficiency

The energy efficiency related targets include reductions in TFEC and energy intensity. TFEC projections (see Fig. 11) indicate an increase to 2020 and beyond, which is greater than the target of an 8% reduction from the BAU (APERC) by 2020. While the TFEC target appears ambitious, the energy intensity target of 10% reduction by energy-intensive industries by 2020 may be manageable according to accessible projections. Considering 2010 data and projections to 2030 (note, not 2020 specifically), potential reductions of 13% could occur.

Untapped sources for energy efficiency are likely linked to generating policies and mechanisms that are more stringent at targeting demand side, outcomes for Vietnam. Energy policy has been driven by supply-side bias globally, rather than considering curving consumption. Vietnam currently has two laws and one strategy, which directly relate to energy efficiency, along with mechanisms and programs in place. Consumption likely needs to become a focal point of policy and related mechanisms, especially since efficiencies are so closely linked to progress for security and GHG emission reductions (Hulst, 2017).

There is no explicit connection in reviewed literature between the regulations or policies; however, they have similar broad objectives of efficiencies, RE and electrification. The majority of energy efficiency related policies and laws are governed by MOIT with many line ministries having a role in delivering objectives, such as the ministry of industry and trade, the ministry of construction and ministry of science and technology (MOJ, 2010).

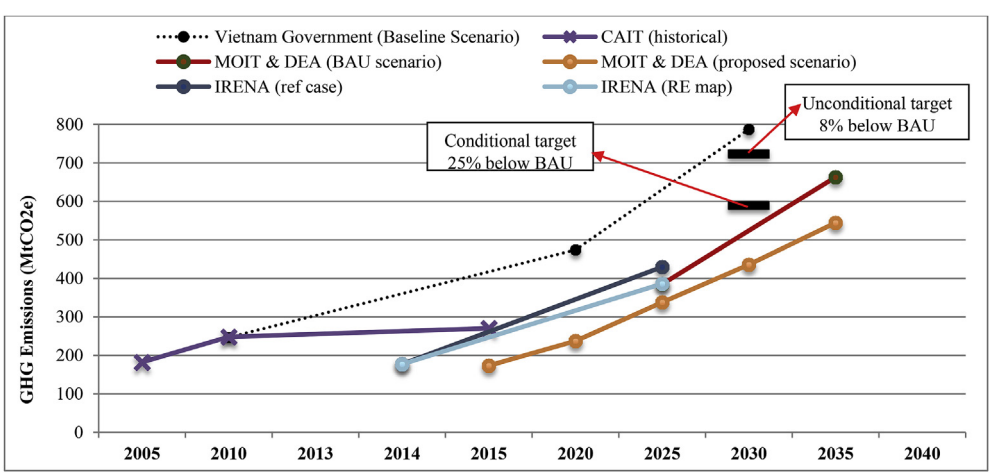


**Fig. 10.** Projections and targets for GHG emissions. Sources: collated from (IRENA and ACE, 2016; MOIT and DEA, 2017).

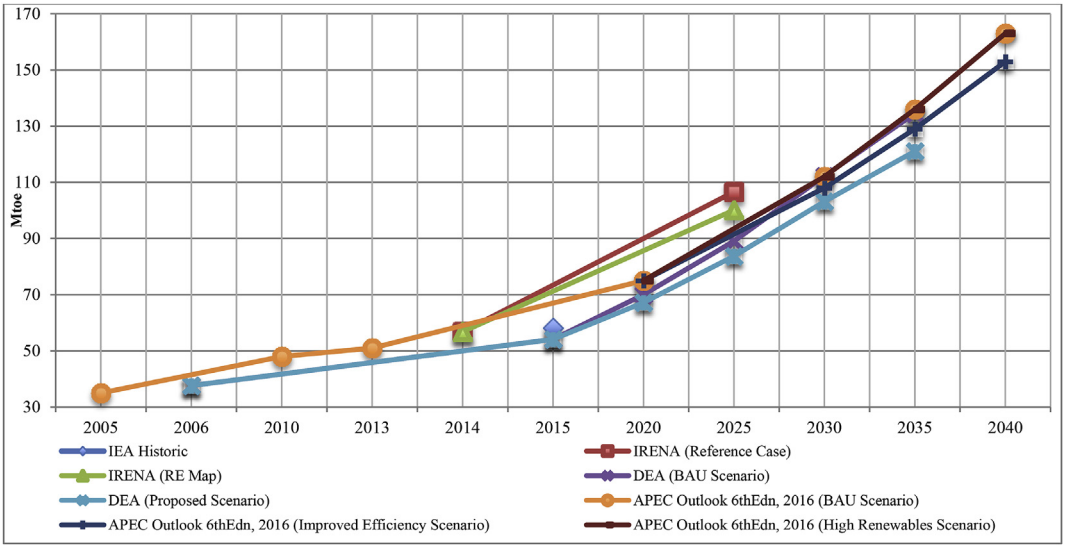


**Fig. 11.** Projections and targets for TFEC. Sources: collated from (IEA, 2015; APERC, 2016; IRENA and ACE, 2016; MOIT and DEA, 2017).

#### 4.2.3. Electrification

Universal electrification for Vietnam was achieved in 2016 (World Bank, 2018a), see Fig. 12, which is six years earlier than the target of 2022. Vietnam's success with electrification for its population can be attributed to government direction, policy implementation, coordination of the EVN and international organisation support (News, 2017).

Further, the National Rural Electrification Programme (NREP) was integrated with broader SDGs, such as poverty alleviation (GNESD n.d.), heightening its importance. Vietnam governance and policy indicated a willingness to learn and change course where necessary to meet electrification goals (IBRD and World Bank 2017).

#### 4.2.4. Renewables

The NPDP VII set the RE targets for a power generation capacity of 12.5% by 2025 (excluding large hydro) and 21% by 2030. Projections and targets for RE percentage of fuel mix are presented in Fig. 13. The scenario potentials indicate that the 2025 target (12.5%) will likely be met even exceeded, based on the MOIT & DEA proposed scenario indicating 15% RE. However, from 2025 to 2035 the derived RE percentage ranges from 13 to 17% is just shy of reaching the target of 21%. Electricity demand for 2025 is projected at 347,527 to 351,228 Gigawatt hours (GWh), National Energy Planning and NPDP VII respectively (MOIT and DEA, 2017). Therefore, target power generation capacity for 2025 of 12.5% would equate to a share of approximately 43,67 GWh of RE if achieved. (an increase by more than 3000% from 2014, 1428 GWh).

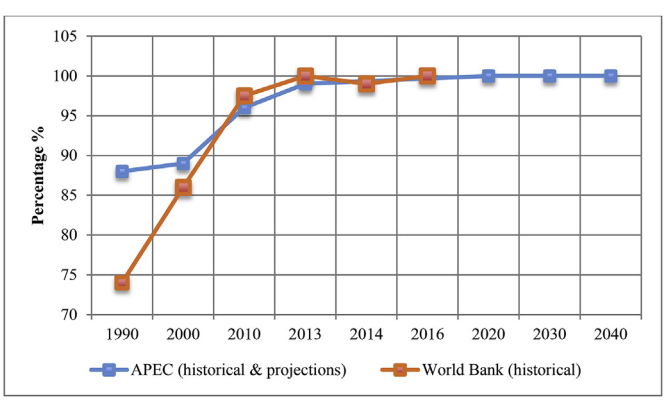


**Fig. 12.** Projections and targets for electrification. Sources: collated from (APERC, 2016, IBRD and World Bank 2017).

The primary policies related to RE are the NPDP VII and REDS, which foster many smaller decrees that support financial mechanisms (such as SPPAs, FITs), incentives and exemptions for corporate entities and licensing. Despite many policy mechanisms existing and much desire for increased RE, there are varying targets across the respective policies. Vietnam has had success at RE policy establishment; however, implementation status and the level of success of existing mechanisms are difficult to gauge.

### 4.3. Summary of energy policy review

After carrying out comprehensive policy review, it was obtained that Vietnam's energy policy repertoire includes qualitative targets and quantitative objectives for Climate Change, Efficiency, Electrification and Renewables ranging from 2020 to 2050. In order to compare the effectiveness of current policies, 26 energy policy options are chosen from four main energy policy categories mentioned in Section 4.2. These options are considered inputs for multi criteria decision analysis as listed in Table 4. As inferred from the table, mostly renewable energy and climate change policy options are taken into account besides electrification and efficiency policies. The effectiveness of chosen policies is mentioned in section 4.6 by considering chronological and hierarchical policy taxonomy.

### 4.4. Gaps and barriers

Policies have been established, creating a solid foundation for a low carbon transition, however, there is a lack of enforcement, coordination and ambition towards mechanisms and tangible outcomes. There is also difficulty in quantifying policy implementation status for resulting impacts as the majority of sources provided qualitative information. Identification of specific policy gaps such as the NDC, with GHG emission targets, considers mitigation for all sectors except for industry, the biggest energy user for Vietnam (Vieweg et al., 2017). Gaps and barriers identified from the review and classified under four main subjects: institutional, financial, technical, and information, outlined in Table 5. Considering the slow uptake of RE resources, where policy gaps influence progress, two significant barriers include:

- Bridging the gap between technical potential and technical – economical potential (MOIT and DEA, 2017); and
- The state of the power sector reform, currently a monopoly by EVN (Pranadi, 2018).

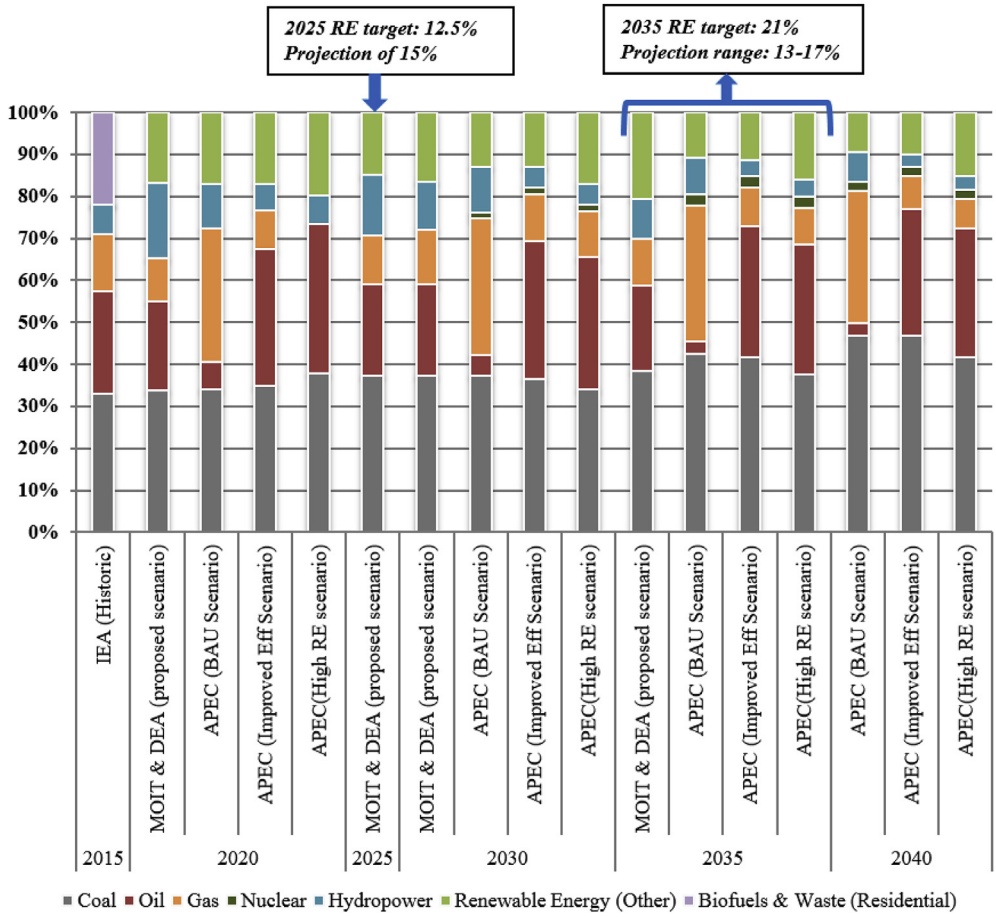


**Fig. 13.** Projections and targets for RE percentage of TPES fuel mix. Sources: collated from (IEA, 2015; APERC, 2016; MOIT and DEA, 2017).

Renewable development is crucial to assist with the low carbon development, but also in the short term to meet proposed targets (ie RE percentage of TPES). Strong RE policies are in place; however, at this point, the accompanying mechanisms are having little success. Some sources note that approaches such as EV standards and carbon pricing have not yet been considered, along with specific laws for RE

**Table 4**
Energy policies considered for MCDM.

| Energy policy options | | Policy Category |
|---|---|---|
| Option 1 | 2005: Environmental Protection Law | Climate Change |
| Option 2 | 2006: Grid Connection Regulations | Electrification |
| Option 3 | 2007: Financial Mechanism (Import Duty Exemption) for Clean Development Mechanism Projects | Climate Change |
| Option 4 | 2007: Development Scheme for Biofuels up to 2015 with an Outlook to 2025 | Renewable Energy |
| Option 5 | 2007: National Energy Development Strategy up to 2020 with an Outlook to 2050 | Climate Change |
| Option 6 | 2008: Supporting mechanisms (ACVT and SPPA) for Small Renewable Energy Power Plants | Renewable Energy |
| Option 7 | 2009: Financial Mechanism (Import Tax Exemptions) for Renewable Projects | Renewable Energy |
| Option 8 | 2009: National Strategy on Comprehensive Management of solid wastes for the period up to 2025, vision to 2050 | Climate Change, Energy Efficiency |
| Option 9 | 2010: Regulations on Interconnecting Power Plants to Power T&D Grid | Electrification |
| Option 10 | 2011: Supporting mechanism (FiT) for Wind Power Projects | Renewable Energy |
| Option 11 | 2012: Electricity Law | Electrification |
| Option 12 | 2012: Regulations for Project Development and SPPA wind power projects | Renewable Energy |
| Option 13 | 2013: Corporate Income Tax for RE-Based Power Projects | Renewable Energy |
| Option 14 | 2013: Biofuels Blending Mandate | Renewable Energy, Energy Efficiency |
| Option 15 | 2013: Accelerated Depreciation for RE Projects | Renewable Energy |
| Option 16 | 2014: Supporting mechanism (Project Development and SPPA) for Biomass Cogeneration Projects | Renewable Energy, Energy Efficiency |
| Option 17 | 2014: Supporting Mechanism (FiT) for Solid Waste-Based Power Projects | Climate Change, Energy Efficiency |
| Option 18 | 2014: Regulations on Electricity Selling Tariff and SPPA for Small Hydro Projects | Renewable Energy |
| Option 19 | 2015: Regulations on Issuance, Revocation and Duration of Power Operation License | Electrification |
| Option 20 | 2015: Regulations on Preparation, Appraisal and Approval of Biomass Energy Development and Utilisation Plans | Renewable Energy |
| Option 21 | 2015: Supporting Mechanism (SPPA) for Solid Waste-Based Power Projects | Climate Change, Energy Efficiency |
| Option 22 | 2015: Renewable Energy Development Strategy up to 2030 with an Outlook to 2050 | Renewable Energy |
| Option 23 | 2015: Regulations on Interconnecting Power Plants to Power Distribution Grid | Electrification |
| Option 24 | 2015: Intended Nationally Determined Contribution (INDC) | Climate Change |
| Option 25 | 2016: Revised National Power Development Master Plan VII (NPDP VII) | Climate Change |
| Option 26 | 2017: Supporting Mechanism (FiT) for Solar PV Projects | Renewable Energy |

**Table 5**
Gaps and barriers.

| | |
|---|---|
| Institutional | - The effectiveness of policy framework<br>- Political structure<br>- Lack of incentives for implantation of mechanisms<br>- Minimal regulations around RE development |
| Financial | - Low electricity and coal prices<br>- Lack of incentives<br>- High investment risks<br>- Power and industry sector are mainly state-owned enterprises (therefore minimal competition from private enterprises) |
| Technical | - Domestic technology development<br>- Manufacturer installation and operation capacities<br>- Rely on imported RE technologies |
| Information | - Awareness of country situation<br>- Sustainable development options<br>- Technical knowledge base |

Sources: (MOIT and DEA, 2017, Vieweg et al., 2017):

technologies. Development of appropriate legal frameworks that support technology advancements, energy security and international, private and government cooperation would benefit Vietnam's clean energy progression (MOIT and DEA, 2017).

### 4.5. Policy timeline

The policy timeline indicates when energy-related policies have been introduced from 2005 onwards and the corresponding amount of RE installed capacity for Vietnam from 2007 to 2017. Fig. 14 indicates that as the energy policy suite develops, the installed capacity of RE also increases. Small hydropower capabilities mainly drive the renewable capacity; however, diversification in RE sources is also noted, with the inclusion of biomass and wind power in more recent years. The policy suite includes supporting mechanisms for these renewable technologies and other potential RE sources, including biogas, solar and solid waste. There is also the potential for geothermal in Vietnam; however, no policy mechanisms exist at this point.

### 4.6. The effectiveness of current policy

The MCDA analysis of policy implementation status and resulting impact allowed for the creation of a policy taxonomy, which supports analysis of existing policy effectiveness. The policy taxonomy is displayed chronologically and then hierarchical in the following sections.

#### 4.6.1. Chronological Policy Taxonomy

The chronological display of the policy taxonomy indicates that there is no real correlation between the year of application and the effective progress for this policy portfolio as presented in Fig. 15. However, it is notable that around one-third of the policy suite, have been enacted since 2014 which coincides with the adoption of the SDGs and the ratification of the Paris Agreement on Climate Change, 2015, 2016 respectively (Nations n.d.). Vietnam produced its NDC in 2015, showing its intent towards reducing GHG emissions unconditionally and conditionally (UNFCCC, 2019, n.d). In turn, other policies have been generated for the nation to support its commitment and the current globally endorsed UN programs.

Policies introduced from 2014 onwards have only been enforced for a short amount of time, with the majority indicating minimal impact to date, which is common as impact assessment requires a policy to be active for a minimum of 2 years (ACE, 2016). However, some of the recently introduced policies ranked on the higher end (green) of the policy taxonomy, giving the impression of some successful

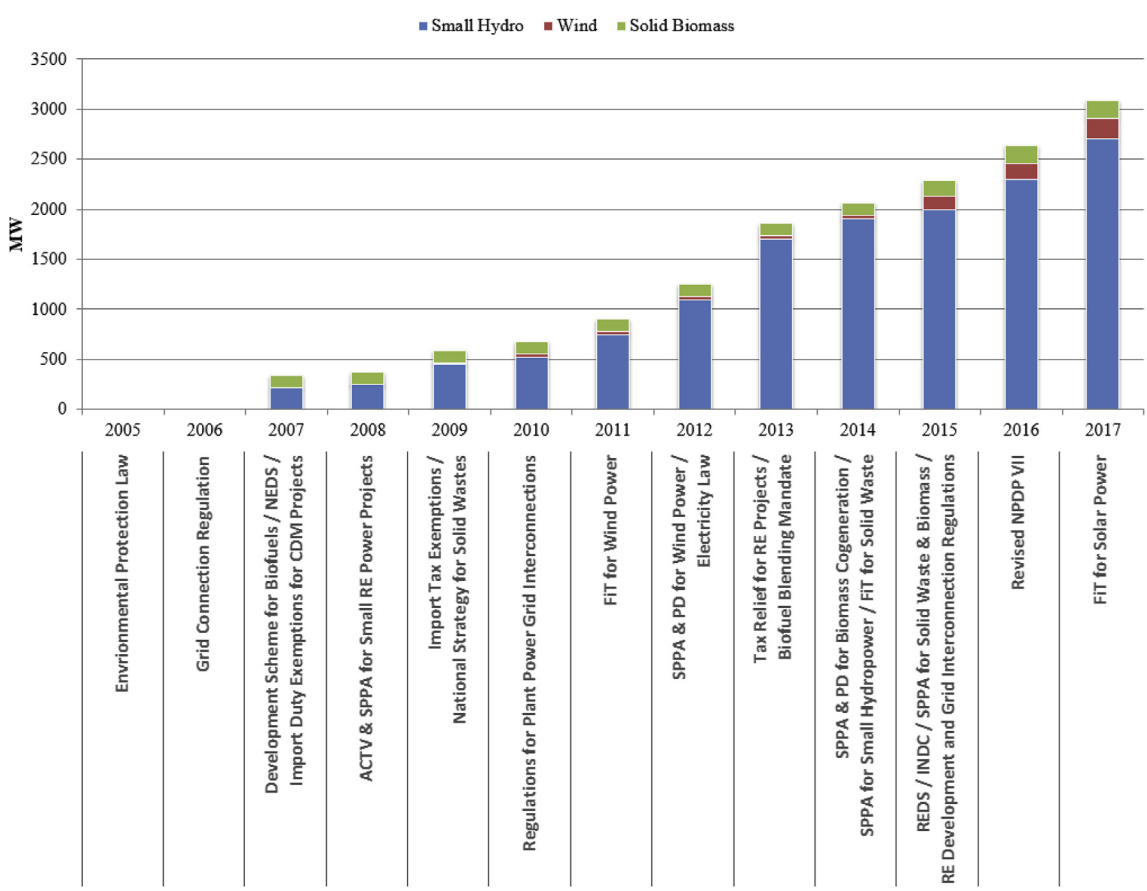


**Fig. 14.** Policy and renewable energy installed capacity timeline.
Sources: collated from (ACE, 2016; MOIT and DEA, 2017; IRENA, 2018b).

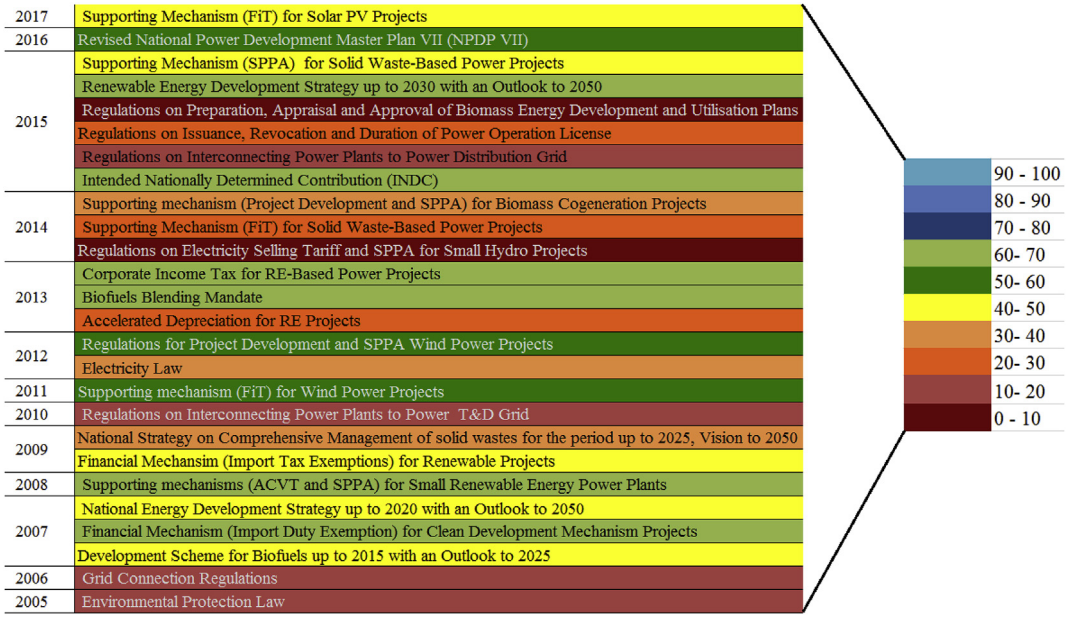


**Fig. 15.** Chronological policy taxonomy.

implementation and resulting impact towards low carbon development.

The taxonomy includes broad strategies and plans for the development of the energy sector, considering climate change, renewables and power targets such as included the NDC, REDS and NDPD VII. These are at the higher end of the taxonomy, but indicate low levels of implementation and impact based on criterion one and six respectively, which is anticipated based on how long they have been active for. However, their ranking for the policy taxonomy was the result of a higher overall score based on the weighting and influence of criterion two, three and five, which consider reducing emissions, increasing renewable technology and quantitative targets. Perceived impact levels of these policies slightly skew the reliance that can be quantified from the policy taxonomy. However, when considering the hierarchical display of the policy taxonomy some of the supporting mechanisms for renewable technologies and mandates indicate higher implementation and resulting impact.

### *4.6.2. Hierarchical policy taxonomy*

The hierarchical policy taxonomy, Fig. 16, indicates varying levels of implementation, from very little (shades of red) to some (orange and yellow), with only a handful of policies indicating higher levels of implementation and resulting impact (shades of green).

The highest ranking for the policy suite was 68.3 (light green). Six of the 26 policies fell into the light green bracket of the policy taxonomy indicating that of the policy suite the highest-ranking policies signified some implementation achieved and measured impact. Further, the criteria for these policies may have been favourable towards emission-reducing activities or increase in RE technologies, mechanisms for private investment or international cooperation and provided qualitative targets.

The three highest scores for implementation and resulting impact were allocated to supporting mechanisms and mandates:

- 2007: Financial Mechanism (Import Duty Exemption) for CDM Projects
- 2008: Supporting mechanisms (ACVT and SPPA) for Small RE Power Plants
- 2013: Biofuels Blending Mandate

The common denominator for these three policies was that the quantitative information collated in the policy timeline was able to indicate some measurable impact (criterion one) and some policy implementation achieved (criterion three). Key points for the measurable progress included:

- ✓ CDM portfolio of 255 projects in 2017 with measurable certified emission reductions achieved (Healy, 2017)
- ✓ Installed capacity of small hydro increasing six times from 350 MW (2009) to 1984 MW in (2014) (ERIA, 2016)
- ✓ Introduction of E5 blending target to sell to road and motor vehicles in January 2018 (Sapp, 2017)

Since some impact was measurable, each of these policies also displayed setbacks, barriers and gaps in the qualitative information sourced. For example, it is unclear if the E5 blending target was a selective or nationwide shift and the CDM projects lack a diverse portfolio (mainly hydro based) and unilateral projects, therefore deficient foreign investment and involvement (Healy, 2017). Further, two of these three policies have contributed to the installed capacity of small hydropower which is the current driver and most accessible of RE technologies. The policy suite covers many other RE technologies, including wind, solar and biomass which all have potential to contribute to the national energy mix; however, implementation and resulting impact are currently minimal.

While criterion one and six were comparable for these three policies, criterion two to five were not consistently scored across the three policies. The least influential parameter appeared to be quantitative targets. These policies were set apart based on their influence with small hydro projects to date, a mandate for the transport sector and also the available information for review.

Less progress has been identified for lower ranking policies such as 2006: Grid Connection Regulations (pink) and 2014: Supporting Mechanisms (FiT) for Waste Based Power Projects (orange). Both of these policies indicate difficulty in measuring implementation (criterion six) and impact (criterion one). The other criteria, also ranked on the lower end of the scale, except for an increase in RE technology (criterion three), which was mentioned in both policies; however, no supporting actions could be identified to justify progress. The extent of information for Grid Connection Regulations indicated that in 2016 transmission grids were underdeveloped (OECD and IEA, 2016). Meanwhile, the perception of FiTs is a lack of effectiveness for the development of new waste to energy projects (ERIA, 2016;

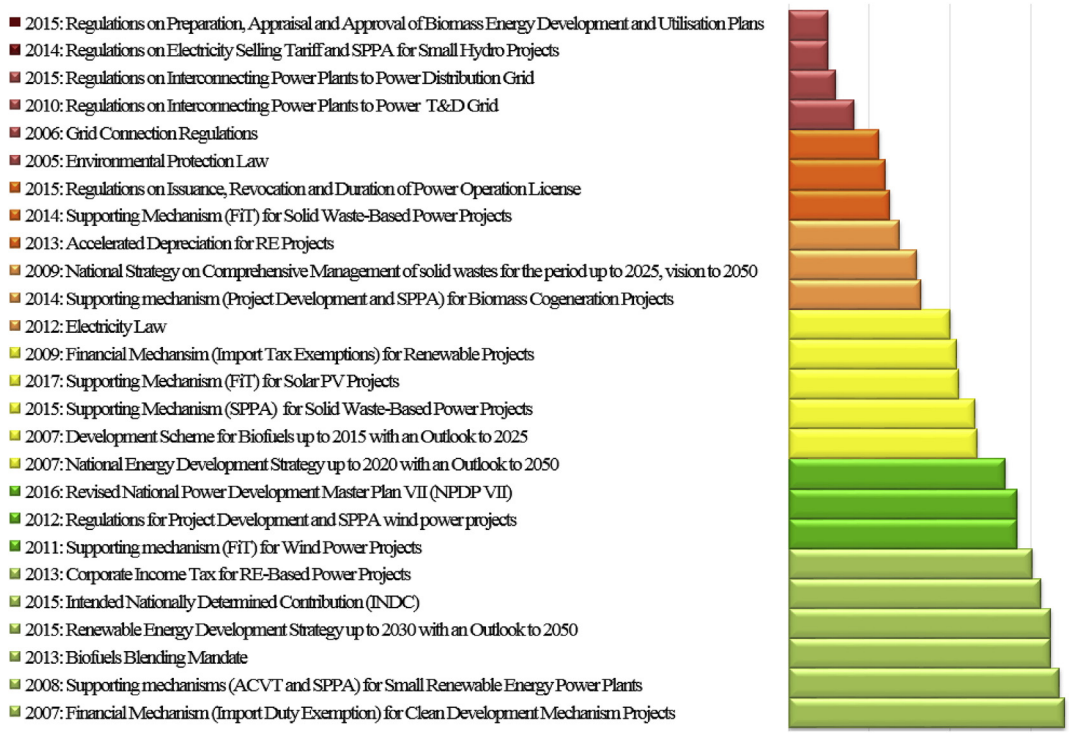


**Fig. 16.** Hierarchical policy taxonomy.

Climatescope, 2017). However, assessment of the impact may be premature as the policy has only recently been introduced (ACE, 2016).

## 5. Discussions

Based on the MCDA, no policy to date has achieved a high level of implementation (70–100), the greatest score achieved was 68.3 for financial mechanisms in support of CDM projects. Nine of the 26 policies ranked greater than 50 (green in colour), including all current strategic documents containing RE and GHG emission targets, along with established support mechanisms, such as SPPAs, FiTs and fiscal incentives. These policies had higher overall scores for the six criteria along with favourable weighting for criterion three: increase in RE technology.

The majority of policies ranked below 50 (yellow, orange or red), which indicated little to no implementation, with the exception of newly enacted policies (such as Solar PV Tariffs, 2017). Lower scores across the six criteria accompanied a lower ranking. The majority of these policies still scored well for criterion three: increase in RE technology, indicating a common objective amongst the policy suite. However, without an increase in scores for criteria such as private investment or international support (criterion four) and ease of implementation (criterion six), impact and effective change for low carbon development will likely be a slow process.

One of the options holding energy-related policy implementation back appears to be associated with criterion four: mobilization of private investment or international contribution. Private and international support can provide economic and technical capabilities for RE growth. An increased score for criterion four may provide progress for RE potential and implementation status. The country has focused on financial mechanisms for RE technologies, incentives for the private sector and government subsidies for international cooperation to date. In theory these seem adequate; however, there is a missing link with ease of implementation and resulting impact.

The six criteria chosen were weighted similarly, as all the criteria were considered necessary to understanding progression for clean energy progression to date. The resulting policy taxonomy indicates that with similar weightings all six criteria hold value and therefore work as a whole. A policy needs to display strong characteristics across the majority of criteria (one to six), to prove meaningful implementation.

However, upon interpreting the hierarchical policy taxonomy, an observation can be drawn that the respective criteria do not always indicate successful implementation. For example, one of the top ranking policies, 2013: biofuels blending mandate, has fulfilled one of its targets as recently as January 2018; rolling out E5 as a fuel option to road motor vehicles nationwide. Nevertheless, implementation has not received a positive response to date, with fossil fuel options only slightly greater in cost and consumers behavioural change to the new fuel option being poor. This indicates a gap in the MCDA for understanding policy influence towards clean energy progression. Further criteria, different weightings or a primary source of information in the MCDA are all options to strengthen the results obtained, potentially informing the analysis in a slightly different manner.

Summary of significant policy suite findings supporting a pathway towards low carbon development include:

- Minimal to some implementation resulting in clean energy progression has been achieved via the policy suite.
- Policies that ranked above 50 had higher overall scores and favourable weighting for criterion three: increase in RE technology.
- Low ranking policies indicated a favourable weighting for criterion three also; however, other criteria scores were weaker, suggesting the need for support for other criteria.
- Low scores for criterion four: mobilization of private investment or international contribution is likely holding back opportunities for growth in the energy sector.
- Results for implementation and resulting impact are likely stunted or skewed based on the secondary nature of data utilized. Greater insights into policies abilities to support clean energy progression may come from increased criteria, different weightings and a primary source of information.

Effective implementation is crucial for progression towards a cleaner future and in turn a pathway towards zero emissions; however,

to achieve successful implementation there are necessary factors that Vietnam needs to consider. The criteria applied are useful for the direction headed and indicates that Vietnam has policy mechanisms in place; however, the success of these mechanisms along with greater action is needed to support these. Firstly, the root causes, such as useful and effective government intervention and support, along with reform of the electricity market needs to occur, allowing for competition. Beyond these economic barriers from investors may seem less risky, along with knowledge sharing, technical capacity and opportunities to look towards the renewable potentials stated in the literature. The policy taxonomy highlighted this, policies ranked low when criteria were ranked low on the scaling system.

A way to boost these scores is to increase action; the Vietnam policy suite needs mechanisms that are achievable and accessible to all, accompanied by support from private investment and international cooperation (criterion four) to realize a change in the short term, before looking long term. For instance, the selling price of RE technology generation is comparatively low in Vietnam compared to the majority of the ASEAN region. There is a noticeable link between energy and many SDG goals which should be the connection needed to boost the priority of energy action, therefore policy mechanisms and outcomes, not only targets.

Additionally, the outcomes of the chronological and hierarchical policy taxonomy indicated the following findings and some limitations related to the six criteria used for MCDA:

- Quantitative and occasionally qualitative progress was difficult to gauge from the available information sources available, making it challenging to determine a score for criterion one (ability to measure the impact).
- Many of the energy-related policies indicated relevance to decreasing emissions (criterion two) or increasing renewable technology (criterion three) via purpose, objectives and targets or financial mechanisms. However, few policies could prove progress or contribution to the respective outcomes.
- An attribute of policy implementation success is the support of the private sector or international cooperation (criterion four). Many policies alluded to relationships of such, with some supporting information found. An increase in private and international support for economic, technical and social purposes may encourage the rate of progression for renewable and sustainable goals. Stating quantitative targets (criterion five) is setting a goal; however, actions are needed to accompany the progress of the goals, which is where private and international support can be a pillar for progression.
- Few policies appeared easy to implement (criterion six). This comes back to resources, education, financial means and also the government's commitment to the cause. The Government were engaged with achieving energy access for all via electrification, which reached its target prior to 2022.

Finally, due to the nature of the MCDA, other limitations include the use of secondary data sources only, potential bias in the data as the majority of sources were intergovernmental reports and online articles, lack of qualitative data to gauge implementation and resulting impact to date, and limited sensitivity analysis undertaken for the MCDA.

## 6. Conclusion and policy implementation

Vietnam has a suite of policies, which address fossil fuels, renewables, climate change, efficiency's, security and access; however, the country will benefit from developing effective policies that provide practical outcomes and support implementation that results in actions and impact towards a clean energy development pathway. Institutional reforms, such as the power network becoming a competitive wholesale market should provide a shift in behaviour between fossil fuel and renewable sources for energy supply and demand.

Vietnam's current energy policies and respective targets are mainly over four key categories, including:

- Climate Change – reduce GHG emissions 8% below BAU by 2030, and 25% with international support;
- Efficiency – reduce Total Final Energy Consumption (TFEC) by 8% in 2020 from BAU. Reduce the energy intensity of energy-intensive industries by 10% by 2020;
- Electrification – Universal electrification by 2020; and
- Renewables – Increase power generation capacity to 12.5% by 2025 (excluding hydro) and 21% by 2030 (IEA, 2017).

Policies have been established, creating a solid foundation for a low carbon transition, however, institutional, financial, technical, and information gaps and barriers exist for Vietnam. On the other hand, as the energy policy suite develops, the installed capacity of RE also increases in Vietnam.

Existing policies need to align with one another and the respective governing bodies so that all policies move in the same direction minimizing overlap. Further, a monitoring system for the implementation of existing and new policies would allow for regular feedback, learnings and changes where necessary. One possibility to guide implementation is roadmaps with short and long-term goals for applying objectives. Such practical planning should allow clearer directions to achieve targets. Significant issues for Vietnam to address include electricity pricing, market structure, uptake of cleaner technologies and education for knowledge gain. Existing and new policies will be the drivers for these key issues, shaping the energy sectors maturity and growth along with providing approaches to a cleaner energy pathway into the future.

Considering the outcomes of the policy taxonomy, energy policy should include:

- A clear purpose, such as reducing emissions (criterion two) or increasing RE technology (criterion three), along with supporting mechanisms;
- External support, such as private investment or international cooperation (criterion three); and
- A way to measure progression and impact (criterion one), such as quantitative targets or qualitative support mechanisms.

Further research is needed to understand how rural grid connections, increased transmission capabilities and regional cooperation could play a role in increasing RE access options in a short time in Vietnam to support low carbon development and its policy direction. Additionally, an in-depth research is needed to identify effective policies by applying MCDA using stakeholder consultation in Vietnam with sensitivity analysis on weighting factor.

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## Appendix A

Table A1

Summary of main energy-related targets

| | Targets | Quantitative Status & Projections | Policies* | Mechanisms, Programs, Initiatives Implemented To Date | Challenges To Meet Targets |
|---|---|---|---|---|---|
| **CLIMATE CHANGE** | **Reduce GHG emissions 8% below BAU by 2030 (unconditional target), and 25% with international support (conditional target)** | **Historic GHG Emissions**<br>**2010:** 246.8 MtCO2e (8)<br>**2015:** 270.30 MtCO2e (excluding LUCF) (11)<br>***An increase of 9.5% GHG emissions from 2010 to 2015***<br>**Projected GHG Emissions**<br>**2020:** 212–237 MtCO2e (13, 14)<br>**2025:** 2025: 338–385 MtCO2e (13)<br>**2030:** 336–436 MtCO2e (13, 14)<br>***Government estimates 2030 GHG emissions (based on 2010 BAU data) to be 787 MtCO2e (12). This is higher than projections by MOIT & DEA and APERC.***<br>***'Energy sector to equate for 81% of GHG emissions by 2030' (12)***<br>**2035:** 440–633 MtCO2e (13, 14)<br>**2040:** 574–632 (14) | Environment Law (EL, 2014)<br>Vietnam Green Growth Strategy (VGGS, 2012)<br>National Climate Change Strategy (2011)<br>Economic and Efficient use of Energy Law (2010)<br>NDC (2015) | NAMAs<br>Financial Support Program to Respond to Climate Change: Vietnam received a credit of 90 million USD in 2016 from the World Bank for policy reforms to climate change and green growth (6)<br>EE collective mechanisms: resilience building and mitigation Technology Implementation, restoring natural assets, green lifestyle promotion (VGGS, 2012)<br>Transport mechanisms: fiscal incentives, tax exemption for EV, Sustainable public transport incentive, Fuel economy standards or vehicle efficiency incentives | Climate Planning and Budgeting Reform (9)<br>Climate Policy and Institutional Coordination and Strengthening (9)<br>Legal framework<br>Science-based policymaking process (8)<br>Awareness, information sharing and capacity building (8)<br>Triple cooperation: planning, research and industries (8) |
| **EFFICIENCY** | **Reduce TFEC by 8% in 2020 from BAU.**<br>**Reduce the energy intensity of energy-intensive industries by 10% by 2020.** | **Historic TFEC**<br>2010: 48 Mtoe (10)<br>2015: 58 Mtoe (10)<br>***An increase of 20.6% TFEC from 2010 to 2015***<br>**Projected TFEC**<br>2025: 83-107 Mtoe (13, 16)<br>2035: 120-135 Mtoe (13)<br>***Considering projections an increasing trend for TFEC to 2020 and beyond***<br>**Historic Energy intensity**<br>2010: 113–172 toe/GDP (14)<br>2013: 110–154 toe/GDP (14)<br>**Projected Energy Intensity**<br>2020: 100–152 toe/GDP (14)<br>2030: 80–134 toe/GDP (14)<br>2040: 64–116 toe/GDP (14)<br>***Considering*** APERC (2016) ***data above, from 2010 to 2030 potential reduction in energy intensity of 13%, with the target being met for either scenario in 2020.*** | Energy Efficiency and Conservation Law (EECL, 2010)<br>Energy Efficiency Strategy (2011)<br>Electricity Law, 2005 | National Target Program for Energy Efficiency and Conservation (NTPEEC, 2012–2015)<br>Energy Efficient Building Code (EEBC, 2013): technical standards for construction greater than 2500m2<br>Financial Support - External and Internal Funding: March 2018 launched, $102 million projects to help Vietnam Industrial Sector adopt energy efficient technologies and practises, a joint venture of The World Bank and Vietnam's Ministry of Industry and Trade (3)<br>Data collection: Database by General Statistics Office, Establishment of Socio-economic Data and Energy Data (4)<br>EECL (2010) mechanisms: Audits, taxes, incentives and energy labelling | Creation of a National Energy Database (4)<br>Sector success at the implementation of codes and mechanisms |
| **ELECTRIFICATION** | **Universal electrification by 2020** | ***Since 2016 electricity access has been available to 100% of the population (2)*** | NPDP VII, 2016<br>Electricity Law, 2005 | National Rural Electrification Program (1998–2013) (15)<br>Power supply project for five provinces without electricity in the Central Highlands (2006–2009) (15)<br><br>National poverty reduction programme included funds for electrification (16)<br><br>World Bank support - infrastructure investment (Electrification program 2014–2020) (15)<br><br>Power corporations – local capacity building: technical and commercial operations and maintenance training (15) | |
| **RENEWABLES** | **Increase power generation capacity to 12.5% by 2025 (excluding large hydro) and 21% by 2030** | ***Fuel Supply mix* - 2015 RE *less than 1% (excluding hydro) (10)***<br>Projections (excluding large hydro)<br>**2020:** 17–18% (13, 14)<br>**2025:** 15% (13)<br>**2030:** 13–17% (13, 14)<br>**2035:** 13–17% (13, 14)<br>**2040:** 10–15% (14)<br>***2025 target of 15% will likely be met; however, from 2025 – 2035 the RE percentage only increases slightly, not reaching the target of 21%.*** | NPDP VII, 2016<br>REDS, 2016<br>Electricity Law, 2005 | Wind: Feed-in tariff (FIT) (2011), Financial Mechanism (2012), PD and SPPA (2012) (1)<br>Small hydro: avoided cost tariff (AVCT) (2008 and 2014) (1)<br>Biomass: FIT (2014), PD and SPPA (2015) (1)<br>Solar: Net metering and SPPA (2017)<br>RE collective mechanisms: tax exemptions, incentives and investments (1) | Fossil Fuel Subsidies (18)<br>Investors<br>Electricity Market Structure |

*Policies: includes related laws, mandates, regulations, strategies and policies.
Sources: collated from (1) (GIZ, 2016); (2) (SEforALL, 2017); (3) (World Bank, 2018c); (4) (Kim n.d.); (5) (APERC, 2017); (6) (World Bank, 2016); (7) (US AID, 2017); (8) (Lam, 2015); (9) (Bank, 2015); (10) (IEA, 2015); (11) (WRI, 2017); (12) (Vieweg et al., 2017); (13) (MOIT and DEA, 2017); (14) (APERC, 2016); (15) (News, 2017); (16) (GNESD n.d.); (17) (IRENA and ACE, 2016); (18) (VNNews, 2018).

## Abbreviations

| | |
|---|---|
| ACE | ASEAN Centre for Energy |
| APEC | Asia Pacific Energy Research Institute |
| ASEAN | Association of South East Asian Nations |
| BAU | Business as Usual |
| CDMs | Clean Development Mechanisms |
| DEA | Danish Energy Agency |
| EVN | Vietnam Electricity Corporation |
| FiT | Feed-in Tariff |
| GGAP | Green Growth Action Plan |
| GHG | Greenhouse Gas |
| IEA | International Energy Agency |
| IRENA | International Renewable Energy Agency |
| MCDA | Multi-Criteria Decision Analysis |
| MCDM | Multi-Criteria Decision Methods |
| MOIT | Ministry of Industry and Trade |
| MtCO2e | Metric tons of carbon dioxide equivalent |
| MW | Megawatt |
| NAMAs | Nationally Appropriate Mitigation Actions |
| NDC | National Determined Contribution |
| NEDS | National Energy Development Strategy |
| NPDP | VII National Power Development Plan Version 7 |
| PV | Photovoltaic |
| RE | Renewable Energy |
| REDS | Renewable Energy Development Strategy |
| SEA | South East Asia |
| SDGs | Sustainable Development Goals |
| SPPA | Standardized Power Purchase Agreement |
| TFEC | Total Final Energy Consumption |
| TPED | Total Primary Energy Demand |
| TPES | Total Primary Energy Supply |
| TWh | Terawatt hours |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VGGS | Vietnam Green Growth Strategy |

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