Energy transition to renewable energies

Opportunities for Australian cooperation with Vietnam

ENERGY TRANSITION HUB an Australian-German innovation partnership

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Summary/Key messages

Vietnam is at a turning point. It is one of the most vulnerable countries to climate change, it is undergoing fast economic growth, and it recently achieved universal electrification. Vietnam has a heightening need for energy from sustainable sources to implement its Paris Agreement commitment and achieve its Sustainable Development Goals (SDGs). Australia has world-class solar and wind energy resources that could be harnessed and exported to assist Vietnam. This could contribute to Vietnam achieving these goals through a transition away from fossil fuels and towards renewable energy.

This briefing paper assesses the opportunities for Vietnam to transition towards 100% renewable energy, and to overcome a series of challenges that the country faces. These include high energy demand, the need for energy security, and over-reliance on emissions intensive fossil fuels. Scenario analyses suggest that Vietnam could meet its Paris Agreement targets though achieving renewable energy and energy efficiency targets, but also transition to 100% renewable energy in the longer term. However, Vietnam's laws and policies require coordination and coherence to achieve the country's energy transition, particularly in moving away from coal-fired power generation and avoiding its future expansion.

Vietnam and Australia have developed a strong bilateral relationship; Australia has an opportunity to support Vietnam in transitioning to renewable energy.

- Australia can explore options to assist Vietnam in meeting its energy demands through technology upgrades in renewable energy and energy efficiency.
- There are also opportunities to harness and export Australia's renewable energy resources with green hydrogen as a fuel carrier, or through a high-voltage direct current (HVDC) transmissions line to Asia, and through energy intensive products, to help meet Vietnam's energy demand.

Contents

1. Introduction

Vietnam has experienced rapid economic and population growth over the past three decades, developing from one of the world's poorest countries to a lower middle-income country (Vietnam Government, 2016), and is one of the most energy-intensive economies in South East Asia (MOIT & DEA 2017). Energy infrastructure has been a government priority; 100% electricity access was achieved in 2016 (Word Bank, 2019). Increases in population and economic growth are placing mounting pressure on energy resources and heightening the need for a secure and sustainable energy supply. Vietnam's increasing energy demand has transformed the country from net exporter to net importer (MOIT & DEA 2017).

Vietnam's greenhouse gas emissions have increased more than 50% in the past decade (Vietnam Government, 2015a). Such an increase is attributed to rapid economic growth for the country, where most significantly, energy sources have shifted from traditional biofuels and hydropower to fossil fuels (MOIT & DEA 2017). Vietnam is highly vulnerable to climate change; is a member of the Climate Vulnerable Forum; and has shown commitment to renewable energy and the Paris Agreement.

Vietnam set an unconditional target to reduce greenhouse gas emissions[1] by 8% from business-as-usual (BAU), and a conditional target to reduce emissions by 25% from BAU, depending on international support (Vietnam Government, 2016). This target is based on a highly overinflated BAU and has been assessed as critically insufficient by the Climate Action Tracker (2019). The government is working on updating its targets (Climate Action Tracker, 2019). Vietnam has energy efficiency and renewable energy goals to complement this target. The country plans to reduce its total final energy consumption by 5-7% in 2025 compared to BAU levels, and by 8-10% in 2030 (Vietnam Government, 2018). The renewable energy targets for total primary energy consumption are 31% in 2020, 32.3% in 2030, 44% in 2050 (Vietnam Government, 2015b).

This briefing paper investigates the opportunities for Vietnam to transition to renewable energy, and in so doing so, to achieve its emissions targets and SDGs, including through

[1] This target excludes industrial processes emissions. Vietnam's emissions reduction targets have subtargets for reducing emissions intensity per GDP, and a 45% forest cover target. See the Nationally Determined Contribution for details (Vietnam Government, 2016)

cooperation with Australia. In this context, we assess Vietnam's energy mix, current and future energy demands, greenhouse gas emissions and renewable energy goals, investment requirements and current policy gaps and barriers.

2. Vietnam's energy system at crossroads: targets, investment needs, projections

Vietnam: an energy system dominated by fossil fuels

Vietnam's energy sector is responsible for half of the country's greenhouse gas emissions (Vieweg et al. 2017). The current energy fuel mix includes fossil fuel resources of coal, crude oil, natural gas and renewable resources of biomass and hydropower (MOIT & DEA 2017). In 2015, total primary energy supply and final demand equated to 70,588 and 54,080 kilotonne of oil equivalent (KTOE) respectively (MOIT & DEA, 2017). Commercial sectors are responsible for the majority share at 75.5%, leaving 24.5% for non-commercial sectors (MOIT & DEA 2017).

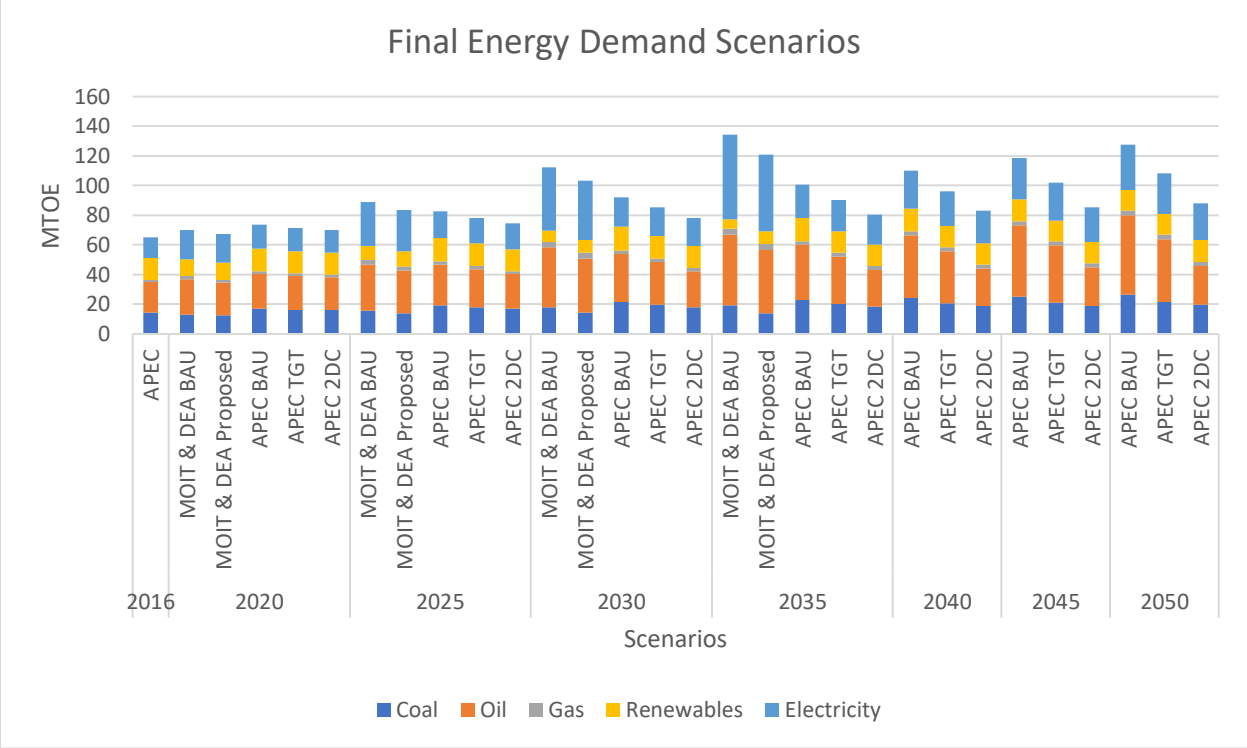

Figure 1: Current and projected scenarios of Vietnam's Final Energy Demand. Sources: MOIT & DEA (2017), and APEC (Asia Pacific Economic Cooperation) scenarios from: (APERC, 2019). See Table A1 in Annex for scenario assumption details. (MOIT= Vietnam's Ministry of Industry and Trade, DEA = Danish Energy Agency, BAU= Business as usual scenario, TGT = Target scenario,

2DC = 2 degrees celcius scenario).

Fossil fuels represent a large portion of the energy demand in all scenarios. The Asia Pacific Energy Research Centre (APERC) finds that renewable energy can create a greener economy at significantly lower investment expenditures, while reducing greenhouse gas emissions (APERC, 2019). The Ministry of Industry and Trade (MOIT) & Danish Energy Agency (DEA) (2017) study found that renewable energy and energy efficiency can reduce Vietnam's dependence on energy imports, and reduce environmental impacts.

The MOIT & DEA (2017) BAU scenario to 2035 projects the final energy demand to increase by 2.5 times from 2015 with an annual growth of 4.7% (see assumptions in Table A1, in the Annex) (MOIT & DEA 2017). 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 & DEA 2017).

Electricity demand is projected to increase by around 100,000 GWh every five years, from 2015 to 2035, an average of 8% annually (MOIT & DEA 2017). This is likely due to electrification accessibility for all, increasing energy access, growing population and technological and social advancements in Vietnam.

Historically Vietnam has been energy-autarkic. However with economic growth and increased energy demands Vietnam became a net importer by 2015, with a total of 5% of the energy demand (APERC 2016). The MOIT & DEA (2017) project that by 2035, 58.5% of energy demands will be imported, and IRENA (2018) supports a similar prediction of 30% self-sufficiency for the country by 2030. Imports of coal are mainly being channelled towards the rise in domestic demand for power generation and industrial sector needs (APERC 2016, IRENA 2018).

Vietnam is still one of the 20 countries with the largest deficit in access to cooking with clean energy (IBRD / World Bank 2018). However it is making progress, as the growth in access to clean cooking is accelerating at a higher rate than population growth in recent years via distribution of LPG and piped natural gas (IBRD / World Bank 2018). Access gains since 2010 have mainly been driven by nongovernmental organisations with some support from the government in the form of price stabilisation for LPG (IBRD / World Bank 2018).

Domestic coal resources are likely to be depleted within the next 70 years (MOIT & DEA 2017), mature oil field productions have declining outputs (IRENA 2018) and natural gas production is plateauing (ACE 2015). Substantial oil and gas reserves exist, with Vietnam identified as one of the top three ASEAN countries for oil, gas and coal reserves (IRENA 2018). However, technical challenges such as inter-sectoral cooperation and lack of investment in exploration prevent access to some reserves (APERC 2016, Vieweg 2017). Vietnam is investing in gas and coal power station infrastructure as dependence on imports is predicted to increase (ACE 2015, IRENA 2018).

Energy and climate governance, targets, and policies

The Vietnamese political system is led by one party that plays a large role in the governance of the energy sector. The national assembly produces framework legislation and the government provides guidance on legislation implementation (Vieweg 2017). Economic development is shifting the governance structure, allowing for international investment (Vieweg 2017).

Energy activities fall under the governance of the MOIT along with coordination and advisory services (APERC 2016, Vieweg 2017). Key advisory units that align with the MOIT are the General Directorate of Energy and the Energy Regulatory Authority of Vietnam (APERC 2017). MOIT established the Energy Efficiency and Conservation Office to support the National Energy Efficiency Programme and one of their responsibilities is Nationally Determined Contribution (NDC) progress (Vieweg 2017).

Climate change activities fall under the Ministry of Natural Resources and Environment supported by the Department of Meteorology, Hydrology and Climate Change. This institution includes an inter-ministerial working group for Nationally Appropriate Mitigation Options (NAMAs) and Clean Development Mechanisms (Vieweg 2017). Further federal influence and support are provided by individual ministries including the Ministry of Planning and Ministry of Finance (Vieweg 2017). Figure 2 shows the governance structure for the energy sector.

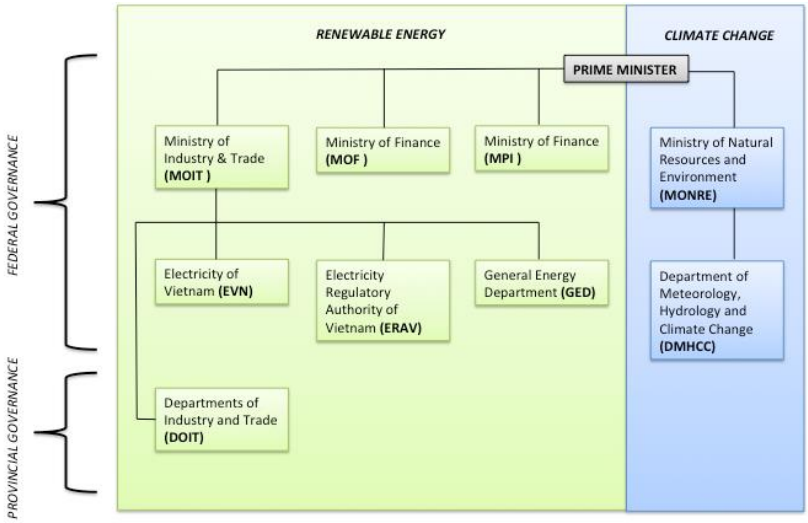

Figure 2: Outline of Vietnam's Governance Structure for Energy Sector and Climate Change - Source: Interpreted from Economic Research Institute for ASEAN and East Asia (2016) & Vieweg (2017)

Vietnam's energy policy repertoire includes targets for climate change, energy efficiency, electrification and renewables. Table 1 lists Vietnam's main policies in this space. Shem et al. (2019) provide a broader representation of Vietnam's targets, projections, related laws, policies and strategies, mechanisms and challenges. Tariffs are commonly applied to renewable technologies and projects, such as feed-in-tariffs (FITs). Incentives are offered that include reduced fees on land and import tax exemptions. Further financial support via state investment, favourable interest rates, regulations for permits and licensing are also current mechanisms used to support energy policy.

Vietnam's National Energy Efficiency Programme 2019-2030 (VNEEP3) includes the main objectives in Table 1, in addition to other targets specific to industrial sectors, the transport sector, energy labeling, and others (Vietnam Government, 2018).

The Renewable Energ Development Strategy (REDS) was approved in a decision by the Prime Minister in 2015. The Revised Power Development Plan 7 (PDP7) approved in 2016, was informed by REDS, however some of the targets are less ambitious. For example, REDS targets solar to represent 6% of total electricity generated in 2030, whereas the revised PDP7 targets solar to be 3.3% of electricity produced in 2030 (Vietnam Government, 2015b, 2017). Therefore the political commitment to the REDS targets is unclear.

The Revised PDP7 also shows that the government aims to increase coal based electricity produced and imported from over 49% in 2020 to over 53% in 2030 (Vietnam Governmnet

2017). Such a high proportion of coal power is completely at odds with the need to phase out coal for power generation by 2040 globally, including in Vietnam (Climate Analytics, 2019; Fuentes et al 2019).

Table 1: Vietnam's main policies and targets relating to renewable energy, energy efficiency and greenhouse gas emissions.

Category	**Policy and targets**	**Reference**
Efficiency	**Vietnam's National Energy Efficiency Programme 2019-2030 (VNEEP3):** - Reduce total final energy consumption by 5-7% in 2025 compared to BAU levels, and by 8-10% in 2030	(Vietnam Government, 2018)
Electrification	**Rural Electrification Programme:** -to electrify rural Vietnam	(World Bank, 2011)
Renewables	**Renewable Energy Development Strategy (REDS):** - increase renewable energy in the total primary energy consumption to 31% in 2020, 32.3% in 2030, 44% in 2050	(Vietnam Government, 2015b)
Greenhouse gas emissions	**NDC:** 8% below BAU by 2030 or 25% below BAU conditional on international support. (excluding industrial processes) **National Green Growth Strategy 2011-2020:** - reduce GHG emissions intensity by 8-10% below 2010 levels by 2020 - reduce energy consumption per unit of GDP by 1-1.5% per year - reduce GHG emissions from energy activities by 10-20% below BAU	(Vietnam Government, 2016) (VGGS, 2012)

Vietnam set NDC targets under the Paris Agreement (see Table 2). Scenario analyses have found that Vietnam can achieve its emission reductions targets through a variety of proposed scenarios (IRENA, 2016; MOIT & DEA, 2017, 2019). A recent analysis by the Climate Action Tracker (2019) finds that Vietnam is likely to achieve its target following its current policy trajectory as the targets allow for a steep incline in emissions. The Climate Action Tracker rates the current NDC pledge as 'critically insufficient,' and consistent with warming of over 4°C (rather than limiting warming to 1.5°C) above pre-industrial levels. Vietnam is in the process of revising these targets, with potential to raise ambition of both the targets and its current policy pathway (Climate Action Tracker, 2019).

Vietnam's Green Growth Strategy focuses on the 2011 to 2020 period (see Table 1). The strategy has also set Vietnam's "orientation" targets towards 2030 to reduce greenhouse gas emissions by 1.5-2% annually for 2030 and 2050, and reduce emissions from energy activity by 20-30% compared to BAU by 2030 (VGGS, 2012).

Vietnam is renowned for achieving 100% access to electricity for its population[2] (World Bank, 2017). Vietnam's success with electrification for its population so far can be attributed to government direction, policy implementation, coordination of the EVN (Vietnam's largest power company) and international organisation support (VBS 2017). Further the National Rural Electrification Programme was integrated with broader development goals, such as alleviating poverty heightening electrifications importance (Tongsopit Sopitsuda 2016). Vietnam's governance and policies indicate a willingness to learn and change course where necessary to meet its electrification goals (World Bank, 2017).

Investments, trade and international relations

As Vietnam's dependence on imports is increasing it is investing in gas and coal power infrastructure to utilise these new imports (ACE 2015, IRENA 2018) and has become one of the few remaining growth markets for coal exporters (Burton 2018). Australia hopes to capitalise on fossil fuel exports to Vietnam, despite the stated support for the goals of the Paris Agreement and the need to phase out coal (Burton 2018, IPCC, 2018). According to Fuentes et al. (2019), if all coal expansion plans were to go ahead, the commited emissions would peak by 2040, locking Vietnam into a carbon intensive energy system, incompatible with the Paris Agreement.

Considering renewable energy, IRENA (2018) indicates that between 2006 and 2015 Vietnam invested varying amounts for renewable energy into the power sector, ranging from 5 to 40%. However in 2016 no investments were made, 'driven by a decrease in financing for small scale hydropower and bioenergy sectors' (IRENA 2018).

The MOIT and DEA (2019) modelled five scenarios finding that cost effective CO_2 reductions with energy efficiency and renewable energy would require the cessation of investments in new coal power plants, with investments needed in the transmission grid and electricity storage capacity. The study finds that energy efficiency policy could be more ambitious than the current VNEEP3 as investments in energy efficiency outweigh the costs (MOIT & DEA 2019). Investing in energy efficiency would equate to savings ranging from

[2] There are still a few remote rural mountanous locations without access (APERC 2019).

3 billion USD in 2030 and 30 billion USD by 2050, as the costs of fuel and supply sector investments would be reduced (MOIT & DEA 2019). The MOIT & DEA (2019) find that wind and solar will be cost effective compared to coal by 2030, with the least cost power mix building up from 1GW/year of wind power and 1-2GW/year for solar between 2020 and 2030.

APERC (2019) models three scenarios: the BAU scenario follows Vietnam's current policies, a "target" (TGT) scenario follows APEC goals, and a "two degrees celcius" (2DC) scenario models a low carbon energy system (see Figure 1, and Table A1 in the annex for scenario details). From the three scenarios, investments are lowest in the 2DC scenario as there is a lower fuel expenditure, and the 2DC scenario investment needs are valued at 1,363 billion USD, which is 87% of the TGT scenario requirements and 82% of the BAU scenario needs.

The Teske et al. (2019) study found that the most ambitious modelled pathway of renewable energy was the most cost effective model. Renewable energy requires significant investment, but reducing the investment in coal power saves costs (Teske et al 2019). Overall, the cost savings create a cost benefit of more than 6.5 billion USD from 2020 to 2030 in one scenario (Teske et al 2019). Renewables will be more cost effective than fossil fuel alternatives due to the decline in costs of solar and wind and advances in storage technology (Teske et al 2019). In addition, construction times for solar PV and wind are less than gas or coal powered plants (Teske et al 2019). Teske et al (2019) find that the cost of onshore wind will be cheaper than coal within five years. Similar to the MOIT & DEA (2019) study, Teske et al. (2019) find that by 2030 utility scale solar PV and onshore and offshore wind will be cheaper than coal generation in Vietnam.

Breu et al. (2019) found that with the decline in costs of solar photovoltaics and wind energy, renewable energy reached the tipping point of being cheaper than traditional generation sources in 2017. The study found a renewable-led pathway outperforms the current Revised PDP7 in cost, energy security, and reduces greenhouse gas emissions (Breu et al. 2019). However, the current power-purchase agreement for renewables is too risky for investors due to curtailment risks, lack of government guarantees, political issues, dispute resolution issues, and tariffs (Breu et al. 2019). The high risks make renewables unbankable and limits foreign direct investment (Breu et al. 2019).

3. Renewable energy potential benefits for sustainable development

Beyond the energy sector investment savings that are possible, renewable energy and energy efficiency can assist Vietnam in meeting the SDGs. Vietnam has abundant solar and wind resources. Vietnam has large untapped renewable energy potential, in particular solar and wind. Covering 1.5% of Vietnam's land area with optimally oriented PV panels could generate seven times as much electricity as is currently consumed (Fuentes et al 2019). The coastal regions of Vietnam offer good wind potential. Despite this, wind and solar together accounted for less than 1% of electricity generation in 2016 (Fuentes et al 2019).

Potential utility scale solar is 48 GW for land in a 10km radius of the existing power grid, which is equivalent to the country's current power capacity (Teske et al. 2019). A conservative estimate for onshore wind power potential is 40 GW, with an additional large technical potential for offshore wind of 609 GW along a 3000 km coastline (Teske et al. 2019).

Teske et al (2019) conducted a study on modelling renewable energy scenarios for Vietnam. The scenarios are developed with the aim of reducing the use of coal, oil and gas as fast as technically and economically possible, including accelerating the replacement of oil-based combustion engines in the transport sector (Teske et al 2019). In a Renewable Energy 1 (RE1) scenario, renewables represent a 16% primary energy share in 2030 and 43% in 2050. In a Renewable Energy 2 (RE2) scenario, renewables will represent 84% of the primary energy share in 2050 (Teske et al 2019).

In both the scenarios, fossil fuels are phased out of electricity production after 2030 (Teske et al., 2019). The RE1 scenario models a 38% renewables share of electricity production by 2030, reaching 75% by 2050, of which wind and solar account for 19% and 58% respectively (Teske et al., 2019). In the RE 2 scenario, renewables represent a 50% share of electricity generation in 2030, and nearly 90% in 2050 (Teske et al., 2019), with offshore wind forming the backbone of the renewable energy capacity, almost in line with the benchmarks for a Paris Agreement consistent scenario for the ASEAN region (Fuentes et al 2019) of fully decarbonised electricity generation by 2050 and 50% decarbonised by 2030.

Importantly, while the more ambitious RE2 scenario requires significantly greater investment in renewables, the overall cost savings in fuel and reduced investments in coal entail a cost benefit of over 6.5 billion USD between 2020 and 2030, making the RE2 pathway the most economic pathway. Gas does not exceed a capacity of 15 GW in this scenario, highlighting the risk of stranded assets when investing in gas rather than in renewable energy to replace coal. Other regional modelling studies show that a faster decarbonisation is possible, with an increase of renewable electricity to up to 100% by 2050, and energy efficiency and sector coupling allowing for the overall system transformation and decarbonisation necessary for progress towards meeting the long-term temperature goal of the Paris Agreement (Fuentes et al 2019).

Benefits of a transition to renewable energy

Renewable energy has multiple implications for meeting the SDGs. For example, SDG 7 relates to clean and affordable energy. Transitioning to renewables will move Vietnam from a fossil fuel dominated economy to sources of clean energy. High energy demand has resulted in net energy imports, which reduces energy security. As much as 3.8% of Vietnam's GDP is spent on fuel imports, equating to around 7.7 billion USD (Fuentes et al 2019). Renewable energy offers a solution to combat energy import reliance. It also removes public expenditure of energy imports freeing up the finance for other investments (Fuentes et al 2019).

The unreliability of electricity is a concern in Vietnam. A total of 26% of businesses reported power outages in 2015, costing 2.2% of sales (Fuentes et al 2019). Well managed renewable energy paired with battery storage can ensure a reliable power supply (Teske et al. 2019). Renewables are also not dependent on fossil fuel price variations creating security.

SDG 3 focuses on health and wellbeing. Renewable energy can help improve access to modern energy, particularly for remote locations. Transitioning to clean cooking fuels reduces exposure to indoor air pollution (Fuentes et al 2019). The World Health Organisation estimated that over 60,000 deaths were linked to air pollution in Vietnam in 2016, and transitioning from fossil fuels to renewables would reduce emissions and their impacts on health (Breu et al. 2019).

4. Policy gaps and barriers

The mounting pressure for a secure energy supply has to a large extent been met with fossil fuels rather than renewables. Vietnam faces a number of policy gaps and barriers preventing the uptake of renewables:

- The installations of energy projects are not balanced with demand in the different regions causing pressure on the transmission system, which can be resolved with solar and battery technology, investment in transmission systems and pumped hydro storage (MOIT & DEA 2019).
- The low price of coal and electricity, resulting from indirect subsidies for natural gas and coal, hinders the transition to renewables and energy efficiency (Vieweg 2017).
- Utility-scale renewable energy projects entail large upfront investments yet banks and investors are unwilling to invest (MOIT & DEA 2019, Vieweg 2017, Breu et al, 2019).
- State-owned enterprises manage the energy sector, making it difficult for the private market to compete in the sector (Vieweg 2017).
- It is difficult to determine the level of implementation or success of policies. For instance, Vietnam's Green Growth Strategy aims to '…contribute to the implementation of the national climate change strategy…' and to '…establish and complete frameworks to effectively implement laws, including law on environment…' (VGGS, 2012) but the current status of these objectives is unclear.
- Despite many policy mechanisms existing and much desire for increased renewable energy, energy efficiency, and climate change mitigation there are varying targets, and minimal interplay between the targets. A recent study (Urban, Siciliano, Wallbott, Lederer, & Nguyen, 2018) found green growth, sustainable development, and climate change strategies compete. There is a lack of coordination between policies and experts and the need for a framework for investment. There is also a lack of an ambitious renewables roadmap and financial restrictions. Policy alignment, interplay and cooperation are crucial for progression.

5. Options for collaboration between Australia and Vietnam

Vietnam benefits from an array of donors supporting energy and climate change initiatives. According to the now expired Australia – Vietnam Climate Change Delivery Strategy 2011-2016, Australia has a range of institutions that work on climate change activities in cooperation with Vietnam (AusAID, 2011). Vietnam and Australia have built strong and substantive relations. In 2018, to mark its 45th anniversary of diplomatic partnership, Vietnam and Australia committed to deepening ties signing a strategic partnership (DFAT, 2018a). Both countries are committed to continuing to work together to address regional and global emerging issues, in the areas of energy security, sustainable development, environmental protection and management, responses to climate change and resilience to natural disasters consistent with the implementation of the 2030 Agenda for Sustainable Development.

The Australian Department of Foreign Affairs and Trade (DFAT) finds that Vietnam's rapid economic growth and demand for imports offers opportunities for Australian energy exporters (DFAT 2019b). DFAT and Australian Aid have provided 2.465 million AUD to assist the Vietnam Energy Efficiency Standards and Labelling Program (EnergyRating, 2015).

Documents released under the *Freedom of Information Act* to the Australian Conservation Foundation revealed the Australian Prime Minister Scott Morrison and the Department of Industry, Innovation and Science focused on coal in recent talks with Vietnam (ACF 2019). There is no evidence of any specific collaboration on renewable energy and therefore, there is a scope to provide support in renewable energy areas.

Other governments have offered "greener" support to Vietnam and its energy sector. The German development cooperation agency GIZ and Vietnam's MOIT have partnered to develop the MOIT/GIZ Energy Support Program. The program has many completed and ongoing projects in wind energy (2009-2012), bioenergy (2012-2015), upscaling wind power (2014-2018), Project Development Programme (2015-2020), Renewable and Energy Efficiency (2015-2020), Smart Grids for Renewable Energy and Energy Efficiency (SGREEE) (2017-2021) and Climate Protection through Sustainable Bioenergy Markets in Viet Nam (BEM) (2019 – 2023) (GIZ Energy 2019).

EU's Energy Sector Support Programme has provided funding for launching a a technical assistance facility that has a budget of 108 million Euros (EEAS 2018). The programme is cofinanced by the EU and German Government and operated by GIZ in cooperation with Vietnam's MOIT. The programme promotes efficient clean renewable energy.

Other governments such as Denmark have energy ties with Vietnam. The Danish Energy Partnership Programme 2017-2020 aims to assist a number of countries including Vietnam with an energy transition, in keeping with the Paris Agreement (MOFAD 2017).

Supportive renewable energy assistance from others serve as examples for how Australia and Vietnam can benefit from cooperation. There are mutually beneficial opportunities in Australia exporting energy to Vietnam. Although Australia has flagged an intention to capitalise on coal exports to Vietnam (Burton 2018, ACF 2019), Australia is well placed, through its vast experience in research, energy efficiency, and renewable energy projects, to provide support for Vietnam to meet its Paris Agreement pledges. This type of support could include:

- Support for studies into renewable energy expansion between Australia and Vietnam to highlight the benefits of such a partnership: Vietnam's surging energy demand can be met with renewable energy sources, with support from Australia. Studies could model the potential long-term transition to 100% renewable energy across all sectors for the mid-century, with intermediate plans, technology and policy roadmaps.
- Support for energy efficiency projects to manage energy demand and through technology upgrades: As an energy intensive country, Australia is well placed to assist Vietnam in this.
- Collaboration on removing policy barriers, exchanging policy development, and working with industry to attract investment in renewable energy: This is particularly the case as studies have found that renewable energy and energy efficiency pathways are a more cost effective option (MOIT & DEA 2019; APERC 2019, Teske et al. 2019).
- Regional cooperation and collaboration on phasing out coal, ensuring a just transition: Studies have found that from the 2030s coal powered generation will not be price competitive compared to renewables in Vietnam (MOIT & DEA 2019, Teske et al. 2019). The Breu et al (2019) study found that renewable energy is already the cheapest form of new power generation. Support or plans for further coal powered generation will likely result in expensive stranded assets. Vietnam's PDP8 will need to phase out

coal and accelerate renewable energy plans to avoid this expense, and transition to renewables.

- Regional cooperation exploring options from renewable energy power based fuels: Options might include offshore wind, green hydrogen, HVDC transmission lines from Australia to the South East Asian neighbours and trade in energy intensive goods such as metals or synthetic fuels using renewables (Fuentes et al. 2018, Burdon 2019). Mella et al. (2017) evaluated the potential to export Pilbara (Western Australia) solar resources to the proposed ASEAN grid via a subsea HVDC interconnector. More recent considerations have focused on exporting green hydrogen from the Pilbara (Asian Renewable Energy Hub 2019). While this project focuses on Japan and South Korea as importers, Vietnam could be an option in the longer term.
- Collaboration on further research exploring opportunities for green hydrogen export to Vietnam: This could help to meet Vietnam's high energy demand, in particular for the industry and transport sectors, consistent with the Paris Agreement and SDGs. Teske et al (2019) note that full decarbonisation of Vietnam's sectors is a possibility with increased imports of renewable electricity and renewably produced synthetic fuels and hydrogen. Australia has recently developed a National Hydrogen Strategy (COAG Energy Council, 2019). Yet the strategy is at risk of propping up the fossil fuel industry, incompatible with the Paris Agreement (Mazengarb, 2019). Studies into green hydrogen exports to Vietnam would help ensure this "technology neutral" strategy benefits from green hydrogen exports.
- Regional cooperation on updating both Australia and Vietnam's NDC pledge for 2020 and developing long term strategies towards net-zero emissions and 100% renewable energy: Both countries have ratified the Paris Agreement and developed NDCs. As part of the Paris Agreement, countries agreed to communicate an updated NDC every five years and the first update is due in 2020. Vietnam is currently revising its NDC (MOIT & DEA 2019). The research suggested above could inform the next level of ambition for both countries.

6. Conclusion

As one of the leading ASEAN countries for renewable energy policy, Vietnam could be an example of an ASEAN country transitioning to zero emissions and renewable energy in the long term, in cooperation with Australia. Scenario analyses indicate that Vietnam will meet and overachieve its current insufficient NDC targets under current policies. Vietnam has vast potential to improve both its targets, and current policy trajectory. The next Power Development Plan (PDP8) and the planned update of the NDC are important opportunities for aligning with a pathway towards a sustainable energy future, including through revising the Renewable Energy Development Strategy and targets. Scenario analysis shows the potential to aim for 50% renewable energy by 2030 and near full decarbonisation by 2050.

Vietnam needs to coordinate its laws, policies and targets in renewable energy, energy efficiency and climate policy to streamline the country's direction. The success of the government's determination and effective policy direction in electrifying the majority of the country is testament to what the country can achieve in increasing its policy ambition.

Building on the strong partnership between Vietnam and Australia, and in line with the 2030 Agenda for Sustainable Development and the Paris Agreement, Australia can support Vietnam in transitioning to renewables through exploring:

- Opportunities for meeting Vietnam's energy demand with technology, infrastructure, and policy upgrades in renewable energy and energy efficiency.
- Opportunities to harvest the world-class renewable energy of Australia, particularly its solar and wind resources, and export green energy through hydrogen as a carrier, through an HVDC transmission line to South East Asia, and through energy intensive goods to help meet Vietnam's energy demands.

7. Annex

Table A1. Assumptions for scenarios in Figure 1.

MOIT & DEA (2017)

- BAU Scenario:
  The BAU scenario follows a 'baseline' economic growth and follows IMF forecasts. It assumes GDP will increase, estimated at VND 2,879 billion in 2010, and VND 2879 billion in 2015, to VND 8375 billion in 2030. GDP growth from 2016 to 2020 is assumed to be 6.7%; from 2021 to 2025 8.2%; and 2026 to 2030 7.2%.

- Proposed Scenario
  The proposed scenario adjusts the energy demand, reflecting an assessment of energy savings in economic sectors and based on reducing CO_2 emissions in the final energy demand. The scenario assumes a CO_2 reduction of 5% in 2020, and 15% in 2030 based on the BAU scenario. This reflects a cumulative total of 956 million tons of CO_2 ($MtCO_2$).

APEC (APERC 2019)

- Historical data for year 2016: Data to provide context to projections.

- BAU scenario
  The BAU scenario follows current policies and trends. It assumes building energy use from appliances, and electricity reflect economic growth and urbanisation. Industry is dominated by steel, iron and cement. In the transport sector it assumes energy eleasticisity is linked to GDP and vehicle stock rises. It assumes no biodiesel. For the energy supply mix, coal and natural gas follow sectoral plans. The electricity mix is based on the revised PDP7. The planned LNG terminals proceed. Oil production follows historical data and avaliable reserves. Renewable energy is mainly inefficient biomass. Energy is imported when domestic supply does not meet demand.

- TGT Scenario
  The TGT (or Target) scenario is modelled in line with APEC's goals to reduce energy intensity by 45% by 2035 from 2005 levels and double the renewables share in the energy mix by 2030 from 2010 levels. Compared to the BAU scenario, the final energy demand is 10% less and CO_2 emissions are 7% less in the TGT scenario. TPES is 4.4% higher in the TGT scenario compared to BAU.

- 2DC Scenario

  The 2DC (or 2 Degrees) scenario aims to increase renewable energy to reduce energy intensity and CO_2 emissions, sufficient to provide a 50% chance of limiting the average global temperature warming to 2 degrees by 2050. Compared to the BAU scenario, the final energy demand is 19% less and CO_2 is 38% less in the 2DC scenario. TPES is 20% higher in 2DC compared to BAU.

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