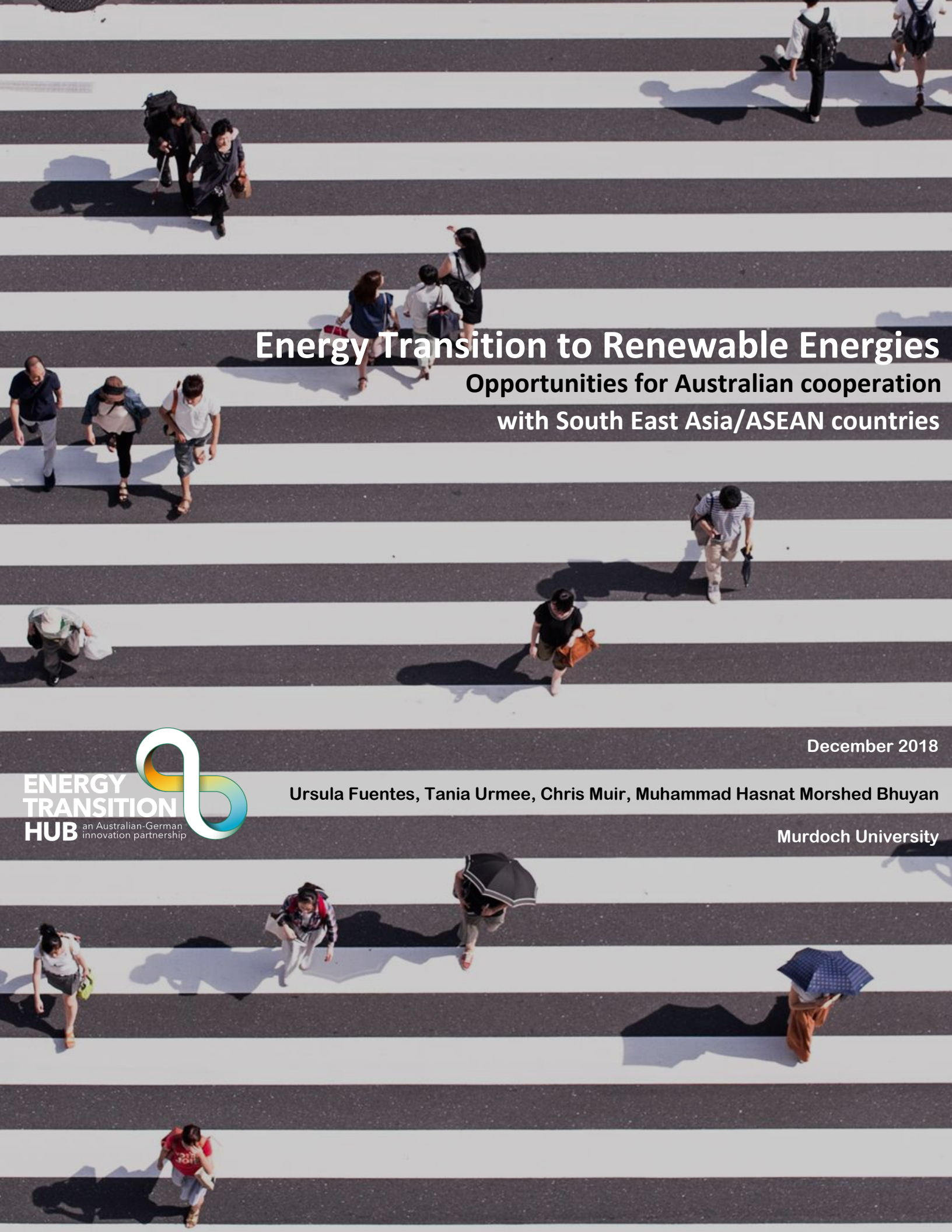

Energy Transition to Renewable Energies

Opportunities for Australian cooperation with South East Asia/ASEAN countries

ENERGY TRANSITION HUB
an Australian-German innovation partnership

December 2018

Ursula Fuentes, Tania Urmee, Chris Muir, Muhammad Hasnat Morshed Bhuyan

Murdoch University

The global shift to a net-zero emissions economy presents genuine opportunities for Australia and Germany

About the Australian-German Energy Transition Hub

The Energy Transition Hub is a collaborative venture supported by the Australian Department of Foreign Affairs of Trade and the German Federal Ministry of Education and Research. It brings together researchers, industry experts, government, and communities to address energy transition challenges across a range of disciplines. Core partners are the University of Melbourne, the Australian National University, Potsdam Institute for Climate Impact Research, Münster University's Centre of Applied Economic Research, and the Mercator Research Institute of Global Commons and Climate Change.

The Hub's research aligns with four themes and includes such focii as reform to energy markets; regulation and policy to support low-carbon energy investment; technical aspects of the transition to a renewables-intensive electricity supply; roadmaps to effective and sustainable deployment of negative emissions technologies; and creating new industry trade and export opportunities. It aims to maximize economic and geopolitical opportunities for Australia and for Germany through research and academic-public sector-industry collaboration. The Hub will bring together more than 60 Australian and German researchers with industry partners and government bodies.

If you are interested in becoming a partner of the Hub, please contact us (Rebecca.burdon@unimelb.edu.au). We welcome industry, government and civil society partners in exploring the energy transition and its opportunities, incorporating technical, economic, policy and social dimensions.

Imprint

Date: November 2018
Version: Final
Author and Contact: Ursula Fuentes Hutfilter; ursula.fuentes@murdoch.edu.au
Murdoch University
Title page design: Steven Tan

Murdoch
UNIVERSITY

Summary/Key Messages

Countries in the South East Asia (SEA) region are at a crossroads regarding their energy supply systems, to keep pace with economic growth and at the same time implement the Paris Agreement (PA) as well as achieving their Sustainable Development Goals (SDG).

Currently, only a small fraction of the existing renewable energy potential is being used in the region, despite the large benefits for sustainable development that can be expected from tapping this large potential. Current projections show a high growth in energy demand, and a continuation of reliance on fossil fuels, at odds with the climate and sustainable development goals for a region that is highly vulnerable to the impacts of climate change. A significant fraction of projected global coal capacity growth in the next 10 to 15 years could occur in this region, in particular Indonesia, Vietnam, and the Philippines – threatening the achievement of the Paris Agreement temperature goal of limiting global warming to 1.5˚C.

This briefing paper looks at opportunities for the SEA countries to embark on a transition towards zero emissions based on renewable energy, including through cooperation in the region itself, as well as cooperation opportunities between Australia and SEA countries.

The analysis in this briefing paper highlights the following opportunities for collaboration between Australia and South-East Asia to enhance investment in renewable energy in South-East Asia:

- Large untapped potentials for expanding renewable energy investments in South-East Asia exist and need to be made available at a scale and speed needed to implement the Paris Agreement and achieve sustainable development goals (SDGs) in the region.

- There are mostly untapped opportunities for strengthening and focusing cooperation between Australia and the ASEAN countries in the area of renewable energy, both building on existing close cooperation in other areas, as well as exploiting unique ASEAN renewable energy potentials, and Australian experiences and skills. This can also build on existing infrastructure and experience in Australia for renewable energy and storage technologies, microgrid and other experience of deploying renewable energy in remote regions.

- There is an opportunity to link such a strengthened cooperation to opportunities for transformation of the Australian energy system and transitioning from a fossil fuel to a renewable energy exporting energy super power and a regional leader, through exploration of areas of cooperation and trade, as well as exports of green (renewable energy based) electricity or hydrogen from Australia to ASEAN countries.

- To support this collaboration, in-depth quantitative analysis is needed to develop energy system scenarios analyzing how energy systems in the ASEAN and wider ASIA Pacific region can be decarbonised while addressing the need for access to modern energy services, building on renewable energy and storage technologies as well as cooperation and connection of energy systems and markets.

- Such research and scenario analysis should be developed jointly with institutions and stakeholders in the region and can contribute to enhancing contributions to the Paris Agreement, through development of long-term strategies as well as enhanced nationally determined contributions (NDC) which are both due by 2020.

Contents

1. Introduction

Countries in the South East Asia (SEA) region are developing very dynamically, with high economic and population growth and corresponding growth in energy demand and, in particular, electricity consumption. Countries in this region are at a crossroads regarding their energy supply systems, to keep pace with economic growth and at the same time implement the Paris Agreement (PA) and achieve Sustainable Development Goals (SDG), with some countries in the region still working towards achieving universal access to electricity and clean cooking fuels.

Currently, only a small fraction of the existing renewable energy potential is being used in the region, with progress in renewable energy deployment being very diverse across each country. Current projections show a high growth in energy demand, and a continuation of reliance on fossil fuels, at odds with the climate and sustainable development goals for a region that is highly vulnerable to the impacts of climate change. A significant fraction of projected global coal capacity growth in the next 10 to 15 years could occur in this region, in particular Indonesia, Vietnam, and the Philippines – threatening the achievement of the Paris Agreement temperature goal of limiting global warming to 1.5dC.

This briefing paper looks at opportunities for the SEA countries to embark on a transition towards zero emissions based on renewable energy, including through cooperation in the region, as well as cooperation opportunities between Australia and SEA. We analyse where the region stands regarding current and future energy demands, climate and sustainable development goals, highlighting current and planned policies to achieve these and outlining potentials and benefits of a pathway towards zero emissions in particular in the context of cooperation opportunities.

2. SEA energy systems at crossroads: Targets, investment needs, projections

Renewable energy: Targets and, investment needs

Most ASEAN countries have adopted targets (see Annex) and are implementing policies to increase the adoption of renewable energy, with a focus on power generation. There is a strong correlation between policy implementation (for example feed-in tariffs) and investment increase in renewable energy, with investments already increasing substantially due to increasing number of policies. However, IRENA estimates that investment in renewable energy would have to be significantly scaled up from about 3 million USD annually at present to 27 billion USD annually (IRENA 2018) to achieve the regional objectives.

Eight out of the ten ASEAN member states have adopted, in their Nationally Determined Contributions (NDC) to the Paris Agreement, quantitative targets to reduce greenhouse gas emissions compared to a business-as-usual (BAU) path. Each of the ten ASEAN member states have set targets for energy efficiency (EE), renewable energy (RE), and, in some cases, electrification targets.

For some countries renewable energy and energy efficiency targets are stated as part of their NDC contributions, whereas for others, they existed previously in national plans, or have been formulated in more recent government policies (see Annex).

ASEAN member states have in addition jointly agreed a target to increase the share of modern, sustainable renewable energy to 23% (excluding traditional biomass) of total primary energy mix and reducing energy intensity by 30% by 2025 through the ASEAN Plan of Action of Energy Cooperation (ACE 2015b).

Two of the ASEAN countries, the Philippines and Vietnam, have an aspirational goal of supplying 100% of its power with renewable energy, as part of a commitment by the Climate Vulnerable Forum countries (Climate Vulnerable Forum 2016).

Based on projections by IRENA (2016) and ACE (2017b) the achievement of the regional targets for renewable energy and energy efficiency needs more policies and efforts than the achievement of individual member states targets. According to the IRENA (2016) and ACE (2017b), current national policies so far would only lead to a share of less than 15% in 2025, and achieving national targets would lead to a share of 17% in 2025, compared to less than 10% in 2014, leaving a gap of 6 percentage points to the regional target (23%).

Energy demand growing fast

Southeast Asia is one of the most rapidly growing regions of the world. According to the Alliance of South East Asian Nations (ASEAN) Centre for Energy, the region has exhibited a sustained annual average real GDP growth rate of 5.3% from 2017-2015 and is expected to exhibit a GDP growth at an annual rate of 4.5% until 2040. Together with population growth and urbanisation, this has led to energy demand increasing from 381 Mtoe in 2010 to 442 Mtoe in 2015 (ESCAP 2017). Under a range of projections reflecting existing policies and targets (ACE 2017a, IEA 2017b) energy demand in the region is expected to grow by a factor of 1.4 to 2.3 by 2040, with the highest projection for a BAU scenario and the lowest for a scenario implementing existing regional targets for renewable energy and energy efficiency and Sustainable Development Goals (SDG) (ACE 2017a, IEA 2017a, ACE 2017b, IEA 2017b). (see Figure 1)

The different scenarios considered in this paper have been taken from projections of ACE, IEA and IRENA projecting until 2040 (ACE, IEA) and 2030 (IRENA). These scenarios in their key assumptions regarding implementation of policies:

- ACE Scenarios: The 5th ASEAN Energy Outlook 2015-2040(ACE 2017b)has outlined three scenarios which are:
    - Business-as-usual (BAU): ACE assumed that there is no significant policy change and no drive for achieving the renewable energy (RE) or energy efficiency (EE) targets by the ASEAN member states.
    - ASEAN "MS Targets Scenario" (ATS): This scenario assumes that the ASEAN member states will reach their individual (country level) RE and EE targets.
    - ASEAN "Progressive Scenario" (APS): This target-based scenario assumed that, the regional Renewable Energy and Energy Efficiency objective agreed by ASEAN will be achieved. Each ASEAN member state needs to be more ambitious than the ATS scenario in terms of RE and EE diffusion in the energy system. It builds on the IRENA REMap Scenario.
- IEA Scenarios: In its special report on Southeast Asia Energy Outlook (IEA 2017a) IEA has developed the following three scenarios based on existing and proposed policies:
    - Current Policies Scenario (CPS): In this scenario, only the current policies and measures that were implemented by mid-2017 are taken into account.
    - New Policies Scenario (NPS): Based on the central scenario in the IEA World Energy Outlook, it shows the future energy sector with existing government policies and new policies by the member states in line with the NDC targets.
    - Sustainable Development Scenario (SDS): This scenario is assumed to be in line with the Paris Agreement as well as the achievement of SDG7 through universal access to energy by 2030 and reduced energy related air pollution. However, analysis of the scenario shows it is not really consistent with the Paris Agreement (Climate Analytics, forthcoming).
- IRENA Scenarios (IRENA REMap 2016): The renewable energy outlook for ASEAN (IRENA 2016) includes two scenarios based on renewable energy deployment in energy system:
    - Reference Case: IRENA developed this scenario based on planned policies and market development in technologies considering the Renewable Energy targets of individual member country. This scenario is based on energy demand forecast of individual member states and resembles the AMS scenario of the earlier ACE ASEAN Energy Outlook (AEO4).
    - REMap: The REMap scenario includes the measures and policies to bridge the gap between the ASEAN regional RE target of 23% and the 17% share in the Reference Case in 2025.

Energy mix dominated by fossil fuels

At present, the energy mix in the region is dominated by fossil fuels, with the present share of 75% increasing to 80% in a scenario without any additional policies (BAU) (ACE 2017a, ACE 2017b) and similarly in the Current Policy Scenario (IEA). Only in the most ambitious scenario (IEA SDS) does the fossil fuel share not increase by 2040, with the share of renewable energy (without hydro) increasing from 14% in 2015 to 30%.

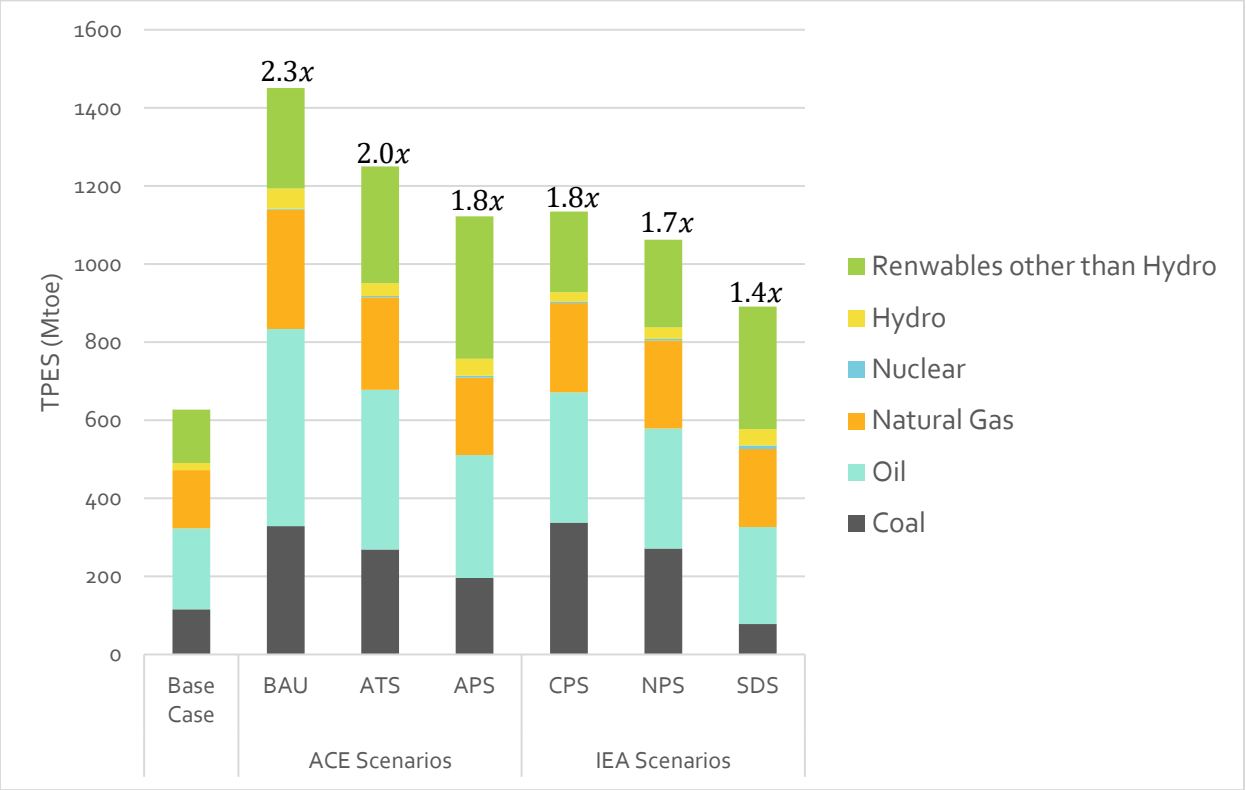

Figure 1 - Current (2015) and Projected (2040) Total Primary Energy Supply (TPES) by Sources for Base case, ACE and IEA scenarios. Supply increases between 1.4 and 2.3, depending on the scenario. Source: (IEA 2017a, ACE 2017b)

Costs of current pathway: Decreasing energy security, increasing import dependency, increasing air pollution

Energy security is an important objective across the SEA region. With increased energy demand though economic and population growth, ASEAN energy security has already decreased between 2005-2010, with declining fossil fuels reserves, slow rates of alternative

energy adoption (Tongsopit Sopitsuda (2016)), and even more severe droughts impacting generation capacity in fossil fuel plants and hydro energy which provides the majority of existing power (Shadman F 2016).

Current policies will exacerbate this trend, and, in addition, lead to curtailed economic growth and a high increase in costs due to increased air pollution (IRENA 2016).

Even though some of the SEA countries are major fossil fuel producers, most of the countries in the region are currently relying on import of fuels, mostly oil. Singapore, Thailand and the Philippines are the most energy import dependent countries in the region, with other countries, in particular Indonesia being major producers (and exporters) of fossil fuels (Figure 2).

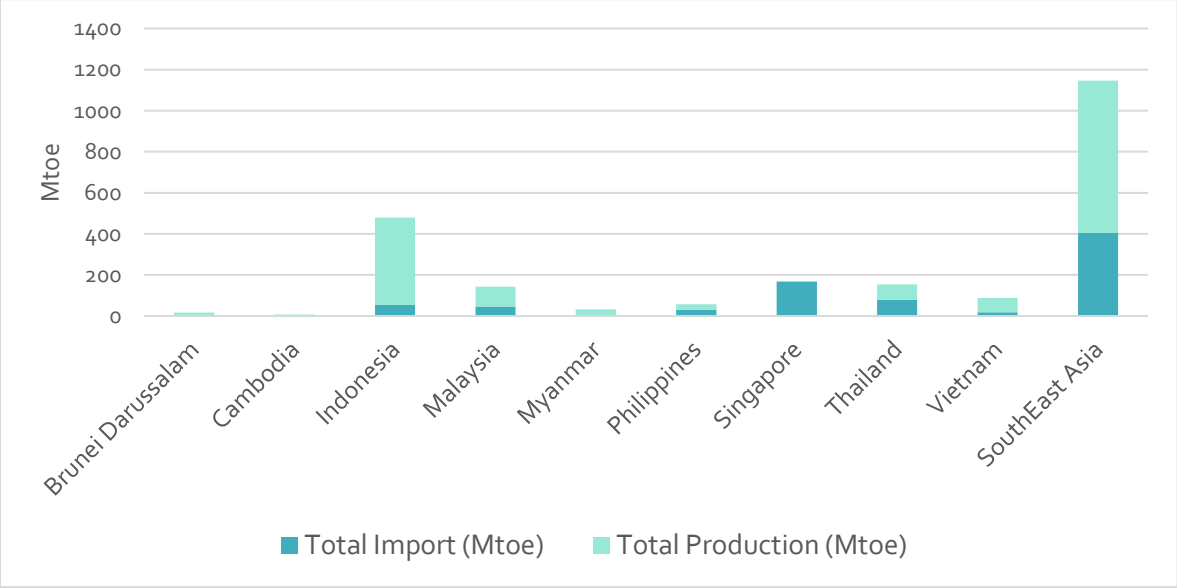

Figure 2 - Total Import and Production in Total Primary Energy Supply of ASEAN and Its Member States in 2015 (IEA 2018).

With increasing demand, the import dependency is projected to increase in the region under current policies, with the region as a whole moving from a net exporting to a net importing region for all fossil fuels for all fossil fuels (IEA, NPS Scenario)(IEA 2017a) (Figure 3) with oil import needs increasing, and the region shifting from becoming a net exporter of coal and gas to becoming a net importer of gas by around 2025, and coal production not exceeding demand in the region by 2040.

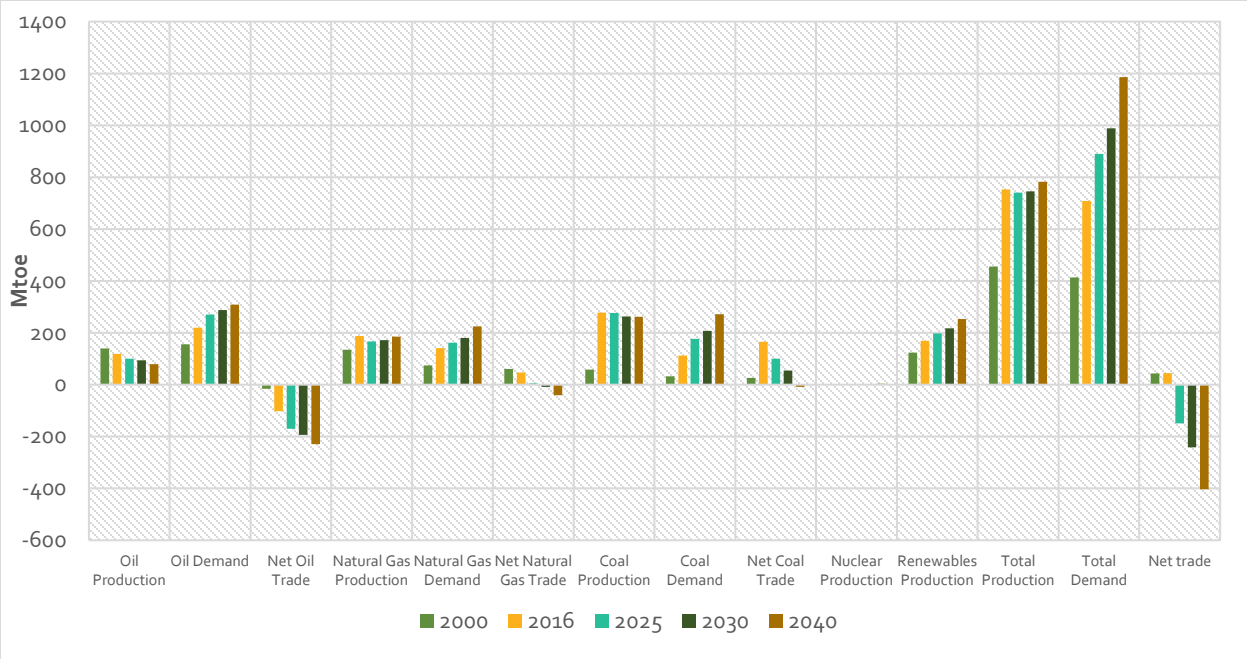

Figure 3 - Net Trade (Export/Import) Projection by Energy sources in IEA New Policies Scenario (IEA 2017a)

Electricity demand growing even faster – power developments not in line with targets:

Demand for electricity is increasing at rates well above the world average (IEA 2017a) and is expected to increase faster than overall energy demand, (Figure 4) with some countries still having to achieve universal access to electricity. Electrification rate in the region is 90% at present (IEA 2017a), with 95% of the region's population without electricity concentrated in four countries: Indonesia, Philippines, Myanmar, Cambodia (IEA 2017a). Universal access to electricity is expected to be achieved by 2040 the latest in most scenarios.

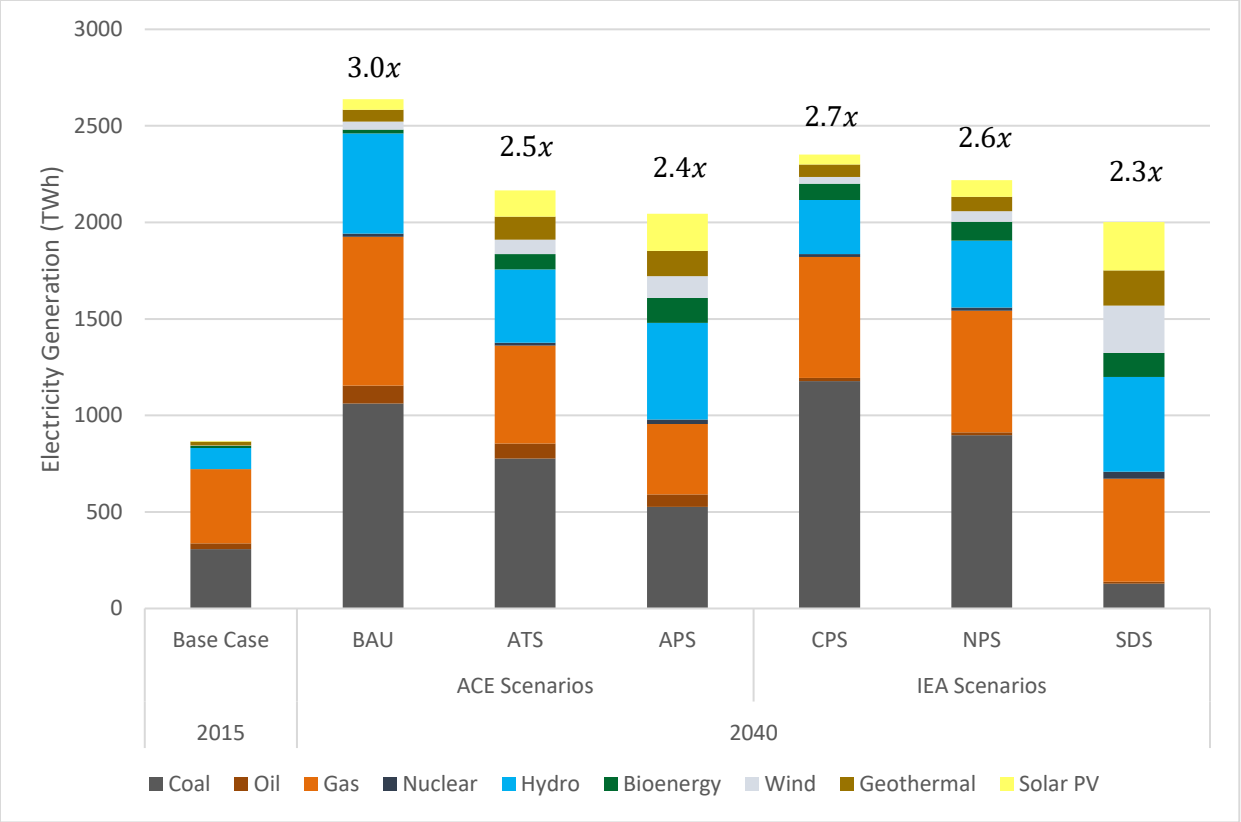

Figure 4 - Electricity Generation Projection in IEA and ACE Scenarios for 2040 (IEA 2017a, ACE 2017b)

Currently, electricity production is dominated by fossil fuels (83%), mostly natural gas and coal, and in scenarios with no additional policies, this dominance will stay, with coal becoming the dominant fuel ahead of natural gas (Figure 5). Current renewable energy capacity is dominated by hydropower, with the share of renewable energy without hydropower only being 5%. To achieve the overall regional renewable energy target, (IRENA 2016) estimates a share of 34% of electricity generation by renewable energy in 2025 corresponding with the 23% overall renewable energy share. This would imply an increase of installed capacity from 51 GW in 2014, to 180 GW in 2025 as opposed to 124 GW in the reference case.

Looking beyond 2025, The (ACE 2017b) estimates that installed capacity would need to increase to 319 GW so that renewable energy will comprise of 52% of generation and 55% of total capacity by 2040 in a scenario based on the regional 23% renewable energy target by 2025. Similarly, IEA projections also indicate that the share of renewable energy in total electricity generation (around 2000 TWh) should exceed the share of non-renewables by

2040 if the region wants to meet the regional target and SDGs and capacity would increase to 464 GW (IEA 2017a, ACE 2017b).

However, most scenarios (apart from the most ambitious scenario – IEA SDS) still project an increase in fossil fuel use in power generation and in particular an increase in coal, which is not in line with the Paris Agreement temperature goal, where the power sector needs to decarbonise before 2050, and in particular coal would need to be phased out in the power sector globally by 2050 (IPCC 2018).

Existing power development plans are not yet consistent even with the less ambitious scenarios for increasing the share of renewable energy, as they focus on the existing dominance of coal, as well as hydropower. Coal accounts for a large share of 65% of total new-built capacity in the region based on the existing power development plans (Blume and Hang 2018)

In particular wind and solar resources are not currently projected to be exploited as much as they could to achieve higher renewable energy shares and achieve the regional target (Figure 5).

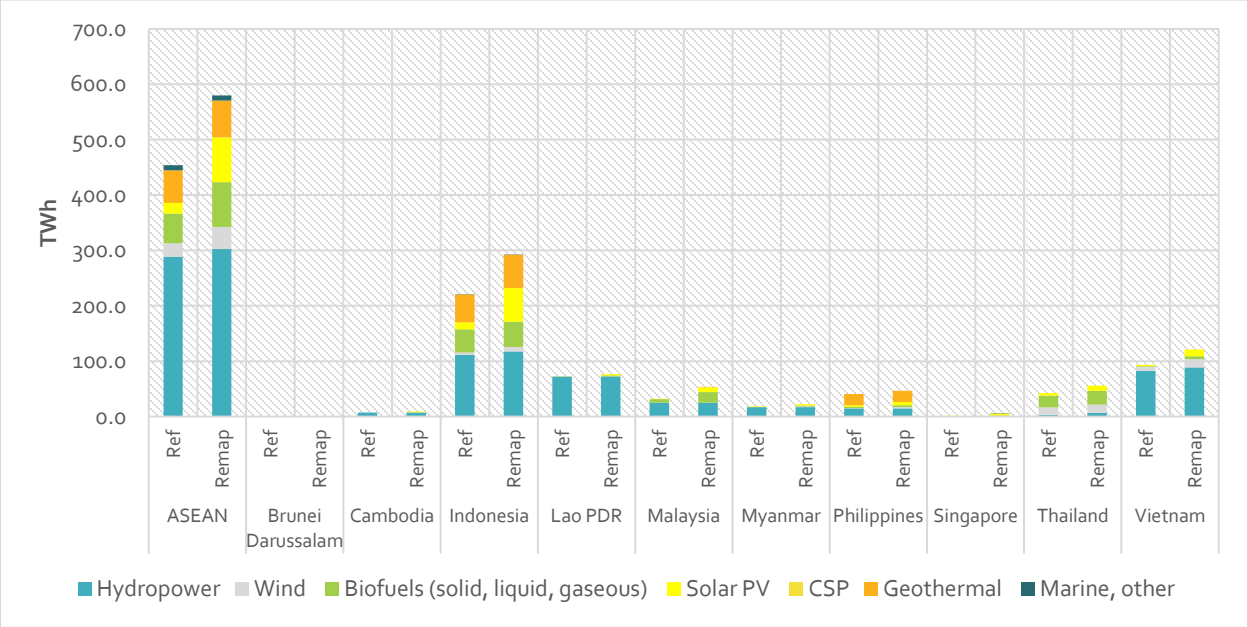

Figure 5 - Potential for electricity generation from different renewable sources in ASEAN countries in 2025 (IRENA 2016)

3. Renewable energy potentials and benefits

Large untapped renewable energy potentials across the region

While IRENA (2016) has analysed the still untapped potential for renewable energy sources across the region and across all sectors to achieve the short term 2025 target of 23% renewable energy, some analyst also refer to the overall large potential for renewable energy in the region, that remain largely unexploited (with exception of hydropower), and with large variations between and within countries. Indonesia has a large geothermal energy potential (largest potential worldwide), of which only 5% are presently utilised (Khuong 2017). Hydropower potentials are large in Vietnam, Thailand, Malaysia, Cambodia, and also Indonesia and the Philippines. In addition there are large untapped potentials for solar and wind energy across the region (Ölz and Beerepoot 2010, Bakhtyar, Sopian et al. 2013, IRENA 2018).

The region has a large potential for harnessing solar energy and in scenarios with large share of renewable energy in the future (Gulagi, Bogdanov et al. 2017) solar energy will dominate the energy mix in Southeast Asian countries, in contrast to its low share at present and in short-term projections.

In addition, the Philippines, Thailand, Indonesia and Vietnam have vast wind energy potentials (ACE 2015a) (Bakhtyar, Sopian et al. 2013).

The region also has significant potential for Bioenergy (Lidula, Mithulananthan et al. 2007, Bakhtyar, Sopian et al. 2013)and some promising tidal power potential has been identified (Lidula, Mithulananthan et al. 2007, Bakhtyar, Sopian et al. 2013 also for Singapore (ACE 2015a).

Decarbonising the energy system: Towards 100% renewable energy? Some insights from few studies with large shares of renewable energy available

Renewable energy is widely recognized as the key solution to decarbonise energy systems and achieve emissions reductions necessary to implement the Paris Agreement long-term temperature goal and at the same time a wide range of Sustainable Development Goals (SDG).

While there is a wide range of studies looking at long term scenarios for achieving 100% renewable energy globally and at national level for many geographies, there are not yet many studies of this kind for the ASEAN region. However, some studies show that 100% RE can be a cost-effective sustainable solution for energy system of ASEAN countries compared to fossil fuel based carbon capture technologies to achieve the necessary decarbonisation of the energy system. Renewables can contribute 60% and almost 100% of the total electricity generation mix by 2030 and 2050 respectively according to (Teske, Sawyer et al. 2013). (Blakers, Luther et al. 2012) sees import and transmission of renewable electricity through HVDC line from Australia as cost competitive solution to meet the regional electricity demand with 100% renewable energy. (Gulagi, Bogdanov et al. 2017) find the development of energy storage technology more financially feasible than the transmission of renewable energy through HVDC. According to their integrated scenario incorporating desalination and industrial gas demand, solar and wind will dominate the renewable electricity technologies with decreasing price of photovoltaics and wind technologies (Gulagi, Bogdanov et al. 2017). (Huber, Roger et al. 2015) focus on the decarbonisation of electricity supply and find that all kinds of renewable sources would have to be utilised, with none of them having a share of more than one third. They find that an ASEAN power grid would enable a transition to 100% renewable energy to enable transportation from best sites to load centres and to balance out fluctuations.

Benefits of a transition to renewable energy

In addition to reduced greenhouse gas emissions and reduced air pollution with significant health benefits, (IRENA 2018) has analysed that the development of renewable energy is highly correlated with increasing income, job creation, industrial development and improved livelihood.

Access to decentralised renewables can substantially reduce poverty by empowering individuals and communities to gain control over their energy supply, reduce their energy spending and improve their livelihoods. The transition to sustainable energy creates benefits and opportunities, such as employment generation, market opportunities, and better health conditions. Economic benefits include energy cost savings, improved income generation and poverty alleviation. One of the multiple benefits is the reduction of expenditure on energy imports that could be lowered by USD 40 billion by 2025 (IRENA 2016).

IRENA also estimates a positive impact on the region's employment with an accelerated renewable energy uptake, with the sector already creating 611,000 jobs across Southeast Asia in 2016 and a further 2.2 million jobs that could be created by this sector (IRENA 2016, IRENA 2018).

Figure 6 shows the cost/savings per country for Remap scenario in ASEAN region and impact on GDP.

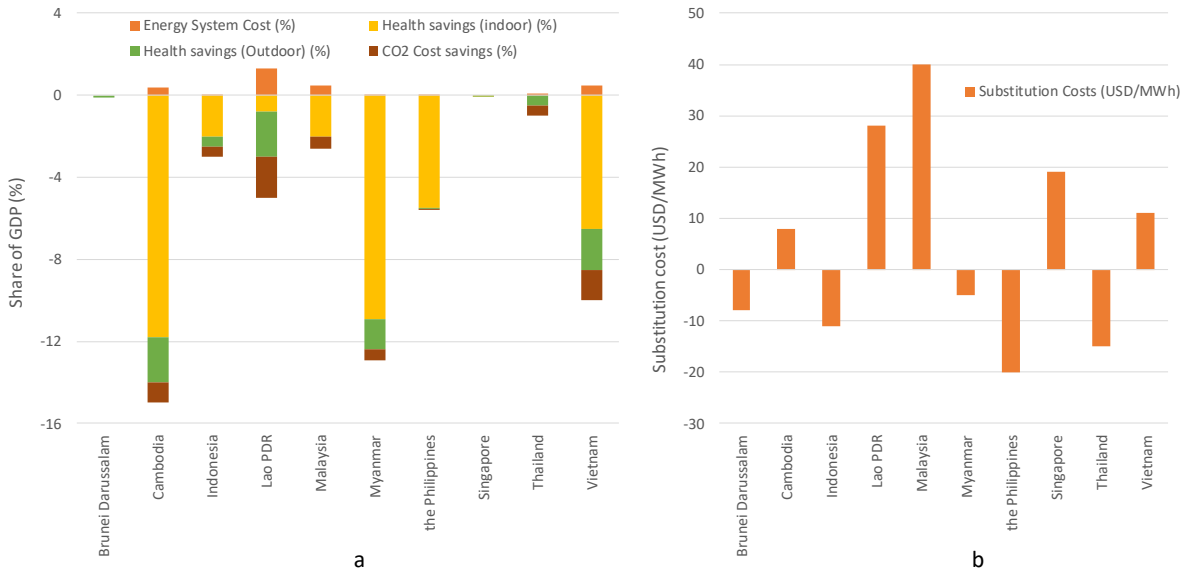

Figure 6 – a: Cost and Savings of RE Map options (IRENA 2016)
b: Substitution cost of Remap Options by country (IRENA 2016)

Figure 6a shows that countries which have abundant geothermal and solar resources, will experience best savings. Savings will come from health especially reducing air pollution and CO2 cost savings. Figure 6b shows that the countries which have large amount of traditional biomass uses have high substitution cost. Overall, the achievement of the

regional target for renewable energy will lead to net savings in particular from avoided out door air pollution outweighing costs for energy system transformation.

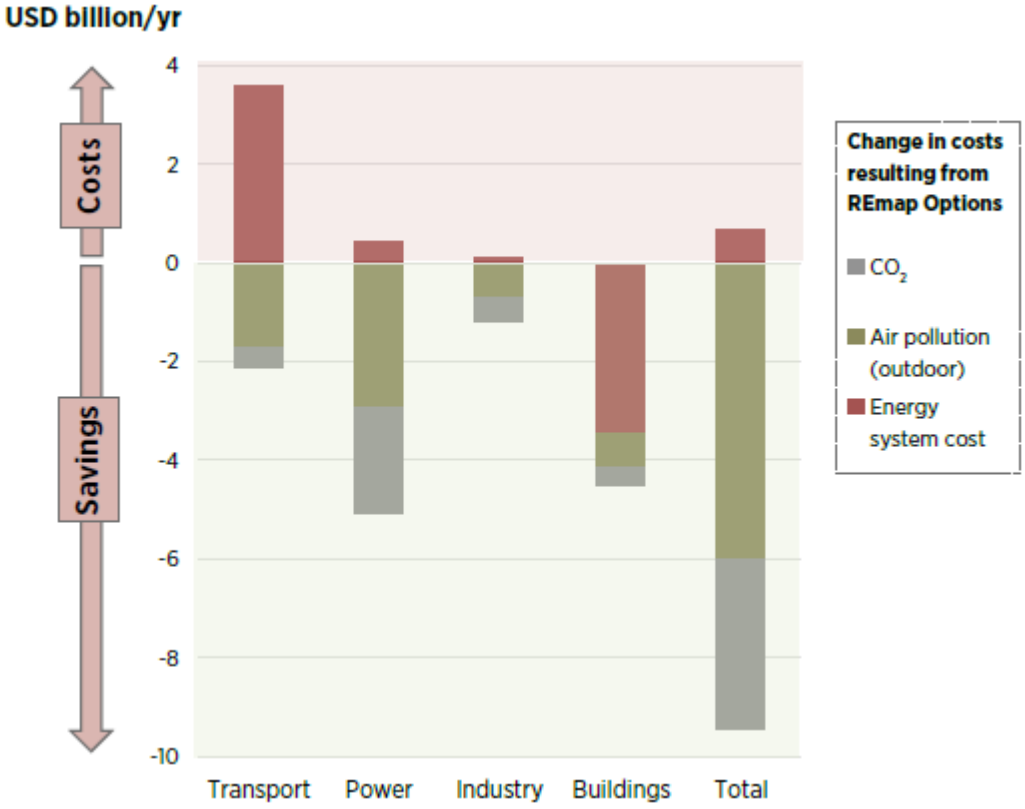

Figure 7 - Sector wise energy system cost including externalities Source: (IRENA 2016)

4. Policy gaps and barriers

Despite the vast potentials and benefits for sustainable development, uptake of renewable energy is still slow in South-East Asia compared to other regions of the world. A large number of barriers have been analysed and are summarized briefly here.

Cost of renewable energy in the region and barriers to investment

While hydro, geothermal, and biomass, are already highly competitive in the region, and onshore wind as well as an increasing number of solar PV projects are also already competitive with the cost of fossil fuel power generation, and expected to continue falling, it is a striking feature for the South East Asian Region that the levelized cost of electricity (LCOE) of solar photovoltaics (solar PV) and wind is still higher in this region compared to other regions of the world and in particular in the rest of Asia.

The LCOE of solar PV has decreased sharply from USD 0.31/kWh in 2012 to an average of USD 0.19/kWh, but is still one of the highest worldwide, twice the cost than in OCEANIA (Australia/New Zealand) and 90% higher than in the rest of Asia (IRENA 2018). LCOE for onshore wind with an average of USD 0.12 is also higher than in most other regions of the world (apart from Central America and Caribbean) and is more than 40% higher than the one observed in the rest of Asia. This points to the large potential to reduce costs in South East Asia for solar and wind, but also to existing barriers that can be addressed though enabling deployment policies, reducing so-called "soft costs" such as licensing, permitting, grid connection, land acquisition and increasing efficiency of supply chains, improving local installation services, introducing risk mitigation products, and unlocking less-costly capital.

Narrative of cheap coal and need for baseload power, policy uncertainty

Given the high growth in demand and the strong past and current focus on fossil fuels, in particular coal, the narrative of supposedly cheap coal and the need to provide "baseload power" to address the growing energy demand is still very dominant in the region. This narrative is kept alive by vested interests largely favouring coal (Michael Jakob and Jan

Steckel 2018). Together with inconsistent policy signals and uncertainty regarding long term goals, this leads to investors holding back more than in other regions. In the case of Indonesia, another important element is the importance of revenues from coal mining not only for the state's budget, but also for regions and municipalities, and a push towards more domestic use of coal in the light of expected downward trends in China and other export destinations (Michael Jakob and Jan Steckel 2018). South East Asian countries are thus among those still expanding coal for power generation, at odds with the need to phase out coal globally by 2050.

Integration of large shares of renewable energy – management and planning needs

The management of variable renewable energy sources into centralized grids remains immature in the region, with a need to improve planning to diversify renewable energy supplies, investigate demand side management with intelligent control systems to dynamically alter the load on central grids, cater for handling over supply scenarios, and in some cases import hydro and other renewable power from neighbouring countries to provide grid stability when required. (IRENA 2017a, IRENA 2017b, IRENA 2017c)

Comprehensive frameworks including all end-use sectors are still missing (IRENA 2018), which could make use of opportunities for electrification of enduse sectors such as transport and industry, and decarbonise the whole energy system.

Recent developments in microgrids and solar PV would avoid relatively costly centralized grids and help further reduce GHG emissions for ASEAN countries (Prachuab Peerapong and Limmeechokchai 2017), but are still in the exploratory phase.

Policy consistency needed

From both a vertical and horizontal perspective within and across government departments and agencies, there is the need to improve the harmonisation and implementation of climate policies and energy policies (IRENA 2017a, IRENA 2017b) as well as resourcing agencies appropriately (IRENA 2017a, IRENA 2017). From the INDC submissions in 2015, while it is possible to find evidence of governments realigning themselves to meet their pledged goals, there are examples such as Indonesia where presidential directives to combat climate change have not filtered through to their main energy agency PLN putting them at odds (IRENA 2017a) (IEEFA 2018). Another example in Thailand where recently

announcements by the energy minister to not increase the acquisition of renewables are contrary to Thailand's own Alternative Energy Development Plan 2015-2036 minister (Sawnanee Gulthawatvichai 2018).

Government processes concerning renewables including legal frameworks, procurement, approval permits, pricing mechanisms, present a wide array of minor to large impediments across countries (IRENA 2017a, IRENA 2017b, IRENA 2017c). As one impediment is cleared others become prominent, a clear path to execution is often difficult.

Financial mechanisms including Feed it Tariffs (FITs) are noted as one of the most effective ways of renewable energy procurement. In a 2018 report the ASEAN Centre for Energy (ACE) and the Chinese Renewable Energy Institute (CREEI) identified FITs as one of the key drivers in helping boost renewable energy development in ASEAN states (Gnanasagaran 2018). With decreasing costs, policies are evolving like in other regions, with auctions being increasingly introduced. However conversely, many financial mechanisms to promote renewables can be out of date, immature, lack the appropriate incentives or send confusing signals to the market and appear ineffective. As example renewable feed in tariffs within Vietnam are perceived to be too low and missing adjustments for CPI (Linh 2017). In addition Power Purchase Agreements (PPAs) in Vietnam are viewed as 'unbankable' and longer term PPAs are required (Austrade, 2018). Conversely a recent 'U-Turn' to Thailand's tariffs for small renewable projects in the short term potentially cancelling project, and in the medium to long term leaving producers uncertain of the government's direction (The Nation 2018).

Bioenergy presents a large potential for ASEAN countries. However polices to address the unique nature of bioenergy still present challenges. Land tenure and use requires tightened policies and legal frameworks to sustain growth (IRENA 2017a, IRENA 2017b, IRENA 2017c).

There is a lack of long-term integrated planning, and the provision of the Paris Agreement for countries to develop long-term low greenhouse gas development strategies by 2020 in addition to enhancing their nationally determined contributions (NDC) by 2020 to strengthen contributions to the goal of limiting global warming to 1.5dC are opportunities both to enhance policy consistency and avoid stranded assets created by investing in fossil fuel infrastructure at odds with the Paris Agreement long term temperature goal and Sustainable Development Goals.

Regional grid integration not yet developed

While ASEAN countries do have a ready supply of RE resources beyond hydro, the overall distribution of these resources are uneven and often lack transmissions lines from remote RE generators (Ahmed Tofael 2017) to the demand centres in each country. Where opportunities exist to supply close neighbouring countries from these remote RE generators, little to no market mechanisms and transmissions lines exist to trade energy across borders to overcome localized imitations (Tongsopit Sopitsuda 2016).

5. Opportunities for collaboration

ASEAN Power Grid and beyond – exporting renewable energy from Australia to ASEAN

ASEAN countries have discussed and agreed to the concept of the ASEAN Power Grid (AGP), as early as 1997 (Andrews-Speed 2016). The AGP is a regional initiative to build transmissions lines across country boundaries in the region to share power, and is framed in the recent Plan of Action (APAEC) to aim at *"Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All" (Andrews-Speed, 2018).* It was not developed specifically for the objective of integrating more renewable energy in the power grid, however, recently, IRENA launched the "Greening ASEAN Power Grid Initiative" to accelerate the development of utility-scale renewables-based electricity. This initiative was approved in 2015 by the ASEAN Senior Officials Meeting (IRENA 2018) but the progress has been slow and several barriers and technical challenges remain (Ahmed Tofael 2017). However it is generally recognized that the AGP will present ASEAN countries with several benefits creating stronger export market opportunities and investment incentives, reducing investment costs and increasing net savings (Ahmed Tofael 2017) (Shi 2016).

A few studies (Taggart, James et al. 2011) (Blakers, Luther et al. 2012) (Gulagi, Bogdanov et al. 2017) have looked into opportunities to connect an ASEAN power grid to other grids, creating wider opportunities for interconnection in the Asia-Pacific region building on the large potentials for renewable energy, in particular wind and solar in Australia. Recently, the opportunities to connect energy systems through export of green hydrogen produced from renewable electricity has been explored (ARENA 2018), but not yet analysed in depth in the context of decarbonizing both Australia and the ASEAN region.

These recent developments provide many opportunities to implement the idea of Australia as a Renewable Energy Superpower (Beyond Zero Emissions 2015).

International cooperation and opportunities for exporting renewable energy from Australia to ASEAN countries

There is an increasing focus of many bilateral and multilateral programmes and initiatives focusing on increasing investments in renewable energy mostly from European countries (Germany, Denmark, Netherlands, Finland) (IRENA 2018). The recent ASEAN Energy Cooperation report 2017 (ACE 2017c) endorsed by ASEAN Energy ministers outlines areas of cooperation on renewable energy at ASEAN-regional level with a range of bilateral partners including the Germany (the ASEAN Renewable Energy Support Programme, AGEP), the US as well as international organisations such as IRENA and IEA. However, it also outlines areas of cooperation on so-called clean coal technologies in particular with China, Japan, Korea, as well as the Global CCS Institute in Australia, which is at odds with the Paris Agreement and the need to phase out coal in the power sector by 2050 (IPCC 2018).

Despite its proximity, large potentials, experience and skills with development of renewable energy technologies and projects including in remote areas, there is no evidence of any bilateral cooperation project on renewable energy between Australia and the ASEAN region.

However, the opportunities have been highlighted at regional level, in particular regarding the potential to export renewable energy from the Western Australian Pilbara region: The Pilbara Regional Commission (Mella, James et al. 2017) releases a feasibility study for exporting renewable energy to ASEAN countries, and this was discussed at the recent Pilbara Kimberley Forum 2018. The Western Australian Government has recently established the Green Hydrogen Council which will also look into export opportunities for green hydrogen. The private sector has also identified these opportunities: One example is the currently planned project for generating electricity from a large scale (11 GW) hybrid wind and solar energy project ("Asian Renewable Energy Hub") (The Asian Renewable Energy Hub 2018) in the Pilbara, with a large share (6 GW) to be exported via a new High Voltage DC transmission cable, and part of the produced electricity to be used to produce green hydrogen as energy carrier for domestic use or for export.

6. Conclusions

The analysis in this briefing paper shows the following opportunities for collaboration between Australia and South-East Asia to enhance investment in renewable energy in South-East Asia should be explored:

- There are huge untapped potentials for expanding renewable energy investments in South-East Asia and these need to be made available at a scale and speed needed to implement the Paris Agreement and achieve sustainable development goals (SDGs) in the region.

- In addition, there are large yet mostly untapped opportunities for strengthening and focusing cooperation between Australia and the ASEAN countries in the area of renewable energy, both building on existing close cooperation in other areas, as well as exploiting unique ASEAN renewable energy potentials, and Australian experiences and skills, as well as existing infrastructure in Australia regarding renewable energy and storage technologies, microgrid and other developments for renewable energy in remote regions.

- There is an opportunity to link cooperation to opportunities for transformation of the Australian energy system and transitioning from a fossil fuel to a renewable energy exporting energy super power and a regional leader.

- This cooperation can support and enhance existing international, building on the specific expertise and close cooperation between Australia and the ASEAN region.

- Active bilateral and engagement in multilateral cooperation with ASEAN in the area of expansion of renewable energy should be complemented with the development of specific areas of cooperation and trade with renewable energy (renewable energy based electricity or green hydrogen).

- To support this collaboration, in-depth quantitative analysis is needed to develop energy system scenarios analysing how energy systems in the ASEAN and wider ASIA Pacific region can be decarbonised while addressing the need for access to modern energy services, building on renewable energy and storage technologies as

well as cooperation and connection of energy systems and markets.

- Such research and scenario analysis should be developed jointly with institutions and stakeholders in the region and can contribute to enhancing contributions to the Paris Agreement, through development of long-term strategies as well as enhanced nationally determined contributions (NDC) which are both due by 2020.

ANNEX – Overview of existing targets

(Source IEA 2017, and additional sources as shown in table)

Country	Category	Policies and targets	Reference	Progress
Brunei Darussalam	Efficiency	Reduce TFEC/GDP by 45% by 2035 based on 2005 level	Energy White Paper (2014)	
		63% reduction in total energy consumption by 2035	UNFCC INDC (2015)	
	Renewables	10% power generation from renewables by 2035	UNFCC INDC (2015)	
	GHG Emissions - Transport	Reduce CO2 emissions from peak hour vehicle use by 40% of BAU by 2035. No other quantitative targets.	UNFCC INDC (2015)	
Cambodia	Efficiency	Reduce TFEC by 20% of BAU in 2035	National Policy, Strategy and Action Plan on Energy Efficiency in Cambodia (2013)	
	Electrification	Electrification of all villages by 2020, 70% of households by 2030	Rural Electrification by Renewable Energy Policy (2006)	60% (2014)
	GHG Emissions	Reduce BAU 2030 emissions by 27% with international assistance	UNFCC INDC (2015)	
Indonesia	Efficiency	Energy intensity below 1% and 17% reduction across sectors by 2025	National Energy Plan (2017)	
	Electrification	Universal electricity by 2020	Rural Electrification Regulation	91% (2014)

	Renewables	23% renewables TPES share by 2025, 31% by 2030	National Energy Policy (Govt Reg No. 79/2014)	
	GHG Emissions	Reduce GHG emissions 29% from BAU levels by 2030, and 41% by 2030 with international support	UNFCC INDC (2015)	
Lao PDR	Efficiency	Reduce TFEC by 10% of BAU in 2030	National Energy Efficiency Policy (2016)	
	Renewables	30% of total energy consumption by 2025, excluding hydro	Renewable Energy Development Strategy Policy (2011)	
Malaysia	Efficiency	10% reduction in electricity consumption by 2025, 15% by 2030	National Green Technology Master Plan (2017)	
	Electric mobility	Introduce 100000 electric vehicles by 2030 with 125000 charging stations	National Green Technology Master Plan (2017)	
	Renewables	2080MW of renewable energy by 2020, excluding hydro, 4000MW by 2030 to account for 11% of electricity generation	National RE Policy and Action Plan (2011) and 11th Malaysia Plan 2016-2020 (2015)	
	GHG Emissions	Reduce GHG intensity of GDP by 35% by 2030 from 2005 levels, increase to 45% with international support	UNFCC INDC (2015)	
Myanmar	Efficiency	8% reduction in primary energy demand by 2030 from 2005 levels, 20% reduction in electricity by 2030 compared to BAU	National Energy Efficiency and Conservation Policy, Strategy and Roadmap (2015)	
	Electrification	Universal electrification by 2030	Electricity Law (2014)	52% (2014)
	Renewables	By 2030/31 achieve 38% hydro and 9% renewables as part of total energy mix	National Renewable Energy Policy	

			and Planning (Draft) (2014)	
	GHG Emissions	No quantitative targets.	UNFCC INDC (2015)	
Philippines	Efficiency	Reduce TFEC by 1% p/a compared to BAU until 2040. Reduce energy intensity TFEC/GDP by 40% by 2040 compared to 2005 levels.	Energy Efficiency Roadmap 2017-20 (2017)	
	Electrification	Universal electrification by 2022	Philippines Development Plan 2017-22	89% (2014)
	Renewables	15.3GW by 2030	National Renewable Energy Program Roadmap 2011-30 (2010)	
	GHG Emissions	Reduce GHG emissions by 70% from BAU level by 2030 with international support	UNFCC INDC (2015)	
Singapore	Efficiency	Reduce energy intensity TFEC/GDP by 36% from 2005 levels by 2030.	Singapore Sustainable Blueprint (2009)	
	Renewables	350MW Solar PV by 2020, 1GW beyond 2030 contributing 8% of electricity capacity	Singapore Sustainable Blueprint (2009)	
	GHG Emissions	Reduce GHG emissions 16% below BAU by 2020.	UNFCC INDC (2015)	
Thailand	Efficiency	Reduce energy intensity TFEC/GDP by 30% from 2010 levels by 2036.	Thailand Energy Efficiency Policy 2015 Plan (2015)	
	Renewables	30% of final energy consumption by 30% by 2036 from 2010 levels.	Alternative Energy Development Plan (2015)	
	GHG Emissions	Reduce GHG emissions by 20% below BAU by 2030, 25% with international support.	UNFCC INDC (2015)	
Vietnam	Efficiency	Reduce TFEC by 8% in 2020 from BAU. Reduce energy intensity of energy	National Target Program for Energy Efficiency and	

		intensive industries by 10% by 2020.	Conservation (2015)	
	Electrification	Universal electrification by 2022	Power Development Plan VII (2017)	99% (2014)
	Renewables	12.5% by 2025 (excluding hydro), 21% by 2030.	Decision 428/QD-TTG (2016)	
	GHG Emissions	Reduce GHG emissions 8% below BAU by 2030, and 25% with international support.	UNFCC INDC (2015)	

ACE (2015a). The 4th ASEAN Energy Outlook 2013-2035. Indonesia, ASEAN Centre for Energy (ACE)**:** 28-29.
ACE (2015b). ASEAN Plan of Action For Energy Cooperation (APAEC) 2016-2025, ASEAN Centre for Energy.
ACE (2017a). ASEAN Renewable Energy Policies. Jakarta, ASEAN Centre for Energy**:** 78,79,80,.
ACE (2017b). The 5th ASEAN Energy Outlook 2015-2040. Indonesia, ASEAN Centre for Energy (ACE)**:** 18, 126-131.
ACE (2017c). ASEAN Energy Cooperation Report 2017, ASEAN Centre for Energy (ACE).
Ahmed Tofael, M. S., Shah Rakibuzzaman, Mithulananthan (2017). "Investigation into transmission options for cross-border power trading in ASEAN power grid." Energy Policy **108**.
Ahmed Tofael, M. S., Shah Rakibuzzaman, Mithulananthan N, Seyedmahmoudian Mehdi, Horand Ben (2017). "ASEAN power grid: A secure transmission infrastructure for clean and sustainable energy for South-East Asia." Renewable and Sustainable Energy Reviews **67**.
Andrews-Speed, P. (2016). Connecting ASEAN through the Power Grid: Next Steps
ARENA (2018). "Opportunities for Australia Hyrdogen Exports."
Bakhtyar, B., K. Sopian, M. Y. Sulaiman and S. A. Ahmad (2013). "Renewable energy in five South East Asian countries: Review on lectricity consumption and economic growth." Renewable and Sustainable Energy Reviews **26**(October 2013): 506-514.
Beyond Zero Emissions (2015). Zero Carbon Australia.
Blakers, A., J. Luther and A. Nadolny (2012). "Asia Pacific Super Grid – Solar electricity generation, storage and distribution." GREEN **2**(4): 189.
Blume, L. and N. T. Hang (2018). "Southeast Asia: hotspot for renewables or dumping ground for coal?" https://energytransition.org/2018/02/southeast-asia-hotspot-for-renewables-or-dumping-ground-for-coal/ 2018.
Climate Vulnerable Forum (2016). Climate Vulnerable Forum Commit to Stronger Climate Action at COP22.
ESCAP. (2017). "Asia Pacific Energy Portal." Retrieved 20 September, 2018, from https://asiapacificenergy.org/#main/lang/en/graph/3/type/1/sort/0/time/[1990,2015]/indicator/[1294:2330]/geo/[SOEA]/legend/1/inspect/0.
Gnanasagaran, A. (2018). "ASEAN: FiT for the future."
Gulagi, A., D. Bogdanov and C. Breyer (2017). "A Cost Optimized Fully Sustainable Power System for Southeast Asia and the Pacific Rim." Energies **10**(5): 583.

Huber, M., A. Roger and T. Hamacher (2015). "Optimizing long-term investments for a sustainable development of the ASEAN power system." Energy **88**: 180-193.
IEA (2017a). IEA South East Asia Energy Outlook 2017. Paris, France, International Energy Agency**:** 134-137.
IEA (2017b). World Energy Outlook 2017. Paris, France, International Energy Agency (IEA).
IEA. (2018). "Statistics: Global energy data at your fingertips." Retrieved 07 November, 2018, from https://www.iea.org/statistics/.
IEEFA (2018). Government Policy Thwarts Uptake of Renewables in Indonesia, Institute for Energy Economics and Financial Analysis (IEEFA).
International Renewable Energy Agency (IRENA) (2017). REmap: Renewable Energy Prospects For Indonesia. Abu Dhabi, United Arab Emirates, International Renewable Energy Agency (IRENA)**:** 43-48, 56.
IPCC (2018). Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. V. Masson-Delmotte, H. O. P. P. Zhai, D. Roberts et al., Intergovernmental Panel on Climate Change.
IRENA (2016). Renewable Energy Outlook For ASEAN. Abu Dhabi, United Arab Emirates, International Renewable Energy Agency (IRENA)**:** 44,45,47, 85-95.
IRENA (2017a). Renewable Energy Prospects For Indonesia. Abu Dhabi, UAE, International Renewable Energy Agency.
IRENA (2017b). Renewable Energy Outlook For Thailand. Abu Dhabi, UAE, International Renewable Energy Agency**:** 74-77.
IRENA (2017c). Renewable Readiness Assessment The Philippines. Abu Dhabi, UAE, International Renewable Energy Agency**:** 35-39.
IRENA (2018). Renewable Energy Market Analysis. Abu Dhabi, United Arab Emirates, International Renewable Energy Agency (IRENA)**:** 63, 64, 68, 65.
Khuong, P. M. (2017). "Renewable Energy in ASEAN." Retrieved 30 July, 2018, from https://www.boell.de/en/2017/08/02/renewable-energy-asean.
Lidula, N. W. A., N. Mithulananthan, W. Ongsakul, C. Widjaya and R. Henson (2007). "ASEAN towards clean and sustainable energy: Potentials, utilization and barriers." Renewable Energy **32**(9): 1441-1452.
Linh, P. B. (2017). "Outlook for Vietnam Renewable Energy." Slide 12, 15.
Mella, S., G. James and K. Chalmers (2017). Evaluating the potential to export Pilbara solar resources to the proposed ASEAN grid via a subsea high voltage direct current interconnector.
Michael Jakob and Jan Steckel. (2018). "On the political economy in Indonesia and Vietnam." from http://blog.mcc-berlin.net/post/article/keeping-the-lights-on.html.
Ölz, S. and M. Beerepoot (2010). Deploying Renewables in Southeast Asia: Trends and potentials.
Prachuab Peerapong and B. Limmeechokchai (2017). "Optimal electricity development by increasing solar resources in diesel-based micro grid of island society in Thailand." Refer paper conclusion.
Sawnanee Gulthawatvichai, F. T. (2018). "Thailand: Energy Policy Developments." International Financial Law Review.
Shadman F, S. S., Moghavvemi M, Saidur R (2016). "Drought and energy security in key ASEAN countries." Renewable and Sustainable Energy Reviews **53**.
Shi, X. (2016). "The future of ASEAN energy mix: A SWOT analysis." Renewable and Sustainable Energy Reviews **53**.
Taggart, S., G. James, Z. Dong and C. Russell (2011). The Future of Renewables Linked by a Transnational Asian Grid.

Teske, S., S. Sawyer, A. Obusan, T. Buakamsri, T. Pregger, S. Simon, T. Naegler and M. O'Sullivan (2013). Energy [R]evolution: A Sustainable ASEAN Energy Outlook. Amsterdam, The Netherlands, Greenpeace International and European Renewable Energy Council (EREC).
The Asian Renewable Energy Hub. (2018). "The Asian Renewable Energy Hub." Retrieved 6 November, 2018, from https://asianrehub.com/.
The Nation (2018). Industry gears up to respond to U-turn on renewable energy policy. The Nation. Thailand.
Tongsopit Sopitsuda, K. N., Chang Youngho, Aksornkij Apinya, Wangjiraniran Weerin (2016). "Energy security in ASEAN: A quantitative approach for sustainable energy policy." Energy Policy **90**.