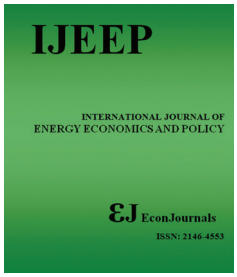

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Renewable Energy Deployment for Sustainable Development in the Asia Pacific: A Review

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ABSTRACT

The prominence of energy in output expansion and industrial growth in the Asia-Pacific is globally acknowledged. Nevertheless, the vigorous utilisation of energy leads to energy security concerns and price volatility are thought to have directed to an undesirable effect of energy dependence in the region. An application of renewable energy technologies (RETs) could promote the steady development of the region since diversifying fuel resources is the first step to enhance energy security and reducing energy dependence. This paper highlighted the current trend of the energy sector in the Asia-Pacific and discussed some measures in facilitating the deployment of alternative energy in the region. Therefore this paper can provide new insight for further investigations on the current energy sector and the application of clean energy for strengthening energy security in the Asia-Pacific.

Keywords: Energy Security, Renewable energy, Asia-Pacific
JEL Classifications: Q2, Q3, Q4

1. INTRODUCTION

It has generally been realised that a viable and abundant amount of energy is crucial in the global community to ensure the economic growth and development of a nation. Like other factors input (e.g. labour and capital), energy serves as a vital input for goods and services in the economy and contribute to an industrialisation process (Apergis and Payne, 2010). Alternately, the rapid pace of economic growth and the industrial revolution has been accompanied by an immense amount of energy demand. Throughout the region, Asia-Pacific has become a leading in electricity generation since 2003 with its electricity generation stood approximately at 10,961 terawatt-hours (TWh) in 2016, 2 times than North America region. At the same time, in China, electricity generation surged by more than 50% over the past 10 years and China has become the world's leading producer of energy in 2016, exceeding the U.S. (BP, 2017).

Nevertheless, the search for economic expansion cannot be separated from the fear of high energy prices and resources scarcity associated with energy security challenges. First, energy acts as a necessary input for economic activity, but at the same time, expanded energy use exerts sizeable pressure on the energy costs and supply disruption linked with the usage of conventional energy sources. Specifically, a high reliance on non-renewables to satisfy domestic requirements may generate a decline in domestic fuel reserves and in turn force the country to import more energy resources at a higher market price.

To overcome the undesirable effects of energy dependence, volatility of energy prices and other problems linked to conventional energy sources, a considerable number of countries are seeking to switch to green energy sources, namely renewable resources. For a country to meet a steady development, there must be an inexpensive, dependable, socially acceptable and economically feasible of green energy sources (UN, 2007).

2. CURRENT NON-RENEWABLE ENERGY DEPLOYMENT IN ASIA-PACIFIC[1]

On principle, there are two forms of energy sources for electricity generation; renewable energy sources and non-renewable energy sources. Renewable energy comes from sources that are neither exhaustible nor finite and include tides, wind, sun and rain – natural resources whose use does not deplete them. Meanwhile, non-renewable energy sources are coming from sources that are exhaustible and finite in the future including coal, oil and natural gas.

Like many regions worldwide, the quickly growing population in Asia-Pacific requires an equally dramatic growth in energy supplies to meet energy demand. The population of the region is estimated at 4.3 billion in 2016 and is projected to increase to 5 billion before levelling off in 2050 (UN, 2017). Based on the BP Statistical Review of World Energy (2017), fossil fuel generation in Asia-Pacific increased between 1980 and 2016 while other regions' production remained stable (Figure 1). Of the total global electricity generation in 2016, Asia-Pacific's share was 43.92%, with China's, India's and Japan's share was 24.58%, 5.62% and 4.18%, respectively. Meanwhile, Figure 2 depicts the share of non-renewable electricity generation of nations, including the Asia-Pacific region, in 2016.

The production of non-renewable electricity sources for the region has been increasing in step with economic development. From Figure 3, comparing the three types of fossil fuels in Asia-Pacific, it can be seen that coal-dominated energy generation over the years, accounting for 80% of total non-renewable electricity generation. Meanwhile, natural gas and oil ranked second and third and their electricity generation remained steady over the years. Similarly in Figure 4, coal dominates the largest fraction of global non-renewable energy proved reserves, and it is predominantly located in Europe and the Middle East region. However, it is evident that Asia-Pacific has the smallest fraction of proved reserve for all fossil fuels. In 2016, coal reserve is sufficient to meet 102 years of the region production and oil is only sufficient to meet 17 years of the region production.

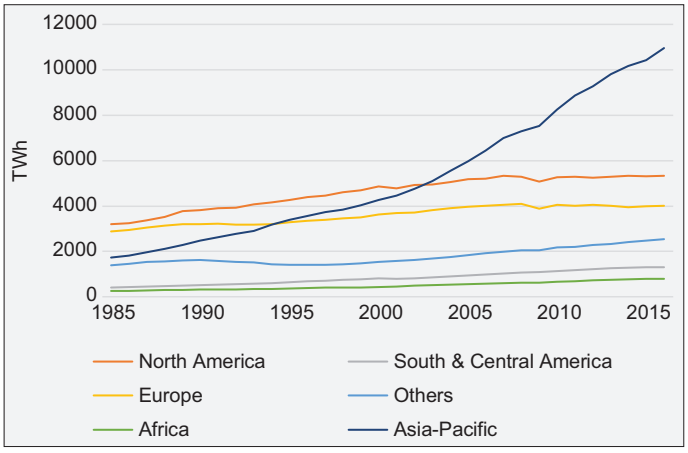
Overall, Asia-Pacific countries depend heavily on fossil fuels in experiencing the growing necessity for energy. It is predictable that as the countries continue to grow at a fast rate, their demand for energy will also increase. This means that these countries depend on carbon fuels to quickly produce electricity in order to reduce their electricity deficit. The growing demand in fossil fuels has entirely changed the global energy market which leads to a surge in energy prices. For instance, the trend of spot crude oil prices have increased tremendously between 2000 and 2012, roughly by 4 times but decreased significantly after 2014 (Figure 5). The dropping oil prices during 2014 and 2016 was one of the greatest oil prices decline since World War II (Alekhina and Yoshino, 2018). Among the factors that contribute to the supply glut was a steady oil supply in the Organization of the Petroleum Exporting countries (OPEC), increased oil exploration in the U.S. and Canada and political unrest in the Middle East countries (OPEC, 2017).[2] Similarly, the coal prices in the Asian market have expanded approximately 2 times compared to the level in the early 2000s (Figure 6). It is noted that Japan has the highest coking coal prices due to lack of resources to produce the fossil fuel.

Figures 7-9 summarise the position of Asia-Pacific in fossil fuels balance in comparison to other regions in the world. Between 1996 and 2016, it can be revealed that the region has the largest gap between fossil fuels demand and supply that widening at an unprecedented speed. Oil denotes the largest imbalance compared to other fossil fuels and it rose more than twofold compared to other regions in the world. The overwhelming reliance on the conventional energy sector has compelled the region to import fossil fuels to accommodate their heavy demand for energy.

Nevertheless, increasing growth in energy demand is a major concern for the region due to the demand is being met through the usage of conventional energy sources, largely imported fossil fuels. Figure 10 depicts the energy imports in the world and Asia-Pacific countries over the period of 1980-2015. The net imports for the world and Asia-Pacific are relatively stable over the years, with Asia-Pacific having the largest net imports in comparison with the rest of the world. It can be seen that both global and Asia-Pacific countries' net imports rose dramatically in 2015, implying a heavy reliance on imports to meet their energy needs. In more detail, Figure 11 shows the net imports (imports minus exports) as a percentage of each economy's domestic energy use between 1990 and 2015 in some of the Asia-Pacific countries. Singapore, Japan and South Korea imported more than 50% of their energy requirements. Similarly, bars to the left in Figure 11

1 Asia-Pacific countries are classified according to Asian Development Bank (2016) members which data for the empirical analyses are available that comprises of Australia, China, Indonesia, India, Laos (Lao People's Democratic Republic), Japan, Malaysia, New Zealand, Philippines, South Korea (Republic of Korea), Sri Lanka, Thailand and Vietnam.

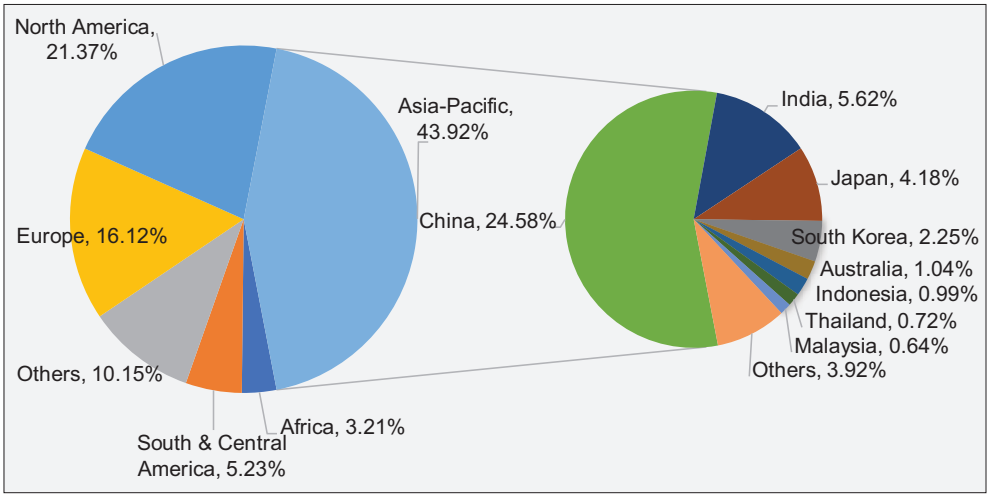
Figure 1: Total non-renewable electricity generation by region, 1980-2016



Source: BP (2017)

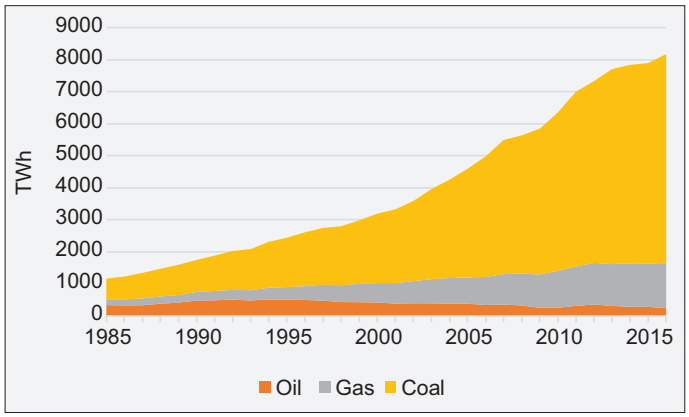
2 OPEC consists of Algeria, Angola, Ecuador, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, and Venezuela. In 2016, OPEC dominates 80 percent of the global crude oil of supply with its proven reserves in the Middle East countries stood approximately 65% (OPEC, 2017).

Figure 2: Total non-renewable electricity generation by region in 2016 (percentage)



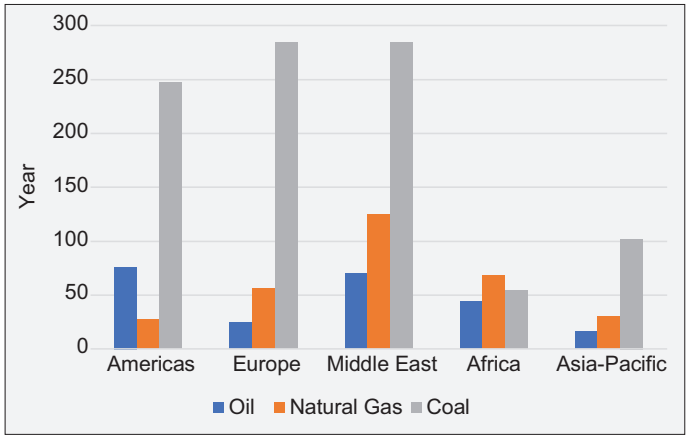
Source: BP (2017)

Figure 3: Total non-renewable electricity generation by sources in Asia-Pacific, 1985-2016



Source: BP (2017)

Figure 4: Reserves to production ratio, 2016



Source: BP (2017)

show countries that are net exporters – Indonesia and Australia exported more than 80% of their energy requirements to other economies. Besides, as illustrated in Figure 11, there were few changes in the net imports of countries between 1990 and 2015, except Malaysia which was a net energy importer in 2015, in comparison to 1990 when the country exported over 120% of its energy supply to other countries. It can be concluded that most countries in the region depend on imports to satisfy their energy requirements.

Therefore, the sustainability of non-renewable resources is a predictably critical concern for the region given the imbalance of production and consumption along with price volatility associated with conventional energy sources. Correspondingly, exploration and development of alternative energy can be a standpoint in reversing the impact of energy security concern in the Asia-Pacific. Energy security improvement can come from renewable energy, which diversifies options for supply and reduces dependency on conventional sources, allowing the foreign exchange to be diverted from energy imports to the imports of other goods that cannot be locally assembled. Deploying increased numbers RETs can help to mitigate the impact of variations and disruptions in supply. Industrial activities, digital technologies and communication infrastructure depend on consistent and efficient electricity supply and as such, securing electricity is essential to well-functioning modern economies and civilisations.

3. CURRENT RENEWABLE ENERGY DEPLOYMENT IN ASIA-PACIFIC

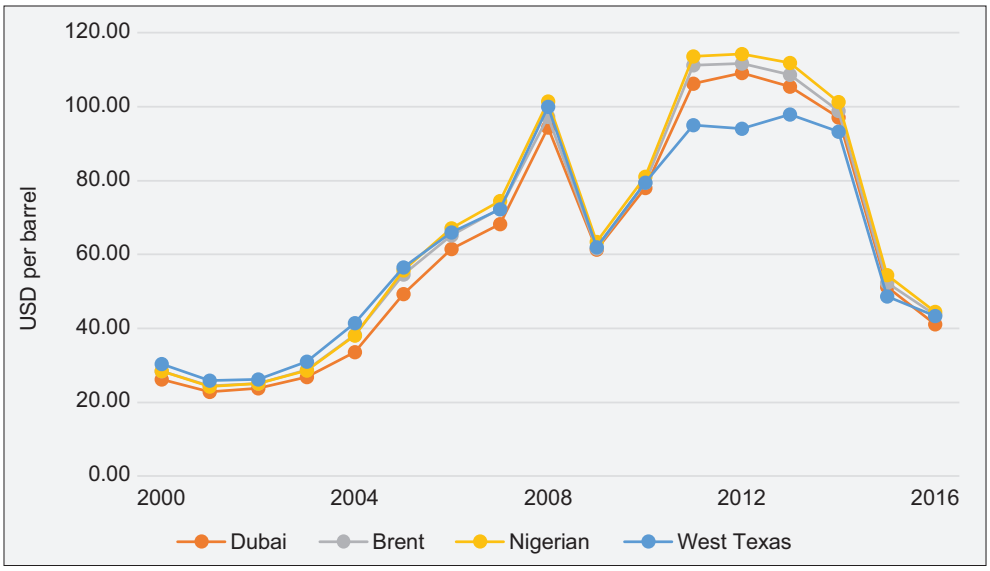
Asia-Pacific electricity generation from renewable sources has accelerated sharply since 2005, with production accounting for 44% of the total region's renewable energy generation in 2016. Likewise, North America and Europe continue to experience a steady increase in renewable electricity generation (Figure 12). In the region, total renewable electricity generation grew by 4% per annum and slightly lowered to 5.2% per annum for conventional energy sources in 2016 (BP, 2017). This is due to recent technological development in energy systems, along with the increasing awareness on RETs towards sustainable growth (Cronshaw and Grafton, 2014). Hydroelectricity remains the largest means of renewable electricity generation, with its share standing at 72.3% in 2015. Figure 13 depicts renewable electricity generation from multiple sources in Asia-Pacific over the period 1980 to 2016.

In recent years Asia-Pacific have realised some progress in reducing their dependence on fossil fuels on diversification of energy sources through the deployment of renewable energy. For instance, although the share of renewables stood only at 6% in 2016, it recorded the fastest-growing of primary energy, with 60% increment between 2005 and 2016 (BP, 2017). However, the development of clean energy sources necessitates additional attempts and examinations to enable the countries to attain their renewable energy goals.

4. STEPS TO FACILITATE THE REALISATION OF CLEAN ENERGY SECTOR IN THE ASIA-PACIFIC

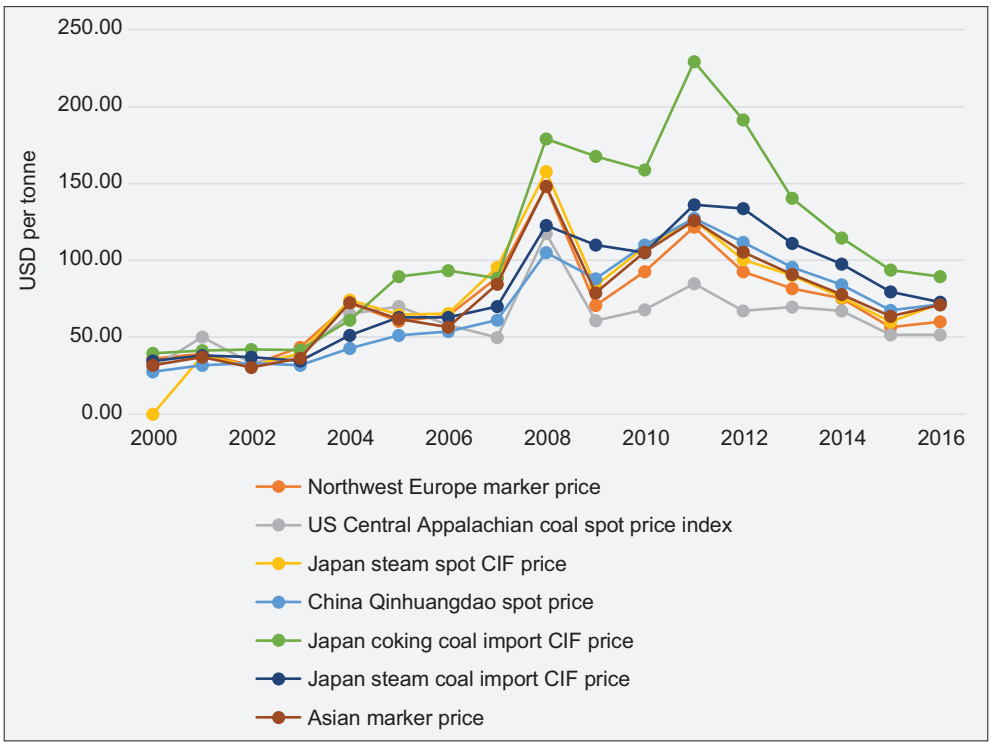
Despite the RETs increasingly attained acceptance, firms remain to invest in fossil-fuels technologies, which suggests that the penetration of clean-energy sectors is at least as similarly costly and complicated as their invention (Jaffe and Stavins, 1995;

Figure 5: Spot crude oil prices, 2000-2016



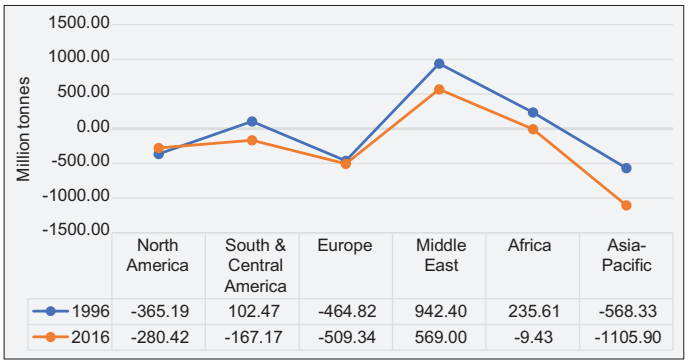
Source: BP (2017)

Figure 6: Coal prices, 2000-2016



Source: BP (2017)

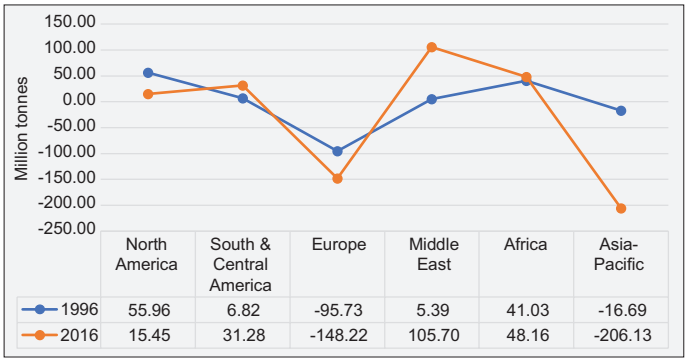
Figure 7: Oil imbalance (production less consumption) of different region between 1996 and 2016



	North America	South & Central America	Europe	Middle East	Africa	Asia-Pacific
1996	-365.19	102.47	-464.82	942.40	235.61	-568.33
2016	-280.42	-167.17	-509.34	569.00	-9.43	-1105.90

Source: Author's calculation based on BP (2017)

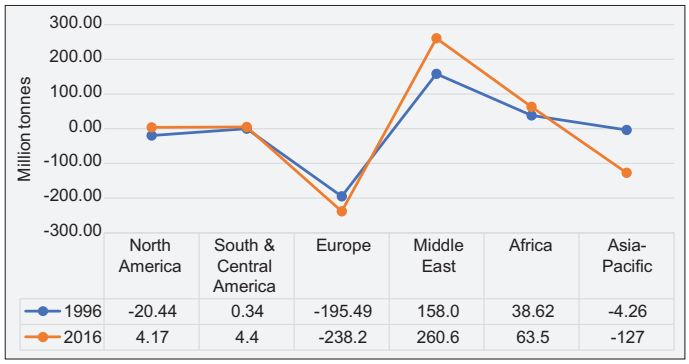
Figure 8: Coal imbalance (production less consumption) of different region between 1996 and 2016



	North America	South & Central America	Europe	Middle East	Africa	Asia-Pacific
1996	55.96	6.82	-95.73	5.39	41.03	-16.69
2016	15.45	31.28	-148.22	105.70	48.16	-206.13

Source: Author's calculation based on BP (2017)

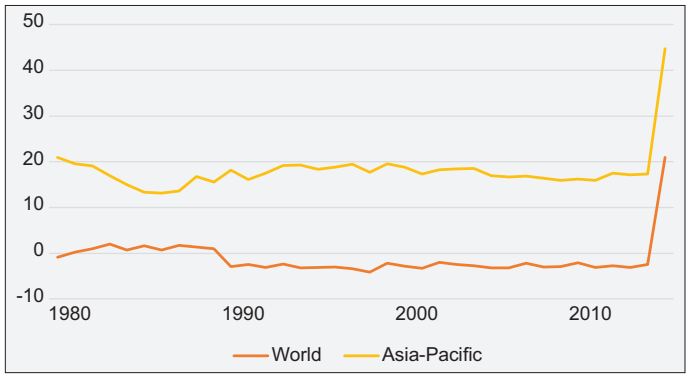
Figure 9: Natural gas imbalance (production less consumption) of different region between 1996 and 2016



	North America	South & Central America	Europe	Middle East	Africa	Asia-Pacific
1996	-20.44	0.34	-195.49	158.0	38.62	-4.26
2016	4.17	4.4	-238.2	260.6	63.5	-127

Source: Author's calculation based on BP (2017)

Figure 10: Energy imports, net, 1980–2015 (percentage of energy use)[3]



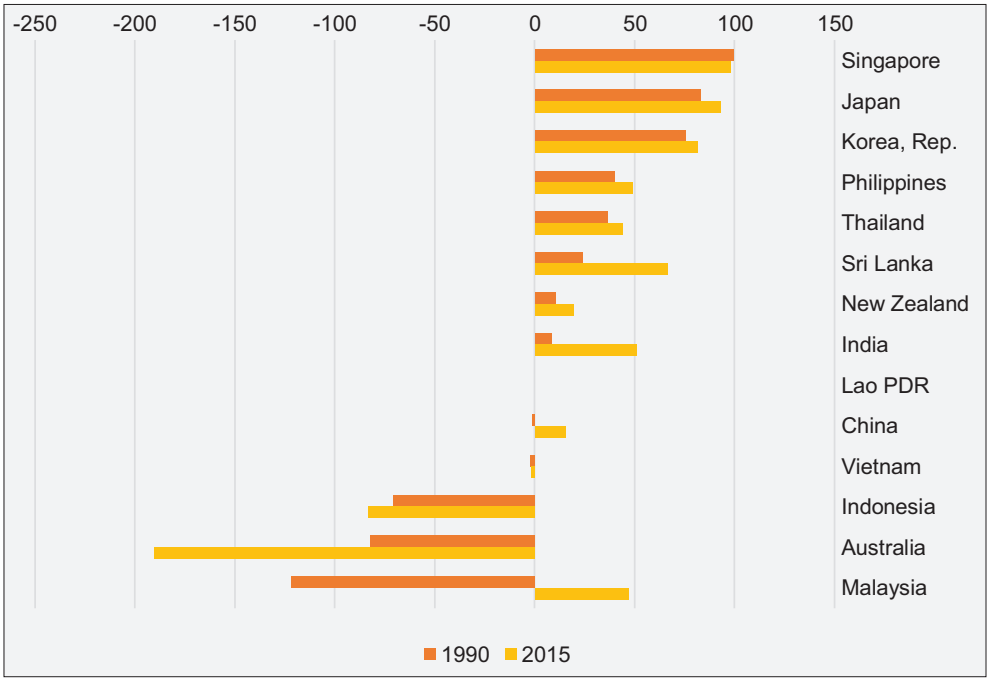
Source: World Bank (2016)

Jaffe et al., 2002; Johnstone et al., 2010). Thus, it is likely that regulatory support policies are beneficial to encourage penetration in alternative energy. Public policy involvement in technological change for clean-energy technologies possibly distinguished into technology-push and market-pull. The purpose of technology-push instruments is to increase the firms' motivation to create new information or knowledge, and they eventually stimulate new RETs or enhances present technologies by lessening the adverse impact due to the deficient appropriability of gain from innovation. In contrast, the purpose of market-pull instruments is to stimulate the need for clean-energy technologies by reducing the market hindrance or by internalising negative externalities (Groba and Breitschopf, 2013). In this context, a feed-in tariff incentive is a price-based option that the energy producer sells at a predetermined rate per kilowatt-hour produced throughout a particular duration (Couture and Gagnon, 2010). The scheme varies significantly depending on the market in which it operates and how the scheme is designed (Jenner et al., 2013). On the other hand, a tax credit is intended to encourage individuals and firms to invest in clean-energy technologies by allowing the investments in RETs to be completely or fractionally subtracted from tax obligations or the earnings of the business. When RETs arrive in the market, they have not reached their optimum performance with regard to reliability and cost. The optimum realisation will be attained steadily through leaning by using or learning-by-doing (Arrow, 1962;). Policy instruments are hence needed so that these low-carbon technologies potentially be accepted above narrow market niches and so that they develop in their learning curves (Menanteau et al., 2003).

There are 110 jurisdictions at national or state level that have enacted feed in tariff policies, resulting in the most widely adopted environmental policies to promote low-carbon growth. In addition, policy design, including tax incentives and grants, continued to be an essential mechanism for stimulating new project deployment and the advancement of RETs development. Nevertheless, the electricity generated from non-hydro renewables only provided an estimated 19.2% of the world's total electricity generation in 2014 (REN21, 2016). Therefore, the policymakers in Asia-Pacific could maximise the benefit of the feed-in tariffs by increasing the incentives receives and the length of the contract by the electricity producer. Besides, agencies and ministries that are involved in promoting the renewable energy sources should provide greater awareness to individuals or firms by managing a seminar or workshop to provide deeper understanding on the application and benefits receives on clean energy installation. Next, the agencies and ministries that are related to the development of alternative

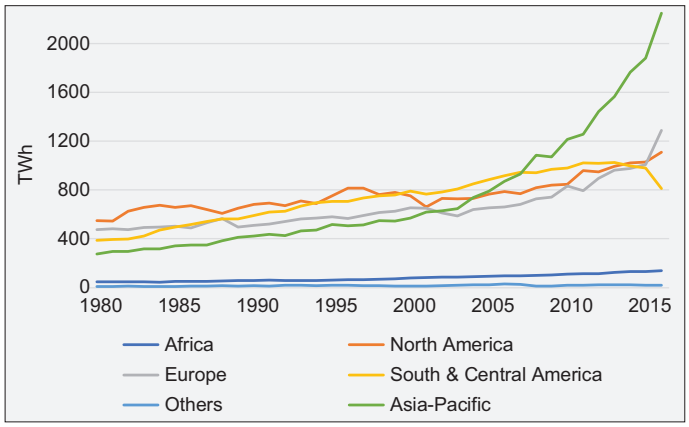
3 Net energy imports are calculated based on energy production minus energy use. Energy use is defined as the use of primary energy before conversion to other energy consumed by the user (e.g. electricity, gasoline and natural gas) which equivalent to the sum of indigenous production, energy import and stock change (difference between the amount of stock energy at the initial and final year) minus exports and fuels dispensed to aircraft and vessel involved in global carriage.

Figure 11: Energy imports in Asia-Pacific, net, 1990–2015 (percentage of energy use)



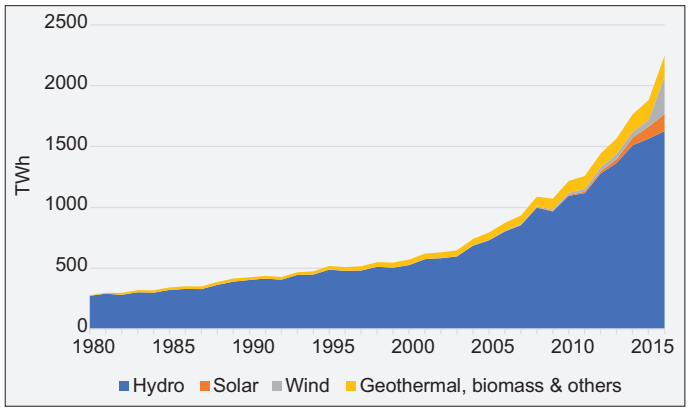
Source: World Bank (2016)

Figure 12: Total renewable electricity generation by region, 1980-2016



Source: BP (2017)

Figure 13: Renewable electricity generation from Asia-Pacific 1980-2016



Source: BP (2017)

sources should make a specific attempt in assessing the consistency of different policy mechanism, which would help to lessen policy incoherence and enhance the overall policy effectiveness.

Another important issue that needs to be raised is that not all sources of finance have the same effect on the deployment of renewable energy sources. The Asia-Pacific region saw clean-energy sector investment growing rapidly from USD 64 billion in 2013 to a peak of USD 164 billion in 2015, before dropping sharply to USD 88 billion in 2016 (IRENA, 2018). Despite the smaller investment patterns, the RETs installed capacity in 2016 increased due to capacity financed in prior years went implemented (IRENA, 2017). During 2013-2016, the annual installed capacity for RETs in the region rose by 46% to 785GW (IRENA, 2018). The apparent inconsistency between smaller investment and greater inauguration trend is likely due to costs reduction and to include inaugurations which are not reflected in installed capacity in the year in which the activity is financed. Several practitioners acknowledged geographical, technological type and project-specific factors are among the keys that need to be considered between time lag of financing and its project realisation (World Bank, 2013; IRENA, 2018). Therefore, the policymaker should devises financial instruments with facilitated financing entrance for firms dealing with the clean-energy sector. Besides, the financial sector should provide expertise in assessing the practicality, viability and hazards associated with green technologies. This can increase their familiarity and experience in handling renewable energy projects and consequently provides better opportunities in establishing the project. Next, broader reform in the regulatory and strategy framework is required in addressing the equity market, especially in the underdeveloped financial market in order to provide financial capital to high risks and uncertain projects.

Meanwhile, the commercial financial institutions should engage in providing loans although there is the existence of public funds. This can be done by increasing its financial and institutional capacity and supplement the public fund with complementary borrowings with its own resources.

5. CONCLUSION

Energy performs a central role in economic activity and sustainable development for a nation. However, the prolongation of reliance on conventional energy sources leads to the vulnerability of energy disruptions and fluctuation of energy prices, which are the main reasons for energy security concern. Continuing with imported fossil fuels to meet the increasing demand could result in an increased energy security risk in the region. Therefore, the use of renewable energy is important in meeting increases in future energy demand by offering national independence in energy supply and stability in energy prices.

Besides, clean energy reduces negative environmental impacts and, as such, are the only types of energy resources currently available that respond to the challenge of sustainable development. Importantly, the utilisation of green energy sources in the region is more desirable than the use of fossil fuels because they are abundant and environmentally friendly. It is then reasonable to anticipate that the Asia-Pacific will be able to lessen their dependence on fossil fuels on diversification of energy sources through the deployment of clean energy by taking some measures in facilitating its deployment.

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