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Dalei, Narendra Nath; Joshi, Jignesh M.

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Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics

Düsternbrooker Weg 120

24105 Kiel (Germany)

E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)

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Narendra N. Dalei,
Jignesh M. Joshi

ANALYSIS OF THE MARKET FOR RENEWABLE ENERGY SOURCES IN THE ASIA-PACIFIC REGION

One of the most promising areas for future infrastructure investment is in the modification of the world's energy mix. Rising renewable energy penetration in the world's electrical supply and energy markets is a topic of intense attention for those concerned with environmental sustainability. Given that the Asia-Pacific region is home to more than half of the world's population and accounts for more than 60 percent of global energy consumption, as well as having strong economic-growth prospects, the world's fastest rising regional energy demand, and vast potential owing to the low market saturation of renewables, accelerating the deployment of renewable energy is of critical importance in the Asia-Pacific region. More than half of the world's emissions come from Asia and the Pacific, making this region a major contributor to climate change. There are many obvious benefits, but the market is still not very well explored. This is because numerous significant problems still exist in the region, including a lack of funding, concerns about system reliability and the changing role of utilities, emissions of greenhouse gases, and the effects of climate change. New possibilities, especially for solar energy, have emerged as a result of the declining cost of renewable energy and associated technological breakthroughs. There are many obstacles to overcome on the way to this goal because of the dynamic character of economies in the Asia-Pacific region. The renewables market in the Asia-Pacific region might use some improvements, such as a more robust regulatory framework and a more alluring return on investment. This study primarily reflected the current status about renewable energy and highlighted the challenges and opportunities facing the renewable market in the Asia-Pacific region in an effort to solve these concerns. The study also offered policy implications to help deal with or lessen the effects of these obstacles in the quest to expand the renewable energy market. This study will help countries, businesses, and investors in the Asia-Pacific region to adopt policies for investment in renewable energy sector as they work towards zero-carbon targets.

Keywords: renewable energy market, Asia Pacific Region, investment, energy consumption, energy generation, sustainable development, climate change.

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1. Introduction

In comparison to energy based on fossil fuels, energy derived from renewable sources is not only environmentally friendly and clean, but it also has the potential to be both economical and sustainable. Renewable energy has already been acknowledged and accepted on a global scale as a source of clean fuel, and the Paris accord has placed significant pressure on the economies of the world to make the switch to renewable energy sources as quickly as possible in order to facilitate the transition to a low carbon economy.

In total, there are 4.7 billion people residing in the Asia-Pacific region, and the economies of the region's countries range from the largest consumer of energy in the world to small island economies that are among the most susceptible to the negative consequences of climate change. Together, Asia and the Pacific make up a massive area that is rich in variety and bustling with activity. More over half of

the world's population, or 52 percent, lives in Asia and the Pacific, where they account for around 60 percent of the world's energy consumption. Approximately 85 percent of the region's overall energy demand is satisfied by fossil fuels. They use traditional methods that involve the use of biomass for heating and cooking because they do not have access to electricity. This accounts for one-tenth of the population in the Asia Pacific region. This region already possesses a significant amount of information and skill regarding renewables, in addition to a large potential for renewable energy [1]. As a result, the Asia-Pacific area has become one of the most important global destinations for the expansion and investment of renewable energy, with the capacity expected to increase by almost two terawatts by the year 2030 [2].

In Asia Pacific region, demand is rising faster than in any other region globally, reinforced by increasing populations, robust economic-growth predictions, and extensive

potential due to the low market saturation of renewables. Being the habitat of 52 % of the global population, the Asia Pacific region supply around 39 % of the global primary energy. As far as the renewable energy in total energy mix is concerned, Southeast Asia contributes around 45.7 % share of renewables, one of the highest percentage followed by South Asia, which contributes around 42 %. Central Asia and Northeast Asia contribute around 16.2 % and 11.7 % of renewables to the total energy mix respectively [2].

The predominant fuel in Asia Pacific region is observed to be fossil fuel (Fig. 1). While around 30 to 40 % of the energy demand is met from crude oil, around 20 % is met from Coal in majority of countries of the Asia Pacific region. On an average 10 to 20 % energy demand of the total energy mix is derived from natural gas across the region except China, which has only 4 % of its energy demand met from natural gas. Therefore, there is enormous scope to meet the energy demand of Asia Pacific region through renewables.

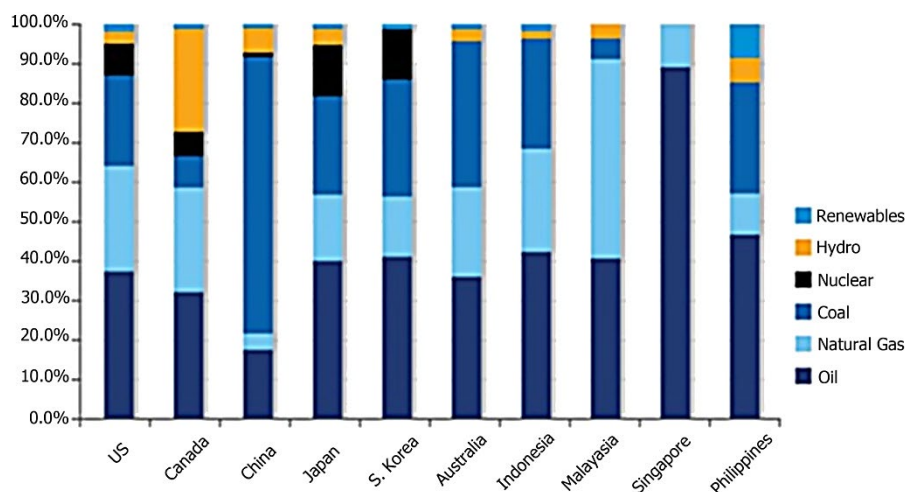


Fig. 1. Energy use in Asia Pacific region [3]

Against this background, *the study aimed* to examine the possibilities and drifts of sustainable progress with renewable energy sources and climate change mitigation in Asia Pacific region. The extent to which it can support and to examine the potential challenges and opportunities it poses. Additionally, how a shift from fossil to renewable energy sources is an assured way of changing energy mix in Asia Pacific region has been analyzed in this study. Moreover, CO₂ emission increased to 16.75 billion metric tons in 2020 in Asia Pacific region, contributing significantly to global warming. Therefore, it is important to analyze the renewable energy policies and market in Asia-Pacific Region.

2. Materials and Methods

Few authors have studied the renewable energy market and its growth in various countries [4–10]. They have summarized the challenges and opportunities for the renewable energy market. After reviewing the various structure of each country and having the potential for emerging as renewable markets, they have suggested the policy implications to encourage the growth of renewable energy market in their respective countries. We have also applied similar approach to analyze the renewable energy market in Asia Pacific region. The literatures are analyzed with respect to the possibilities and sustainable growth of re-

newable energy sources and how it can help in climate change mitigation for this region. Further, we have also studied various challenges and opportunities presents in this renewable energy market for sustainable development.

3. Results and Discussion

3.1. Policies with respect to sustainable development goal and climate change in Asia-Pacific region.

Because this region is setting an example for the rest of the world in terms of increasing energy obligations, and because few of the economies in this region have the major shortfalls in energy access, the decisions and actions taken by Asia-Pacific countries will have a vast influence on the growth towards attaining comprehensive sustainable energy objectives, as well as Sustainable Development Goals (SDGs). This is because this region is leading the way for the rest of the world in terms of increasing energy obligations. The burning of fossil

fuel was the source of 55.2 % of the world's emissions in 2014, and Asia and the Pacific was responsible for the majority of those emissions. The coal is the major contributor for the emission, it accounts for the two thirds of emissions among overall emissions. Thus, Asia Pacific region offer a tough commitments to reduce emission [11]. Although the per capita GHGE in the Asia pacific territory continues to lie below the average global emissions there is an urgent need to decrease the carbon intensity in these countries. India, Indonesia, Japan and Republic of Korea in this region are the countries found to be largest emitters of the globe, amounting to almost 40 per cent of the total global emissions [2].

To minimize the level of carbon emissions, countries like Japan, Kazakhstan and republic of Korea are adopting innovative policies such as carbon tax mechanisms or carbon tax measures. Apart from that, other countries like Vietnam and Thailand are also exploring various policy initiatives relating to carbon pricing. In order to stimulate the usage of sustainable energy, the adoption of various localized innovations is also considered.

3.2. Market, investment and market player in renewable energy sector.

Renewable Energy (RE) market has become the largest and the fastest developing one, having shares of approximately 30 % globally. China along with India constitute 3/4th of the entire region's renewable capacity of energy owing to the large projects. Mostly investment is done in geothermal energy production by these developing countries as it is superior and cost effective. The potential of wind energy focused in this area is almost 80 %. India and China have the biggest capability for photovoltaics (PV) technologies, which are estimated to propagate more in the future. The potential for the production of wind energy is expected to cultivate more in the developing nations. China stands on the top in terms of generation of solar power and wind energy. Estimates reveal that China amounts for approximately 696 GW of renewable energy as compared to that of India, which is 118 GW.

3.2.1. Policies and investment. In spite of putting substantial efforts into enhancing the rural energy access, many countries belonging to the Asia-Pacific region face tremendous challenges in meeting the desired objectives of hundred percent electrification [12]. The current policies pertaining to rural electrification requires expansion coupled with large-scale promotion of «off-grid solar technologies» and «micro-hydropower». Most of the South Asian countries (Bangladesh, India and Sri Lanka) are the torchbearers in increasing the access to energy as they are having an inventive mix of policies and a suitable mixture of off-grid electrification programmers as well as grid extension [1].

The Economic and Social Commission for Asia and the Pacific (ESCAP) acting at the behest of United Nations, has been engaged in promoting collaboration among various Asia Pacific nations to attain comprehensive sustainable development [2]. FITs (Feed in Tariff) are the usual instruments providing support in the Asia Pacific region [13]. Additionally, governments in Asia Pacific region announced various incentives to attract the investor such as attractive returns, supportive regulatory framework, attractive test benefits, carbon pricing incentives, formation of FIT for financial support. In this context, it is expected from the policymakers to come up with clear policy guidelines for emerging and potential renewables market and looking for potential solutions with regards to access to energy.

3.2.2. Market and market player in renewable energy sector. The market for renewable energy in Asia-Pacific region is not only the market that is growing at the fastest rate but also the market that has become the largest. The regional market accounts for close to 30 percent of the total market worldwide. In the Asia Pacific area, China and India account for three quarters of the region's capacity for renewable energy due to the enormous number of projects in both countries (Fig. 2). These emerging economies are putting the majority of their resources towards the generation of geothermal energy because it is not only superior but also relatively inexpensive. The wind energy that can be harnessed in this region has a potential of about 80 %. Additionally, Japan is responsible for the generation of a sizeable amount of energy from renewable sources. Photovoltaic (PV) technologies, which are expected to spread further in the future, have the most potential in China and India. It is anticipated that the growing Asian countries, particularly Thailand and Korea, will see an increase in their production capacities for wind energy in the next years. When it comes to solar power generation capacity as well as wind energy capacity, China is the country that stands out as the most prominent. Compared to India's almost 118 GW, it controls approximately 696 GW of renewable energy. When it comes to manufacturing technologies like solar, wind, and hydropower, China is at the forefront of the pack. The modification of rules within the country with the objective of lowering the pollution caused by coal and other sources of carbon emissions is helping to support the growing demand for sustainable power sources within the region. In 2018, there was a 10 % increase in China's overall capacity. The expansion of industry in China has been aided by policies and initiatives such as the VAT Refund Policy, the Green Certificate Program, and tax rebates. India is an extra major country in the region where there is an increase in the market for renewable energy as a result of expanding industrial tariffs and

constraints as well as the vast number of power plants. Solar power, with its relatively inexpensive initial investment, has become the technology of choice in India. In 2018, there was almost a fifty percent increase in solar power in comparison to the previous year. Feed-in-tariff and other output-based incentives are among the policies helping the business thrive [14].

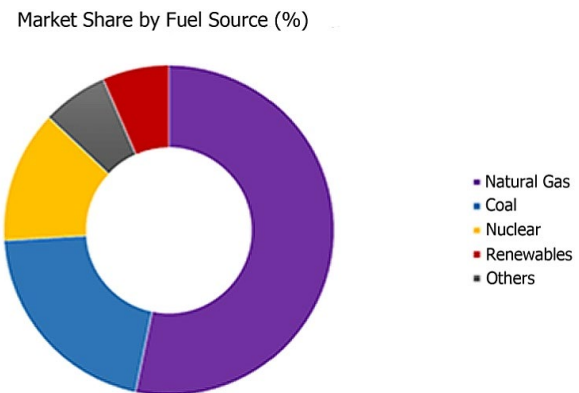


Fig. 2. Asia-Pacific Renewable Energy Market [14]

Based on analysis of the competitive landscape, capacity, and latest developments such as mergers, acquisitions, investments, capacity expansions, and plant turnarounds, EMR identifies, Mahindra EPC Irrigation Limited, TBEA Sunoasis Co., Ltd., Windflow Technology Ltd., Tata Power Limited, Vestas Wind Systems A/S, Suzhou Talesun Solar Technologies Co., Ltd., Zhejiang Chint New Energy Development Co Ltd, and Abengoa as the leading firms in the Asia-Pacific renewable energy market [14].

3.3. Energy transition and investment. The Asia-Pacific region plays an essential role in the global efforts to achieve a transition to green energy and reach net-zero emissions. This is because the region is home to some of the world's most populous countries. Because of its substantial population, the region is responsible for around 45 percent of the world's total emissions of greenhouse gases. Furthermore, it is home to five of the world's 10 largest emitters of greenhouse gases (China, India, Indonesia, Japan, and South Korea). It is also a diverse territory, which means that solutions need to be customized to the particulars of each location in order to be effective. For instance, India is at a crossroads in terms of making important decisions as it strives to deliver an unprecedented expansion of energy supplies to satisfy its rapidly developing economy in a manner that satisfies the government's goal of achieving net-zero emissions by the year 2070. India is attempting to do this in a way that satisfies the goal in a manner that satisfies the government's goal of delivering an unprecedented expansion of energy supplies.

In the midst of an ongoing energy crisis, more countries in the region are stepping up the pace of growth and making progress, which has resulted in a heightened sense of urgency to take action with regard to the development of sustainable transition models. The countries that are a part of the region known as the Asia-Pacific region are the ones that suffer the most damage from natural disasters. The countries that make up this region were hit with 55 earthquakes, 217 storms and cyclones, and 236 incidences of severe flooding during the years of

2014 and 2017. These natural disasters were responsible for the deaths of 33,000 people and had an impact on 650 million people worldwide. Densely inhabited metropolitan regions are more vulnerable to the effects of climate change than less populated places because urbanization and inadequate planning contribute to this vulnerability. This is especially the case in urban areas that are situated in close proximity to important rivers and regions that are located on the shore. As a consequence of this, the Asia-Pacific region needs to place a higher importance not just on the part that companies play in the coming year but also on improving energy efficiency and increasing the use of renewable energy sources.

The Asia-Pacific region is one of the most important fronts in the fight to halt the effects of climate change, which is now underway. In order for this region, which is responsible for more than half of the world's CO₂ emissions, to meet its obligations under the Paris Climate Agreement, it must immediately reduce its reliance on coal and completely commit to decarbonization. As a result of the crisis, governments, businesses, and investors from all across the region have acknowledged and prioritized the necessity to take prompt action in response to the situation. They invested a record 368 USD billion in 2021 to assist in speeding the energy transition, which was a 38 % increase over the amount they invested the previous year to help accelerate the energy transition. Despite the fact that there is positive momentum, the economies in the region face a variety of obstacles and have specific requirements. Prospective decarbonization pathways can be observed when one examines the existing situation in a few of the countries that are located in this region in greater detail (Fig. 3).

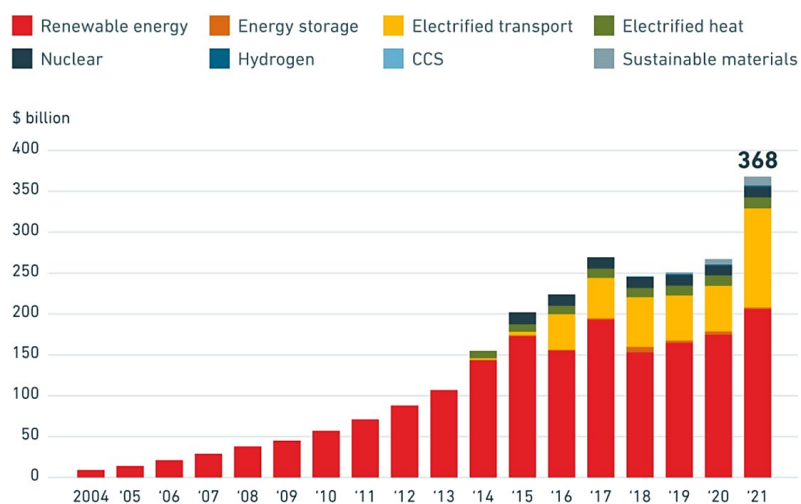


Fig. 3. Energy Transition Investment by sectors in Asia-Pacific Region [15]

3.4. Challenges and opportunities. Due to the changing nature of economies among the Asia Pacific Economic Cooperation (APEC) countries, there are several challenges on the road to achieve the target of sustainable energy market. Alternatively, decreasing cost of renewable energy and associated technological developments offer new opportunities, specifically for solar energy [16].

3.4.1. Challenges. Even though by and large the renewable energy sector is promising in nature, however, the mar-

ket is said to be less explored. The reasons for the same can be attributed to the following:

- *Financing:* In Asia Pacific region, multiple issues are encountered with regards to financing as it is becoming difficult to attain the specific national and international targets for reductions of emissions and decarbonisation of the energy sector. The underlying causes behind the absence of the private entities in facilitating renewable energy systems in remote areas in challenging territory is due to the high amount of capital cost that is involved [2].
- *Reliability on the System and change in the function of Utilities:* There is a change in the shape of renewables investment because of quick variations that have happened in the affordability of the cost and fluctuations. This will affect the interest of private and public lender for the wind and solar assets [2].
- *Greenhouse Gas Emissions (GHGE) and Climate Change:* Asia Pacific territory is considered to be a major contributor to the GHGE at the global level. There seems to be a huge gap between the drive conducted to mitigate climate change as compared to that of the speed of activities to reduce emissions [17].

3.4.2. Opportunities. The energy demand placed by the Asia Pacific territory is on the rise. It is supposed to enhance the volume of renewables, adding more volume than the rest of the world combined:

- Shorter installation times against traditional energy sources attracts the developing economies, which requires that new capacity should be built faster to keep energy access in Asia Pacific region.
- *Improvement of economics:* There is a need of continuous efforts aimed at enhancement of efficiency and targeting development practices in the manufacturing procedure. These coupled with high trade in costs incurred for fuel have aided renewables source to become relatively cost effective relative to fossil resources [18].
- *Supportive Regulatory Framework:* Mostly countries of this region have open and transparent tendering mechanisms, national or regional renewables goals and feed-in tariffs for renewable energy. These are responsible in building the confidence of the investors [18].
- *Alluring Returns:* Due to rising population, energy demand in Asia Pacific region is also rising, which is favourable for the investor to invest in renewables. Returns for renewable energy projects in Asia-Pacific region is greater than for equivalent projects in Europe or the US due to availability of cheap labour and raw materials [18].

4. Conclusions

In Asia Pacific region, demand is rising faster than in any other region globally, reinforced by increasing populations, robust economic-growth predictions, and extensive potential due to the low market saturation of renewables. Alteration of the Global energy mix is said to be one of the important features and is an opportunity conducive for investments at the global level in future. Particularly it is possible to see good-looking investment opportunities in the Asia-Pacific region.

Although encouraging prospects for renewables development exist in Asia Pacific region, each market faces its own set of challenges, requires precise capabilities and an exceptional strategy to win. The role of government in creating positive circumstances for renewable energy is still vital across the majority of Asia Pacific region. The opportunities for renewable energy investment in the region will only increase as more countries, industries and funds strive to meet zero carbon goals.

Asia-Pacific drives green energy and net-zero emissions projects. Most populous nations are here. The region produces 45 % of global greenhouse gases. It comprises five of the top 10 greenhouse gas emitters (China, India, Indonesia, Japan, and South Korea). India must increase energy supplies while meeting its 2070 net-zero emissions objective. As countries grow under an energy crisis, sustainable transition strategies are essential. Natural disasters hit Asia-Pacific nations most. Urbanization and inadequate planning make urban regions vulnerable to climate change. River and coastal cities are most affected. Asia-Pacific nations must prioritize energy efficiency, renewable energy, and business involvement in coming years. Asia-Pacific must combat climate change, which emits half the world's CO₂, must swiftly reduce coal use and fully decarbonize to meet Paris Climate Agreement commitments.

Asia-Pacific has the largest and fastest-growing renewable energy market. 30 % of the global market is regional. Due to their large number of projects, China and India account for three quarters of Asia Pacific's renewable energy capacity. Geothermal energy is superior and cheap, hence these growing economies are focusing on its production. This region offers 80 % wind energy potential. Japan also generates renewable energy. China and India are the most promising markets for photovoltaic (PV) technologies. Wind energy output is expected to rise in developing Asian nations like Thailand and Korea. China leads in solar and wind energy capacity. It owns 696 GW of renewable energy, compared to India's roughly 118. China leads in solar, wind, and hydropower manufacturing. The country's changes to reduce coal and other carbon emissions are supporting the region's desire for sustainable power. The VAT Refund Policy, Green Certificate Program, and tax rebates have helped Chinese business grow. Due to rising industrial tariffs and power plant numbers, India is a prominent renewable energy market.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this article.

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Data availability

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✉ **Narendra N. Dalei**, PhD, Department of Economics, School of Social Sciences, Central University of Himachal Pradesh, Dehra Gopipur, India, e-mail: nndalei@hpcu.ac.in, ORCID: <https://orcid.org/0000-0003-0114-0809>

✉ **Jignesh M. Joshi**, PhD, Refinery Division, Nayara Energy Limited, Devbhumi Dwaraka, Gujarat, India, ORCID: <https://orcid.org/0000-0002-0761-1053>

✉ *Corresponding author*