The next frontier for infrastructure investments

Renewable Energy in Asia-Pacific

pwc

Contents

Foreword

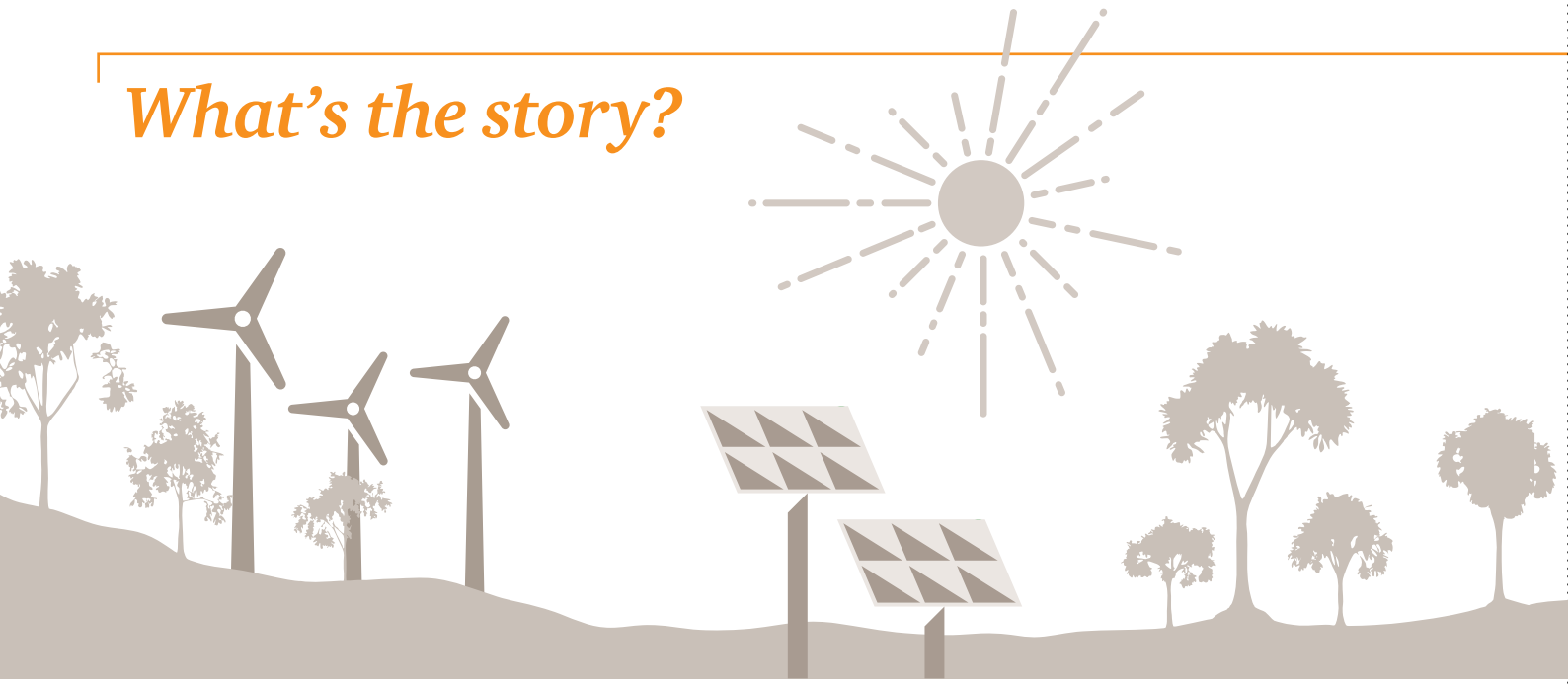
In 2015, PwC conducted a Global Power & Utilities Survey where we asked utility executives about how technology is disrupting the traditional utility business model. About 85% of respondents recognise that falling technology costs for Renewables will result in new sources of power generation becoming widespread and accessible.

Fast forward to year 2017, we have now seen some of the largest volumes of transactions in Renewable markets, in particular Asia-Pacific. The most recent transaction announced in October 2017 relates to a 11GW portfolio (including development assets) of Equis Energy (Singapore) and sold to a consortium led by Global Infrastructure Partners and China Investment Corp. We expect increased investment in the renewable energy market with the recent recovery of oil prices combined with increased interest from oil & gas players.

From new energy storage technologies to the smart grid, 59% of Power & Utilities CEOs say their companies are making significant changes in how they use technology to help them assess wider stakeholder expectations and respond to them more effectively. However, while many utilities recognise the need to develop a robust strategy for disruptive technologies and evolve their business model, most have just started to take the first steps towards implementing their plans.

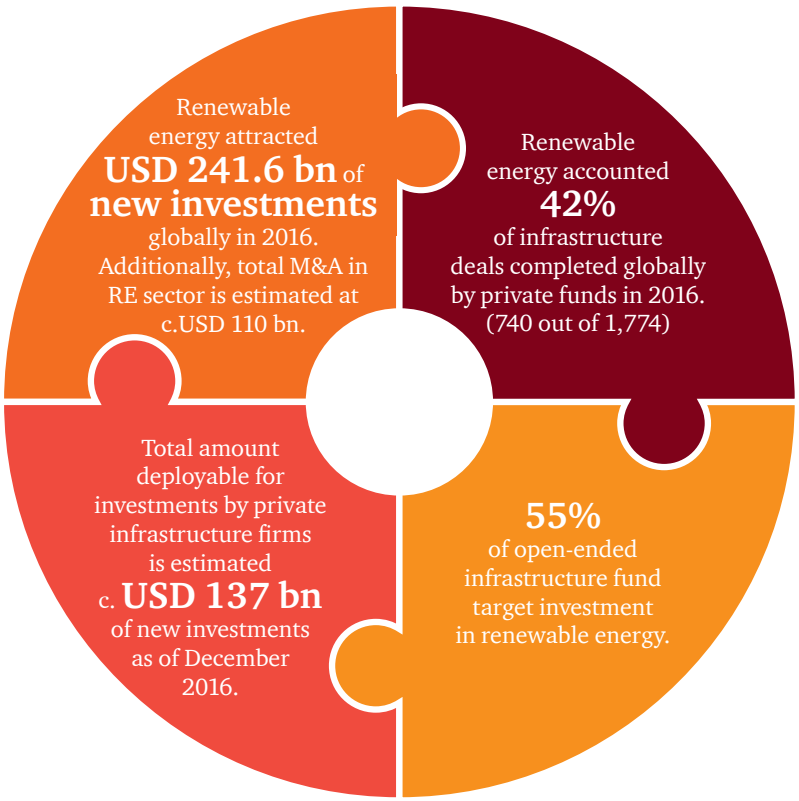
With total renewable energy investments of USD 241.6 billion in 2016, this report provides our view on how renewable energy continues to have a strong economic case in Asia-Pacific, key considerations for investors and emerging trends/ technology in the sector.

What's the story?



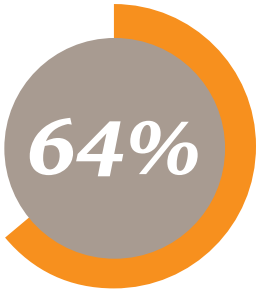
In 2016, **Renewable Energy (RE)** attracted **USD 241.6 billion** of new investments globally with a total capacity addition of 138.5GW[1]. Out of the total new investments, around **USD 114.8 billion** or **47%** were in Asia-Pacific countries. Solar and wind sub-sectors were key drivers for the investments, followed by biomass, small hydro and others.

Figure 1: Global RE investments in 2016



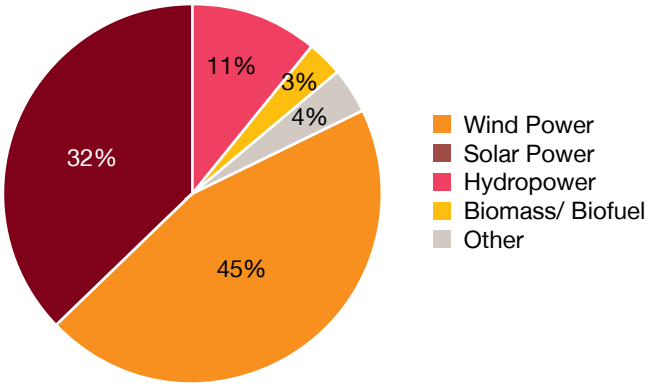
Source: International Energy Agency, UNEP, Bloomberg New Energy Finance, 2017 Preqin Global Infrastructure Report

1 Global Trends in Renewable Energy Investment 2017, http://www.fs-unep-centre.org (Frankfurt am Main)



Infrastructure investors believe RE assets present attractive investment opportunities.

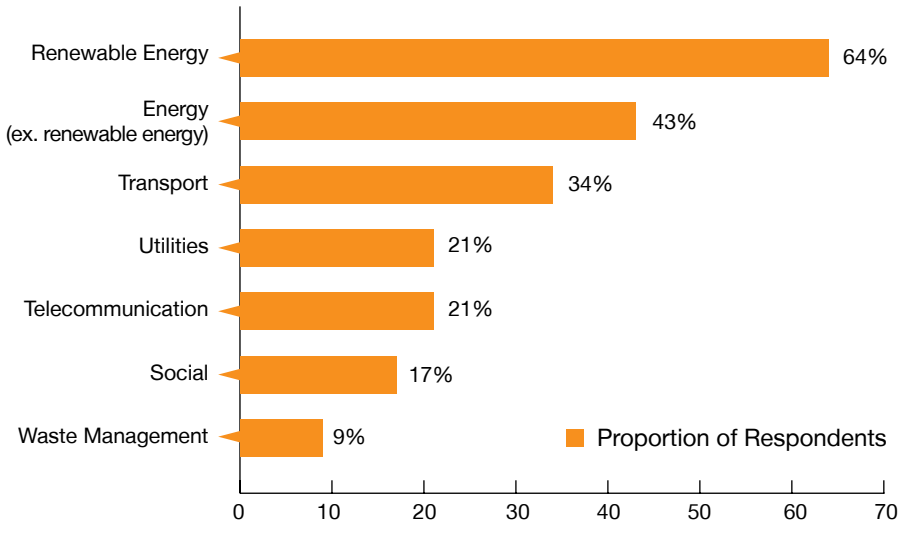
Figure 2: Types of completed RE infrastructure deals by private funds (globally)



Source: 2017 Preqin Global Infrastructure Report

Wind and solar continue to attract maximum number of investments by private funds among the various technologies (Figure 2). RE continues to be seen as a key growth area in the future globally and in key economies of Asia-Pacific, with 64% of respondents having a favourable outlook for RE (Figure 3).

Figure 3: Infrastructure sector investors' view on various sectors as presenting attractive opportunities at present (globally)



Source: 2017 Preqin Global Infrastructure Report

Economic and financial viability is critical for continued investor interest and going forward, governments must play a large role and provide enabling policies or regulatory frameworks to meet the ambitious national targets for RE in the overall energy mix.

Besides traditional RE companies and infrastructure investors, there is also a growing interest from conventional power and oil & gas players.

What's happening: Global oil & gas players are making in-roads to RE sector and pose increased competition for upcoming RE assets

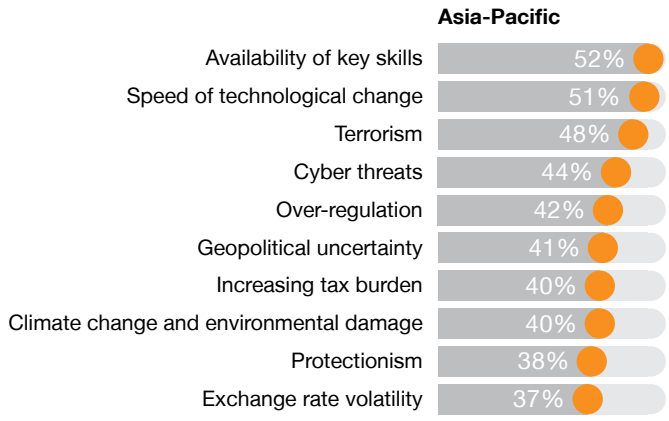
- **Shell**, Europe's largest oil company, has established a separate division, New Energies, to invest in renewable and low-carbon power[2] (May 2016). The company pledged to cut its net greenhouse gas emissions by 20% before 2035 and 50% by 2050, while investing USD 1-2 billion per year in renewables and electric vehicles between 2018 and 2020[3].

- French company, **ENGIE**, lays out a 5.2 GW renewable goal, and its CEO in charge of RE, Gwenaëlle Huet, commits that their "ambition is to reach 3GW of installed capacity of onshore wind farms and 2.2GW of solar photovoltaic power plants by 2021[4]." (December 2017).

- French oil and gas group, **Total SA**, concluded the purchase of a 23% interest in EREN Renewable Energy in September 2017. It is also acquiring GreenFlex, which specialises in finding ways to use energy more efficiently[5].

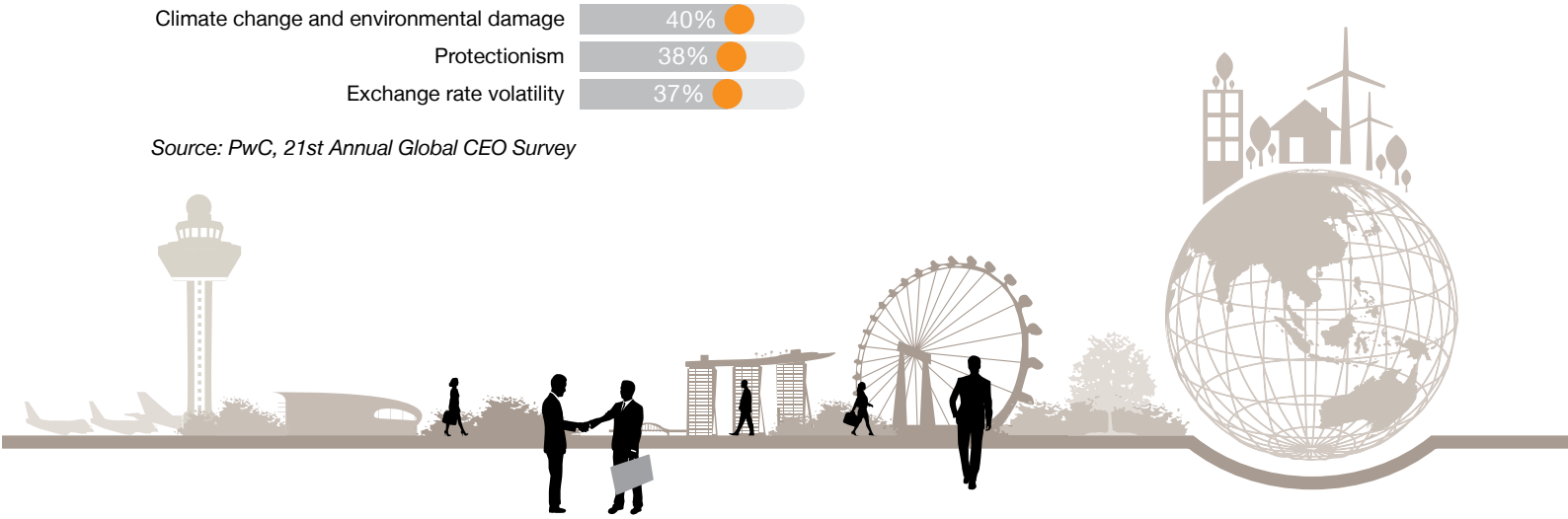
Going forward, there is expected to be increasing competition for both greenfield and brownfield RE assets in Asia-Pacific; and the market is likely to see some consolidation as large players enter into the sector.

Figure 4: Top 10 threats perceived by Asia-Pacific CEOs



Source: PwC, 21st Annual Global CEO Survey

PwC's latest CEO survey also found *"climate change and environmental damage"* as one of the top 10 concerns amongst Asia-Pacific business leaders (Figure 4). With this in mind, we can expect a stronger focus directed at the development and take up of RE coming from business leaders.



2 *Shell creates green energy division to invest in wind power, The Guardian, May 2016*
3 *Shell's green plan underwhelms critics, Eco-Business, December 2017*
4 *French company ENGIE lays out 5.2 GW renewable goal, UPI, December 2017*
5 *Total steps up renewables drive with EREN, GreenFlex deals, Reuters, September 2017*

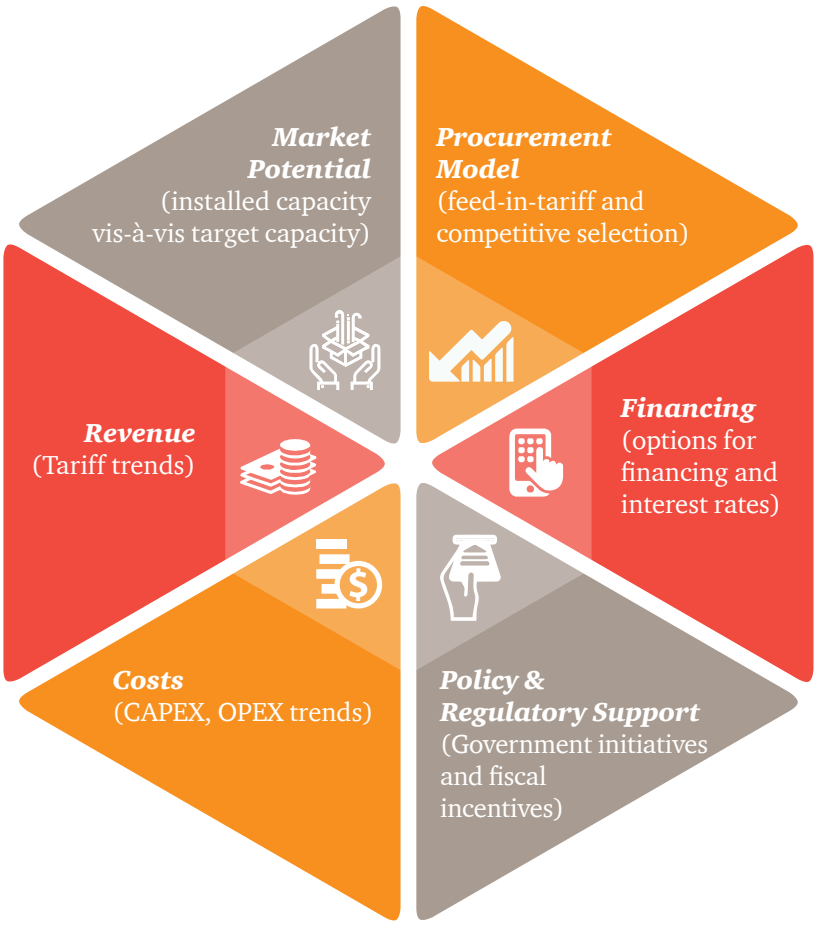
The economic case for RE is certain

With many countries facing sluggish economic growth and the growing ratio of non-performing assets (NPA) from the infrastructure sector on the balance sheets of many banks, it is pertinent to ask the question ***- is there is an economic case for RE?***

In our view, the economic case for different RE technologies (wind, solar, hydro, biomass etc.) is dependent on **six key factors**: market potential, procurement model, financing, policy & regulatory support, costs and revenue (Figure 5).

We see a potential investment of up to USD 250 billion[6] new investments in utility-scale solar and wind projects till 2025 in major Asia-Pacific countries[7] and there continues to be a strong economic case for RE investments in the medium to long term.

Figure 5: Six key factors influencing the economic case for RE



6 *Calculated based on the potential capacity for solar projects for different countries in Asia Pacific and assuming an average cost of USD 800-1,000/ kW for solar project and USD 950 -1,200/kW for wind project.*

7 *The countries include Japan, India, Philippines, Australia, Indonesia, Thailand, Vietnam, Taiwan and South Korea*

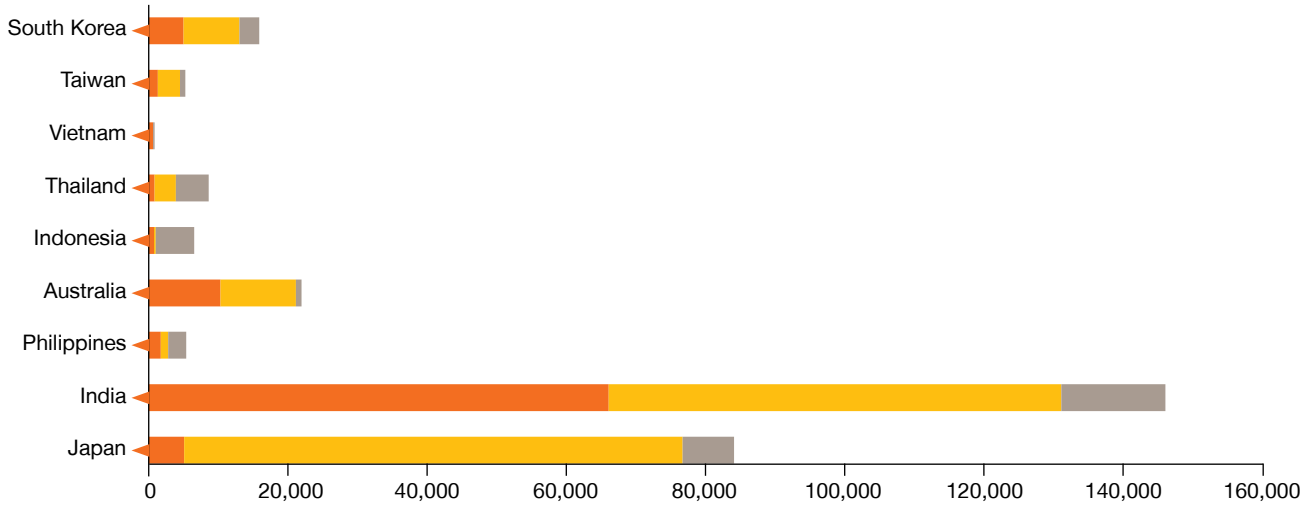
Market potential: Readiness to go green

Many governments in Asia have ramped up their efforts for increasing RE in the overall energy mix, with RE targets being significantly higher in some countries when compared to existing capacity.

For instance, India had 57GW of RE installed as of March 2017, and has a 175GW target by 2022, representing a common annual growth rate (CAGR) of 26% every year[8].

We see a large potential for better technologies in RE - such as more efficient photovoltaic (PV) cells, larger wind turbines and improvements in biomass and waste management, thus, leading to bigger and more scalable projects.

Figure 6: 2025 RE forecast (MW) for select countries in Asia-Pacific



	Japan	India	Philippines	Australia	Indonesia	Thaliand	Vietnam	Taiwan	South Korea
Wind	5,101	66,023	1,732	10,318	775	846	658	1,308	5,003
Solar	71,517	64,979	1,088	10,800	236	3,096	0	3,176	8,040
Others (Biomass, Geothermal)	7,422	14,927	2,581	825	5,523	4,683	198	780	2,841

Source: BMI forecast, December 2016

8 Source: Ministry of New and Renewable Energy (MNRE), India

Procurement model: Countries increasingly moving towards the auction system

The initial projects for all RE technologies in Asia were driven by governments through **Feed-in-Tariff (FIT) mechanisms**, wherein the government buys the energy from RE projects at a fixed price throughout the term of these projects to cover for the cost of installation, operating expenses (including interest costs) and a reasonable equity return.

As of 2017, majority of Asia-Pacific economies have moved to some form of competitive selection process for RE technologies, especially for utility-scale solar and wind projects.

A falling trend in RE tariffs under the auction system in the region indicates a strong market acceptability for the competitive selection process in major economies in Asia-Pacific.

Figure 7: Key economies in Asia-Pacific and their procurement process for RE across solar and wind (2017)

Country	*Solar*	*Wind*
Japan	Auction (starting 2017)	Feed-in-Tariff
India	Auction	Auction
Philippines	Competitive selection process (Auction proposed)	Competitive selection process (Auction proposed)
Australia	Wholesale market	Wholesale market
Indonesia*	Bilateral (agreement with PLN)	Bilateral (agreement with PLN)
Thailand	Competitive bidding (tariff cap defined)	Competitive bidding (tariff cap defined)
Vietnam	Feed-in-Tariff	Feed-in-Tariff
Taiwan	Feed-in-Tariff	Feed-in-Tariff
South Korea	Auction	Auction

Source: PwC Analysis

The most commonly used competitive selective process is the **auction system** – in which the government sets a target megawatt (MW) capacity for RE before each auction and this capacity is allocated to the lowest price bidders, either in full or in blocks as per the received bids (where the size of the bid by any developers varies from 20 to 100 MW).

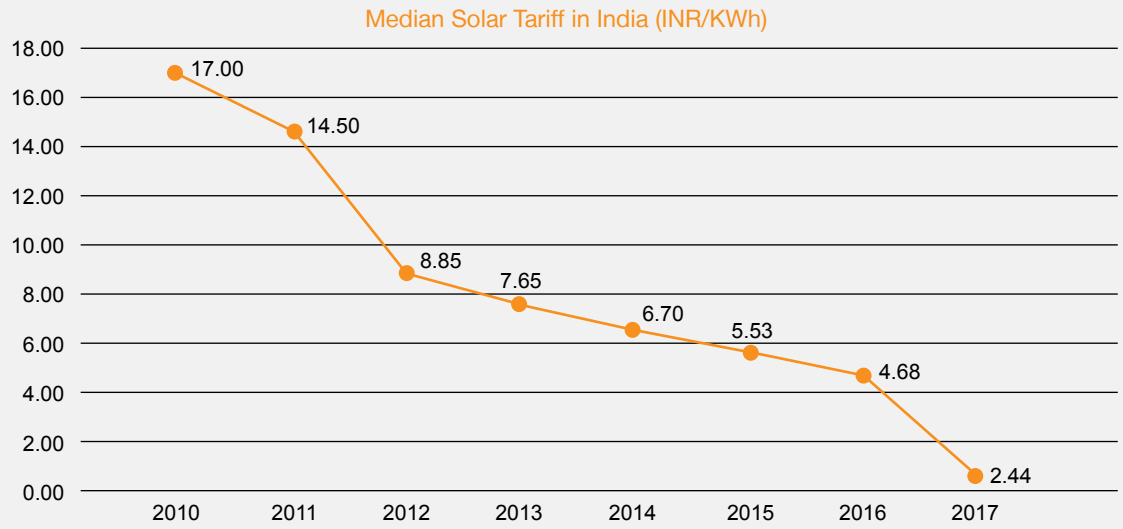
There have been some variations in this auction system (e.g. Swiss challenge) but the end objective is same, to eliminate RE subsidies and FIT mechanisms if the technology is commercially viable.

* *The procurement regime in Indonesia for solar/wind is complex and varies according to the province. For full details, please refer to Chapter 5 of PwC's Power in Indonesia: Investment and Taxation Guide 2017, 5th Edition. This publication is available at https://pwc.to/2AuKgwW*

What's happening: Auctions on discovered solar tariffs (India and Japan)

India – Dramatic fall in solar bids

Figure 8: Solar tariffs in India between 2010 and 2017



Source: Ministry of New and Renewable Energy, India

Highly competitive reverse auctions, falling module and component prices, introduction of solar parks, lower borrowing costs, and the entry of large power conglomerates with strong balance sheets as well as access to cheaper capital have all contributed to the dramatic fall in solar bids in India.

Japan – First solar auction pushes prices down by nearly a quarter

Japan's first auction for contracts to provide solar electricity pushed prices down by nearly a quarter from a previous system. The lowest accepted price for solar projects was **17.2 yen/kWh in November 2017, down from 24 yen/kWh in the year through March 2017** for projects approved under Japan's Ministry of Economy, Trade and Industry's (METI) FIT programme.

METI has set a target for solar tariffs to reach 14 yen/kWh by 2020 and 7 yen/kWh by 2030.

Source: Ministry of Economy, Trade and Industry (METI), Japan

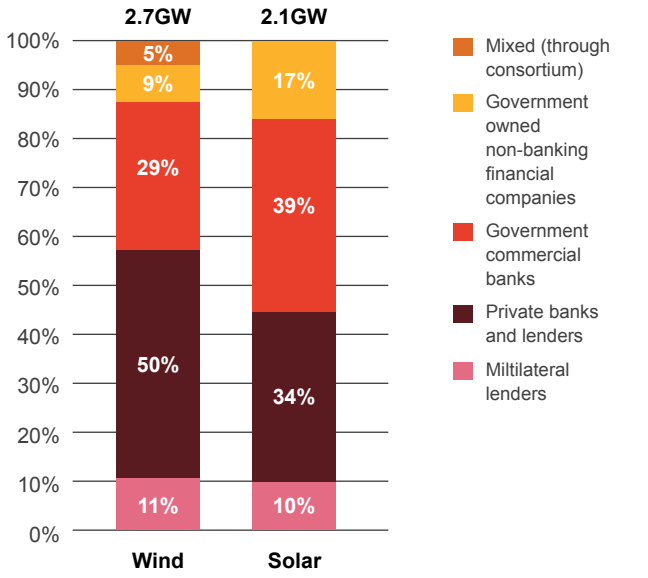
Financing: The fuel to deliver projects

Till date, **private investors/corporates** have provided equity for RE projects with debt financing from **international/domestic banks** – either privately – or government-owned.

Figure 9 depicts the financing sources for wind and solar projects in India for FY 2013-16.

Other key sources of financing include **governments** – through subsidies, viability gap funding mechanisms – and **multilaterals** – Asian Development Bank (ADB), The World Bank, Department for International Development (DFID).

Figure 9: Sources of debt finance for wind and solar projects FY2013-16 in India (%)

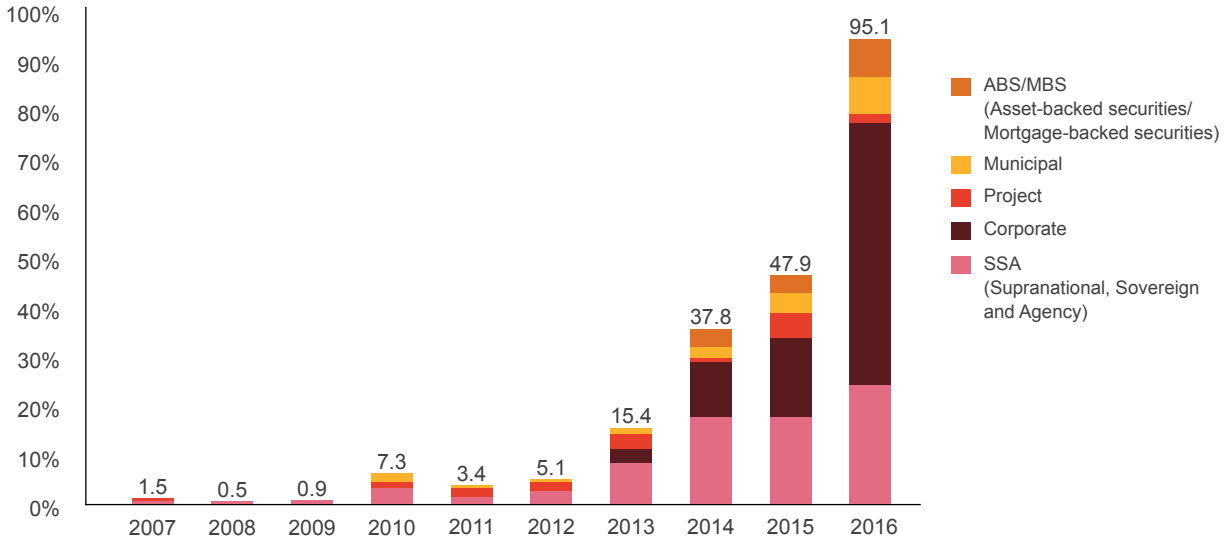


Source: Bloomberg New Energy Finance

What's happening: ADB provides support for solar PV development in Cambodia

ADB is supporting Electricite Du Cambodge (EDC), the government distribution utility in Cambodia, to develop the country's first large scale 100MW national solar park and is expected to provide concessional funds to EDC for the common infrastructure of the solar park. This project will also help in developing a template for solar public-private partnerships ("PPP") in Cambodia and potentially in other parts of neighbouring Southeast Asian countries.[10]

Figure 10: Total Green Bond Issuance by Category (2007-2016), USD billion



Source: Bloomberg New Energy Finance

Besides decreasing financing costs, we expect continued **innovation in financing options** (e.g. infrastructure trusts and green bonds). Further, an increased momentum from public markets (with more RE firms being listed for public offerings, increased secondary market transactions and market consolidation) is expected to provide financing needs for required RE investments.

9 *Source: ADB (https://www.adb.org/news/adb-partner-cambodia-launch-national-solar-park-program)*

Policy & regulatory support: Accelerator of the RE ecosystem

A conducive policy & regulatory framework is instrumental in attracting large capital investments in RE from both domestic and international investors. While the procurement model for RE is a key driver, other government initiatives and fiscal incentives also have a big role to play. Figure 11 provides some examples from Asia-Pacific countries.

Government impetus available in major Asia Pacific economies (e.g. India) to facilitate the take up of electric vehicles (EVs) may also potentially fuel demand for clean power[15].*

Figure 11: Examples of Government initiatives and incentives to promote RE in Asia-Pacific

Government-led initiatives	*Asia-Pacific examples*
National RE targets	Most of the countries now have a target for 25-50% share of renewables in total energy mix. E.g. Philippine Energy Plan 2009-2030[10] aims for renewables to represent 50% of the power generation mix by 2030.
Government funds to support RE projects	Such support can be in form of viability funding, credit guarantee facility or technical assistance. For example, the Energy Service Company (ESCO) fund in Thailand[11] and Sustainable Renewable Energy Fund in Vietnam[12].
Tax incentives	In Philippines, RE developers have exemptions from income tax for seven years, followed by a discounted income-tax rate of only 10% (compared with the standard rate of 35%)[13].
Renewable Purchase Obligations (RPOs)	Large generators/utilities to mandatorily procure 5-10% of energy from RE sources. E.g. all gencos (>1000MW, excluding BOT projects) in Vietnam are mandated to reach 10% RE capacity by 2030[14].
Land Availability	In India, government provides land for solar parks; Vietnam provides exemption/reduction in land use fee for RE projects.
Research & Development Support	Singapore government set-up Solar Energy Research Institute of Singapore (SERIS) to develop industry-oriented research & development (R&D) for the solar energy sector locally and in the region.

** India (the world's fifth-largest auto market) has a target to move completely towards EVs by 2030. This is part of the government's vision to helm a RE revolution in the country.*

10 Philippine Energy Plan 2009-2030, DoE, 2009
11 Website of Energy for Environment Foundation, Thailand
12 The General Directorate of Energy, Ministry of Industry and Trade, Vietnam
13 Green Investment Climate Country Profile – Philippines, The World Bank, 2013
14 The large changes in Energy Development Strategy in Vietnam, Vietnam Energy Online, 2016
15 India to sell only electric cars by 2030, CNN Money, June 2017

Costs: Making renewables competitive

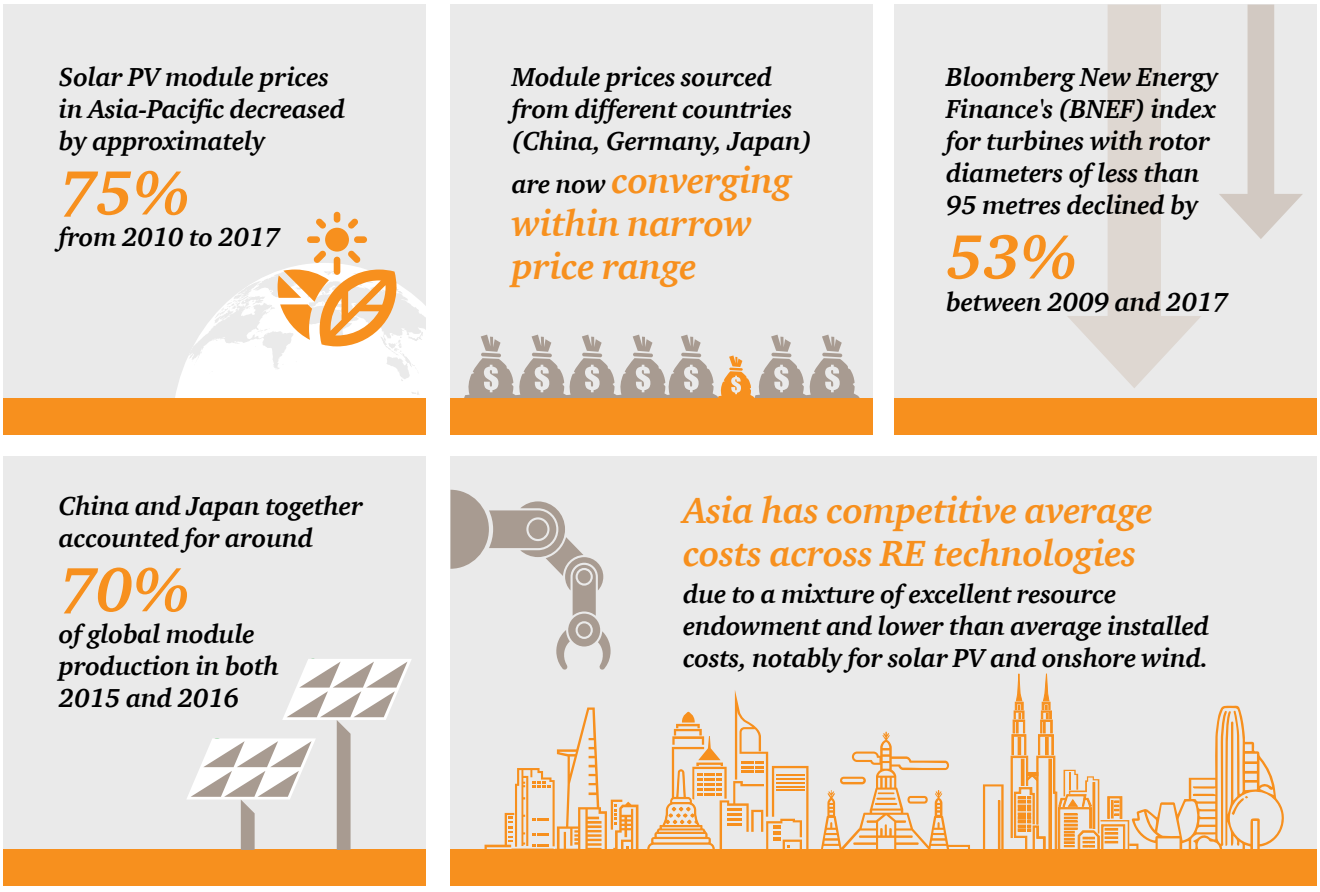
Two most widely employed RE technologies - solar and wind - saw their capital costs falling steadily in recent years, e.g. there was a decline of solar PV module prices by around 75% between the end of 2010 and the end of 2017[17]. Solar PV panel costs account for around 35-50% of total capital cost for a solar plant, depending on size of project and type of PV module.

For wind power projects, the biggest capital cost component is for the turbine *(including wind blades, tower and transformer)* which is around 65% of total capital cost of such projects, with other components being the foundation cost, grid connection costs and other civil works.

Wind turbine prices peaked in 2009 but have started to decline since then and were around USD 950-1,240/MW in 2016 (a 40-50% reduction since the peak prices of c.USD 1,900/MW in 2009)[18]. This decline can be attributed to increased competition among wind turbine manufacturers and lower commodity prices for steel, copper and cement.

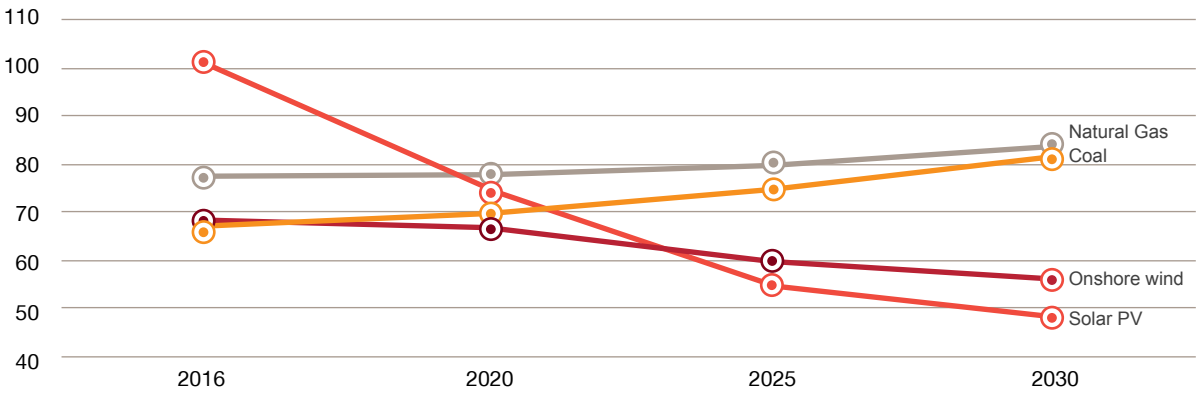
Over the past few years, improving supply chain efficiencies and equipment costs have been driving down the Levelised Cost of Electricity (LCOE) for renewables. Solar PV levelised costs estimated to have fallen 58% between 2010 and 2015 and estimated to fall a further 51% between now and 2030. Figure 13, on the following page, illustrates how solar PV is set to become more affordable than conventional sources (coal and natural gas) to generate electricity.

Figure 12: Global PV module pricing trends



Source: Renewable Power Generation Costs in 2017, IRENA

Figure 13: Comparison and evolution of Levelised Cost of Electricity (LCOE), $/MWh



Source: GlobalData, 2014; pvXchange, 2016; Photon Consulting, 2016.

With improved technology, equipment suppliers are now willing to offer **long term performance warranties** for their equipment. For example, a 20 year replacement warranty in case of equipment failure or degradation below stated performance levels.

Another cost driver affecting the economic business case is **Operation & Maintenance Expenditure (OPEX)**.

Many developers are now going for in-house operations & maintenance (O&M) and managing overall costs by having a centralised regional O&M team – which has partly led to overall decrease in average tariff quoted by RE developers globally.

Revenue: Robust PPAs remain a key consideration for developers

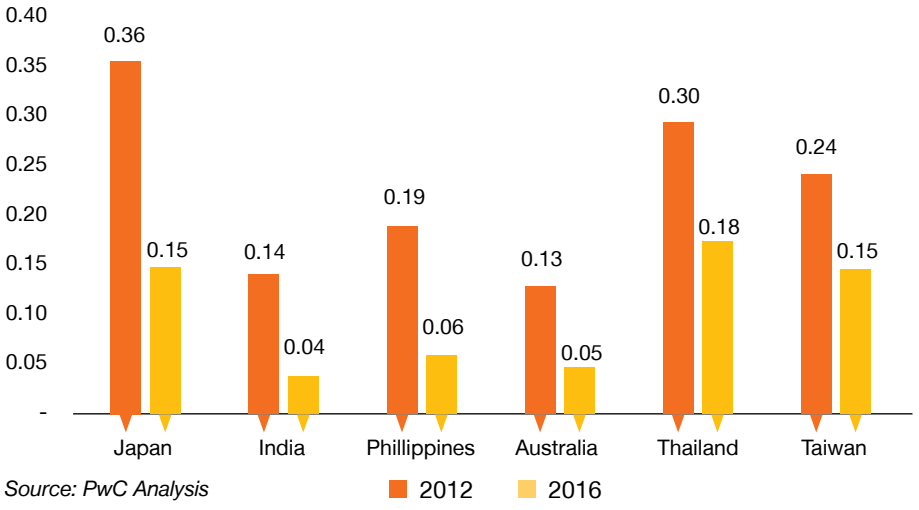
Revenue business models are generally underpinned by Power Purchase Agreements (PPAs) or viable wholesale electricity markets. For RE, some of the factors under consideration by investors include:

- PPA term – long term contracts by government utility off-takers (up to 30 years) or short term commitment by commercial & industrial (C&I) customers
- Payment mechanism – RE projects are likely to have a single levelised tariff throughout the term
- Arrangement with lenders and ring fencing of assets for bankability/project finance
- Termination clauses – transfer/no transfer of assets after end of PPA term
- Force majeure provisions

India and Australia are markets where C&I customers are highly sought after by RE developers to increase electricity off-take with favourable terms.

Due to availability of robust and commercially attractive PPAs, the discovered prices through auctions for solar and wind have shown a declining trend recently. For example, Asia-Pacific countries have seen a tariff drop in solar projects of 50-70% in just four years from 2012-2016[19].

Figure 14: Comparison of solar tariffs in Asia-Pacific countries in 2012 and 2016 (USD/kWh)



Source: PwC Analysis

In our view, RE tariffs for solar and wind will continue to fall in the short term (2-3 years) and may stabilise in the medium term (5-10 years), as market consolidation picks up the pace and margins are compressed to the minimum return required by developers.

19 *The extent of decrease in tariff is dependent upon country and procurement method (auctions have resulted in higher drop in tariff due to increased competition).*

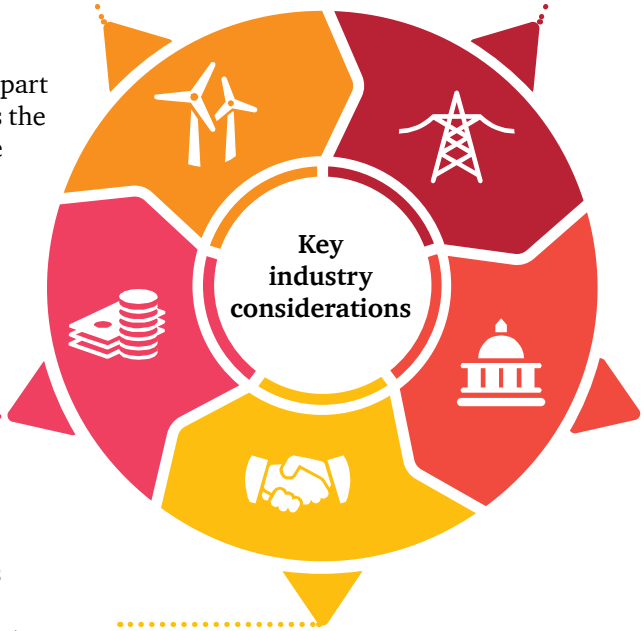
Key considerations for developing RE in Asia-Pacific

As with any business, there is much for a RE developer to consider in terms of potential issues and solutions to those issues when procuring a project, and these considerations vary depending on the jurisdiction in which the developer decides to enter.

Figure 15: Key industry considerations for RE projects

Land procurement
Land procurement for RE projects in the region is one of the big issue that developers encounter. If project land has not been allocated by a government procuring authority (for example, as part of a tender), developer has the responsibility to secure the land required

Grid connectivity & stability
This is an issue which can greatly vary in severity among different jurisdictions and RE developers consider grid connection and/or grid stability as important project viability factors (e.g. securing grid connection, dealing with inadequate grid infrastructure and distance of project from the main grid)



Financing
Although the costs of RE projects have decreased in recent years, the size/ capacity is increasing. This gives rise to considerable CAPEX funding requirements for these projects, of which a sizable debt consideration would usually be required

Off-take security
For a RE developer, securing the off-take remains one of the most critical milestones which drives the commercial viability and bankability of the project

Regulatory & legal framework
This provides the overarching environment for the procurement of the project. For example, a RE developer wouldn't consider a project in a specific country if the energy policy was to generate power from 100% coal. Instead, they may opt for a country where certain financial incentives were provided (e.g. tax breaks) for RE projects developed there

Land procurement

While land procurement is a key concern in most jurisdictions, this may be less so in the future as some regional governments have assumed land allocation risk for RE projects.

Key challenges

1. **Foreign ownership restrictions**
2. **Legal/regulatory issues with land (e.g. parcelling/ reservation of land)**
3. **Disputed ownership of land and multiple land titles with separate landlords**
4. **Cultural sensitivities**
5. **Suitable RE resource requirement**

The Asia-Pacific viewpoint

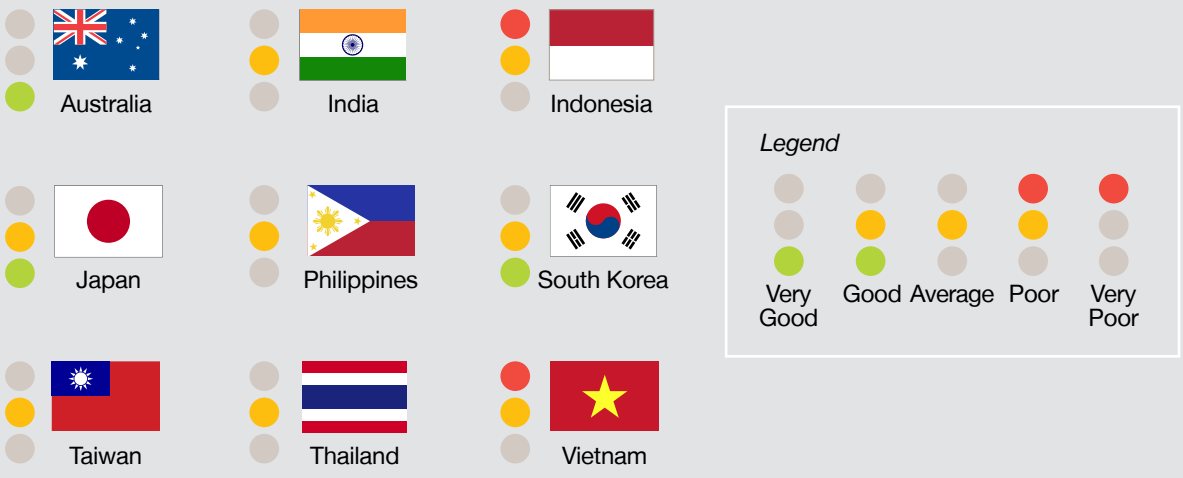
Procurement of suitable land is one of the more significant issues found in the region and has traditionally been the responsibility of the developer.

However, with the trend moving towards government procuring authorities conducting reverse auctions for RE tariffs and to better facilitate RE development, land is being allocated to the developer, negating this issue completely in some cases (e.g. in Thailand for projects of 5MW or less and in India for the Ultra Mega Solar Power Projects programme). Where land is not allocated, long-term leases are a common method of securing land for a project.

In terms of land resource requirements, there is relatively substantial data available on an overall country basis. However, detailed surveys should still be conducted.

Whatever the situation, careful planning in relation to land procurement is essential!

Country analysis



Grid connectivity & stability

A key consideration for RE projects in remote areas separated from the main grid. Further, stable grid networks with the ability to handle the intermittent nature of RE are essential for future large-scale development.

Key challenges

1. **General grid integrity**
2. **Grid coverage**
3. **Intermittent nature of RE**
4. **RE decreases inertia in the grid**
5. **Process & procurement of a grid connection agreement**

The Asia-Pacific viewpoint

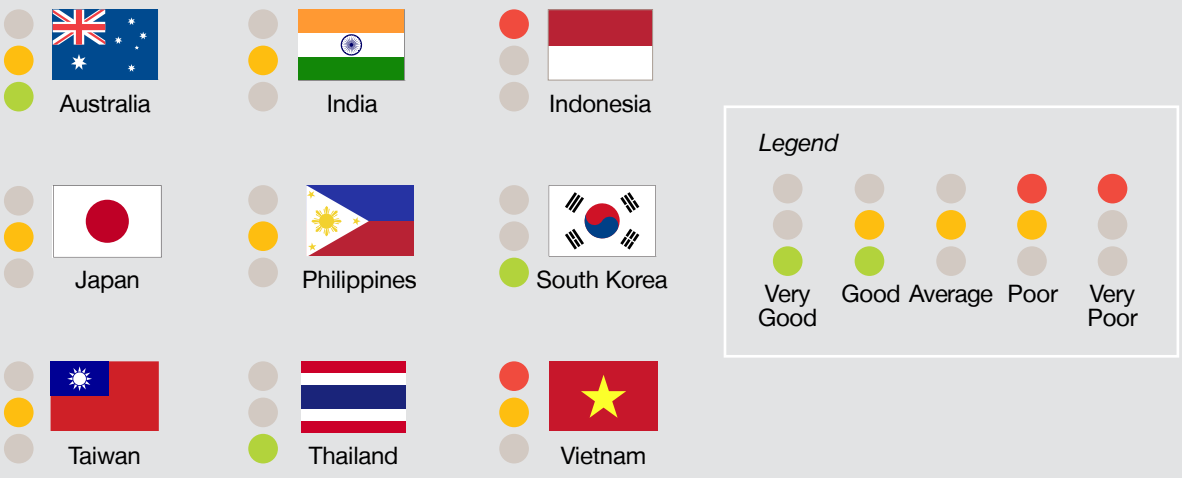
Regionally, there are efforts from governments to upgrade, improve and expand national grids as it is seen as a priority for most countries' infrastructure development.

Off-grid/mini-grid solutions are increasingly being looked at by governments and companies, in order to provide power to remote locations, such as in the Philippines.

In order to solve the intermittency issue that RE has, there are different methods currently being used/developed in order to 'firm' the energy supply from RE sources. These include large utility scale battery storage, or hybrid facilities (e.g. solar and gas/diesel hybrid power plants).

Solutions for reducing the impact of RE on grid inertia are being developed through smart-grids, which produce synthetic inertia to increase grid stability (e.g. distributed energy storage systems).

Country analysis



Regulatory & legal framework

Many governments in the region have favourable regulatory/legal frameworks for RE, with significant RE capacity targets – an encouraging sign for the industry and investors.

Key challenges

1. **Restrictions on foreign investments**
2. **No clear policy for RE development or future targets established**
3. **Lengthy procurement process due to onerous licences and permits required**
4. **High level of corruption**
5. **Lack of RE incentives (both financial and operational)**

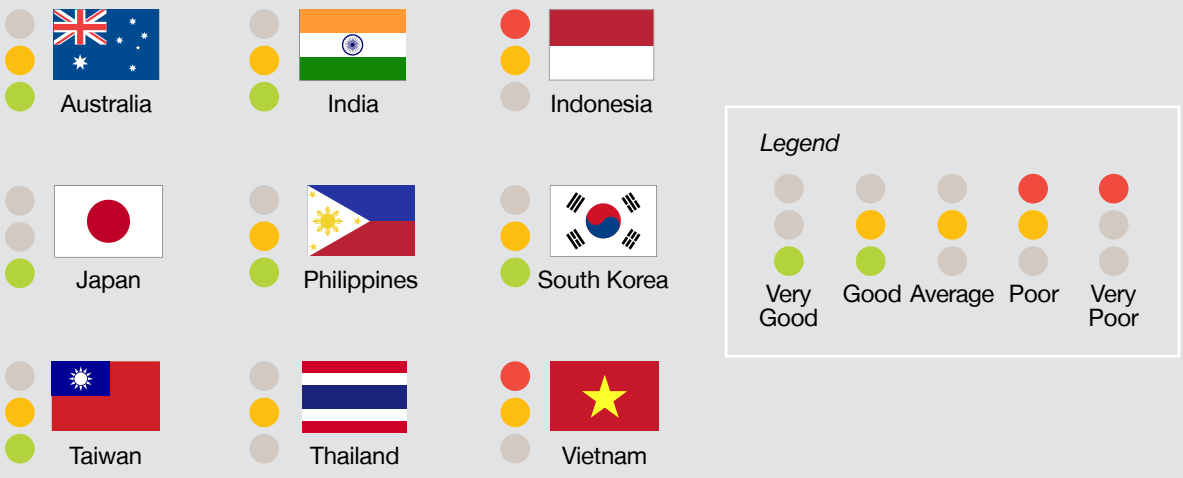
The Asia-Pacific viewpoint

Regulatory and legal issues can be difficult to handle for a developer/investor, as they are largely out of their control. Instead, an investor should carefully assess these types of issues and considerations before committing to a project in a country where they are prevalent.

Most countries in Asia-Pacific have adopted policies and frameworks which strongly facilitate the development of RE. For example, the majority of countries in the region have substantive policies for RE, which clearly state capacity targets for different forms of RE over a stipulated timeframe. Japan has a target to develop 100GW of solar and nearly 40GW of wind generation capacity by 2030. The Philippines is also set to introduce the 'RE Portfolio Standards', which sets a minimum threshold of power generated from RE sources as a percentage of total power generated by companies.

Governments will need to continue developing these RE policies over the coming years in order to further facilitate RE development and achieve their national targets.

Country analysis



Off-take security

Securing reliable PPAs for RE projects is critical. With some regional government off-takers in poor financial health, RE developers are also contracting directly with end consumers to reduce off-take risk.

Key challenges

1. **Getting the right off-take arrangement (e.g. Utility PPAs, other bilateral agreements, merchant sellers)**
2. **Reliability of the off-takers**
3. **Amount of off-takers**
4. **Possibility of curtailment**

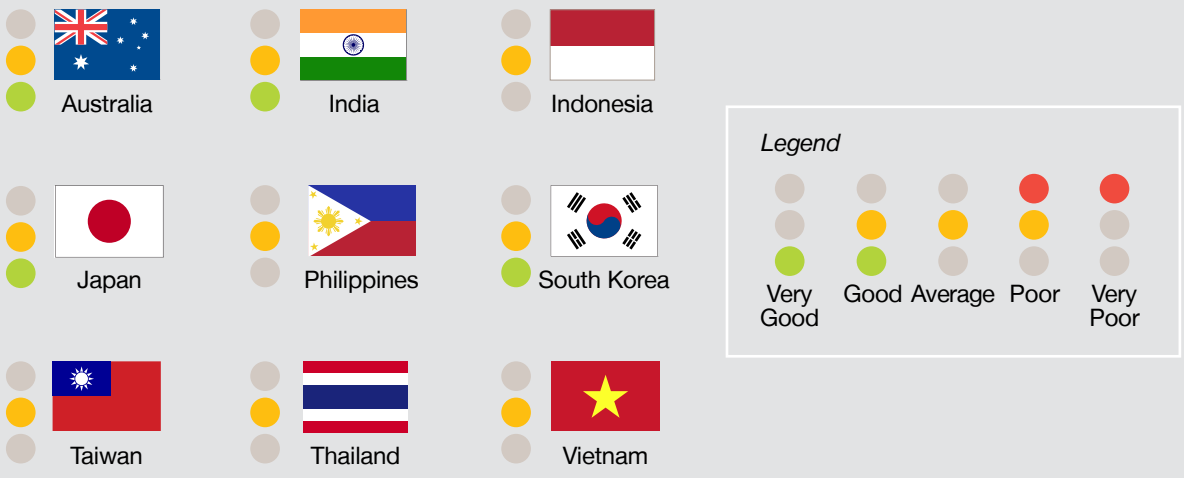
The Asia-Pacific viewpoint

Long-term utility-scale PPAs are usually preferred by RE developers due to secured revenues. This is the most common way of contracting in the region (usually by way of FITs offered or auctions), but direct contracting with corporates is becoming more and more common in places such as India and Australia (either by way of captive supply or 'wheeling' via the main transmission network).

Many off-takers in the region are in poor financial health, increasing the risk of payment default. Further, in some jurisdictions, RE generators fear that off-takers will not honour their long-term PPAs if they can secure cheaper energy elsewhere – although this is usually prohibited by law (e.g. in India).

The Asia-Pacific energy markets are still developing and single-buyer markets are still not uncommon (e.g. Thailand and Indonesia). Although options for off-takers might be limited in some countries, the increasing liberalisation of power markets generally around the region is opening up more avenues for producers to sell their power.

Country analysis



Financing

The availability of local debt, long-term loans and falling interest rates in most countries provides a solid financing platform for RE projects.

Key challenges

1. **Securing low-cost debt**
2. **Availability of financing**
3. **Achieving the optimal capital structure**
4. **Obtaining the right type of financing**

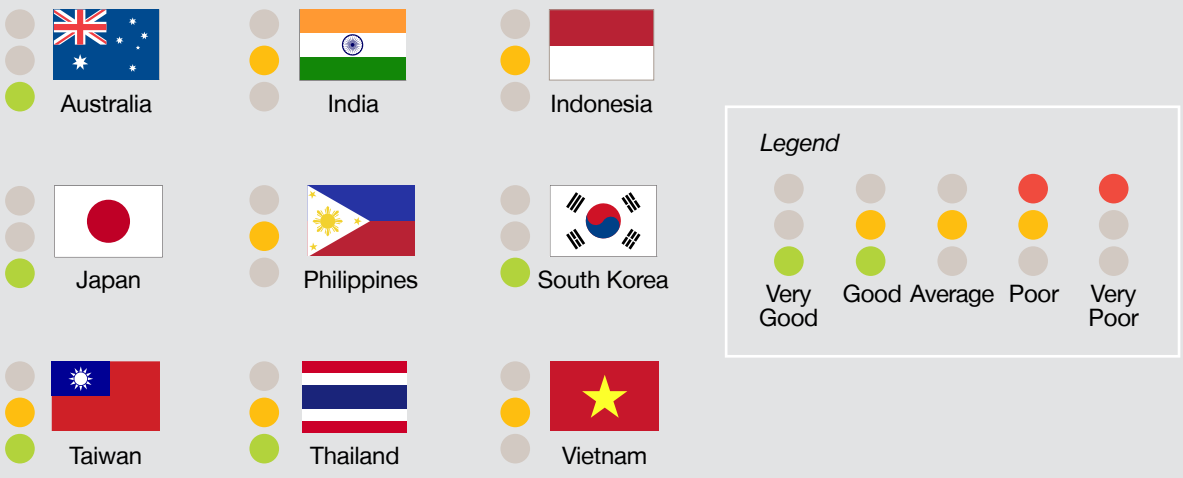
The Asia-Pacific viewpoint

Project financing from commercial lenders is the dominant method of lending to projects in the region.

Local debt has become readily available in most Asia-Pacific countries and lenders are keen to provide debt to RE projects. However, developers may fund their projects with 100% equity in the initial phase for quick progress and achieve commercial operation date (COD). Projects would be refinanced once operational (at lower interest rates than in development) to recycle the equity for further projects.

Interest rates for terms loans (i.e. 15-20 years) have been falling in recent years, but still range greatly from country to country in Asia-Pacific. For example, all-in interest rates for tenors of 20 years in Japan are currently approximately 1%, whereas in India and Indonesia, it can be more than 10%.

Country analysis



Up and coming: Emerging trends in developing RE

Besides traditional RE assets, investors are keen to explore avenues to enter the space. This is primarily because investors may play a "wait and watch" game for asset level investments or are keen to enter into niche areas which may have a significant growth going forward. Figure 16 summarises five key trends which are of interest to new investors.

Based on a continued strong economic case for RE assets coupled with other emerging trends, we believe that this sector presents the next golden era for infrastructure investments in Asia-Pacific.

Figure 16: Emerging trends for RE

1 **Mini-grids or hybrids**		Mini-grids are a set of electricity generators (RE backed by energy storage or diesel as a hybrid solution) interconnected to a distribution network that supplies electricity to a localised group of customers.
2 **Stand-alone systems**		Another form of off-grid electrification. Standalone systems may include rooftop solar systems (for residential and commercial users) or solar home lanterns employed for increasing electricity access.
3 **Utility scale battery storage**		The main objective is to enhance grid stability and remove intermittency of RE generation. Although the costs of such systems are high, they are expected to decrease with evolving technology and wider integration with existing grids.
4 **Building integration**		Building efficiency is a key focus in global environmental sustainability. Adoption of energy efficient equipment, and the inclusion of RE technologies are two crucial components to achieve this.
5 **Artificial Intelligence (AI)**		The application of AI or machine learning can enhance the predictability of demand and supply for renewables, improve energy storage and load management, assist in the integration and reliability of renewables and enable dynamic pricing and trading.

How PwC can help

PwC provides advice across the renewable industry value chain in a diverse range of ways. From evaluating innovative technologies and developing new business models to creating the financial structure of RE projects and ensuring these assets are efficiently constructed and operated, our team can help you no matter where your organisation resides in the value chain.

Business and market entry strategy

We support a range of companies – from utilities, independent power producers, and developers to manufacturers and energy solution providers – with the development of their RE strategies. Examples include market and disruptive technology assessments, business plan development, commercial due diligence and business model innovation.

Project execution

We provide advice to developers, manufacturers, operators, financial institutions, and investors throughout the project lifecycle, including feasibility analysis, financing, tender and procurement, construction, operations and management and project exit. We have experience with solar, wind, energy storage, biomass, and other technologies, and we have worked on projects for large utilities as well as distributed generation solution providers.

Operational excellence

We support RE companies and utilities in all aspects of operations such as sales and marketing, supply chain, product development, finance effectiveness, operations and maintenance, and customer service. We can help design your company's strategy and operating model as well as identify operational efficiency improvements and other means of improving company performance.

Deals and investments

We help with mergers & acquisitions (M&A) and investment–related services for power and utility companies, developers and investors. Our advisory services include assisting with valuation, corporate finance, deal structure designs, business evaluation for stakeholder investments/ divestments, due diligence, post-merger integrations, and power purchase agreement definitions.

Financial and tax structures

We evaluate financial models for RE projects, taking into account the tax and regulatory implications. We also identify advantageous financing and tax structures as well as debt and equity raising strategies. In addition, we help assess and launch innovative financing vehicles such as YieldCos and asset-backed securities.

Government strategy and regulatory frameworks

We support public administrations and a wide range of RE organizations to determine an appropriate energy mix and renewable energy development frameworks. We provide a range of services, from designing policy and regulations to assisting with financial incentive structure design and tariff forecasts.

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