



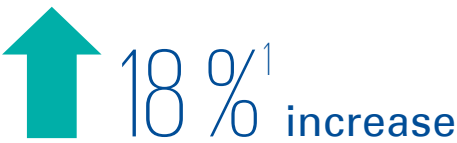
Global Trends in Renewable Energy



In the last decade, there has been a major uptake in various forms of renewable energy, beyond the proof of concept stage, to mainstream use as a commercial alternative to fossil-fuel based energy generation.

During this period:

New investments in renewable energy with



Between 2004 and 2015; with a higher share for developing countries

Total transaction value related to renewable energy assets grew by



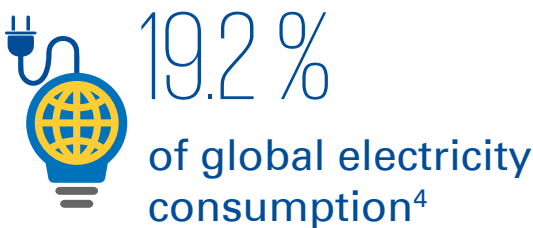
Globally, the new renewable energy power capacity additions were



over 2015 while heat capacity additions were



Renewable energy provided an estimated



Levelised cost of electricity (LCOE)⁵ dropped across sectors, stimulating a larger number and bigger scale of projects.

¹ UNEP, Bloomberg New Energy Finance

² Refer footnote 1

³ 'Renewable 2016 Global Status Report' by the Renewable Energy Policy Network for the 21st Century (REN21)

⁴ Refer footnote 3

⁵ Refer footnote 1



Despite some impact from a prolonged spell of historically low oil prices, there has been a shift in the renewable energy profile in many countries where renewable energy resources exist. This was possible through a combination of interventions:



use of legislation and feed-in-tariff (FiT) where available



tax incentives on technology imports and development



advancement in commercial-scale technology



newer forms of commercial structuring and funding avenues, such as green bond financing

Over the last decade, projects delivering energy from renewable sources have become credible low-carbon alternatives to carbon-intensive fossil fuel-based projects.

Global commitment on climate change mitigation under the Paris Agreement in 2015 also helped reduce the short-term impact of low oil prices by acknowledging the longer-term benefits of renewables. The Paris Agreement has already obtained the instruments of ratification, acceptance, approval or accession from more than 55 countries who are cumulatively responsible for 55% of the global greenhouse gas (GHG) emissions. This is expected to act as a catalyst for renewable energy projects.

In 2015, the UN General Assembly adopted the Sustainable Development Goals on Sustainable Energy for All (SDG 7) initiative. Around the same time, the G7 and G20 groups of countries committed to accelerate

programmes on renewable energy and energy efficiency, respectively.

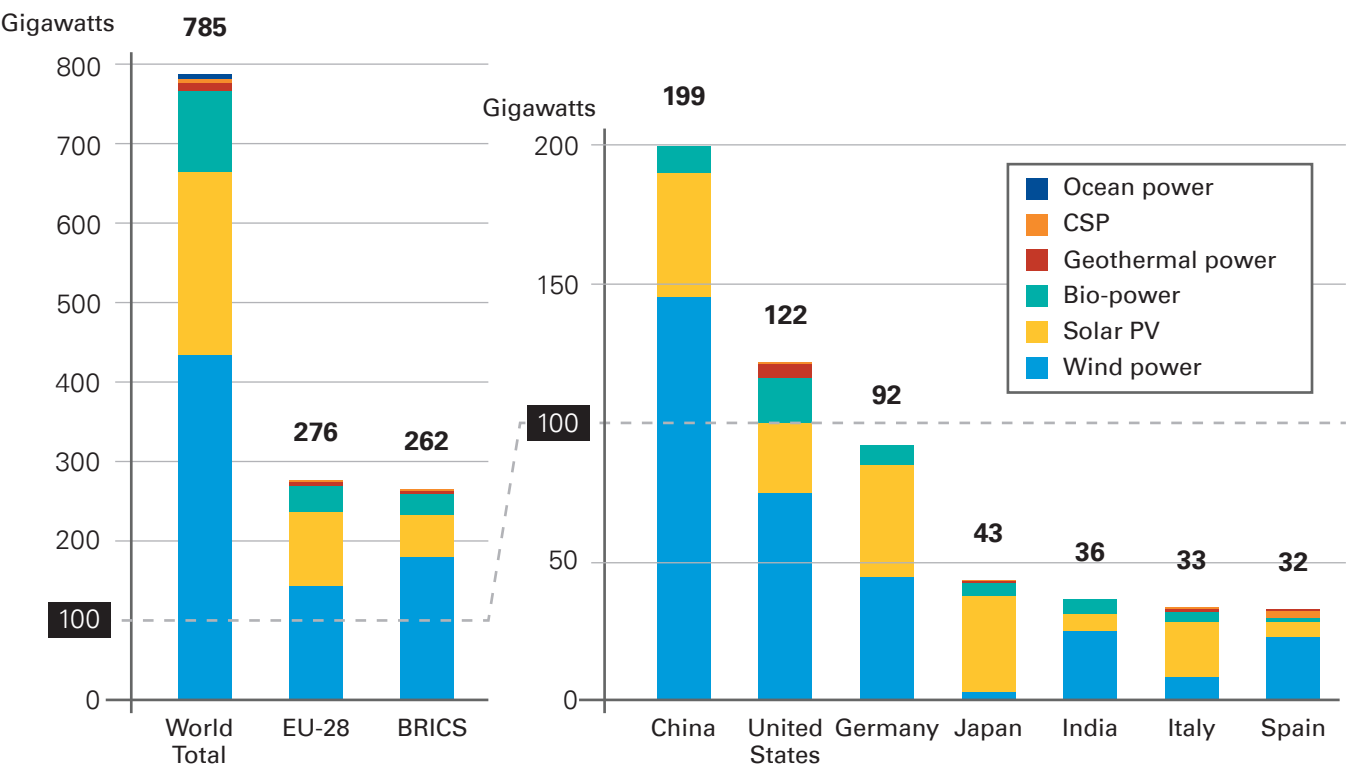
There was some development in the renewable energy policy landscape⁶ too — especially for electricity, heating and cooling, transportation, and city and local government initiatives. Many countries now clearly understand the benefits of using renewable energy as a source of meeting off-grid and distributed demand.

The number of countries with renewable energy targets and policies increased since 2014, and several jurisdictions made their existing targets more ambitious — including a rising number that set their renewable energy/electricity targets at 100%. More than 170 countries have renewable energy targets, and an estimated 150 countries have policies that support renewable energy.⁷

⁶ Refer footnote 3

⁷ Refer footnote 3

Figure 1: Renewable Power Capacities in World, EU 28, BRICS and Top 7 Countries, End-2015



The five BRICS countries are Brazil, the Russian Federation, India, China and South Africa.

Source: 'Renewable 2016 Global Status Report' by REN21

The last ten years also saw a dramatic drop in the prices of renewable energy projects as experience and scale increased. In a 200MW solar photo-voltaic power project, where KPMG⁸ member firms acted as procurement advisor to the Dubai Electricity and Water Authority (DEWA), the tariff achieved was US\$0.06 per kilowatt-hour (kWh), which dropped even further in the following phase of the project of 800MW, currently under evaluation.

With a decade of watershed transformation in fossil-fuel dominated energy generation and the data available (Figure⁹ below), we can reliably predict the future growth potential.

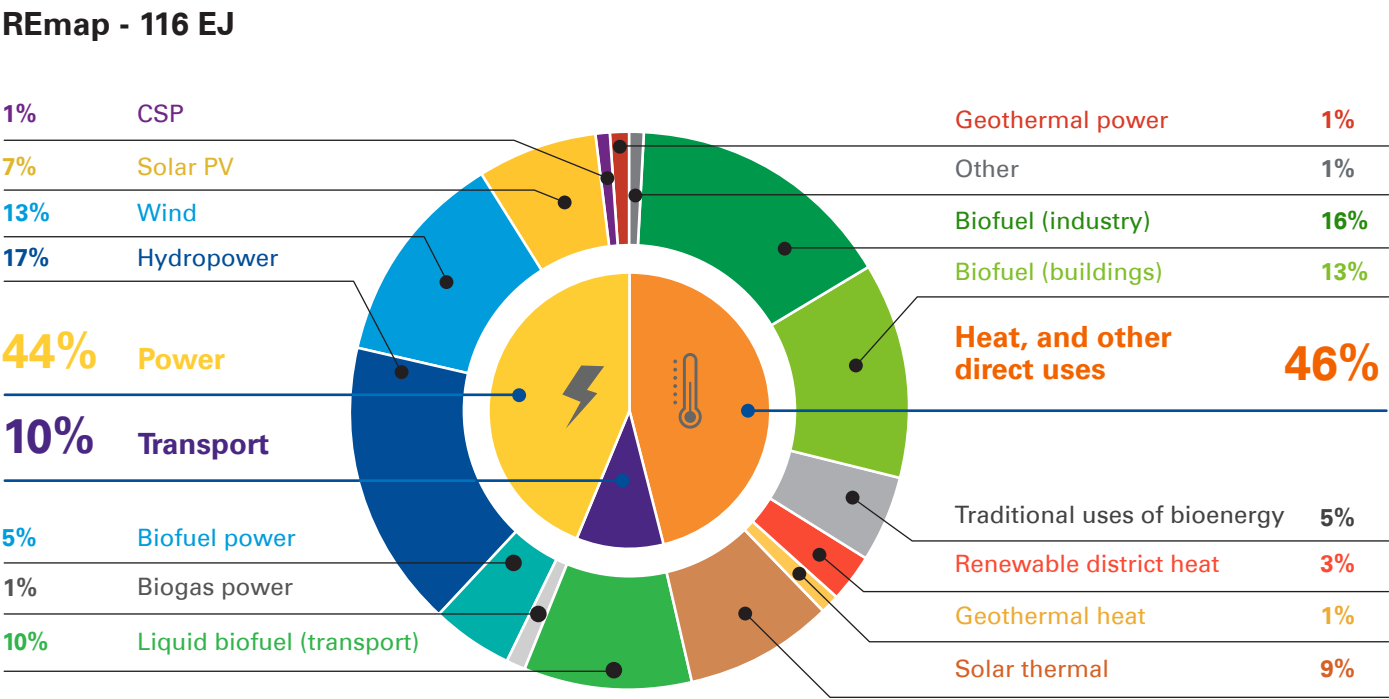
We expect to see increase in developing countries, where a sizeable proportion of the population do not have access to electricity¹⁰. In many developing countries, energy sources such as wind, solar and biomass can support decentralized, mini-grid and off-grid solutions, such as, small wind turbines for powering remote telecommunications, solar-powered irrigation kits and rural scale bio-digesters. In developed countries like Australia, Europe, Japan and North America, we have seen significant growth in "prosumers"—residential customers who produce their own electricity through solar panels.

⁸ <http://www.constructionweekonline.com/article-32197-dewa-awards-phase-ii-deal-for-dubai-solar-project/>

⁹ Refer footnote 3

¹⁰ 'Taxes and incentives for renewable energy' by KPMG International (refer "kpmg.com/energytax")

Figure 2: Renewable Energy use in 2030 with REmap Options, including Modern Energy Access with Renewables



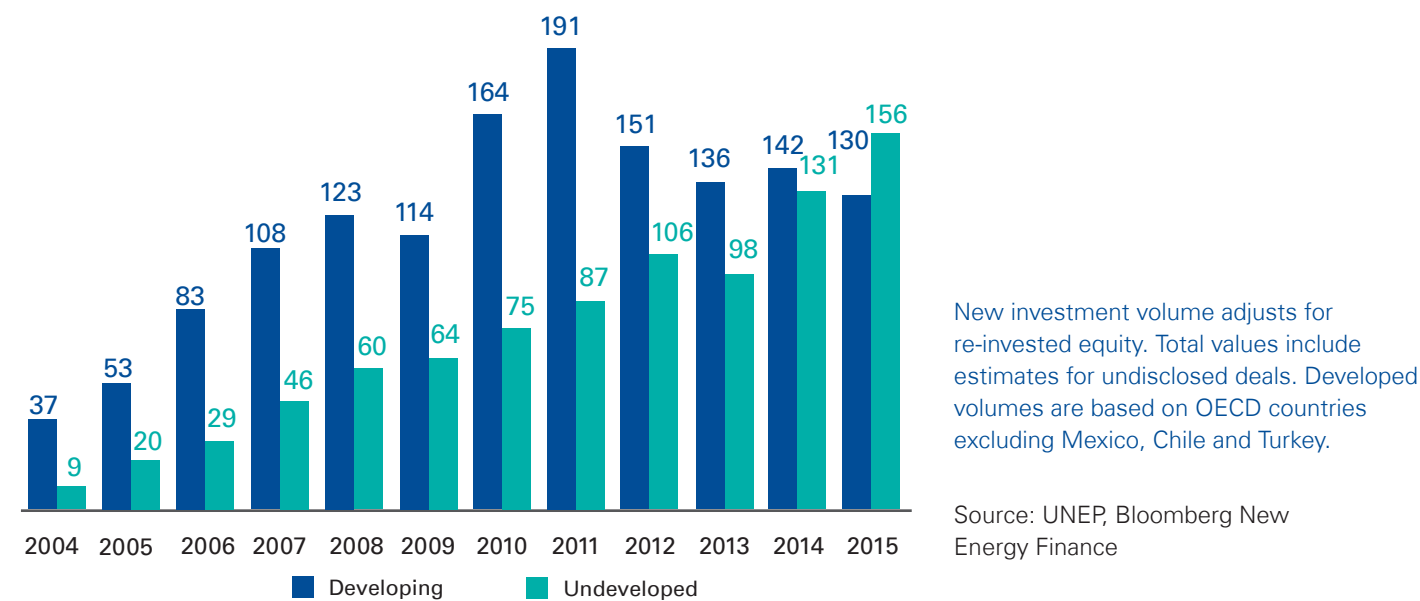
Source: 'Roadmap for a Renewable Energy Future, 2016 Edition' by the International Renewable Energy Agency (IRENA)

Based on a mix of policy interventions to limit the funding on fossil-fuel (primarily coal) based generation, easier access to funding for renewable energy projects, and technology improvements that reduce project development and operational cost – project developers have accessed several sources of funding. New investments in renewable energy grew by 18% (in CAGR terms) between 2004 and 2015, to US\$285.9 with a higher share for developing countries.¹¹

During the same period, the total transaction value related to renewable energy assets grew by 19% to US\$379.8 million. New sources of investment are increasingly available from sources such as the Green Climate Fund and Asian Infrastructure Investment Bank. The Asian Development Bank has also launched several programmes to support renewable energy deployment in Asia including framework development initiatives and funding programmes for project development.

¹¹ Global Trends in Renewable Energy Investment 2016 by the United Nations Environment Programme (UNEP)

Figure 3: Global Investment Trends in Renewable Energy (in USD billions)



As a result, the affordability, cost of electricity to grid off-takers and availability improved significantly. Data available shows that the LCOE for renewable energy projects by sub-sectors reduced across the board. (Figure 4)

Figure 4: Summary of Lowest Global LCOE Achieved¹²

Renewable Energy Sub-sector	Geography	LCOE (US\$/kwh) Weighted Average
On-shore Wind	China, US	0.055
Off-shore Wind	US	0.12
Solar Photo-voltaic (PV)	India	0.09
Concentrating Solar-Thermal Power (CSP)	India	0.22
Geothermal	Asia	0.07
Hydro	China	0.03
Bio-power	China, India	0.04

Riding on the success of developing renewable energy projects, newer and more innovative technologies are looking to address the need for higher efficiencies, and generation and supply balance between peak and off-peak demands through energy storage and hybrid

generation systems. Intra-day variability is an inherent characteristic in renewable energy portfolios, such as in solar PV and wind sources, thereby increasing focus on commercialisation of energy storage technologies to enhance affordability. Effective storage will assist with creating a buffer to balance grid frequency fluctuation as well as supply during times when the resource is not available (e.g, solar PV at night).

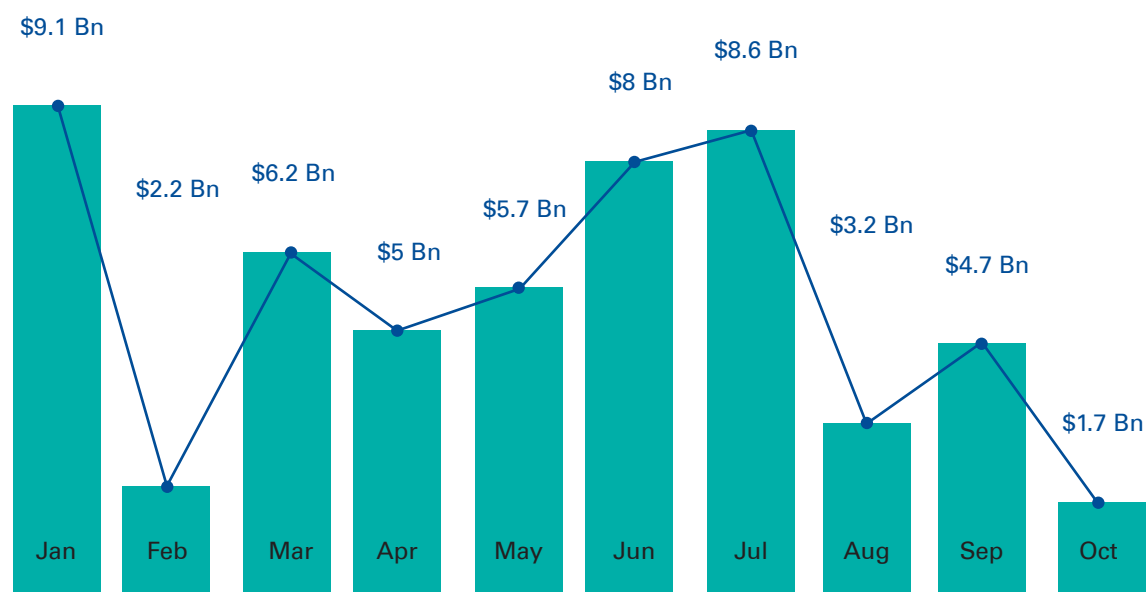
One advantage of biomass power and base load hydropower is the ability to manage the load factor and some countries, such as the Philippines and Thailand have used this successfully to balance their renewable power mix.

Newer project financing mechanisms are also gaining traction. One such example is debt financing using the proceeds from Green Bonds. This form of fund raising by banks (private, national and multi-lateral) and corporations has been particularly useful in mobilising significant volumes solely to fund green (environmentally beneficial) projects. As per the Climate Bond Initiative, the total green bond issuance so far in 2016 has been more than US\$50 billion.

A host of international private equity firms are active in the region and have set up dedicated green energy funds, including Asia Green Capital Partners, Equis, Infravest, Black Rock, MacQuarie Energy and Olympus Capital Asia to name a few. This has helped to develop a very healthy ecosystem of greenfield as well as secondary markets in the green energy space in Asia.

¹² Refer footnote 3

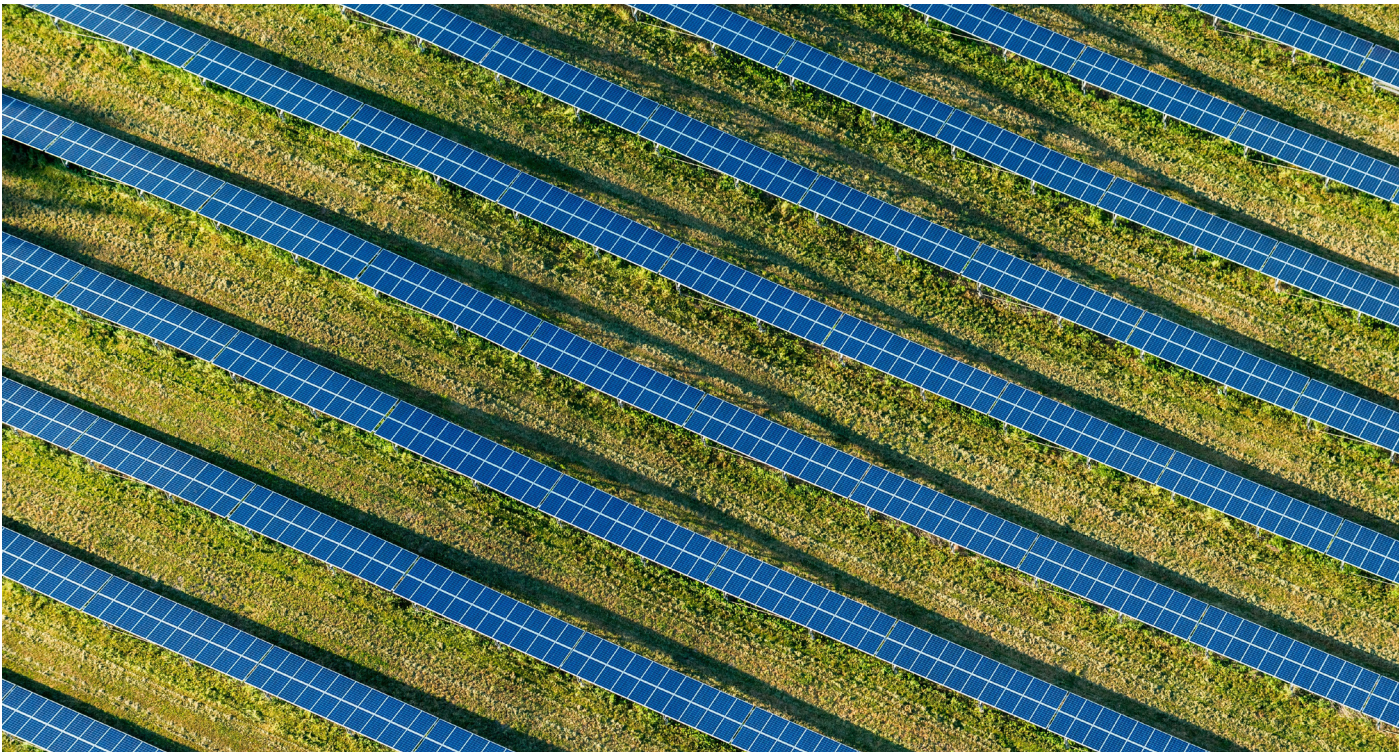
Figure 5: Green Bonds Market 2016



By virtue of new financial options available, in addition to power project developers, there is new interest among cities and municipalities to include renewable energy targets in their building codes.

The private sector is also looking at renewable energy options for operations that are heavy consumers of

electricity, such as data centres. Google had announced a goal of 100% renewable energy power and their commitment to purchase ~2.5GW of renewable energy. Google¹³ has also committed to invest nearly USD2.5 billion in renewable energy projects. Recently, Apple¹⁴ too issued USD1.5 billion green bonds to finance renewable energy, energy storage and energy efficiency projects.



¹³ <http://www.google.com/green/energy/>

¹⁴ <http://www.reuters.com/article/us-apple-greenbonds-iddUSKCN0VQ2K2>

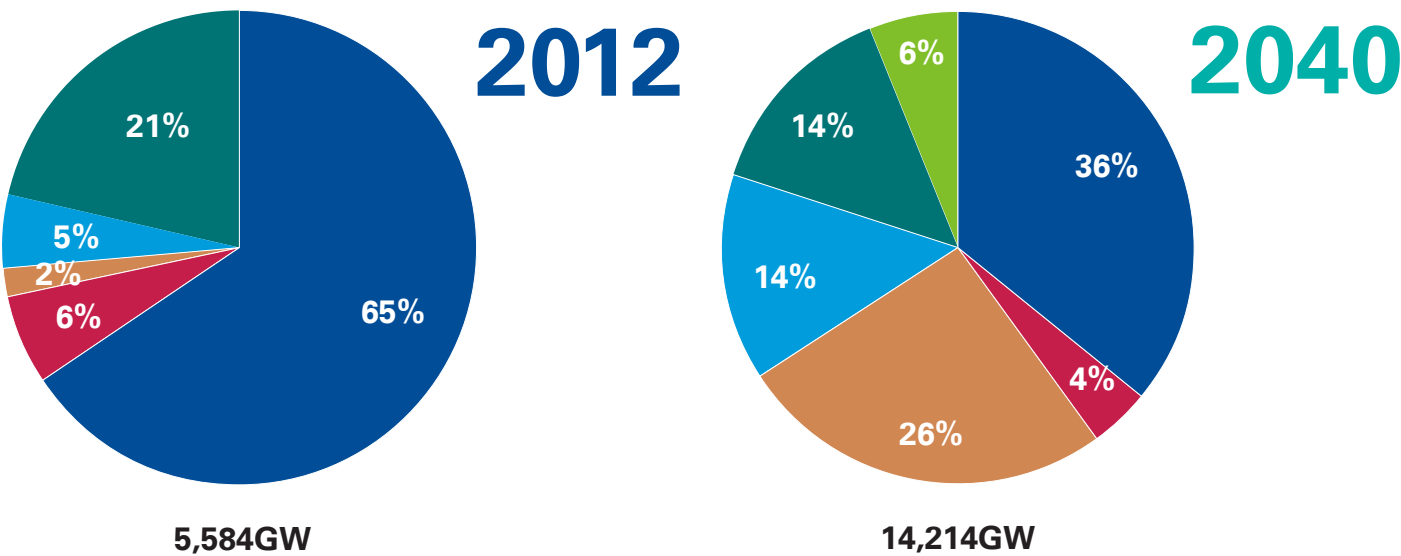
Recent Industry Trends

Recent gains¹⁵ in the renewable energy sector provides indications on how the global proportions of such projects will develop over the next two decades^{16,17} below.

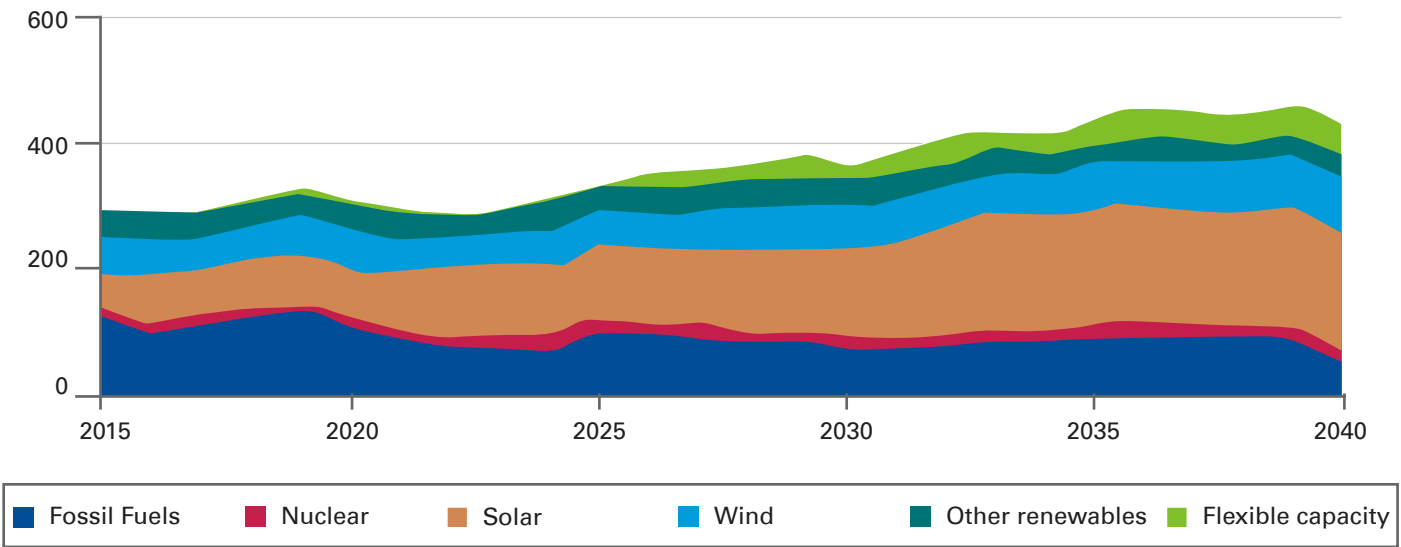
The trends show that solar (PV, CSP, and Heating and Cooling), wind (on-shore and off-shore), hydro and bio-power are more popular with developers and investors.

Figure 6: Projected Capacity Addition Trends

Annual Capacity additions, 2015-40 (GW)



Projected global installed capacity to 2040, by technology (GW)



Source: Bloomberg New Energy Finance

¹⁵ Bloomberg New Energy Finance

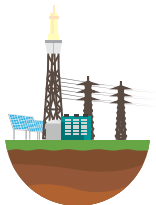
¹⁶ Refer footnote 9

¹⁷ Refer footnote 3



Solar PV

Although hydropower is still the main source of renewable energy with the cheapest LCOE, rapidly falling costs have made solar PV the largest market for new investment. In fact, unsubsidized solar PV-generated electricity has now become cost competitive with fossil fuels in a number of locations around the world. The recovery that began in 2013 for solar PV continued in 2015, with an estimated 50GW installed for a total global capacity of ~227GW, representing 27% of growth in 2014; this was by far the highest growth rate within all sub-sectors. China, Germany and Japan accounted for the vast majority of the new capacity. However, significant new capacity was planned for or added in Latin America, parts of Africa, and parts of the Middle East, such as Dubai and Saudi Arabia. In January 2014, DEWA in Dubai awarded a contract to build a 200MW, US\$330 million PV plant to a group led by Saudi Arabia's ACWA Power International, where KPMG was the procurement advisor. In 2015, a further 800MW capacity addition was initiated, which is currently under negotiation with a preferred bidder, with KPMG in Dubai and Singapore as procurement advisors.



Concentrating Solar Thermal Power (CSP)

This sub-sector maintained a moderate to strong growth of 9 percent total capacity additions adding up to a global total of 4.8GW. The top three countries in terms of new capacity additions were Spain, United States and India. Most capacity is delivered through parabolic trough plants, with some diversification of technologies, such as linear Fresnel and tower plants that produce energy as heat through the use of long and narrow segments of mirror that pivot to reflect sunlight onto a fixed absorber tube. Morocco and South Africa continued construction and planning for CSP. In general, the costs for CSP continue to decline, particularly in the global sun-belt, and a variety of technology is under development to support CSP, such as thermal energy storage (TES) systems. Interestingly, DEWA in addition to its solar PV projects, have initiated the procurement of a 200MW CSP project, where KPMG is the procurement advisor.



Solar Thermal Heating and Cooling

Solar thermal heating technologies capture the heat of the sun and transfer it to air or water to heat buildings. Solar chillers use thermal energy to produce cold air or water through absorption cooling technology. These technologies are used primarily for large domestic water heating systems in hotels, schools, factories and other large complexes. In general, solar thermal technologies marginally increased to 435GW_{th}, which is equivalent to 6 percent growth from 2014. The top three countries that saw capacity additions were China, United States and Germany.



Wind Power

Wind-based capacities are still growing rapidly, propelled by the proven track record and precedence of the previous decade, in addition to the low LCOEs. This sub-sector showed a 17% growth since 2014; the global capacity stood at 433GW by the end of 2015 with China, United States and Germany leading the way. There has been continued research in this sub-sector to increase turbine capacity and efficiency.



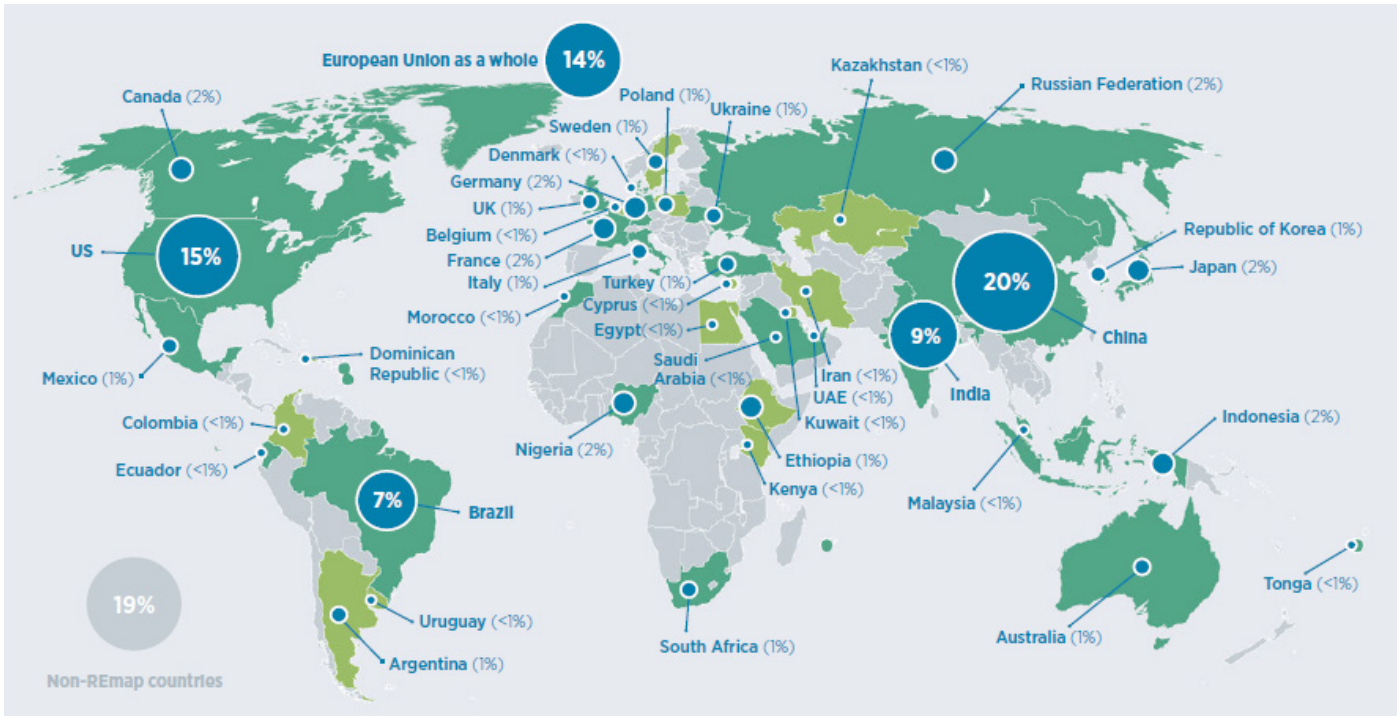
Biopower

Despite the fact that global new investment in biomass and waste-to-energy declined by 29% from 2014 to 2015, investment in this sector still ranks third (at USD 6 billion) after wind and solar. Although 75% of this was attributed to developed countries, the majority being based in Europe, developing countries like India, China and Brazil have also been active in this sector. A notable deal in this sector included the 300MW Klabin Ortigueira biomass power plant in Brazil, while acquisitions in biomass and waste to energy increased by 10% from 2014, to a deal value of USD 2.1 billion.

Opportunities in the Growth Markets in Asia-Pacific

As per research by the IRENA, there appears to be a possibility that many of the countries in Asia-Pacific will see a significant portion of energy consumption sourced from renewable energy.

Figure 7: Anticipated Renewable Energy Portfolios Globally



Note: Percentage indicates how much renewable energy each country consumes in 2030 if the REmap Options are deployed.



For example, 20% of energy to be consumed in China will come from renewable energy. This in itself provides an indication of the market size for renewable energy growth in Asia-Pacific. Most of the countries in this region have committed to GHG emission reductions in Paris and have linked those aspirations to partial decarbonisation of the respective economies. The post COP21 period has seen rapid expansion of the green bond market in the region, signalling higher investor confidence in new renewable energy projects. Such growth prospects are already supported by existing regulatory policies and fiscal incentives available in the region.

Figure 8: Summary from a KPMG study¹⁸ on selected countries are included below

Country	Renewable energy targets	Regulatory Policies							Fiscal Incentives and Public Financing				
		Feed-in-tariff/premium payment	Electric utility quota obligation/RPS	Net metering	Biofuels obligation/ mandate	Heat obligation/ mandate	Tradable REC	Tendering	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants
High Income Countries													
Australia	O	●	O		●	●	O	★ *	O				O
Japan	R	R	O	O			O	O	O				O
New Zealand	O								O				O
South Korea	O		O	O	O	O	O		O	O	O		O
Singapore	O			O				O			O	O	O
Upper-Middle Income Countries													
China	R	R	O		O	O		O	O	O	O	O	O
Low-Middle Income Countries													
India	O	O	O	●	O	●	O	★	O	O	★	O	O
Philippines	O	O	O	O	O			O	O	O	O	O	O

Index

- O – existing national (could also include state/provincial)
- – existing state/provincial (but no national)
- ★* – new (* indicates state/provincial),
- R – revised



Of all the renewable energy resources, solar energy is relatively abundant in most of the Asia-Pacific region. As a result, several countries in this region have medium to long-term policies to support growth in solar and other resources in their overall energy portfolio. Some examples of these in the ASEAN context are discussed below in comparison to Japan (high income) and China (upper middle income).

¹⁸ 'Taxes and incentives for renewable energy' by KPMG International (refer "kpmg.com/energytax")



Singapore

- 350MW solar power by 2020
- SolarNova Singapore Programme, encouraging solar deployment in Housing Development Board (HDB) estates and government building, and solar leasing
- Government grants available for R&D, capacity development, and demonstration projects. There are several grants available from the National Environmental Agency (NEA) in Singapore on energy efficiency (EE) programmes and projects. For Singapore, EE opportunities form a significant part of cleantech alternatives
- Tax incentives for R&D, which also extend to the renewable energy sector, corporate tax reduction/ exemption for supported activities
- Asia Infrastructure Centre of Excellence, a joint initiative from IE Singapore, ADB and the Canada Department for Foreign Affairs, Trade and Development



Malaysia

- National Renewable Energy Policy and Action Plan 2009 for 21% renewable energy by 2050
- Feed-in-Tariff (FiT), tax incentives (e.g. 10-year pioneer status)
- Renewable Energy (RE) fund – RM 300 million seed fund and annual RM 325 million contribution
- Green technology financing scheme – RM 1.5 billion soft loan
- 1,250MW Solar Power by 2020.



Indonesia

- National Energy Policy – 40% renewable power generation development
- Ministry of Finance (MoF)/ Ministry of Energy and Mineral Resources (MEMR) regulations – Guarantee of PLN contracts/ mandatory utilization of renewable sources
- FiT, tax incentives (e.g. corporate tax reduction)
- 620MW Solar Power by 2020.



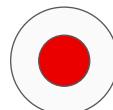
Thailand

- 10-year Alternative Energy Development Plan 2012 – 2021 (AEDP) – 25% renewable energy by 2021
- Several funds available – ENCON, Energy Soft Loan (Revolving Fund), ESCO, IFC backed Clean Tech Fund
- 3GW Solar Power by 2021.



Philippines

- Philippines Energy Plan 2012 – 2030: Triple renewable energy by 2030
- FiT, Tax incentives (e.g. 7-year tax holiday) – new wind projects have already availed of FiT facility
- Renewable energy act of 2008
- Renewable energy trust fund
- Cleantech fund – USD 250 million
- 285MW solar power by 2021.



Japan

- 4th Strategic Energy Plan (issued in April 2014) – 20% renewable energy
- FiT (2012 – 2021), supply grants/ financial aids for R&D, demonstration/ field test programmes and market stimulation
- Financial incentives estimated at JPY 779 million targeting energy storage systems earlier in 2015
- 49GW solar power by 2020.



China

- 13th Five Year Plan (2016 – 2020) – target 35GW by end 2015 and additional 65GW from 2016 to 2020
- FiT, Tax incentives (e.g. corporate tax reduction), export credits, low interest loans
- Renewable energy development fund
- Special fund for construction with renewable energy
- Green subsidy – 70% for independent power projects (IPP) in remote areas
- 50GW solar power by 2021.

Replicable Case Studies for ASEAN



We present three case studies, two of which focus on renewable energy and showcases how to leverage available policies and market developments in technology

and funding structures. The third case study deals with recovery of energy from urban wastes.

Dubai Electricity and Water Authority

DEWA has ambitions¹⁹ to develop a solar park of 5,000MW capacity by 2030. This was estimated to provide electricity to 800,000 homes and to cost Dirham 50 billion.

The project is planned to contribute towards increasing the renewable energy portfolio in Dubai from 7% by 2020, to 25% by 2030 to 75% by 2050.

- Phase 1: 13MW solar PV (already implemented to gain experience)
- Phase 2: 200MW solar PV (under implementation)
- Phase 3: 800MW solar PV (under negotiation with preferred bidder)
- Phase 4: 200MW solar CSP with energy storage facility (expression of interest).

Having been involved in Phase 2 to 4, we have experienced how a forward looking policy could spur innovative financial engineering to achieve extremely competitive LCOEs as better technology hits the market.

Energy Development Corporation

The Energy Development Corporation (EDC) through its group subsidiary EDC Burgos Wind Power (EBWPC) commissioned²⁰ a 150MW wind power project in Burgos, Ilocos Norte, Philippines, in November 2014. This is the largest wind farm in the Philippines which was previously recognised for using its geothermal resources and to a lesser extent hydro resources, but was still in deficit and relied on fossil fuels. Being the first successful large- scale wind farm in the Philippines, the project faced the obstacles usually faced by first movers who set a precedence in the industry.

This landmark project, estimated at USD 450 million, was the first selected by the Department of Energy as eligible for the FiT scheme.

Under the Renewable Energy Act of 2008, the Philippine Energy Regulatory Commission (REC) may “(guarantee) fixed rate per kilowatt-hour – the FiT rates – for power producers harnessing renewable energy under the FiT system.” In February 2015, the ERC agreed to pay a FiT rate of P8.53 per kilowatt hour for 20 years to the Burgos Wind Farm. The project also benefits from loan support from the Asian Development Bank and the carbon finance under the United Nations Framework Convention on Climate Change (UNFCCC).

As of 30 June 2016, there is a pipeline of 10 other wind farm projects in the Philippines with approval for FiT. The success of these projects has paved the way for replicating these structures where FiT is available, such as Malaysia and Indonesia.

National Environment Agency of Singapore

Singapore has had great success in rolling out public private partnership (PPP) projects in the waste to energy (WtE) sector. Advised by KPMG in Singapore, in 2015, the National Environment Agency (NEA) of Singapore invited tenders for its sixth and largest WtE plant designed to process a minimum of 2,400 tons of waste per day under a 25-year concession period. The scope of the project contract includes design, build, finance, operate and maintain (DBFOM) approach for the SGD 750 million plant, which will be one of the world's most efficient WtE plants in terms of energy recovery from per unit waste incinerated. The SGD 653 million (USD 476.5 million) project finance loan reached financial close in May 2016.

Wastes for energy generation, though not a traditional renewable energy source, can yet be designated as a variation of bio-power energy source, since cities generate volumes of energy containing wastes that would pollute the environment if not treated. By implementing WtE projects, not only the dependency of fossil fuels is reduced, but safe treatment to wastes is also provided. The success of such WtE projects provides replication opportunities for all other cities and towns where waste management and disposal is a problem.

¹⁹ https://www.dewa.gov.ae/en/about-dewa/news-and-media/press-and-news/latest-news/2016/03/dewas-shams-dubai-initiative-continues_march7

²⁰ <http://www.energy.com.ph/burgos-wind-power-project-successfully-commissioned/>

Summary

Increasingly, governments around the world, including in emerging markets have started focusing on renewable energy as an important part of the energy portfolio. This is driven not only by energy security and diversification considerations, but also based on environmental considerations, global commitments, renewable technology development (which in some cases is fast approaching grid parity), and strong sector appetite for green projects.

The key risks pertaining to the renewable energy projects have been addressed very effectively in many jurisdictions: -

- Market risk: tariff, off-taker, currency/exchange rate – long term PPA being made available, supported by a strong policy framework
- Operational risk: engineering, procurement and construction (EPC) and operation and maintenance (O&M) contractors experience has grown and very many credible players have committed to this sector with a proven technological base.

- Reliability of resource: availability of a reliable data and validating tools for confirming secure resource
- Infrastructure readiness: grid infrastructure development, maintenance and evacuation has been strengthened to address any intermittency issues
- Policy support: national and sub-national/regional targets, open/transparent tendering mechanisms, FiT has helped investors with transparent and reliable frameworks
- Technology improvement: innovations and upgrades with better efficiency, operational flexibilities and lower costs thereby making renewable energy tariffs approach grid parity.

We believe the next decade will see further growth and penetration of renewable energy in various countries. Clean and green power is no longer an idealistic aspiration but an economically compelling and sustainable proposition, making it a critical part of the energy portfolio of most utilities.



kpmg.com.sg

Contact us

Sharad Somani

**Partner, Head of Infrastructure
Advisory**

KPMG in Singapore

T : +65 6213 2276

E : sharadsomani@kpmg.com.sg

Harvey Koenig

Partner

KPMG in Singapore

T : +65 6213 7383

E : harveykoenig@kpmg.com.sg

kpmg.com.sg/socialmedia



The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. Although we endeavor to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.

© 2016 KPMG Services Pte. Ltd. (Registration No: 200003956G), a Singapore incorporated company and a member firm of the KPMG network of independent member firms affiliated with KPMG International Cooperative ("KPMG International"), a Swiss entity.

The KPMG name and logo are registered trademarks or trademarks of KPMG international.

Publication name: Global Trends in Renewable Energy