

GLOBAL CLEAN ENERGY OUTLOOK



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Executive Summary

Global warming caused by the release of greenhouse gases (GHG) is one of the biggest threats to our planet. The power, transportation and manufacturing industries have been key contributors to GHG emissions, which trap heat and harm our health, environment and climate. Some of the most dangerous consequences of global warming are climate change, droughts, melting of glaciers, decreasing crop production and hurricanes.

In April 2016, 175 countries signed the Paris Climate Change Agreement to contain the increasing global average temperature and reduce net greenhouse gas emissions. The Paris Agreement set a long-term vision for reducing global emissions and decarbonising the energy sector. It reinforced the belief that a rapid and global transition to clean energy is the ideal means to achieve sustainable development and avoid catastrophic climate change. Clean energy has now been recognised as being indispensable to achieve climate and sustainability objectives.

The US, Mexico and Canada have pledged to boost their use of wind, solar and other carbon-free sources of electricity to enable North America to meet its ambitious goal of generating at least 50% of its energy from clean sources by 2025. They are expected to scale up clean energy consumption through aggressive domestic initiatives and policies. The three countries have

pledged to remove fossil fuel subsidies by 2025 and called on other members of the G20 group to follow suit.

Falling coal and gas prices have reduced the cost of electricity from new fossil fuel power stations, posing a serious challenge for investment growth in clean energy. Despite falling fossil fuel prices, 2015 witnessed the largest global capacity additions for renewables to date. Cheaper coal and gas were not able to derail the agenda of transformation and decarbonisation of the world's power systems. However, the competitiveness of wind and solar energy has been increasing relative to traditional power sources as production costs have declined due to technological advances, policy support and improved financing conditions. According to BNEF, the cost of onshore wind energy is expected to drop 41% by 2040, while solar energy would emerge as the least-cost power generation technology in most countries by 2030. Renewables are now cost-competitive with fossil fuels in most markets.

In 2015, global investment in renewables scaled new heights, with investment in developing countries surpassing that of industrialised countries. Renewable power generation capacity rose 8.3%, the sharpest increase recorded, mainly driven by significant capacity additions in Asia.

Despite growing competitiveness, policies remain vital to stimulating investment in the capital-intensive renewables sector. Scaling up deployment would require stable, long-term policy frameworks. Existing bottlenecks should be resolved to meet the target of reduced emissions set by regional, state and local governments as well as by the private sector.



Greenhouse Gas Emissions (GHG) Driving Clean Energy Adoption

Greenhouse gas emissions (carbon dioxide, methane and nitrous oxide) from combustion of fossil fuels and other traditional energy sources slow or prevent the loss of heat to space, resulting in climate change. Climate change has numerous detrimental effects, such as stronger hurricanes, severe heat waves, reduction in agriculture yields, and other health and environmental hazards. To prevent the irreversible damage that climate change could cause, almost 200 countries signed the historic Paris Climate Change Agreement to adopt clean energy sources, reduce emissions and limit the rise in global temperatures to 2°C or below.

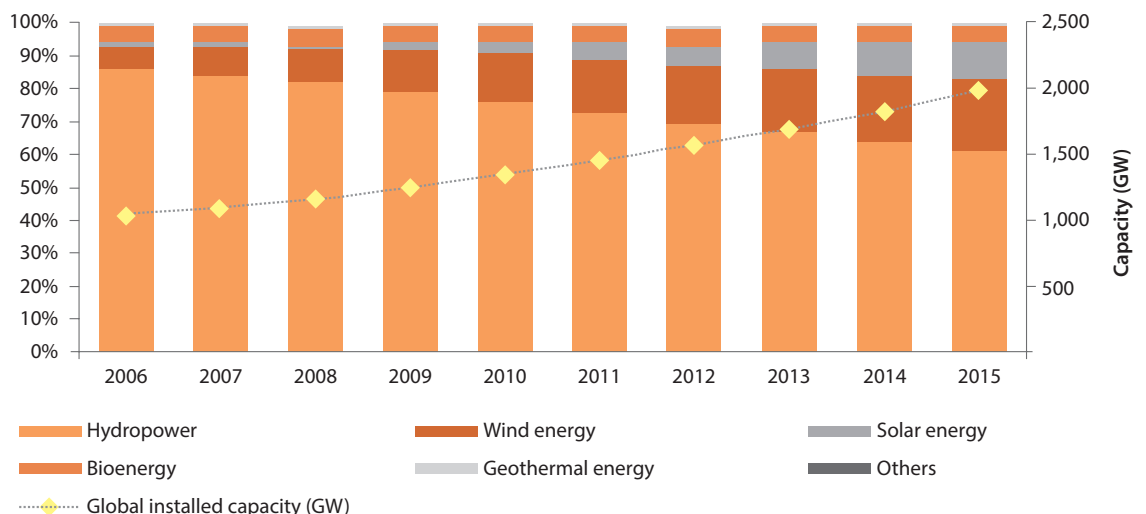
This produced encouraging results, evident from carbon dioxide emissions data for 2015; the emissions had stayed flat for a second consecutive year despite an expanding global economy, demonstrating that sustainability and growth can go hand in hand. The reduction in growth of emissions seen in previous years was primarily due to a shift in China's energy consumption away from coal. Globally, coal accounted for almost 31% of total energy capacity in 2015, which is forecast by BNEF to decline to 16% by 2040 as policymakers create favourable frameworks for a rapid shift towards clean energy.

Swift Transition Towards Clean Energy

The transition to clean-energy sources has picked up steam globally over the last few years. Despite ongoing fossil fuel subsidies and tumbling prices in 2015, renewable energy continued to grow rapidly in terms of capacity addition and energy generation. In 2015, renewable power generation capacity increased 8.3% to 1,985 GW, accounting for 23.7% of global electricity supply. The growth came predominantly from Asia (up 12.4%),

which accounted for 58% of new global renewable power generation capacity. China led globally in terms of hydro, wind and solar power installations. Global solar power capacity increased 26% due to a significant price reduction in the technology. Wind power generation rose 17%, driven by declines in onshore turbine prices and accounted for 3.3% of total electricity generation.

Chart 1: Global Installed Renewable Power Capacity



Source: International Renewable Energy Agency

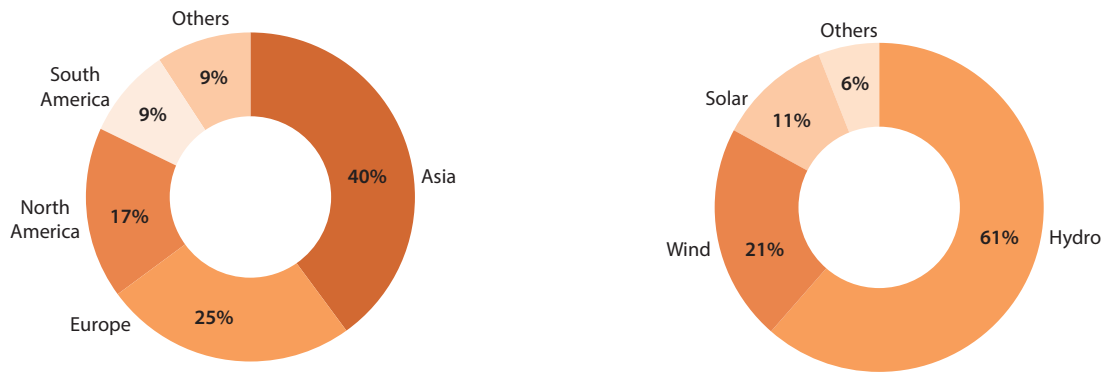


Asia Leads in Terms of Renewable Capacity Additions

Asia, Europe and North America accounted for 40%, 25% and 17%, respectively, of the total global installed renewable energy capacity (1,985 GW) in 2015. Of the total global installed

renewable energy capacity, hydro, wind and solar energy accounted for 61%, 22% and 11%, respectively.

Chart 2: Global Installed Capacity Breakdown by Region and Energy Source (2015)

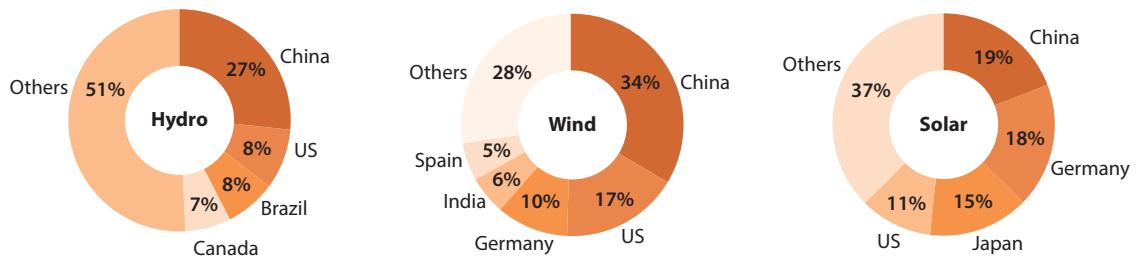


Source: International Renewable Energy Agency

China led in terms of capacity additions for all three major renewable energy sources. With 321 GW of hydropower capacity installed as of 2015, China accounted for 27% of global hydropower capacity, ahead of the United States (102 GW; 8%) and Brazil (92 GW; 8%). In terms of wind energy

capacity, China accounted for 34% (145 GW) of total global installed capacity in 2015, ahead of the US (73 GW; 17%) and Germany (45 GW; 10%). China accounted for 19% (43 GW) of total global installed solar energy capacity in 2015, ahead of Germany (40 GW; 18%) and Japan (33 GW; 15%).

Chart 3: Global Installed Capacity Breakdown by Region for Hydro, Wind and Solar Power (2015)



Source: International Renewable Energy Agency



Record Investments in China's Renewables Sector

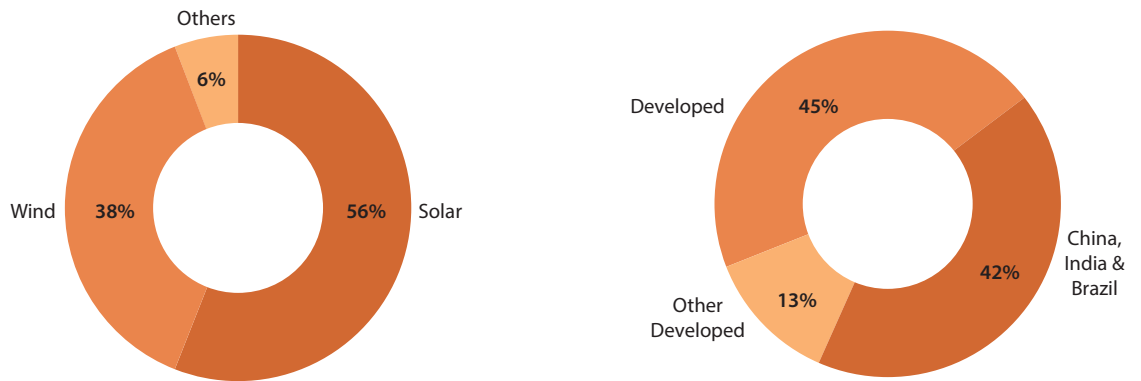
Despite a decline in the prices of fossil fuels (oil, coal and gas), renewable energy investment scaled new heights in 2015, reaching nearly USD 286 billion. Solar and wind energy accounted for 56% and 38% of the total investment, respectively. With 147 GW of renewable electricity coming online in 2015, the investment in renewable energy was twice what was invested in coal and gas-fired power generation.

For the first time, emerging economies invested more in green energy than industrialised nations. According to a report by UN Environment Programme, China, India and Brazil witnessed a 16% rise in investments, while other developing economies enjoyed a 30% increase.

Developing and emerging economies committed USD 156 billion to renewable projects, up 19% from 2014 compared to USD 130 billion by developed countries, an 8% decline from 2014. The shift in investment towards developing countries and away from developed economies may be attributed to China's push for wind and solar energy, reducing cost of renewables, slowdown in growth in the developed world and subsidy cuts in Europe.

Investment in developed countries has been declining since 2011. In Europe, investment dropped 21% after the withdrawal of policy supports, such as clean energy subsidies and binding targets in 2015.

Chart 4: Global Clean Energy Investment Breakdown by Source and Region (2015)

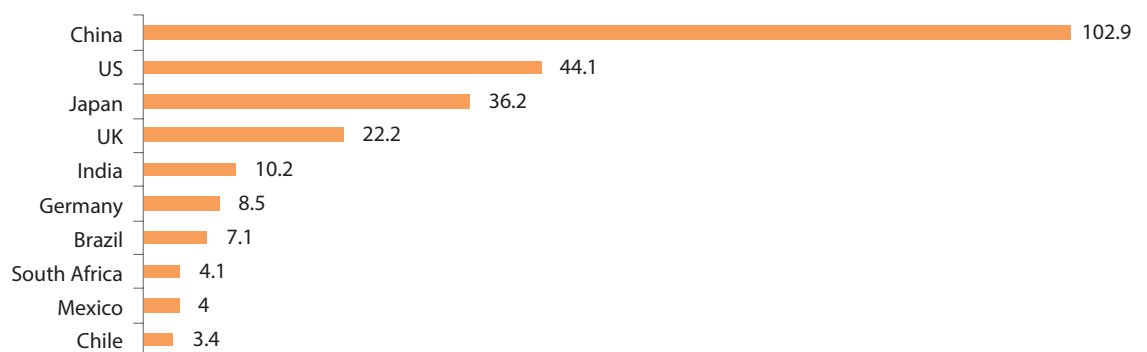


Source: International Renewable Energy Agency

In 2015, China led in terms of investment in renewables, excluding large hydro energy projects, with USD 102.9 billion, representing more than one-third of global investments. USA came second, with USD 44.1 billion of total investment. Japan ranked third, with USD 36.2 billion worth of investment, led by a 13% rise in investment in small-scale solar energy initiatives (ground-mounted projects less than 1MW) worth USD 31.7 billion, its highest annual figure, helped by the country's favourable feed-in

tariff. The UK recorded a 25% rise in renewable energy investments, which may slow down due to a cut in solar subsidies and prevailing delays in onshore wind planning approvals. India witnessed investment in renewables rise 22% due to falling capital costs for PV projects. Investment commitment in Germany fell 46%, primarily due to uncertainty about its future policy, while that in Brazil declined 10% due to delays in the building of new transmission links.

Chart 5: Investment in Renewable Energy, by Country (USD Bn) (2015)



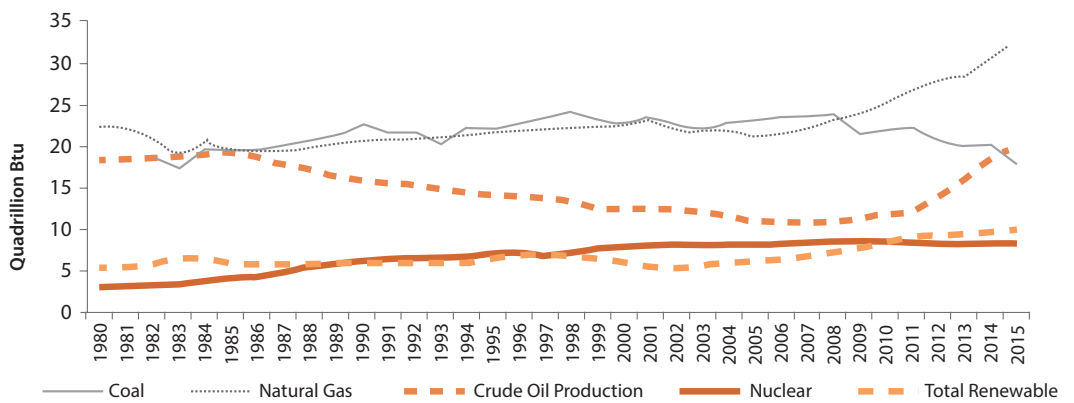
Source: Bloomberg New Energy Finance

US Trailing China's Clean Energy Efforts

China and USA account for more than 40% of the world's carbon pollution. For the first time, developing countries, including China, were ahead of developed countries, such as USA, in terms of investment in renewable energy. In 2015, excluding large hydro projects, China invested USD 102.9 billion in renewables compared with the USA' USD 44.1 billion.

Traditional energy sources, such as petroleum, natural gas and coal, have historically accounted for more than 80% of USA's energy consumption. In 2015, fossil fuels accounted for 80% of energy production in USA (88.1 quadrillion Btu). Natural gas, crude oil and coal accounted for 46%, 28% and 26%, respectively, of fossil fuel energy generation.

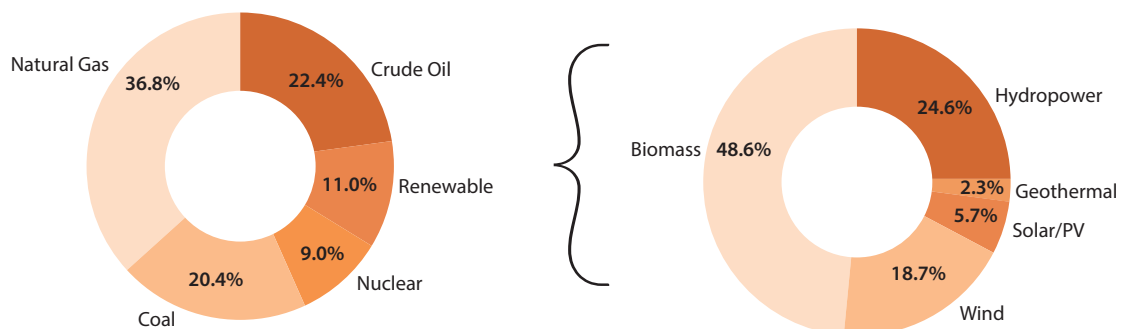
Chart 6: USA Primary Energy Production, by Source (1980–2015)



USA has pledged to increase its power generation from clean energy to 50% by 2025 from around 33% currently. Meeting the goal would entail clean energy development and deployment (including that of renewable, nuclear, and carbon capture and storage technologies), clean energy innovation (through

the Mission Innovation initiative) and increased energy efficiency push. The share of renewable energy in total energy production remained flat at 11% in 2015. Biomass constituted 48.6% of renewable energy production, followed by hydropower (24.6%) and wind energy (18.7%).

Chart 7: USA Primary Energy Production, by Source (2015)



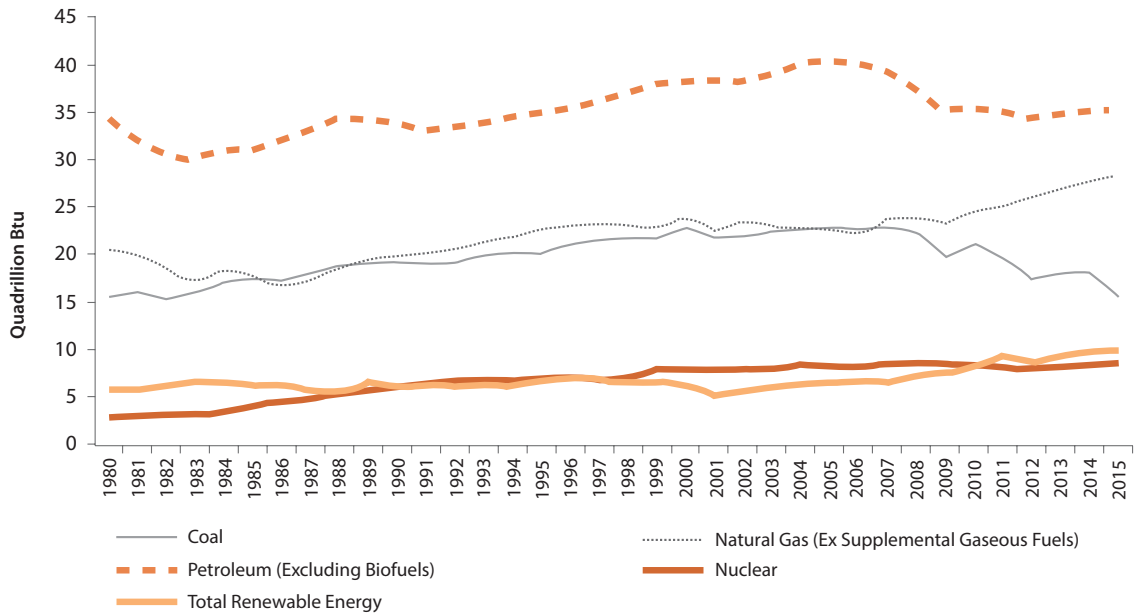
Source: US Energy Information Administration



In 2015, fossil fuels contributed 81.5% to USA's energy consumption (97.5 quadrillion Btu), the lowest share in the past century. USA's coal consumption fell 13%, the sharpest annual percentage decrease of any fossil fuel over

the past 50 years. Petroleum, natural gas and coal constituted 45%, 36% and 20%, respectively, of total energy consumption from fossil fuels in 2015.

Chart 8: USA Primary Energy Consumption, by Source (1980–2015)

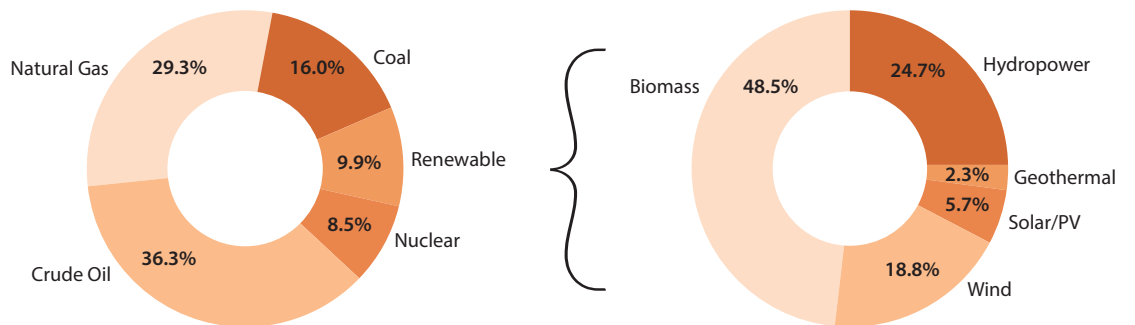


Source: US Energy Information Administration

Owing to a construction boom in solar energy and wind energy production farms as well as the increasing use of biofuels in vehicles, the share of renewable energy in USA's energy consumption rose to nearly 10% in 2015, according to the Energy Information Administration.

Total renewable energy consumption increased by 0.3%, with solar power consumption rising by 31%. Biomass constituted 48.5% of renewable energy consumption, followed by hydropower (24.7%) and wind energy (18.8%).

Chart 9: USA Primary Energy Consumption, by Source (2015)



Source: US Energy Information Administration

Clean Energy Offers Immense Opportunities...

Both G7 and G20 countries have made commitments to accelerate access to renewable energy and increase energy efficiency. At the United Nations Framework Convention on Climate Change (UNFCCC)'s 21st Conference of the Parties (COP21) in Paris, 195 countries agreed to limit the rise in global temperatures to well below 2°C. There are tremendous growth opportunities for the usage of clean energy, some of which are listed below.

1. Transitioning to Clean Energy Necessary to Combat Climate Change

Clean energy consumption would curb emissions, thus limiting the average rise in global temperatures below 2°C and prevent catastrophic climate change. By 2030, global investment in renewable energy is forecasted to reach USD 900 billion.

2. Increasing Solar and Wind Energy Share in the Energy Mix for More Reliable, Resilient Power Systems

Wind and solar power are better suited to

withstand intentional and unintentional disruptions, and provide more reliable services than conventional power plants due to the use of power electronics and other advanced technologies.

3. Limitless Nature of Renewable Energy Sources

Unlike traditional energy sources, which are finite, renewable energy sources can be constantly replenished. Solar, wind, hydro, geothermal and bioenergy sources can be replenished infinitely from the sun, wind, water, heat inside the earth and organic matter from plants. These diverse sources of renewable energy can continue meeting the global energy requirement without the risk of depletion.

4. Significant Health and Climate Benefits

Fossil fuel power generation results in the emission of harmful gases, which causes various health and climate hazards. Clean energy sources generate negligible harmful emissions and do not negatively impact health or the environment.

...but there are bumps ahead

Roadblocks in the development of clean energy technologies include high capital costs, inadequate policy support and price distortion due to fossil fuel subsidies.

1. Lack of Transmission Infrastructure and Curtailment of Wind Generation

To maintain a real-time balance between supply and demand on the grid, some renewable energy generation must be wasted. As most renewable projects are financed and contracted using Power-Purchase Agreements (PPAs) structured around generated electricity, reducing total output can create significant financial risks.

2. High Storage Cost and Space Requirement

Solar PV power plants require double the space required for coal plants and the storage cost of energy is very high.

3. Unfavourable Policy Landscape

Barriers such as subsidies for conventional forms of energy, high initial capital cost, imperfect capital markets, and various other regulatory and institutional factors put renewable energy at a disadvantage relative to other forms of energy. Hence, in the absence of policy support, investment in clean energy could take a back seat.

4. Grid Access

Power companies in Japan have stymied the growth of renewable energy by halting the addition of a significant amount of solar power in the grid, as it was believed to compromise the transmission and distribution networks. These utilities regard renewable energy sources such as solar and wind inconvenient for operating a power grid as the intermittent supply from these sources disrupts the functioning of the grid.



Clean Energy Poised for Exponential Growth

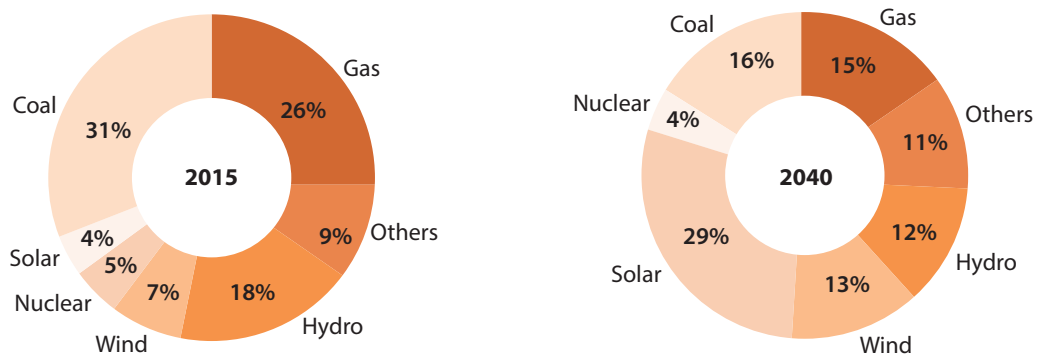
Substantial growth in renewable energy deployment has already taken place in the recent past. However, the growth outlook for clean energy adoption remains favourable as most countries have pledged to reduce emissions and limit the global temperature rise to 2°C. In 2015, nearly 200 countries signed up for the 17 goals of the 2030 Agenda for Sustainable Development and the Paris Climate Change Agreement, which calls for a substantial increase of renewables in the global energy mix by 2030. These initiatives related to climate change would act as a catalyst for the increased deployment of clean energy.

According to BNEF, wind and solar energy would account for nearly 64% of the 8.6 TW of power generating capacity to be added worldwide over

the next 25 years and almost 60% of the USD 11.4 trillion to be invested. By 2040, zero-emission energy sources are forecasted to account for 60% of the installed capacity.

The US Energy Information Administration forecasts the amount of renewable energy on the electricity grid in the US to more than double to nearly 500 GW of capacity by 2040. In Europe, renewable energy is forecast to account for 70% of power generation in 2040. Renewable energy penetration in Asia-Pacific is forecast to reach 38% by 2040, up from 21% in 2015. In the Middle East and Africa, renewable energy is forecasted to increase eight-fold over the next 25 years to constitute 55% of power generating capacity by 2040, up from 16% in 2015.

Chart 10: Global Installed Capacity Breakdown for 2015 and 2040



Source: Bloomberg New Energy Finance

The world is entering an era of clean energy growth with an aim to reduce the risks of climate change and usher in climate-resilient, zero-emission economic growth. Climate change policies and improving cost-competitiveness have been the key drivers of the rapid transition from traditional carbon-emitting energy sources

to clean energy sources; the swift transition has led to significant growth in the sector. This trend is expected to continue, with clean energy sources poised for exponential growth due to favourable policy support and improving economics.

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