Longer Term Investments

Renewables

Chief Investment Office Americas, Wealth Management | 23 August 2017
James Dobson, MLP and Utilities Equity Sector Strategist Americas, james.dobson@ubs.com; **Carsten Schlufter**, analyst; **Tobias Knoblich**; **Alexander Stiehler**, CFA, analyst

- Population growth and ongoing urbanization are increasing the consumption of electricity. The fossil fuels burned to generate it are naturally finite and environmentally incompatible, so transitioning toward infinitely plentiful alternative sources is essential.
- Political support in certain regions initially boosted the attractiveness of renewables. Technological progress made in recent years has dramatically improved the economics of solar and wind renewable power. As a result of falling costs and improving efficiency, solar and wind are now cost competitive with fossil fuels. In some markets today, they are already the cheapest way of producing electricity.
- We think the renewables theme has a lot of potential, especially for project developers and wind turbine manufacturers. Topics like clean air, energy efficiency and storage, and electric vehicles are closely linked to the theme.

Our view

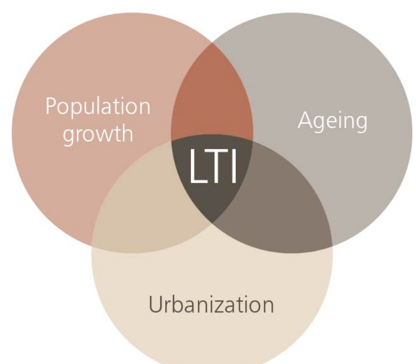
The growth of renewable energy has been impressive in recent years. Renewables are transforming the global power generation mix and we expect them to do so even more rapidly in the near future. In key markets, they have already reached an inflection point by becoming the cheapest means of producing electricity. Market specialists see three primary renewable technologies that should continue to grow:

1. **Wind**: Due to further efficiency improvements, global wind capacity is expected to exceed 1,000 GW by 2025 (it's now around 485 GW), while the share of global electricity generation should increase to 10% from today's 4%.
2. **Solar photovoltaic (PV)**: Worldwide, new solar installations are estimated to grow by 7% annually, from 83 GW (2017) to 104 GW (2020), while the costs for electricity generation should continue to decline. Already today the solar PV market exceeds 300 GW.
3. **Hydro:** The growth of hydro is expected to continue but vary by country because of geographical restrictions and relatively high capital intensity. Its share in power generation already surpasses 15%, with global capacity topping 1,000 GW.

Rising population and ongoing urbanization are the key drivers of the increasing demand for electricity. We think alternative fuels will play

Introduction to the Longer Term Investments (LTI) series

- **The Longer Term Investments (LTI)** series contains thematic investment ideas based on long term structural developments.
- Secular trends such as population growth, ageing, and increased urbanization create a variety of longer term investment opportunities.
- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.



an essential part in the future generation mix. According to IEA forecasts, cumulative investment in renewables will reach USD 5.8–8.8trn by 2035.

The political and regulatory support of renewable energies widely diverges by region (see annex). But in recent years supportive non-economic frameworks have become less and less relevant. So falling costs and technological advances make renewables attractive for investors with a long-term, selective and diversified focus.

1. Energy, electricity and alternative fuels

Global electricity demand is following a clear upward trend due mainly to technological progress, economic and population growth, and ongoing urbanization. Renewable energy enjoys an advantage over fossil fuels today thanks to falling costs and enhanced political support for and social acceptance of them, especially relative to nuclear power.

Energy and electricity demand increases
Primary energy is an energy form found in nature that has not been subjected to any conversion or transformation process. It is a basic human need, the demand for it as old as the human race itself. Humans use primary energy sources in two ways: for "direct consumption" (e.g. for making fire) or to transform it through thermal losses into secondary energy, also called energy carriers. The latter is exemplified by electricity.

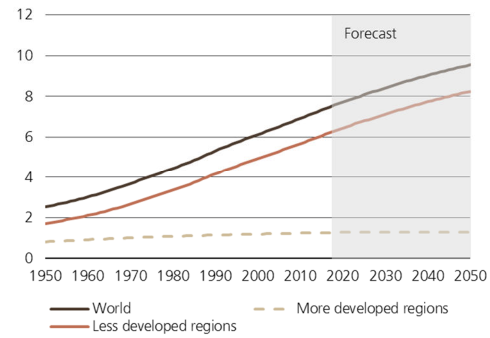
Global demand for primary energy increased from 4 billion tonnes of oil equivalents in 1965 to almost 14 billion in 2015. The International Energy Agency (IEA) expects this number to rise to 18 billion by the late 2030s. While energy consumption of OECD countries stabilized in the early 21st century, that of non-OECD countries is likely to continue rising, especially in developing countries like China and India.

The demand for electricity itself is likely to increase despite an intense political focus on energy efficiency, since the demand-weakening efficiency effect is likely to be outweighed by a demand-strengthening quantity effect. The ongoing technological, economic and social development of emerging markets, combined with their continued population growth, reinforces the increased consumption of electricity.

The IEA forecasts an electricity production increase of 65-70% by 2040. Three key factors will drive it:

- According to UN forecasts, the global population will approach 10 billion by 2050 from 7.4 billion today (see Fig. 1). The increase will be greatest in less-developed countries (including China), while the populations of more developed

Fig. 1: World population (in billions, 1950–2050)
Less-developed countries fueling growth



Source: United Nations (UN), UBS

nations will stay relatively flat. Due to the ongoing development of emerging countries, more people will have access to modern energy services. Not only will they fuel the increased use of electricity, industrial demand for it will climb since larger populations require more goods and services, and more jobs.

- Ongoing **technological progress** in the West, i.e. digitalization, automation and robotics, offers people more opportunities for improving and simplifying their lives. Developing countries are also following this technological transformation, with a time lag but at an even faster pace. As a result global GDP should continue to expand. But every step forward in science and technology requires an energy source. So the demand for primary energy and electricity is likely to increase alongside technological progress for many years to come.

- The global balance between urban and rural populations is expected to go from approximately minus 1 billion in 1950 to more than plus 3 billion in 2050 (see Fig. 2). Such **increasing urbanization** fuels the demand for electricity in various ways. Inadequate urban infrastructure will have to be upgraded continuously. Large urban populations require improved supplies of drinking water, more effective public transport services, more extensive networks of supermarkets, a well-functioning job market to relieve high unemployment, and better provisioning of essential goods and services to combat poverty (see other Longer Term Investment themes, e.g. "Water scarcity"). These collective improvements directly or indirectly require electricity and will boost demand for it. Individual households too, as the number of, for instance, per-capita electrical appliances rises, will further increase it.

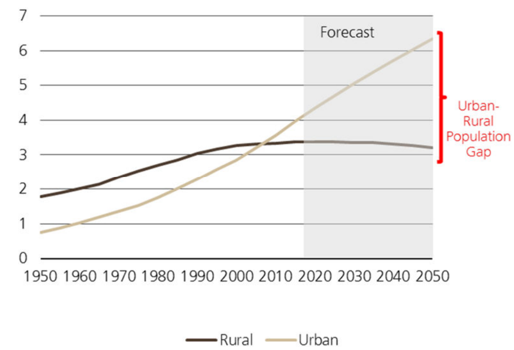
Fossil fuels remain dominant, but transformation is to alternatives

The 19th and 20th centuries ran on fossil fuel and nuclear power. Even today more than two-thirds of global electricity production depends on coal, gas and oil (see Fig. 3), with the share of nuclear power exceeding 10%. But fossil fuel sources are by nature finite. So alternative energy sources have to be discovered and/or further developed as a sustainable solution to soaring energy needs. According to IEA forecasts, the global share of renewables used in electricity generation will approach 35% by 2040 from 20-25% today, while the percentage from nuclear power is expected to follow a stable upward trend. The relatively high share of renewable energy in the global electricity mix today is due to hydropower, but solar and wind will be key as renewables grow.

Another serious problem posed by fossil fuels is the pollution

Fig. 2: World urban and rural population (in billions, 1950–2050)

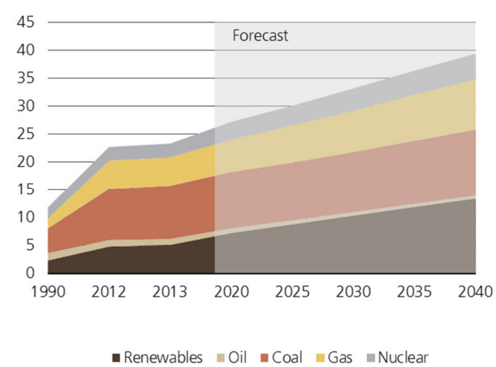
By 2050 a majority of the world's population will live in urban areas



Source: United Nations (UN), UBS

Fig. 3: Global electricity generation (in thousand TWh, 1990-2040 projected)

More than half of global electricity generation is still based on fossil fuels



Source: © OECD/IEA 2015, World Energy Outlook 2015, IEA Publishing; as modified by UBS. Licence: www.iea.org/t&c
Note: Based on non-annual data

they cause. Transforming them into electricity produces greenhouse gas emissions. According to the IEA, CO_2 emissions have almost doubled since the 1980s, reaching 32 billion tons in 2014, a figure expected to climb to 43 billion tons by 2040 (see Fig. 4). Since 2005 non-OECD countries, in general less-developed countries, have accounted for the increase. From an industrial perspective, more than 65% of per-capita global CO_2 emissions is generated to produce electricity and heat and to power transportation. The percentage is much higher in OECD countries (see Fig. 5). To meet these needs the global electricity generation mix will likely move toward a higher share of alternative fuels.

Fossil fuels vs. alternative fuels, economically and politically

The cost of installing **renewable power plants** has plummeted in the last few years. As a consequence the transformation process toward renewable sources for electricity generation will probably proceed faster than expected, especially in Europe. When investment costs are taken into account, wind and solar are the cheapest way of generating electricity in some regions at the moment. Depending on the assumed load factors (i.e. the measure of utilization rate), the cost for wind or solar generated electricity in Europe is about half that of coal (see Fig. 6). Since 2009 the costs for wind and solar have dropped by 50% and 70%, respectively. On the other hand, installing new hydropower plants is still relatively expensive, though their operating costs are quite low.

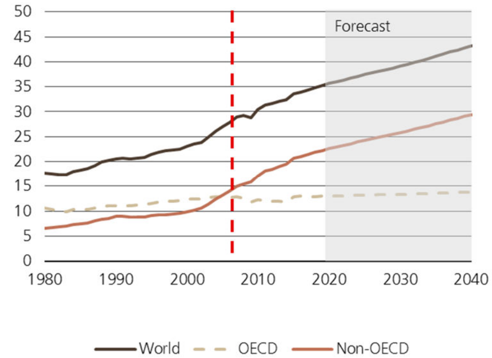
To solve the problem of fossil fuel finiteness, increasing electricity demand and CO_2 emissions, nuclear-generated power could come to be seen as a clean alternative and a direct competitor to renewables. The higher costs for security and its low social acceptance in some regions have resulted in significant cost disadvantages for it, though it could remain an alternative in such countries as China and Korea, and the technology could evolve further and gain greater acceptance.

Addressing the disadvantages of fossil fuels, various governments around the world have focused on clean energy from renewables in recent years. This political will is reflected in the broad range of national policies and regulations supporting renewables worldwide, ones that cover their use for electricity, for heating and cooling, and for transportation. There are also local government policies.

The UN has emphasized the global relevance of meeting the demand for clean energy, which is enshrined in one of its 17 **Sustainable Development Goals** (SDGs). It is all the more relevant since greater access to affordable, reliable, sustainable energy affects nine other SDGs, including reducing poverty and

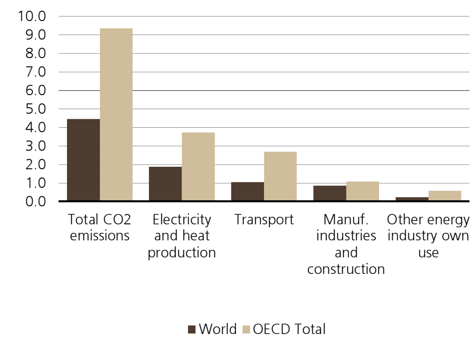
Fig. 4: Global CO2 emissions (in billion tons of CO2, 1980–2040 projected)

CO2 emissions follow an upward trend globally



Source: Based on IEA data from: CO2 Emissions from fuel combustion 2016 © OECD/IEA/ US Energy Information Administration (EIA) 2016, www.iea.org/statistics, Licence: www.iea.org/t&c; as modified by UBS
Note: Historical data 1980-2014 refers to IEA, data 2015-2040 refers to the reference scenario of EIA

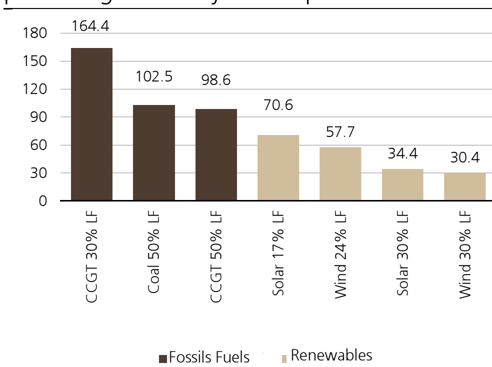
Fig. 5: Global CO2 emissions per industrial sector (in tons of CO2 per capita annually)



Source: Based on IEA data from: CO2 Emissions from fuel combustion 2016 © OECD/IEA 2016, www.iea.org/statistics, Licence: www.iea.org/t&c; as modified by UBS

Fig. 6: Levelized cost of energy (LCOE) incl. investment costs in Europe (in USD/MWh)

Wind and solar are currently the cheapest ways of producing electricity in Europe



Source: Goldman Sachs Global Investment Research (GS), UBS
* CCGT = Combined cycle gas turbine
** percentage numbers indicate assumed load factors
Note: LCOE = stream of equal payments, divided by expected output, which would allow owner to recover all costs over production cycle.

improving the quality of education.

Nevertheless, during the last two years the focus has shifted from purely political measures toward an economically supportive framework. In other words, politics was the rocket rail in early years, while economic competitiveness is now the rocket propellant.

2. Renewable energies in detail

To satisfy the increasing demand for electricity and to reduce global carbon emissions, renewable sources have taken center stage. Hydropower provides the largest amount of global installed capacities for electricity generation today. But solar and wind is likely gradually become the most important renewable energies.

After the era of fossil energy, renewable energies rediscovered

The large advantage of renewables is their infinite availability and low carbon emissions, which have gained them broad support in many countries. It also has led to a cost-related advantage, and as a consequence reinforced their growth. In recent years, new alternative forms like wind and solar have enjoyed a substantial boost.

They also suffer from certain weaknesses: using them to generate electricity is restricted by time, geography and area-intensity. The wind does not blow and the sun does not shine constantly. Here, energy storage could be a solution, either via traditional batteries or through innovative technologies like power-to-gas.

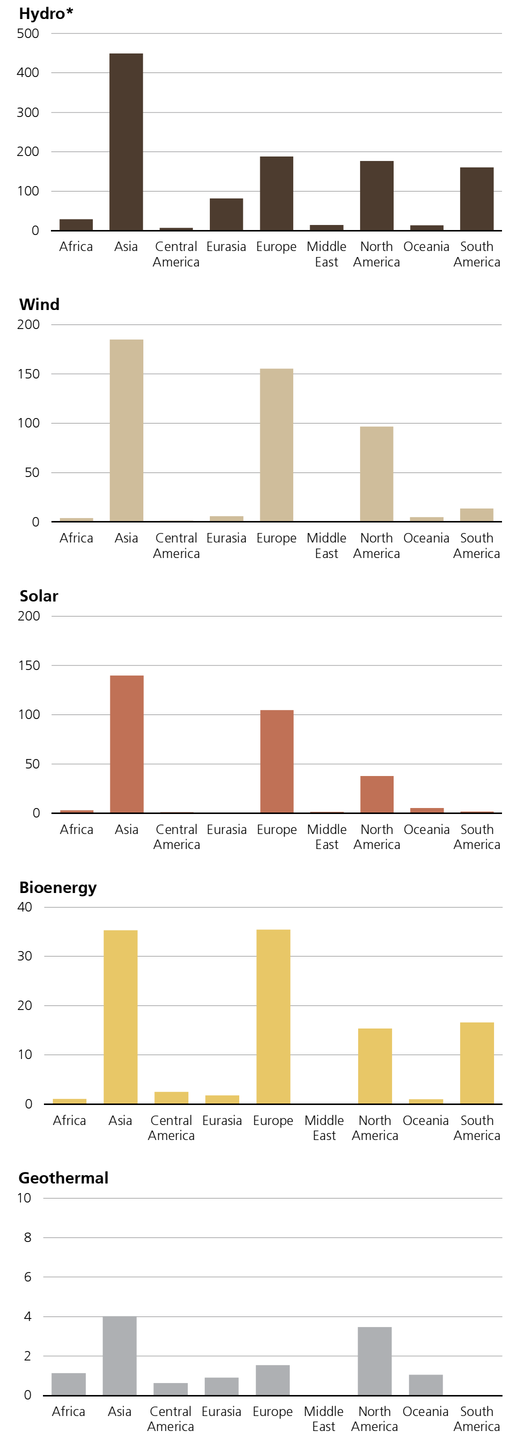
Renewables will not be able to fully replace fossils in the foreseeable future. But they will likely cover a major share of global electricity generation. While **energy efficiency**, **the transition to renewables** and **decarbonization** are not substitutes for coal, oil and gas, they can complement them. No single energy source on its own can meet the challenges of the increasing demand for electricity and the need to combat growing emissions of carbon dioxide.

The most relevant renewable energy sources today are:

- **Hydro**, which mechanically transforms drop height and/or the kinetic energy of water into rotation energy and then electricity. Hydro power plants can be categorized as run-of-the-river or storage (technically, not real power plants since they only store electricity).
- **Wind**, which employs on- and offshore turbines to convert

Fig. 7: Global installed renewable energy capacity (in GW)

Asia, Europe and North America as pioneers in renewable energies



Source: International Renewable Energy Agency (IRENA), UBS, as of 2016
* including marine

kinetic energy from wind into mechanical energy and then electricity. Improvements in hub height and blade length have increased efficiency in recent years.

- **Solar**, both photovoltaic and thermal. The former transforms sun power directly into electricity, the latter is used either for heating or indirect electricity generation.
- **Bioenergy**, which consists of fuels with low carbon emissions produced through biological processes (e.g. agriculture).
- **Geothermal** is an energy source utilizing the earth's underground heat, which can be distinguished, depending on depth and kind of heat used, into near-surface (<400 meters) and deep geothermal energy (>400 meters).

In 2016 around 80% of all renewable capacity, which totaled more than 1,600 GW, was installed in Asia, Europe or North America. In Asia carbon-free energy sources are becoming progressively popular (see Fig. 7). Hydro power and its 1,096 GW (excluding pumped storage) make up 56% of all renewable capacity globally, followed by wind with 23% and solar with 15%. But relatively high installation costs for new hydro power plants make solar and wind more attractive for investment. According to market specialists, over the next 20 years, the number of wind and solar capacity is expected to more than triple. From a primary energy supply point of view (see Box 1 for distinction between capacity and supply) solar and wind are already today the renewable technologies with the highest annual growth rates. Between 1990 and 2014 solar photovoltaic's rate was 46%, wind's 24% (see Fig. 8).

Power-to-gas technology as a derivative of classical renewables

The development of power-to-gas technologies, based on classical renewables, could offer a number of new opportunities. Power-to-gas describes the process of generating electricity by converting renewable sources into gas. Hydrogen captured from pure water in a so-called electrolyzer is only one possibility. The so-transformed electricity can then be used in the natural gas infrastructure or directly transferred to end-consumers (see Fig. 9) for such applications as:

- Offering alternative, low climate-damaging **fuels in the transport sector** by replacing stepwise the classical fossil fuels currently being used.
- As an ecofriendly **replacement for hydrogen** produced from fossil fuels.
- As a renewable gas that could flow to **heating systems** and substitute there for other gas fuels from fossil sources.
- An alternative to standard **energy storage** methods like lithium-ion batteries, helping to store renewable electricity at relatively low cost using gas tanks.

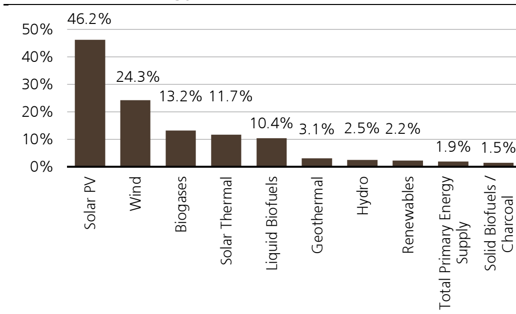
Box 1: Capacity vs. supply

- Energy generation capacity (the same is valid for electricity) is the maximum electric output an energy generator can produce under specific conditions. Capacities are typically measured in megawatt (MW) or gigawatt (GW).
- Energy production (generation) is the amount of energy a generator produces over a specific time period. Many generators do not operate at their full capacity all the time. Supply (generation) is typically measured in megawatt per hour (MWh) or terawatt per hour (TWh).

Source: U.S. Energy Information Administration (EIA), UBS

Fig. 8: Global annual growth rates of total primary energy supply by renewables (in %, 1990–2014)

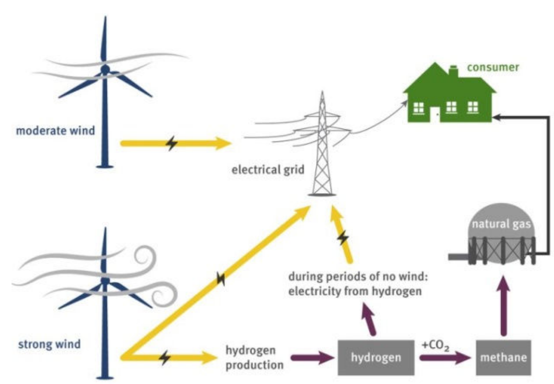
Wind and solar have been the fastest-growing renewable energy sources worldwide



Source: © OECD/IEA 2016, Key Renewables Trends 2016, IEA Publishing; as modified by UBS. Licence: www.iea.org/t&c

Fig. 9: Power-to-gas technology

An efficient way to store electricity from renewable sources or to use it directly for industry, transportation or heating



Source: Paul Scherrer Institut (PSI)

2a. Wind – support through higher efficiency

Annual installations of new wind farms are expected to remain high at 50-70 GW until 2025. The share of global electricity generation provided by off- and onshore wind will increase to 10% from 4%. Wind has benefited from a supportive regulatory framework. Now its purely political advantage over fossil fuels has receded into the background. Today, the competitiveness of wind power is primarily driven by the improved efficiency of wind turbines (higher capacity at lower cost).

Wind market is expected to grow further

Because wind power plants convert kinetic energy from wind into mechanical energy and then electrical energy, there are no fuel costs, in contrast to most fossil energy sources. So no energy commodity price risk exists. Their operating and maintenance costs are relatively low, and in recent years their efficiency has dramatically increased due to **technological improvements** in hub height and blade length. While wind power benefits from high capacity utilization, low cost structures and no carbon emissions, the relatively high land utilization compared with other renewable energy sources, and the electricity transmission to the final consumer might be disadvantageous. The wind power industry can be broken down into onshore and offshore plants.

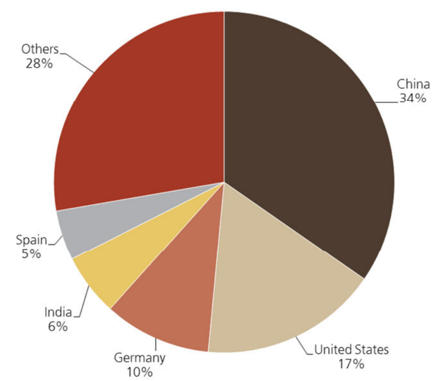
Total worldwide wind capacity (on- and offshore) rose to nearly 487 GW in 2016. China and the US represent more than 50% of this figure (see Fig. 10). Market specialists expect that the capacity continues growing until 2025, and the share of global electricity generation provided by wind is forecast to reach 10% in 2025, up from 4% in 2015.

Global capacity in onshore wind power rose 14.5% from 2015 to 2016, which corresponds to an additional 60 GW and made for a total capacity of 474 GW. China (+22.7 GW), Europe (+12.7 GW) and the US (+8.8 GW) powered this growth. Globally, between 2006 and 2016, onshore wind capacities increased more than sixfold, while the annual addition rate quadrupled, with non-OECD countries playing a key role. Goldman Sachs expects onshore wind capacities worldwide to exceed 1,000 GW in 2025, while annual new installations by then will be above 67 GW (see Fig. 11).

The large investments in new offshore wind parks in recent years (e.g. by Dong Energy, E.ON) provide evidence that they too are following a clear growth path. Many very large wind farms, like the onshore Jaisalmer Wind Park in India (1.1 GW capacity) and the offshore London Array Farm in UK (0.6 GW capacity), have been built of late. In 2020 one of the world's largest onshore

Fig. 10: Country share of global wind power capacities (in %)

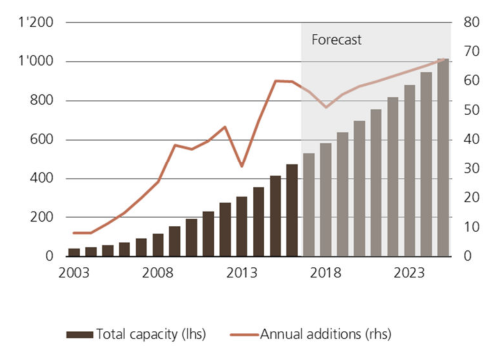
China and US represent >50% of global wind power capacity



Source: REN21, < 2017 >, < Renewables 2017 Global Status Report > (Paris: REN21 Secretariat), UBS, as of 2016

Fig. 11: Global onshore wind capacities and annual additions (in GW, 2003–2025 proj.)

Global capacities for wind power are expected to increase



Source: Goldman Sachs Global Investment Research (GS), UBS
Note: lhs = left hand side; rhs = right hand side

wind farms, the Gansu Wind Farm in China with a planned capacity of 20 GW, will go on line. All of this supports our expectations for renewable energy growth globally.

Supply chain consists primarily of mid and large-cap companies

The wind supply chain consists of primarily mid- and large-cap operators, developers and manufacturers, like Siemens-Gamesa and Vestas, from the industrial and utilities sector. Because turbines are mechanical constructions, their supply chain is made up of the following component segments:

- Blades
- Bearings
- Gearboxes
- Generators
- Towers
- Integrated players

Except for the generator and tower market, the wind supply chain is highly concentrated.

Declining costs support wind power generally

In the early years of renewable energy, wind primarily benefited from a supportive regulatory framework provided by governments worldwide. This purely political advantage over fossil fuels has receded into the background. Today the ongoing growth of the wind market is mainly driven by declining costs. This accelerating fall in costs is also reflected by the low wind prices achieved in recent renewable auctions (see Box 2) worldwide.

The levelized cost of energy (LCOE) (see Fig. 12) has decreased by approximately 50% since 2009, and will likely decline by another 35% by 2026. This development stems mainly from **economies of scale**, **turbine efficiency**, **project clustering** and **industrialization**.

Onshore vs. offshore wind

In 1980 a standard onshore wind turbine with a diameter of 17m produced 75 KW. Fifteen years later the average capacity had already increased by 10x (diameter of 50m), and in 2016 a 130-160m diameter offshore wind turbine generated 8 MW. This progress is expected to continue until, by 2025, a single wind turbine with a diameter of 200m could add 10-15 MW to existing capacities.

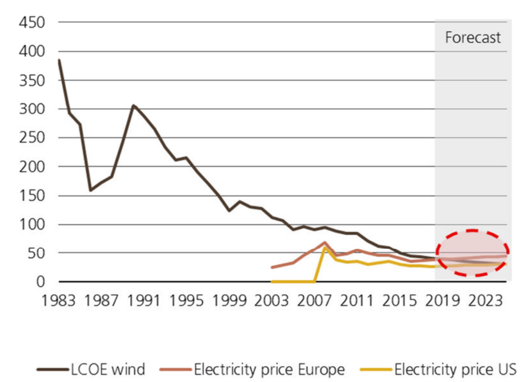
Global power generation from onshore wind has soared from 339 TWh in 2010 to exceed 800 TWh in 2016. By 2025 production is expected to eclipse 2,200 TWh (see Fig. 13).

Box 2: Energy auctions

Energy auctions are widely used market tools which are able to guarantee, that (renewable) energy services follow the compliance of pre-defined quality standards combined with the cheapest possible price.

Fig. 12: Levelized cost of energy (in USD per MWh vs. electricity prices, 2003–2025 proj.)

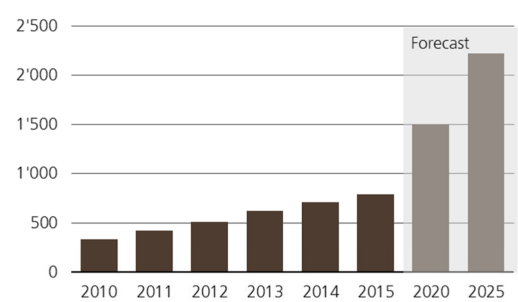
Costs of generating electricity from wind power in Europe is forecast to fall further



Source: Goldman Sachs Global Investment Research (GS), UBS

Fig. 13: Global electricity production from onshore wind (in TWh, 2010–2025 proj.)

Total generated electricity from onshore wind is expected to increase



Source: International Renewable Energy Agency (IRENA), UBS
Note: Our forecasts are based on annual additions of 60 GW and average load factors of 24% in 2020, respectively 25% in 2025

Offshore wind power is still significantly more expensive than onshore, but the LCOE for the former is also expected to decline. Because of **efficiency improvements** the costs of wind power (on- and offshore) will further decline.

2b. Solar – significant growth opportunities

According to market estimates, global demand for solar power is expected to grow at 7% annually between 2017 and 2020, while the share of global electricity generation provided by solar will increase to around 3.5% from today's 1.5%. This ongoing growth stems mainly from huge cost reductions due to oversupply along the supply chain.

Solar market promises significant growth in demand until 2020

Solar is the only renewable that involves few moving parts, in contrast to wind and hydro power. This characteristic destines it for distributed energy generation, which means the generation occurs close to the point of consumption, e.g. on rooftops of individual residential houses. The solar power industry can be subdivided into **solar photovoltaics (PV)**, **concentrating solar thermal power (CSP)** – also known as **solar thermal electricity (STE)** – and **solar thermal heating and cooling** in addition to utility-scale application.

For the generation of solar power, solar PV is the most economical source, benefiting from competition and market developments in recent years. According to the Renewable Energy Policy Network for 21st Century (REN21), solar PV's capacities increased in 2016 by more than 32% over 2015, which corresponds to an added installation of 75 GW (more than wind contributed and equivalent to 31,000 new solar panels coming on line every hour). China and the US were responsible for 46% and 20% of the increase, respectively, with Japan at 11.5%. The total global capacity of solar PV in 2016 was 303 GW, with around 66% provided by China and the US (see Fig. 14).

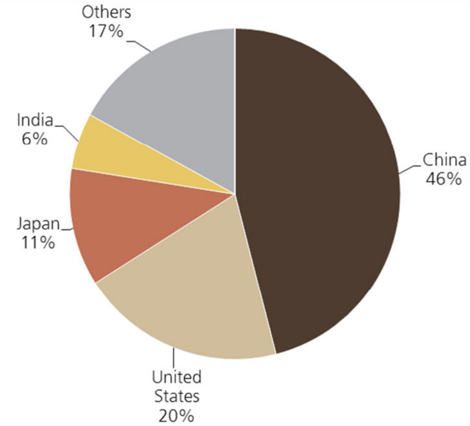
Additionally, CSP climbed to more than 4.8 GW in 2016 while the market for solar heating and cooling grew by newly installed capacities of 21 GW, pushing its global capacity to 456 GW.

PV capacity installations follow an ongoing growth path. While global demand, represented by new solar installations, was around 20 GW in 2010, it more than tripled to 75 GW by 2016. Based on market estimates, 7% more solar installations will be added annually between 2017 and 2020, which would result in excess of 100 GW by 2020 (see Fig. 15).

According to market estimates, 30 TWh were generated by solar globally in 2010 (for context, nuclear generated 2,600 TWh). This

Fig. 14: Country share of global capacity in solar PV power (in %)

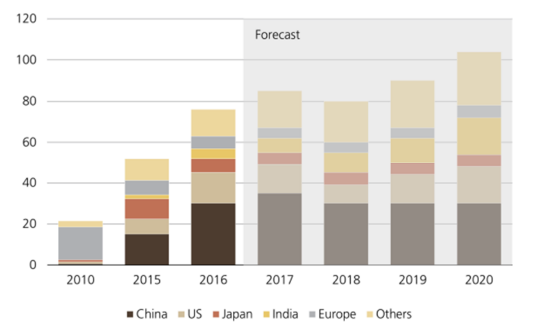
China and the US represent 66% of global solar PV capacities



Source: REN21, < 2017 >, < Renewables 2017 Global Status Report > (Paris: REN21 Secretariat), UBS, as of 2016

Fig. 15: Annual new installations in solar total (in GW, 2010–2020 proj.)

Annual global installations of solar are expected to exceed 100 GW in 2020



Source: Credit Suisse (CS), UBS

figure will rise to 740 TWh (nuclear: 3,000 TWh) by 2020 (see Fig. 16), which corresponds to a 40% annual growth rate (nuclear's is 1%). In 2015, the share of global electricity generation provided by solar was around 1.5%, a figure forecast to reach 3.5% by 2020.

The largest solar park in the world is Longyangxia Solar in China, with an estimated capacity of 850 MW, followed by Topaz Solar in the US with a capacity of 550 MW.

Supply chain consists of broad range of companies across sectors

The suppliers include operators, developers and manufacturers across the industrial and utility sectors. This characteristic of the market makes it particularly interesting for investment because it generates value in downstream and upstream manufacturing. The supply chain mainly consists of the following segments:

- Glass
- Silicon
- Crystalline silicon modules (wafers, solar cells, modules)
- Distribution
- Inverter
- Installation

In Asia the markets along the supply chain are characterized by a large number of small and midcap companies, a market structure caused by **low barriers** to new entrants that is ratcheting up competition.

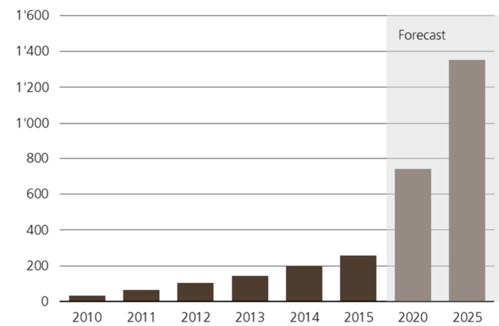
Declining costs and oversupply increase competitiveness of solar

The solar industry primarily focuses on soft costs by optimizing and improving equipment, using robotic technologies and boosting the efficiency of modules. These ongoing developments, along with the general attractiveness of the renewable/solar power market, have motivated more and more small and midcap companies to enter it along the solar supply chain. This has led to marked oversupply.

Because of **production oversupply**, costs have declined by 84% across the polysilicon supply chain alone between 2000 and 2016. A return to significantly higher prices is not expected today. Wafer and cell market prices too are under pressure due to oversupply, which is good for demand growth but bad for manufacturers (see Box 3). In 2017 markets anticipate a utilization rate for polysilicon components, especially wafers, of around 70% globally. For solar cells the utilization is estimated to be a bit lower, at 60-65%. The overcapacities for cells and wafers could start self-correcting in 2018.

Fig. 16: Global electricity production from solar PV (in TWh, 2010–2025 proj.)

Total generated electricity from solar PV is forecast to increase



Source: International Renewable Energy Agency (IRENA), UBS
Note: Our forecasts are based on annual additions of 75 GW until 2020 (after 2020 85 GW) and average loading factors of 14% in 2020, respectively 15% in 2025

Box 3: Solar-related terms

- **Panel**: A photovoltaic module consisting of a number of solar cells.
- **Wafer**: A thin slice of semiconductor material used to fabricate wafer-based solar cells.
- **Inverter**: Converts direct current (DC) power produced by solar panels into usable alternating current (AC) power.
- **Tracker**: Advanced technology for solar panels tracking the sun. Produces higher electricity output than stationary counterpart due to increased direct sun exposure, though is more expensive.

Large companies are likely to fare moderately well in this environment because of improved factory utilizations, brand strengths and low cost structures. Small and midcap companies meanwhile may continue to suffer because of significant inabilities to fund capacity improvements or grow scale. A **continued consolidation process** across the supply chain is expected. Nevertheless, some governments recently have started to intervene against cost-dumping in the solar market. India initiated an anti-dumping investigation against the importation of solar cells and modules from China, Taiwan and Malaysia. The US also considering tariffs on imported solar panels (see annex at the end of this report)

While equipment costs for solar power should continue declining, panel efficiency will likely rise further. When all costs are included, solar already today is the cheapest way of producing electricity besides wind in Europe. Once installed, a solar plant runs at near-zero marginal cost for generating electricity. Annual operations and maintenance expense is around 1% of capital costs and consists of inverter replacement, panel cleaning and performance monitoring. The levelized cost of energy (LCOE) is expected to fall further.

2c. Hydro – relevance varies by country

More than 15% of global electricity generation today is provided by hydropower. But its place in the electricity production mix varies greatly by country due to geographical restrictions and its relative high capital intensity compared to solar or wind energy.

Electricity production from hydropower varies across regions

Hydropower plants convert kinetic energy from a natural source – water – into mechanical energy by using turbines and then into electricity. In sharp contrast to wind power, hydro needs a relatively large area and its use is more restricted by local settings.

There are four general types of hydropower plants:

- An **impoundment facility** stores water in a reservoir. When released it generates electricity through turbines. In Switzerland this type of hydropower plant is in wide use.
- A **run-of-the-river hydro plant** uses the natural flow and elevation drop of a river to generate electricity.
- A **wave or marital power plant** is a special type of run-of-the-river hydro plant since it uses the energy of oceans (marital waves or tides) to generate electricity.
- A **pumped-storage plant** uses electricity (typically at times of low demand) to pump water uphill to an upper reservoir so it

be used to generate electricity when demand is higher. It does not generate new power since it only stores electricity.

In 2016 global hydropower capacity additions were estimated by REN21 at 25 GW, while total hydro capacity reached 1,096 GW (excluding pumped storage). This growth came primarily from China (+8.9 GW) and Brazil (+5.3GW). Overall, 28% of global capacity is provided by China, with Brazil, the US and Canada each contributing 9% (see Fig. 17). Additionally, the global pumped storage capacity reached around 150 GW (+ 6.4 GW over 2015).

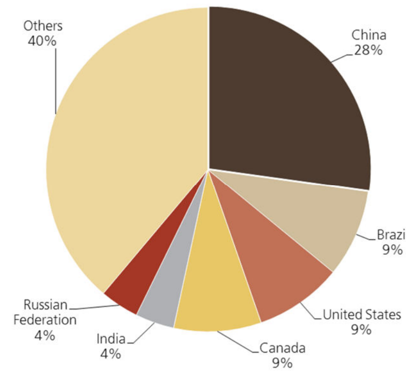
The electricity generated from hydropower worldwide was around 4,100 TWh in 2016 (3.2% more than in 2015). This corresponds to 15% of total electricity generation, a figure anticipated to exceed 17% by 2030. Since 1973 hydro in Asia and South America has markedly increased with respect to regional shares of hydropower production (see Fig. 18).

Due to the geographical restrictions and the relatively high capital intensity (especially compared to solar and wind power), hydro will remain a regionally specific alternative. Switzerland has generated the majority of its electricity from hydropower for many years. In Brazil, too, hydropower, at about three-quarters of the total, is an important pillar of electricity generation. In other countries it will remain more of a niche alternative.

The Three Gorges Dam in China, with an installed capacity of about 20 GW, and the Itaipú Dam in Brazil, with a capacity of 14 GW, rank among the largest hydro power plants worldwide.

Fig. 17: Country share of global capacity in hydro power (in %)

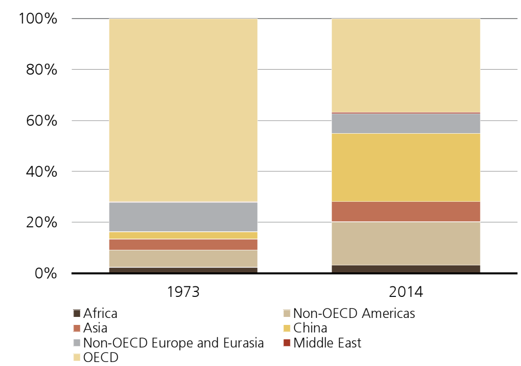
China and Brazil represent 37% of the global capacities in hydropower



Source: REN21, < 2017 >, < Renewables 2017 Global Status Report > (Paris: REN21 Secretariat), UBS, as of 2016

Fig. 18: Regional share of hydro production (in %, 1973 vs. 2014)

Asia's share has increased by more than 27% since 1973 due to Chinese growth



Source: © OECD/IEA 2016, Key world energy statistics 2016, IEA Publishing; as modified by UBS. Licence: www.iea.org/t&c

2d. Energy storage – the key to renewables

Energy storage is vital to advancing renewable energy generation. Efficient technologies are able to reduce electricity costs to smooth volatilities in electricity supply, and to improve power quality. Because of supportive policy shifts and new applications, the share of electrical energy storage relative to global battery demand is expected to increase its share.

Energy storage is closely linked to renewable energy generation

Due to its natural origins, the output of renewable energy generation, especially for wind and solar PV, is characterized by relatively high volatility and uncertainty, which makes energy storage (see also pumped-storage plants) an important topic. Within this framework, electrical energy storage fulfills three main roles regarding renewable energy generation: First, it reduces costs by storing electricity obtained at off-peak times when its price is lower for use at peak times when its price is relatively high because of greater demand. Second, it can supply end-consumers with electricity should power network failures occur. And third, it improves power quality, frequency and voltage.

Electrical energy storage systems can be classified into:

- **Mechanical systems**, with pumped hydroelectric power plants and flywheel energy storage as the most common technologies.
- **Electrochemical and pure chemical systems**, mainly content batteries like Lithium-ion cells and hydrogen or synthetic natural gas storage applications.
- **Electrical and thermal systems**, which involve technologies like double-layer capacitors or magnetic energy storage.

The growing market for electrical vehicles is positively correlated with energy storage, which benefits from the technological progress made in batteries for electric cars. Another efficient solution to the storage issue in the context of renewables could be **power-to-gas technology**, which transforms renewable electricity into gas for direct use or for feeding into natural gas infrastructure.

Storage market offers high growth potential
Worldwide battery demand in 2015 was 70 GWh. While one-third of it came from electric vehicles, less than 5% originated in the energy storage sector. We share the view of market specialists that the global **battery market** is likely to increase above 530 GWh p.a. by the mid-2020s. The energy storage market is expected to grow up from presently around 3 GWh p.a. to 60-80 GWh p.a. until mid-2020s. This would imply an annual growth rate for energy storage of more than 30%. It would be underpinned chiefly by supportive political frameworks and ongoing technological progress. Meanwhile the market for batteries has been primarily influenced since 2010 by significant reductions in cell costs, which, for lithium-ion cells, plummeted from 900 USD/kWh in 2010 to 225 USD/kWh in 2015. By 2020, a further 75 USD/kWh reduction is likely, which would consolidate lithium-ion as the cheapest battery technology on the market.

3. Potential risks for renewable energies

Despite the current support they receive, renewable energies face risks. Rising commodity prices, the increasing attractiveness of nuclear power and/or greater competitive pressure could prove unfavorable. Unproven cost forecasts for new technologies or climate change could also slow the current renewables boom.

Market risks
Even if renewable technologies become more efficient, they are untested over long operational lifetimes. Returns for new projects would fall if operating and maintenance costs are higher than forecast or production levels lower than expected. Also, changes in non-renewable technologies (e.g. nuclear) could have negative impacts.

Commodity prices (for coal, gas, etc.) influence wholesale power prices in liberalized markets. Depending on the profitability of the traditional (non-renewable) power generation business, they could directly affect investment in renewables, if coal or gas-fueled power plants generated higher returns, for instance.

The introduction of regional **trading barriers**, too**,** could worsen the cost structure and the actual cost advantage of renewable energy production. Other, less-expensive fuels would be supported by markets and further improved in terms of efficiency and effectiveness (see annex for country sections on potential US trade barriers).

In the wind market the consolidation process is almost complete. By contrast the **market competition** within the solar supply chain is still increasing, due mainly to production overcapacities. A rising number of new market entrants could trigger ruinous competition. Consequently, many (especially solar) companies could fall by the wayside due to bankruptcy or acquisitions.

Political risks
In many Western countries the advantage of renewable over fossil fuels has already shifted from a purely political one toward an economic one. Nevertheless, renewables are not yet totally independent of politics (e.g. near term risks like US's International Trade Commission investigation; for more details see annex). If governments were to broadly **support other technologies** through favorable regulatory frameworks, the competitive pressure on renewables would rise. The resulting unattractiveness of them would dry up capital flow. Existing operators, manufacturers and developers might decide to shift their focus toward these other technologies. Potential start-up companies would not be able to raise sufficient funds for further research on renewables.

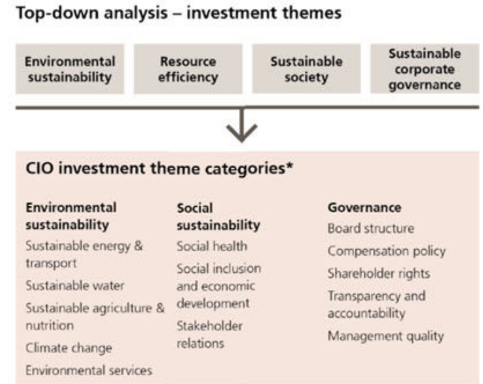
Other risks
Climate change itself could have an impact on renewables. Hydropower generation could decline due to less water in some regions. Changes in average wind speeds could reduce production levels, while increasing extreme wind speeds could influence the loads of turbines and, hence, their cost structure.

4. Link to sustainable investing

To identify whether a Longer Term Investment (LTI) theme qualifies as a **sustainable investment (SI)** theme. LTIs are assessed according to whether they match one or more of the sustainability topics within the **environmental, social or governance (ESG**) categories (see Fig. 19). In general, these themes must contribute to environmental sustainability (e.g. a low-carbon economy), resource efficiency (e.g. energy, water), a sustainable society (e.g. health, education, etc.) or sustainable corporate governance.

We discussed above the underlying trends of our theme – urbanization, population growth, and the tendency toward clean energy (with low or preferably no CO2 emissions) – that will boost demand for renewable energies, which many countries already support. We think our theme dovetails nicely with the SI thematic framework, addressing environmental sustainability in particular.

Fig. 19: Overview of LTI topic clusters



Source: UBS
* All topic clusters include several subcategories not included in the graph. E.g. sustainable water includes water utilities, treatment, desalination, infrastructure & technology, water efficiency and ballast-water treatment. Within each subcategory are further specifications; e.g. water treatment includes filtration, purification and waste treatment. In total, we have more than 100 categories (potential sustainable investment themes) in our thematic database.

5. Link to impact investing and UN SDGs

Investing in renewable energies contributes to many of the UN Sustainable Development Goals (SDGs). Renewables reduce carbon emissions and permit future generations to rely on a stable energy infrastructure to further develop socially and economically. In addition to the obvious contributions to improving **access to energy (Goal 7)** and **combatting climate change (Goal 13)**, investing in renewables can directly contribute to **ending poverty (Goal 1)**, **ensuring health lives (Goal 3)** and improving **access to inclusive and equitable quality education (Goal 4).**

In particular, investors can contribute to the sustainable development agenda by investing in the following:

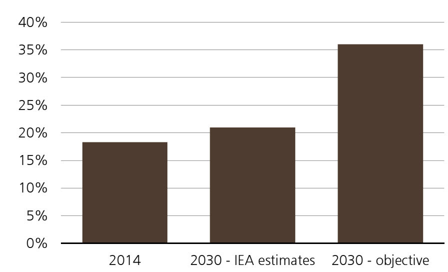
- Sustainable infrastructure helps achieve the Paris Accord goals: the IEA's 450 Scenario is consistent with a 50% chance to keep global warming below 2°C. In the scenario, 60% of electricity comes from renewables by 2040 and 50% of renewable power is generated by wind and solar.

- According to the IEA, 16% of the world population had no access to electricity in 2016 and 85% of the world's energy poor live in remote, low-density rural areas. Therefore, off-grid renewable energy particularly benefits rural areas.

- To reach the goal for access to energy (Goal 7), 36% of total electricity generation should come from renewable energy by 2030, as compared to 18.3% in 2014. According to The World Bank and the IEA estimates, additional efforts are needed (see Fig. 20).

- The market for branded pico-solar products, such as solar

Fig. 20: Renewable energy share in total electricity generation
Share of renewable energy in total electricity generation is forecast to reach 21% by 2030



Source: The World Bank 2017, Global Tracking Framework, Progress toward Sustainable Energy (based on IEA data), 2017; UBS lanterns and homes systems, had a compound annual growth rate of 109% between 2011 and 2014 in unit sales. According to Bloomberg, the key markets are India and Kenya.

By focusing on countries where access to energy is a persistent challenge, impact investors can both reduce global warming and contribute to inclusive, sustainable economic growth. Most impact funds focus on the US, while emerging markets constitute as much transaction volume as the developed countries excluding the US.

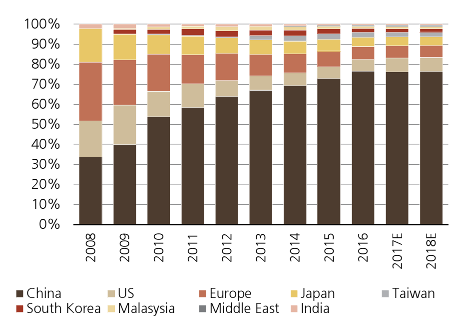
Increasing global renewable energy capacity is both a necessity and an attractive investment opportunity, making it one of the most popular themes for impact investors. Approximately 14% of the impact investment fund universe is engaged in renewable energy investments, according to ImpactBase. In addition, investors may access this theme through generalist renewable energy funds or via direct investments. As always, when investing using non-impact-specific vehicles, impact investors must assess on their own whether individual investments meet their impact criteria, including intent, measurability and verification.

Andrew Lee*, Head Impact Investing and Private Markets*
James Gifford*, Senior Impact Investing Strategist*
Manon Lüthy*, Impact Investing Analyst*

6. What has happened to renewables stocks

Since the financial market crisis in 2008, the **PV industry** has changed from a seller's to a buyer's market. Today, most production is from Asia (see Fig. 21). The US thin-film module producer First Solar is virtually the only big manufacturer with 4GW of planned capacity, and there too a large part of it comes from Asia. Compared to wind turbines, PV production is less engineering intensive, highly automated and its products can easily be shipped across the world at low cost.

Fig. 21: Nominal PV module manufacturing capacity, regional split
Chinese dominate the PV module production



Source: Goldman Sachs Global Investment Research (GS), UBS

Mass PV production grants Chinese manufacturers one important advantage over their peers: economies of scale. An additional plus in recent years was access to financing. In sum, the industry faces a supply/demand problem with virtually no possibility of differentiating between products, which consequently resulted in huge price declines. Virtually no solar stock escaped the general pullback in stock prices. This picture has slightly improved due to market consolidation, but investors still have to be **very selective**, and timing is also important in this segment of the solar value chain.

The **wind industry** endured a similar tough period after the financial market crisis, but for different reasons, though most listed companies survived it. A lack of project financing in developed markets, lower subsidies and fierce competition led to weak performance until 2012. Unlike PV equipment, wind turbines are engineering products, and wind companies' future revenue streams depend highly on turbine efficiency and availability. Chinese manufacturers haven't managed yet to establish a major presence outside of their domestic market as mastering developed-market technology and ensuring reliability appear to be much tougher hurdles to overcome than those in the PV sector. Another advantage developed-market wind companies have over their PV counterparts stems from the maintenance and repair aspect of the business, from which manufacturers can generate additional (high-margin) revenue. In sum, we are far **more positive on wind turbine manufacturers than on the PV market.**

7. Investment conclusion

Today energy and electricity are basic human needs. To meet the increasing demand for them (see Fig. 22) and to limit CO2 emissions (see LTI theme "Clean air and carbon reduction"), the relevance of renewable energy as an efficient, cost-effective alternative to fossil fuels has increased enormously in recent years.

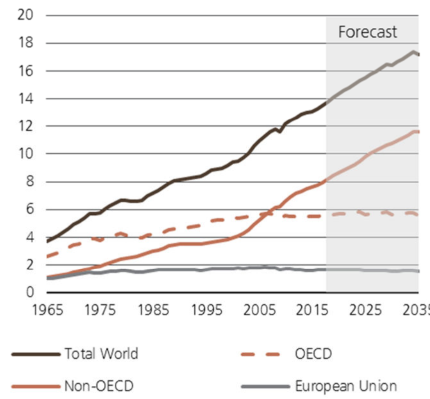
The renewable energy market comprises a broad range of **operators**, **developers** and **manufacturers** from various industries, especially the industrial, energy, information technology and utility sectors. According to the IEA, the **renewables market** is expected to expand from USD 153bn p.a. (2000-2013) to USD 234bn p.a. (2021-2025) and USD 326bn p.a. (2031-2035) under the New Policies Scenario (NPS) (see Fig. 23). This represents 3.5% annual growth. Cumulative investment is forecast to reach USD 5.8trn under the NPS scenario and possibly USD 8.8trn under the 450 scenario by 2035 (see Fig. 24).

From today's market perspective, we see the greatest potential in certain **project developers from the utility sector** and **wind turbine manufacturers.**

We recommend investing in this theme because the transition from feed-in tariffs to auctions is occurring now and further reducing costs for wind and solar, which makes them cost competitive now. Given current development we expect the renewables industry to grow at an attractive pace over the next two decades. The shift from a mainly politically supported industry toward a **cost-supported** one should prove a plus. The higher penetration of **electrical vehicles** and the related increase in energy storage/capacity should solve one of today's most relevant issues of renewable energy.

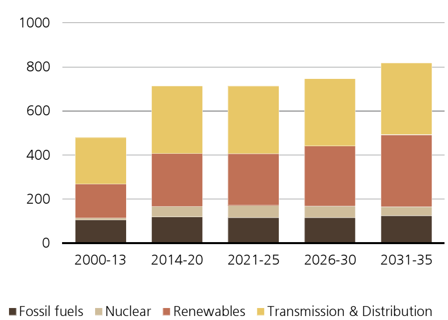
On the other hand, because of the competitive dynamics due to the global political and economic framework, this theme has to be actively managed. The stiff competition in solar caused by the **oversupply in production**, in particular, will likely make many near-term adjustments in this segment necessary. These potential risks necessitate that investors **be highly selective, especially with regard to small and mid-cap companies within industries and regions.**

Fig. 22: Primary energy consumption (in billion tons oil equivalent, 1965–2035 proj.)



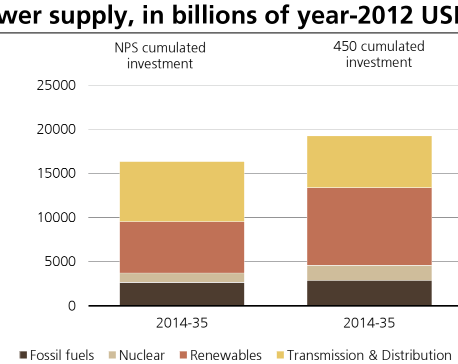
Source: BP, UBS
Note: Forecast is based on non-annual data; i.e. BP provides forecasts for 2020, 2025, 2030 and 2035 (intermediate values are linearly interpolated by UBS).

Fig. 23: Global investment in power supply, in billions of year-2012 USD (NPS scenario)
Renewable investments will rise from USD 153bn (2000-13) to USD 326bn p.a. (2031-35)



Source: © OECD/IEA 2014, World Energy Investment Outlook 2014, IEA Publishing; as modified by UBS. Licence: www.iea.org/t&c

Fig. 24: Cumulative global investment in power supply, in billions of year-2012 USD



Source: © OECD/IEA 2014, World Energy Investment Outlook 2014, IEA Publishing; as modified by UBS. Licence: www.iea.org/t&c
Note: NPS scenario = IEA baseline scenario. 450 scenario = energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO2.

Annex: Regional politics, regulatory frameworks and economic development

I think we can say our energy system will be the most efficient and environmentally friendly in the world.
(Angela Merkel, Germany)

In Europe at the moment renewable energies are broadly supported by national and supranational regulatory frameworks. In Asia there is wide divergence in terms of the economics and politics of renewables. Their deployment is limited in Southeast Asia by attractive economics for coal-fired power plants, while China and India offer opportunities for alternative power fuels. The Americas have a similarly divergent picture.

Renewable energy in Europe

Europe has converged greatly in terms of relative renewable/fossil economics, regulatory overlay and utility competitive positioning with respect to affordable renewable energy.

The expansion of **Germany's** renewable energy industry is a central pillar in the EU's targeted energy transition. According to the Federal Ministry for Economic Affairs and Energy, more than 40% of electricity consumed in Germany should derive from renewables by 2025. A special focus lies on solar, wind and biomass power. In **France**, too, renewable energies are becoming increasingly important, especially relative to nuclear power. The share of nuclear power in the national electricity mix is targeted to decline to 50% by 2025.

In **Italy** and **Spain** the situation varies: while Italy has followed a renewable-friendly policy for many years, the Spanish government just returned to a clean energy policy after a four-year moratorium ended in 2016. The **UK** became an industrial powerhouse thanks in large part to fossil fuels (especially coal). But the British government has decided to close all coal plants by 2025 and focus on renewables. The upcoming ban of non-electric vehicles from UK roads strengthens the government's efforts to promote a clean energy supply.

Also in non-EU countries there is a special focus on renewable energies. **Scandinavian** countries have traditionally been the leaders in energy transition for many years (especially through hydropower). They have already relied on renewable energies to the tune of about 30% of their total energy consumption for some time. In **Austria** the use of nuclear power was rejected by a national referendum in the mid-1970s. At more than 50% of the national electricity generation mix, hydro has been the most important energy source for years, and upwards of 69% of Austria's electricity came from renewables in 2015.

Because of its lack of fossil fuels, **Switzerland** has long featured renewable energies, especially hydropower, in its electricity generation mix. In 2016 hydropower made up more than 59%

Table 1: National targets for share of energy from renewables in gross final energy consumption 2020 in Europe

Country	2005	2020
Sweden	39.8%	49%
Latvia	32.6%	40%
Finland	28.5%	38%
Austria	23.3%	34%
Portugal	20.5%	31%
Denmark	17%	30%
Estonia	18%	25%
Slovenia	16%	25%
Romania	17.8%	24%
France	10.3%	23%
Lithuania	15%	23%
Spain	8.7%	20%
Germany	5.8%	18%
Greece	6.9%	18%
Italy	5.2%	17%
Bulgaria	9.4%	16%
Ireland	3.1%	16%
Poland	7.2%	15%
United Kingdom	1.3%	15%
Netherlands	2.4%	14%
Slovak Republic	6.7%	14%
Belgium	2.3%	13%
Czech Republic	6.1%	13%
Cyprus	2.9%	13%
Hungary	4.3%	13%
Luxembourg	0.9%	11%
Malta	0%	10%

Source: Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), UBS

Notes: The values of 2005 represent the effective share of energy from renewable sources in gross final consumption of energy; some countries have reached national targets (e.g. Germany) already today.

of the mix, a figure expected to significantly exceed 60% by 2050. In total, renewables will generate close to 90% of Swiss electricity by then.

To expand these national trends to the whole of Europe, the "Renewable Energy Road Map" was created by the European Commission in 2007. It calls for a mandatory target of at least 20% share of the EU's energy mix to be provided by renewables by 2020. To achieve this objective the **Directive on Renewable Energy** (RES) was adopted two years later. It also requires individual, national targets (see Table 1) and action plans regarding the gross final consumption share of renewable energy. These individual, national targets range from 10% in Malta to 49% in Sweden.

Additionally, at least 10% of transport fuels used in EU countries must come from renewable sources by 2020. And beyond then renewables will play a key role in helping the EU meet its energy needs. Member countries have already agreed on a new renewable energy target of at least 27% of final energy consumption by 2030. At the end of 2016 the Commission published a proposal for a **Revised Renewable Energy Directive**, making the EU a global leader in renewable energy.

But even if European politics continues to play a key role for renewables, the true drivers of the growing market will remain the technological progress advancing the efficiency of wind turbines and solar panels and the globally declining costs for producing components and installing new power plants.

Tobias Knoblich,
economist

Renewable energy in Asia

The region diverges widely in terms of relative renewable/fossil economics, regulatory overlay and utility competitive positioning, all of which affect the growth of affordable renewable energy. China and India are the focus, not only due to the size of their economies but because 60-70% of both countries' electricity is still generated by coal-fired plants. CO2 emissions in China and India combined accounted for more than one-third of the global total in 2015. The countries' fast economic growth in recent decades comes at a price. A more sustainable growth model requires that they fundamentally transform their energy market and focus on renewables.

Our task is tough, and our time is limited. Party organizations and governments at all levels must give priority to emission reduction and bring the idea deep into people's hearts.
(Hu Jintao, China)

China benefits from rapid technological improvement and the cost declines of renewables, mainly through locally produced equipment. The country has now the world’s largest installation of wind and solar power facilities. China more than doubled its solar and wind power capacity from 2013-16, and its wind and solar capacity combined could continue to grow to around 320

GW (210 GW wind and 110 GW solar) by 2020 under the government's plans. While renewable investments in the country still require government subsidies before grid parity (i.e. demand and supply equalize) arrives, which is likely by 2020, the government is effectively reducing its subsidies by changing the feed-in-tariff-based subsidy into the green certificate mechanism because the country's Renewable Energy Fund is running a large deficit. The proposed voluntary green certificate program began on 1 July 2017, while the compulsory green certificate is to begin trading in 2018.

India recently reached an inflection point. In the past six months solar power became the cheapest way to generate electricity for the first time. From spring 2014 to spring 2017, solar power capacity in India quadrupled to 12 GW, and the government is targeting an additional 115 GW of wind and solar by 2022. India will remain among the fastest-growing solar markets in the world through 2020.

On the other hand, there are around 50 GW worth of coal-fired power plants under construction, implying a dependence on fossil-based generation that is not likely to be phased out as rapidly as in other parts of the world. India's current power infrastructure is still incapable of providing sufficient reliable electricity for its fast-growing economy.

In **Southeast Asia** we do not see significant disruption from renewables occurring. Very long-term contracts tied to the output from fossil fuel power plants in the region exist, and the deployment of renewables is limited given the attractive economics for coal-fired generation and cheaper gas prices that stem partly from government subsidies.

The picture for renewable energy equipment manufacturers in Asia has been complicated by some US solar panel makers filing a petition to the US’s International Trade Commission (ITC) in May 2017. We see a possibility of US regulators introducing higher tariffs on low-priced solar imports from China late 2017 or early 2018.

The case could be another test of President Donald Trump’s trade policies and stance on renewable energy. If higher tariffs are imposed, they would increase the price of solar panels in the US and affect whether the US solar industry can compete on cost against other energy sources in producing electricity.

China exported USD 14bn in solar equipment in 2016; its companies had 21% of the US market. China's rapid technological improvement and the cost declines of solar products are arguably main driving forces that have made solar an increasingly competitive way of generating electricity in recent years.

The US and other countries have imposed tariffs on Chinese solar products for years to protect domestic manufacturers. Chinese solar companies could be hit with even more punitive tariffs if the US ITC and President Trump proceed with protective trade policies on renewable energy, which would reverse the trend of renewables becoming more cost competitive. The tariff strategy drives the cost of renewable energy up, which is the opposite of what most countries and renewable energy companies want these days.

The EU recently revisited and scaled back its system of tariffs and duties on Chinese solar equipment. Two sets of EU tariffs will be extended for 18 months, instead of the Commission's original proposal of a 24- month extension. The commission has also set out plans to gradually reduce tariffs in line with cost reductions in the solar industry.

Hyde Chen,
analyst

To truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy.
(Barack Obama, USA)

Renewable energy in the Americas

Similar to Asia, the Americas diverge widely in their renewable energy policies, and in their significant concentration of electricity generation and carbon emissions. Four countries account for almost 90% of the electricity generated on the two continents: the US, Canada, Brazil and Mexico, with the US representing about 65% of the total. The same four countries account for about 90% of the region's carbon emissions as well. We expect renewable energy to continue to grow rapidly in the region thanks to the improving economics of wind and solar generation and public policy mandates.

Canada and **Brazil** are the largest hydroelectric generators in the world behind China. But their smaller installed bases of electricity generation capacity mean that hydroelectric power represents a significantly higher percentage of total electricity generation. Brazil also has a marked amount of renewable biopower through its use of sugarcane waste and non-food energy crops (eucalyptus, etc.). Renewables including hydro made up 81% and 66% of total electricity production in Brazil and Canada in 2016, with solar and wind constituting 6% in both.

In the **US** solar and wind generation has grown notably over the last five years. The US used renewables (including hydro) to generate about 15% of electricity in 2016, with nuclear providing another 20%. The other 65% is generated using coal and natural gas-fired plants. Federal policies in the US limiting power plant emissions have forced the shuttering of some coal-fired plants in the last five years; they have largely been replaced with natural gas-fired generation.

The US encourages installation of new wind and solar generating capacity through federal tax credits. The wind tax credits extend through 2019, while the solar tax credits extend through 2022. Though we do not expect any changes to them – they were approved by Congress in 2015 – we also do not expect any incremental or additional federal programs to be adopted to encourage installation of more renewable energy in the US. However, some state and local governments continue to encourage the expansion of renewables, and some commercial and industrial customers still consider renewable energy applications when economical on an after-tax basis.

The cost of wind and solar power in the Americas has plunged so it should be economical without tax credits by the time the solar tax credits expire in 2022. According to NextEra Energy, one of the largest renewable developers in the US, the estimated costs of electricity from new wind facilities should be USD 20-30 per MWh, while new solar facilities should generate at USD 30-40 per MWh (post-2020 and excluding tax credits). This compares with new combined-cycle, natural gas-fired power generation of USD 30-40 per MWh.

The improving economics of wind and solar generation will support state policies in the US, generally known as renewable portfolio standards, that mandate more renewable power resources. Two of the largest US states, California and New York, have both adopted plans that mandate 50% of electricity to come from renewable resources by 2030. Renewable resources, in our view, will remain the fastest-growing electricity resource in the US over the next five to 10 years.

In the US the solar industry is closely watching a case at the US ITC on imported crystalline silicon photovoltaic (CSPV) cells. These materials are a component in solar panels and related equipment imported into the country. The case, filed by Suniva, a US producer of solar panels, alleges that imported CSPV cells, primarily coming from China, are being dumped at unfair prices into the US, hurting domestic manufacturers. Suniva is petitioning for a minimum price for imported CSPV cells. It is notable that Suniva filed for protection under Chapter 11 of the US Bankruptcy Code.

Several parties have joined to support Suniva's petition, but several others are against the requested minimum pricing for imported cells. The US ITC accepted the petition for consideration and is scheduled to rule on the case on 22 September, and to make a final recommendation in it to President Trump on 13 November. It is difficult to predict an outcome in it. We are watching an unrelated case advocating steel import tariffs currently being considered by the US president. He has admitted that analyzing and coming to a final decision on it are complicated.

We anticipate imports of CSPV cells accelerating prior to the decision as a hedge against potential price increases. Importantly, though higher prices could modestly slow the growth of solar power in the US in the short term, we expect wind and solar power to continue to grow in the US over the next decade regardless of the decision.

In late 2016 the **Canadian** government adopted a framework to implement a price for carbon emissions in the country beginning in 2018. It applies to all provinces that do not already have a carbon tax regime in place. Quebec and British Columbia adopted a carbon tax in 2007 and 2008, while Alberta and Ontario followed in 2016 and 2017. Since 2010, renewables, primarily wind generation resources, have almost quadrupled as a percentage of total generation in Canada.

Despite a significant amount of hydroelectric generation, the carbon pricing framework is expected to encourage the continued growth of renewable energy resources in Canada, whose climate supports wind generation more than solar generation. The continued decline in installed costs of both solar and wind technologies should also boost their growth over the next decade. Adding to the need for new power generation resources, some coal-fired electrical plants are scheduled to retire over the next decade in light of the new carbon tax.

Brazil has targeted expansion of non-hydro renewable power generation resources since 1997. This follows the country's innovative use of sugarcane ethanol since the 1980s. The legal framework for the renewable energy mandates for electricity production were adopted in the Electricity Law of 2004, which mandates an auction process for renewable resource development and specifies minimum targets for renewable energy in the country. We expect this to go on fueling renewable energy development over the next decade.

Mexico adopted laws in 2014 that mandate targets for renewable energy additions over the next several decades. According to IRENA, the Mexican law targets electricity production from renewable or clean energy sources of 35% by 2024, 40% by 2035 and 50% by 2050. In 2016 Mexico generated about 5% of electricity from solar and wind resources, and a total of about 15% from renewable resources (including wind and solar). So we expect renewable power to continue expanding in the next decade.

James Dobson*, MLP and Utilities Equity Sector Strategist Americas*

Appendix

Terms and Abbreviations

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
A	actual i.e. 2010A	COM	Common shares
E	expected i.e. 2011E	Shares o/s	Shares outstanding
UP	Underperform: The stock is expected to underperform the sector benchmark	CIO	UBS WM Chief Investment Office