



# RENEWABLES MARKETPLACE

Point-of-View

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# Agenda

01

**Objectives and approach**  
page 3

---

02

**Executive summary**  
Page 5

---

03

**Renewable energy market  
overview**  
page 9

---

04

**Renewable energy sectors  
overview**  
page 18

---

05

**Renewable energy market  
investment trends**  
page 34

---

06

**Regulatory  
environment**  
page 42

---

07

**Industries' response to  
renewables trends**  
page 47

---

08

**Energy transformation process  
overview**  
page 59

---

# Objectives

1

What value does the renewable energy market have globally?

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2

What are the segments of renewable energy market and what value do they have?

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3

What investment trends are observed on the renewable energy market?

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4

What is the government and regulatory environment for the renewable energy market?

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5

How other industries are impacted by renewable trends?

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6

What is the energy transformation process?

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# Approach



The research includes an overview of renewable energy market and its segments, as well as drivers affecting the market. Furthermore, the investigation contains an overview of renewable energy market investment trends, government and regulatory environment, industry mash-ups with a specific focus on renewables crossing over all industries, as well as energy transformation process overview.



The approach to this research was to use:

## desk research of publicly available data

- ▶ information from companies' websites
- ▶ academic journals and articles, textbooks, e-books, library services, statistics, guidelines, companies' annual reports, industry journals, analyst reports
- ▶ materials from horizontal and vertical media

## different types of analytical techniques

- ▶ descriptive / exploratory to determine future trends of raised issues
- ▶ financial analysis to investigate the market investment trends

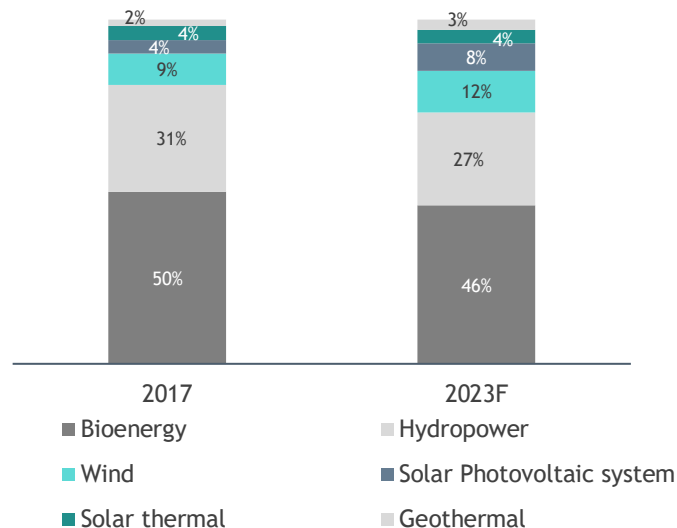




# Executive summary

# Renewable energy capacity is growing rapidly and amounts to about one-third of total installed electricity capacity

Renewable energy consumption by technology, 2017-2023

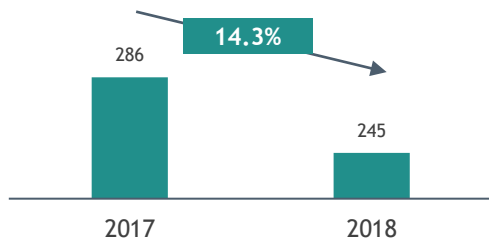


The share of renewables in meeting global energy demand is expected to grow by one-fifth in the next five years to reach 12.4% in 2023.

		Leading regions	Major players
	Solar	China, Canada, USA	Trina Solar, China Canadian Solar, Canada
	Wind	China, EU, USA	Vestas, Denmark Goldwin, China
	Hydro	China, EU	Centrais Electricas Brasileiras, Brazil China Yangtze Power Co, China
	Bio	UK, Germany, Sweden, Brazil	Drax, UK Zolling, Germany Värtaverket, Sweden
	Geothermal	Kenya, Iceland, El Salvador, New Zealand	The Geysers Geothermal Complex, USA Larderello Geothermal Complex, Italy

# Global and regional regulations stimulate investments in the renewable energy market

Global investments, Mn Euro



Despite the general decreasing trend, there are regions which increased investments in renewable energy:

- ▶ Europe (+45.0%)
- ▶ Asia & Oceania (+5.1%)
- ▶ Middle East (+1.6%)

Top 3 financial institutions (public banks) and investments trends

## Export-Import Bank of China (CEXIM)



### Main recipients location

- ▶ Africa
- ▶ South-East Asia
- ▶ Cuba

### Main investment segments

- ▶ Renewable hydropower
- ▶ Solar energy

## European Investment Bank (EIB)



### Main recipients location

- ▶ Europe
- ▶ Africa
- ▶ South America
- ▶ India

### Main investment segments

- ▶ Multiple renewables
- ▶ Renewable hydropower

## World Bank Group (WBG)



### Main recipients location

- ▶ Africa

### Main investment segments

- ▶ Solar energy
- ▶ Bioenergy

Renewable megadeals in offshore wind power shape the European M&A market.

Issuing of **green bonds** is a special opportunity for companies to attract finance for the development of their sustainability projects.

**Paris climate agreement** is currently the global framework for about 195 countries. It establishes target temperature conditions, financing procedure, review mechanism of implemented projects etc.

Other important regional regulatory acts are Directive 2009/28/EC, Renewable Energy Directive 2018/2001/EU, Directive to reduce indirect land use change for biofuels and bioliquids (EU) 2015/1513, Clean energy for all Europeans package.

# Growing demand for renewables may find response among all industries with the focus on green energy transmission



## Mining

- ▶ Investments in renewable energy with the focus on the Asia Pacific region
- ▶ Transition to renewable energy



## Information technology

- ▶ Transition to 100% powering of data centres with renewable energy
- ▶ Investments in self-consumed renewable energy



## Finance

- ▶ Issue of green bonds and financing of renewables projects
- ▶ Targets to use renewable sources of energy



## Real estate

- ▶ Building of Smart cities
- ▶ Implementation of renewable technologies in buildings and development of green building projects

**Energy transformation** is a process that influences social and economic spheres and is driven by **digitalisation, electrification and decentralisation**. Energy transformation increases cooperation between countries and mitigates social, economic and environmental challenges. Digital technologies can support transformation with better control and monitoring of operations, system optimisation and smart contract based on IoT and blockchain technologies.

**Electrification of end-use sectors** is a solution to maintain renewable energy generation and support decarbonisation of heating and transport sectors. In the new paradigm of the energy supply chain, prosumers that both consume and produce electricity, change the dynamics of the sector and have the opportunity to unlock demand-side flexibility.

Distributed energy resources, for example smart electric vehicles, demand response, and behind-the-meter batteries decentralise the system.

**The deployment of distributed energy** makes the consumer an active participant in the power market.





# RENEWABLE ENERGY MARKET OVERVIEW

# Did you know?

By **2050** already, **50%** of global energy demands are expected to be satisfied with wind and solar generation

Renewable energy will be the world's **main power source by 2040**

During the decade, solar and wind energy attracted more than **1 trillion Euro** of investments each

Renewables are expected to grow by **7.1%** each year over the next two decades, eventually displacing coal as the world's top source of power by **2040**

More than **100 cities** worldwide now boast at least **70% renewable energy**, and still others are making commitments to reach **100%**



Regions like **Schleswig-Holstein and Mecklenburg-Vorpommern in Germany** are **100%** on renewable energy. Similarly, **Quebec and British Columbia in Canada** are also **100%** entirely on renewable energy sources

Countries like **Paraguay and Iceland** are **100%** on renewable energy while **Norway** is **98.5%** and **Costa Rica** is **99%**

By the end of 2018, renewable energy targets had been adopted in **169 countries** at the national or state / provincial level

**25%** of the planet's energy comes from renewable sources. However, it is forecasted that **40%** of global energy would come from renewable sources by **2040**

# Companies worldwide are using renewable sources of energy to realise ambitious projects

Hornsedale Power Reserve, the world's largest rechargeable battery installed by Tesla Inc. in South Australia, plays an important role both in the energy sector of the region and in its economy and has reduced network maintenance costs by about 90%.

**HORNSDALE**  
POWER RESERVE

In March 2019, the five-kilometre Tokyo Setagaya rail line, connecting Tokyo's Sangenjaya and Shimotakaido stations, became the first urban rail service in Japan to be powered entirely by renewable energy.



The world's biggest renewable energy project for now is Tengger Desert Solar Park located in China. The largest solar farm is installed in Zhongwei, Ningxia and has a total capacity of 1,547 MW. Tengger Solar Farm spans over a landscape of 1,200 km<sup>2</sup>, which is 3.2% of 36,700 km<sup>2</sup> Tengger desert belt.



As part of the Vienna Public Utility, Wien Energie GmbH uses a 656 square metre solar thermal plant to supply heat to the Vienna district heating network. With a solar yield of 510 megawatt-hours thermal per year, the plant offers savings of an estimated 2,132 tonnes of carbon dioxide over 25 years.



# Wind, solar, hydro, biomass, geothermal and ocean energy are the most common types of renewable energy sources

## Solar



Solar power is generated in two ways. Photovoltaics (PV), also called solar cells, are electronic devices that convert sunlight directly into electricity. Concentrated solar power (CSP) uses mirrors to concentrate solar rays.

## Wind



Wind power is one of the fastest-growing renewable energy technologies. Consumption of wind energy is on the rise worldwide, in part because costs on infrastructure are falling.

## Hydropower



The hydropower energy market is characterised by market stability, rising industry competition and a growing demand for energy storage. It is among the most cost-effective means of generating electricity.

**Renewable energy sources** are sources of energy that are constantly replenished through natural processes. To compare, fossil fuels, like oil and coal, produce energy when they are burned. Their stock is limited because they do not naturally replenish on a short enough timescale.

## Biomass



Biomass has significant potential and can be directly burned for heating or power generation, or it can be converted into oil or gas substitutes. Liquid biofuels, a convenient renewable substitute for gasoline, are mostly used in the transport sector.

## Geothermal



Geothermal energy is harnessed for the generation of electricity and for various thermal applications, including space heating and industrial heat input.

## Ocean power

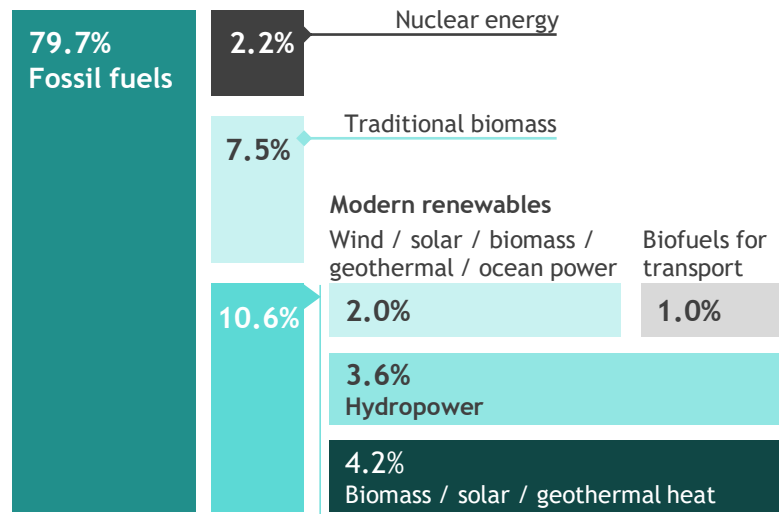


Ocean technologies are still at the research and development stage and not yet commercially available. They include wave, tidal and salinity gradient energy as well as ocean thermal energy conversion.

Source: REN21 – Renewables global status report – [2019]; IRENA website

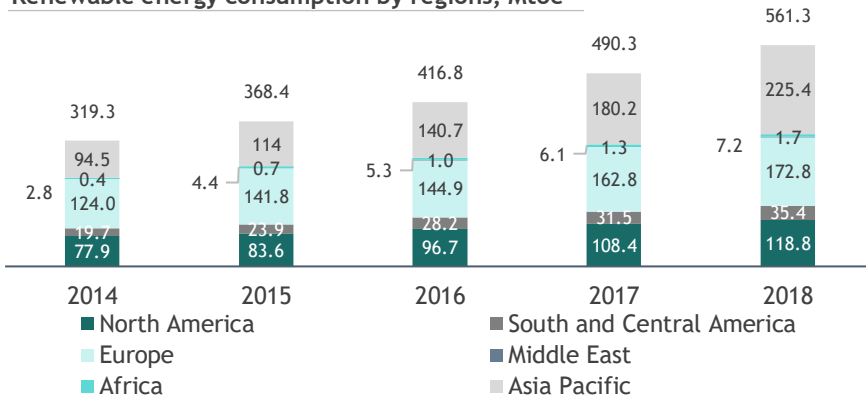
# Renewable energy contributed 18.1% to final energy consumption in 2017

Estimated renewable share of total final energy consumption in 2017<sup>1</sup>



Modern renewables supplied 10.6% of final energy consumption, with an estimated 4.5% growth of demand compared to 2016. The greatest portion of modern renewable sources took renewable heat. In 2018, global renewable energy consumption amounted to 561.3 Mtoe, with the leader being the Asia Pacific region (40.2%).

Renewable energy consumption by regions, Mtoe



- ▶ During 2019-2023, renewable energy consumption is expected to grow with a CAGR of 15.0%, reaching 1,129.0 Mtoe
- ▶ In 2018, over half of final energy demand was from heating and cooling sector, where less than 10% of energy were renewable

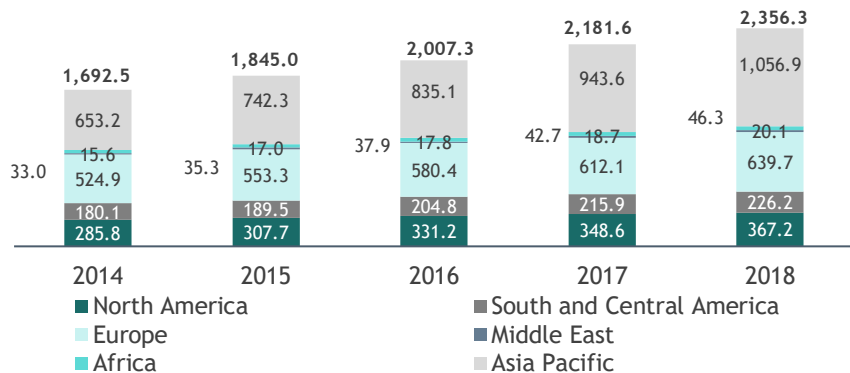
Source: REN21 – Renewables global status report – [2019]; BP – Statistical review of world energy – [2019]

Notes: (1) Numbers may not sum to 100% due to rounding



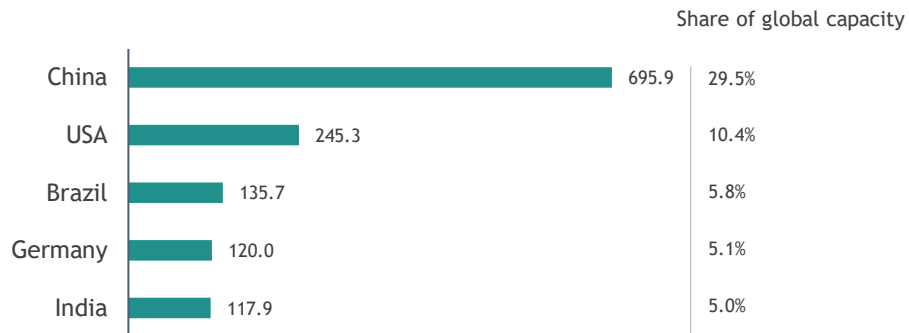
# In 2018, China led the market by installed renewable energy capacity with almost 700 GW

Installed capacity of renewable energy, GW



- ▶ Installed capacity of renewable energy was constantly growing during the 2014-2018 period and amounted to 2,356.3 GW in 2018
- ▶ Asia Pacific was dominating among other regions in the installed capacity of renewable energy during the observed period

Leading countries in installed renewable energy capacity worldwide in 2018, GW



- ▶ The leading country in installed renewable energy capacity in 2018 was China with 29.5% of total global capacity. Among the leaders of installed renewable energy capacity was the USA (10.4%), Brazil (5.8%), Germany (5.1%) and India (5.0%)

Installed capacity of renewables grew by 8.0% from 2017 to 2018. Renewables make up more than one-third of global installed power capacity. The leader by installed capacity was the Asia Pacific region with a 44.9% share of global total.

Source: IRENA – Renewable energy statistics – [2019]

# Cost-effectiveness and climate change are the main factors, which drive the development of renewables



## Cost-effectiveness

In many countries, renewables are now cost-competitive with new fossil fuel and nuclear sources, and even more.



## Political ambitions

At present, governments are embarking on the ambitious undertaking of increasing their countries' market share of renewable energy.



## Climate change

Mitigation of climate change has been the primary rationale behind calls for a 100% renewable energy future.



## Health problems

In many countries, reducing local air pollution and the health problems that it causes is a key driver.



## Energy security

Senior officials in the US military, for example, have called for increased use of renewable power and fuels as a matter of national security, and for the military's own operations.



## New workplaces

With economies around the world facing low growth, the renewable energy sector offers a way to increase income, contribute to industrial development and create jobs.

Source: Ren21 website; Biobasedpress website; Researchgate website

# Increasing demand from corporate customers is a new driver for renewable sources of energy developments



## Declining prices

New consumer demand for renewables is encouraged by a steady decline in the overall costs of wind and solar. Recent reports suggest that the cost of certain renewable technologies will be less than the cost of traditional fossil fuels as early as 2020.



## Investor pressure

Environmental, social and governance factors play a key role in determining risks in responsible investment. Corporations without a clear vision and roadmap to a sustainable future will no longer be supported by investors in the long run.



## Changes to information reporting standards

Corporations will quantify the financial climate-related risks in their organisation and outline the potential threats and opportunities to their own stakeholders through appropriate financial disclosure.



## Customer and employee pressure

Companies that support green energy can attract and keep better employees and also grow their customer base, thereby creating more value for their shareholders.

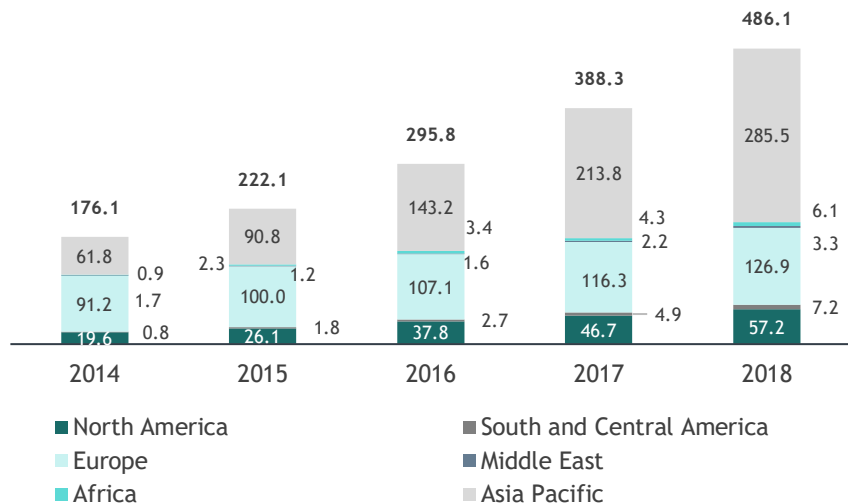
Source: Source: KPMG — New drivers of the renewable energy transition — [2018]



# RENEWABLE ENERGY SECTORS OVERVIEW

# Installed solar energy capacity reached almost 500 GW with a 29% increase from 2017 to 2018

Installed capacity of solar energy, GW



- ▶ The largest investments in 2018 were recorded in China (44.2 GW), which represents a 17% decrease compared to the investment in 2017
- ▶ China accounted for almost 50% of the total growth in global solar capacity. The USA, the EU and India invested around 8 GW each
- ▶ Despite the stagnation in solar investment, solar power generation enjoyed another year of very rapid growth in 2018, with a 29% increase
- ▶ Solar already has a noticeable impact in terms of power generation growth, contributing around 14% of the growth of global power

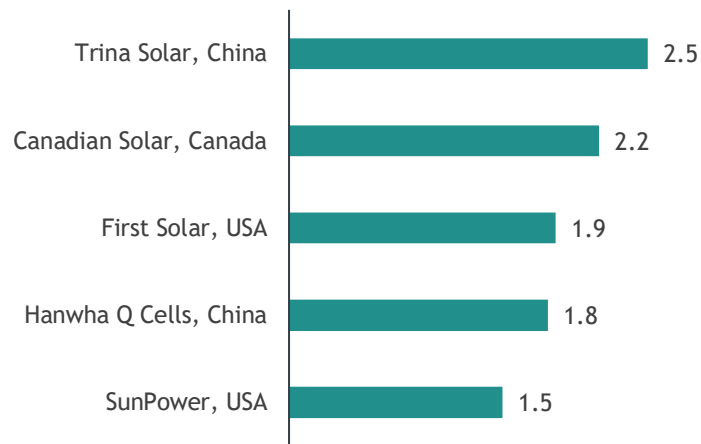
Asia Pacific was the fastest growing region by added capacity of solar energy in 2018. New investments, technologies and regulations stimulated the growth across all the regions.

Source: IRENA – Renewable energy statistics – [2019]



# Leading solar energy companies are located in China, Canada and the USA

Revenues of selected solar energy companies worldwide in 2017, Bn Euro



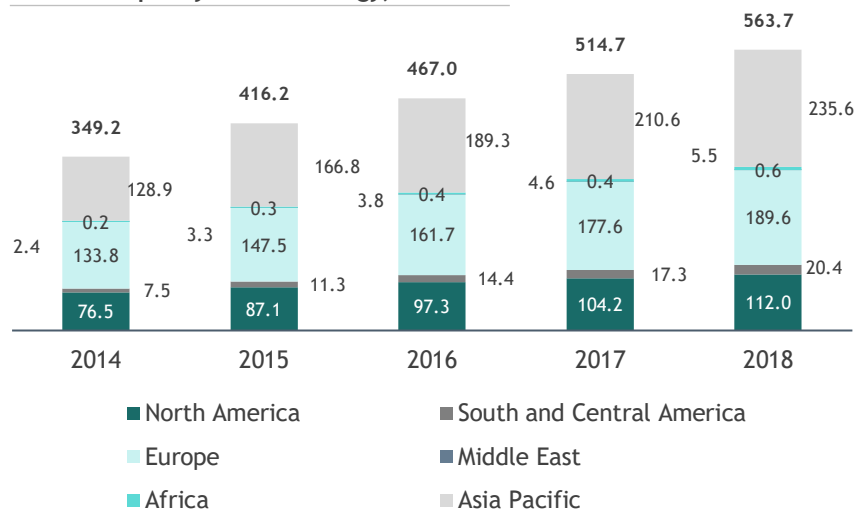
- ▶ Trina Solar Limited from China led the market in 2018. It has numerous branches in the USA, Europe, Asia and Latin America. In 2018, Trina Solar has delivered more than 40 GW of solar modules worldwide
- ▶ Canadian Solar is a second solar energy company after Trina Solar with 2.2 Bn Euro revenue in 2018. The company has production facilities in Canada, China, Indonesia, Vietnam, and Brazil
- ▶ First Solar, Inc. is an American photovoltaic manufacturer of solar panels, and a provider of utility-scale PV power plants and supporting services. In 2019, its total capacity amounted to nearly 5,500 MW

Financial development of solar energy companies, especially those providing photovoltaic products, indicates a growing demand for solar energy. Manufacturers need to invest in solar energy in Middle Eastern and African countries in order to cover a rising power demand.

Source: Statista website; Media overview

# Wind capacity grew by 9.5% due to new installations in 2018, with China as the largest contributor

Installed capacity of wind energy, GW



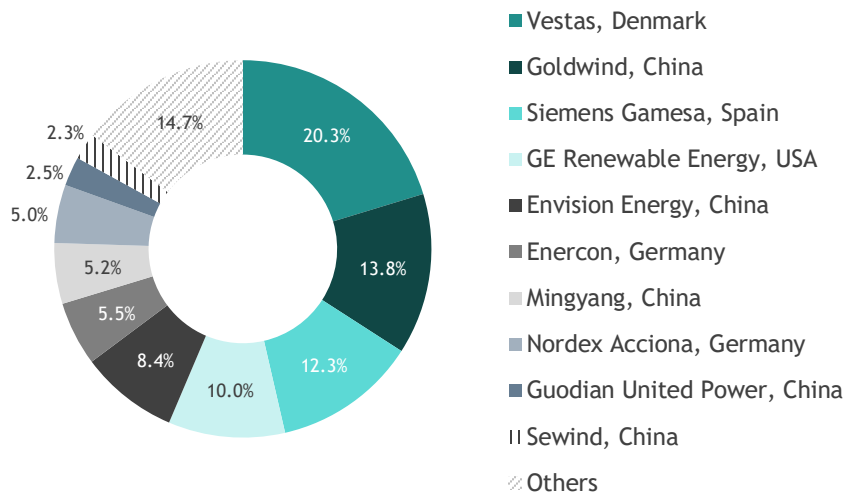
- ▶ China leads the world in terms of installed wind capacity (184.6 GW), and in 2018 China recorded the largest addition of capacity (20.2 GW), followed by the EU (9.4 GW), and the USA (6.7 GW)
- ▶ Emerging markets across Africa, Southeast Asia, Latin America and the Middle East accounted for nearly 10% of new wind installations, up 8% from the previous year
- ▶ In 2018, wind power generation grew by 13% to reach 1,270 TWh, or 4.8% of total world electricity generation
- ▶ Wind energy has become an important contributor to European electricity generation. In Denmark wind power provided more than 46% of power generation in 2018

In 2018, there was a growing trend of wind installations in emerging markets. It shows the interest in this power sector and potential for further investments in it.

Source: IRENA – Renewable energy statistics – [2019]

# The Top-5 wind turbine producers accounted for nearly two-thirds of the turbines delivered in 2018

Market shares of Top-10 wind turbine producers in 2018



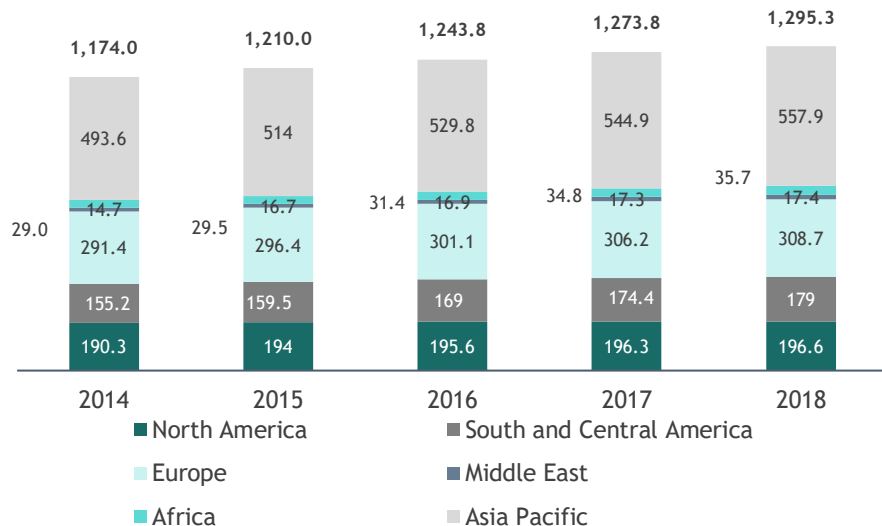
- ▶ Of the Top-10 turbine manufacturers, half are based in China, although Chinese manufacturers continued to rely almost entirely on their home market in 2018
- ▶ German-based Senvion, which ranked ninth globally in 2017, filed for insolvency in early 2019, following project delays, a shrinking home market, falling prices and increased competition
- ▶ While most wind turbine manufacturing takes place in China, the EU, India and the USA, the manufacture of components, the assembly of turbines and the locations of company offices are spreading close to growing wind energy markets. They include Argentina, Australia and the Russian Federation, as companies seek to reduce transport costs and to access new sources of revenue
- ▶ For example, Argentina's Newsan partnered with Vestas to convert an existing manufacturing facility in Buenos Aires into an assembly plant for wind turbines

Revenue of wind turbine producers depends on the geographical locations they cover. The potential markets for wind power production are Argentina, Australia and the Russian Federation, as producers of components are moving closer to these regions.

Source: Statista website; REN21 – Renewables global status report – [2019]

# Hydropower capacity additions are slowing down compared to other renewable sources

Installed capacity of hydropower energy, GW



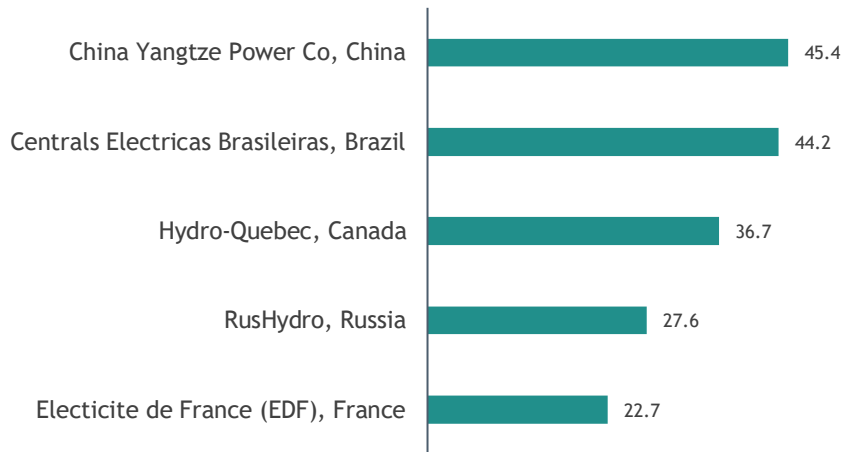
- ▶ Global installed hydropower capacity was constantly growing between 2014 and 2018 and amounted to 1,295.3 GW in 2018
- ▶ Asia Pacific region is the worldwide leader with 43 % of the total installed capacity of hydropower energy. This was driven by new capacity additions and above average hydro inflows in China.
- ▶ The world leaders in hydropower are China, Brazil, Canada, the United States and Russia. Together these countries account for 52 % of total installed capacity

Despite the fact that hydropower capacity additions have slowed down, the biggest growth was experienced in Asia Pacific (up 13 GW) and in South and Central America (up 4.6 GW). In 2018, the biggest part of installed capacity of hydropower energy was in the Asia Pacific region and in Europe.

Source: IRENA – Renewable energy statistics – [2019]

# In 2018, China Yangtze Power Co was the leader in terms of hydropower installed capacity of 45.4 GW

Installed capacity of largest hydropower companies worldwide in 2018, GW



- ▶ China leads the market by hydropower production, as world's largest hydroelectric dams are located there. The biggest of them are Three Gorges Dam (22.5 GW), Xiluodu (13.9 GW) and Xiangjjaba (6.4 GW) owned by China Yangtze Power Co
- ▶ More than 40% of Canada's water resources are in Québec and Hydro-Québec is the fourth largest hydropower producer in the world
- ▶ RusHydro is the Russian's largest power-generating company with more than 70 hydropower facilities

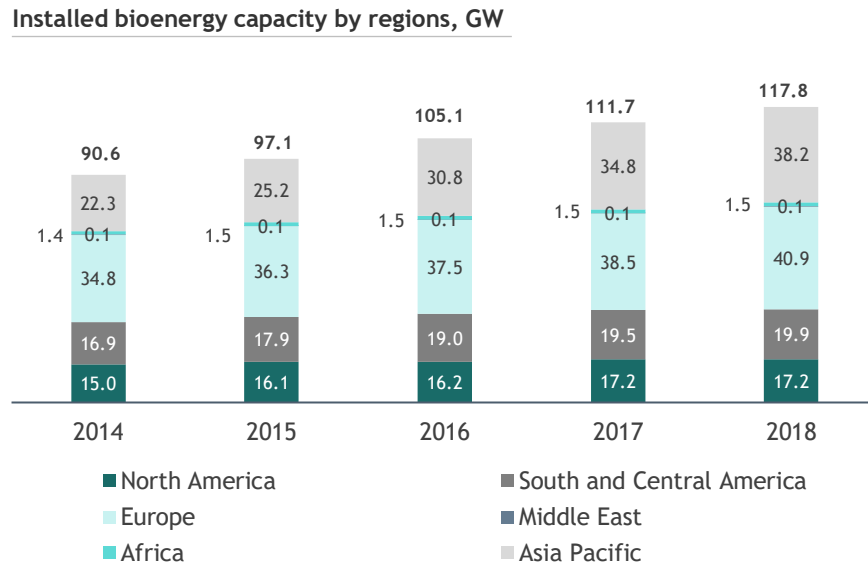
China is by far one of the strongest suppliers of hydroelectric energy in the world. Energy facilities in China are among the cheapest energy facilities to maintain due to low operation costs.

Source: Statista website



# Global rising demand for energy might be partially supplied with the capacity of biomass energy

Installed bioenergy capacity by regions, GW



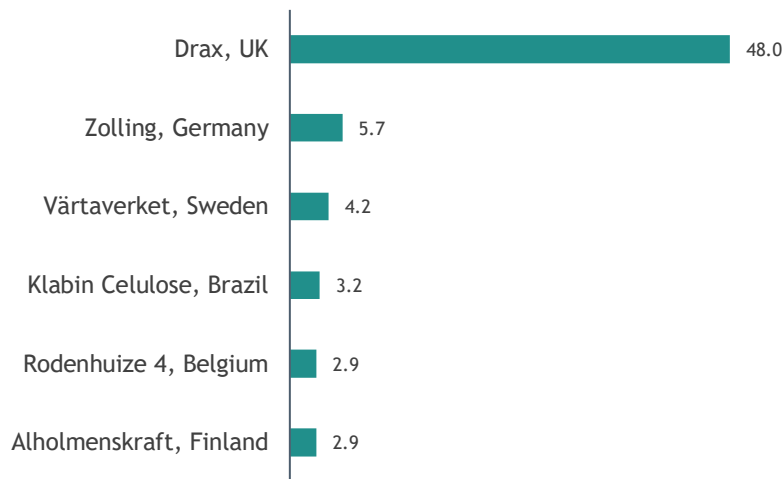
- ▶ Modern bioenergy technologies include liquid biofuels produced from bagasse and other plants, bio-refineries, biogas produced through anaerobic digestion of residues, wood pellet heating systems, and other technologies
- ▶ Biofuels are a central component of national renewable transport policy frameworks, with blending mandates existing in 70 countries at the national or state / provincial level by the end of 2018
- ▶ Trade patterns, especially for transport biofuels, were influenced greatly by changing import tariffs and other similar measures
- ▶ In 2018, investments in biomass and waste energy technologies worldwide amounted to approximately 8 Bn Euro

While Asia Pacific led the markets for solar, wind, hydropower and geothermal energy by installed capacity, Europe had the most bioenergy capacity in 2018 –34.7% of global biomass installed capacity.

Source: IRENA – Renewable energy statistics – [2019]; Statista website

# Five out of six largest biomass power plants are located in Europe

Leading biomass power plants based on generation worldwide in 2018, GWh



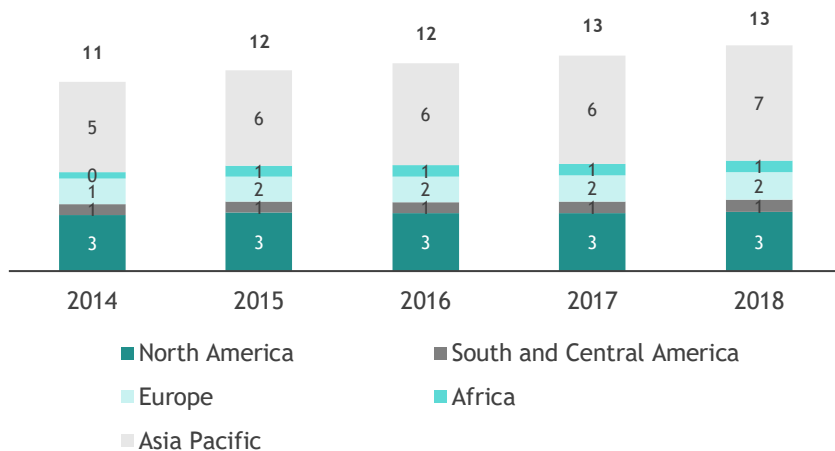
- ▶ In 2018, the EU maintained its lead for the use of modern bioenergy for heating, with progress driven mainly by the EU Renewable Energy Directive
- ▶ The Drax biomass power plant, located in the UK, powered exclusively from wood and other biomass instead of coal, generated 48 GWh in 2018. That was enough to supply 3.4 million people in the United Kingdom with energy
- ▶ Biomass has a significant potential to boost energy supplies in populous nations with rising demand, such as Brazil, India and China
- ▶ Brazil is a leader in liquid biofuels and has the largest fleet of flexible-fuel vehicles, which can run on bioethanol

Europe is the largest consumer of modern bio-heat by regions as it is promoted by regulation of its member states. Italy, France and Germany accounted for 44% of the global total. North America followed the EU for bioenergy consumption in buildings.

Source: Statista website; Media overview

# Asia Pacific dominates by installed geothermal power capacity, followed by North America

Installed capacity of geothermal energy, GW



While overall the geothermal share of global power generation remains very small (0.3%), in certain countries it plays a significant role, for example, in Kenya (44%), Iceland (27%), El Salvador (26%), and New Zealand (18%). 90% of heating demand in Iceland comes from geothermal energy sources.



## Usage of geothermal energy

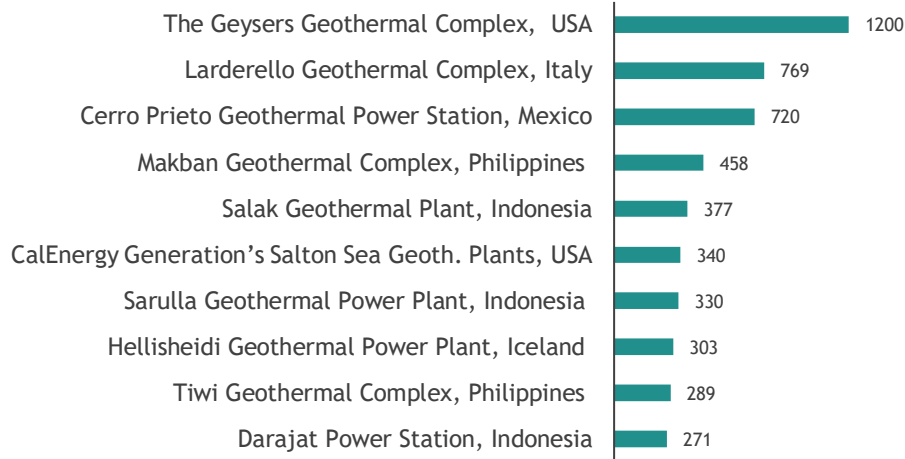
- ▶ Direct usage of geothermal energy: district heating, geothermal heat pumps, greenhouses
- ▶ Electricity generation from hydrothermal reservoirs
- ▶ Usage for industrial purposes, such as dehydration, milk pasteurising, or gold mining
- ▶ New technologies at the development stage as Enhanced Geothermal Systems

Many of the power plants in operation today harness temperatures of more than 180°C, however, medium temperature fields are more and more used for electricity generation. This may be an interesting sector for new plants establishing. Greenhouse gas emissions as a by-product of geothermal power production should be taken into account while investing in new production assets.

Source: IRENA – Renewable energy statistics – [2019]; University of Nairobi – Geothermal Electricity Generation, Challenges, Opportunities and Recommendations – [2019]

# Most of geothermal power producers may demand assets renovations

Combined generating capacity of top largest geothermal power projects, mW



Indonesia is home to three of the ten biggest geothermal power plant installations in the world, followed by the USA and Philippines with two in each.

The Geysers Geothermal Complex located in California is comprised of 15 power plants making it the biggest geothermal installation in the world.

Mitsubishi Heavy Industries, Toshiba were the major suppliers of equipment for the plants of the companies.

Most of the plants were established at the beginning of the XX century or before 1990, so most of the assets need renovation.

Geothermal power plants are expensive installations whose general life expectancy is estimated at 25 years. Many plants have been in operation for longer periods, with some major refurbishment. A good operation and maintenance regime needs to be put in place to ensure the plant operates at an availability factor of not less than 94%.

Source: Power Technology website

# Energy storage systems help to balance renewable energy demand and supply

## Energy storage across the power sector

### Generation

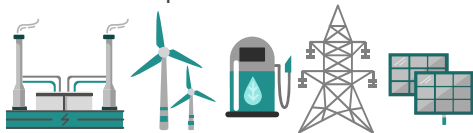
Storage offers an emission free alternative to plant additions as utilities face ageing plants and stringent environmental regulations.

### Renewables

Storage addresses the intermittency issues of renewables by delivering energy only when the grid requires it.

### Consumers

Storage ensures power quality and reliability during outages as well as enables 'behind the meter' energy management practices.



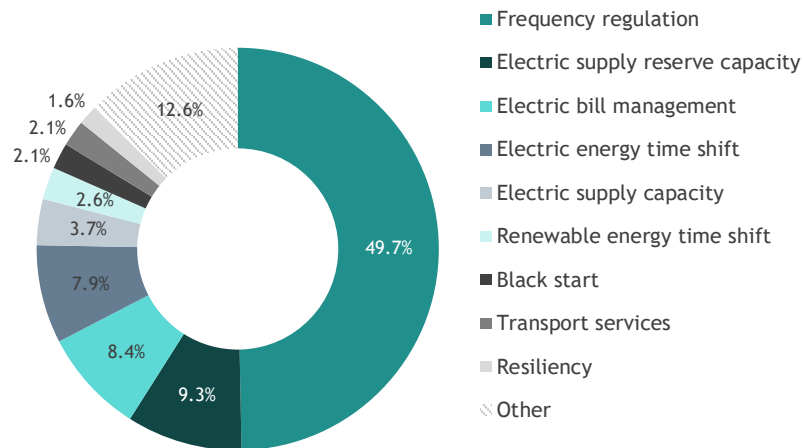
### Independent system operators

Storage improves the quality and stability of a grid that seeks to accommodate disparate and dynamic supply and demand points.

### Transmission & Distribution

Storage enables the deferment of Transmission & Distribution investments as utilities seek to maintain reliability while satisfying growing loads and integrating renewable energies.

## Global battery storage capacity by primary use case



In the power sector, energy storage is needed for all processes from generation to transmission & distribution. The most common use for battery storage is frequency regulation (49.7%), which aims to synchronise generation assets for electrical grid operation.

Source: Deloitte – Supercharged: Challenges and opportunities in global battery storage markets – [2018];  
Deloitte – Energy storage: Tracking the technologies that will transform the power sector – [2015]



# Falling costs of batteries production and government support for renewables drive the energy storage market



- ▶ **Cost and performance improvements.** Particularly relating to lithium-ion batteries, driven by expanding electric vehicle markets and related manufacturing economies of scale, costs are dropping while performance is improving



- ▶ **Grid modernisation.** The growth of battery storage goes hand-in-hand with grid modernisation efforts, including the transition to smart grids



- ▶ **Global movement toward renewables.** Broad support for renewable energy and emissions reduction is also driving adoption of battery storage solutions



- ▶ **Participation in wholesale electricity markets.** Battery storage can help balance the grid and improve power quality regardless of the generation source



- ▶ **Financial incentives.** This reflects the growing awareness of policymakers of the range of benefits battery storage can deliver throughout the electricity value chain



- ▶ **Phase-outs of FITs or net metering.** Reduction of feed-in-tariffs (FITs) or net metering payments is emerging as a driver of behind-the-meter battery deployments



- ▶ **Desire for self-sufficiency.** Motivation for residential and commercial & industrial customers to purchase storage corresponds to their ecological motives, independence from utilities, resiliency, and technical curiosity



- ▶ **National policy.** Many countries are turning to renewable energy storage to reduce dependence on energy imports, enhance the reliability and resiliency of their systems, and move toward environmental and de-carbonisation targets

Though market drivers are converging to propel storage deployment, the market still faces such challenges as speed with which battery storage technologies and their applications are evolving and to multiplicity and flexibility of battery storage.

Source: Deloitte – Supercharged: Challenges and opportunities in global battery storage markets – [2018]

# Along with the expansion of the battery value chain, environmental and social challenges should be addressed

## Battery production has a significant greenhouse gas (GHG) footprint

The production of batteries requires significant amounts of energy – and therefore causes CO<sub>2</sub> emissions.

In the base case scenario 2030, the battery value chain emits 182 Metric tonnes of carbon dioxide equivalent (Mt CO<sub>2</sub>e) while the figure for 2018 is 24 Mt CO<sub>2</sub>e.

The manufacturing of active materials and other components, as well as the manufacturing of cells are the most GHG emission-intense steps in the battery value chain.

The CO<sub>2</sub> footprint of producing a fully electric vehicle, for example, is higher than that of a vehicle with an internal combustion engine (ICE). But the lower direct and indirect emissions during the electric vehicles use lead to an overall CO<sub>2</sub> footprint advantage over its life cycle against a traditional ICE vehicle.

## Other challenges



Social and integrity risks



Lack of production standardisation



The viability of battery-enabled applications is uncertain



Outdated regulatory policy and market design



Perceptions of high prices

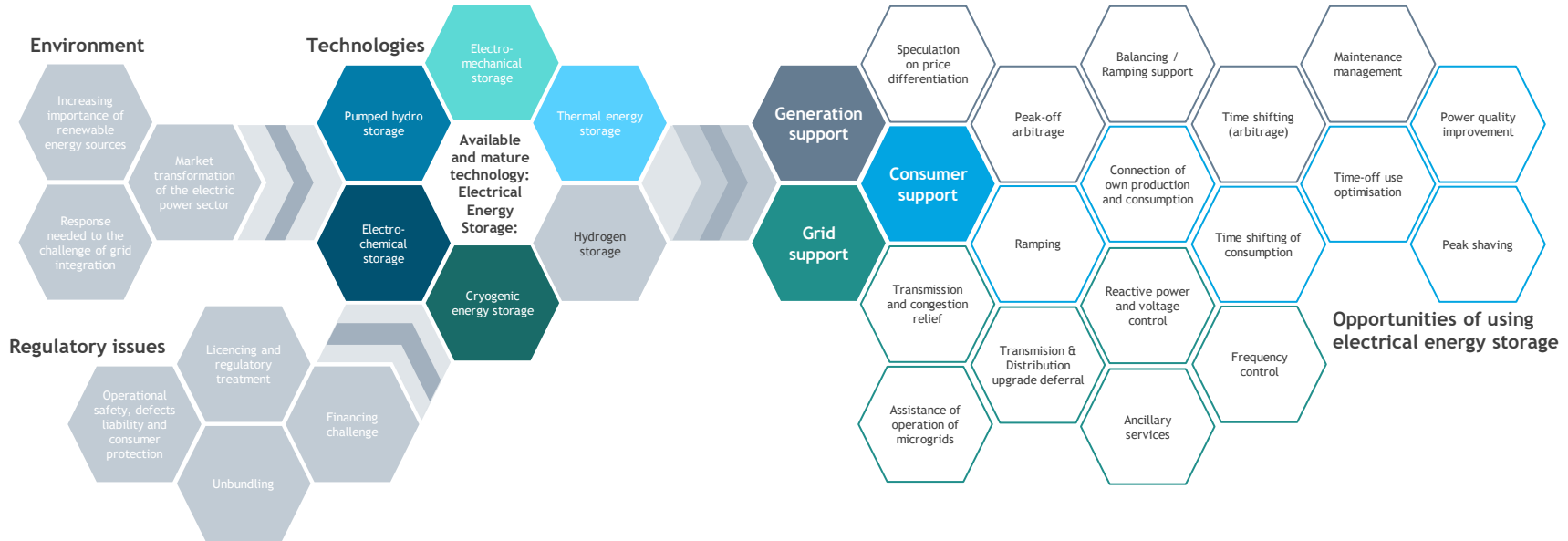


Incomplete definition of energy storage

The most significant challenge is greenhouse gas footprint from the production of batteries. In the future, the amount of emissions in the battery value chain is expected to grow by almost 8 times due to the growing need for batteries usage.

Source: Deloitte – Supercharged: Challenges and opportunities in global battery storage markets – [2018];  
World economic forum – A vision for a sustainable battery value chain in 2030 – [2019]

# Electrical energy storage can be installed across the value chain of generation, consumer and grid support



There is a range of new technologies for electrical energy storage such as cryogenic, hydrogen, thermal, electro-mechanical and electro-chemical. They provide storage solutions at all scales, from household systems through to grid-size solutions.

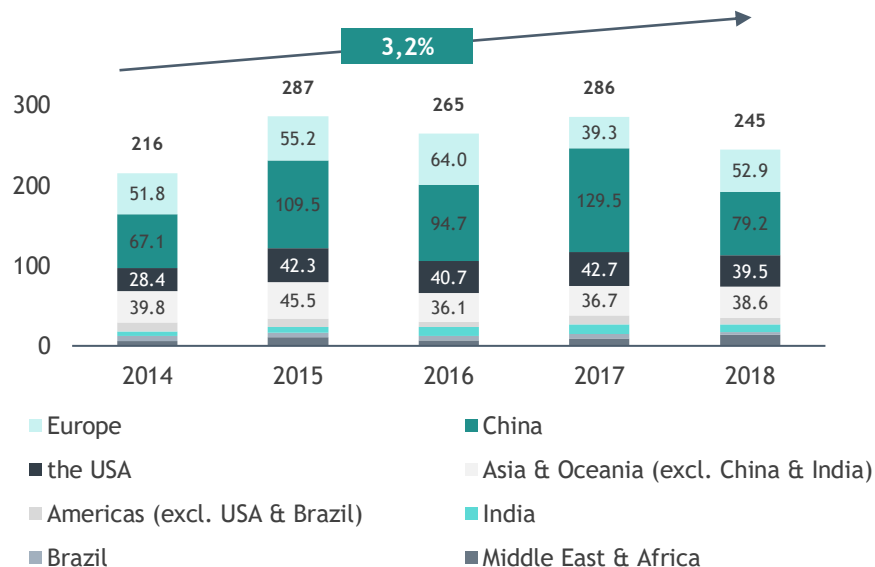
Source: KPMG – Electricity storage insight – [2016]



# RENEWABLE ENERGY MARKET INVESTMENT TRENDS

# In 2018, developed economies demonstrated a short rise in capacity investments but keep cutting them

Global renewable energy investments by regions, Bn Euro<sup>1</sup>



Europe increased its investments in renewables capacity by 45% in 2018. Investments in wind technology increased by 26% to 31.2 Bn Euro, but the biggest growth of investments was in solar technology – by 87% to 16.3 Bn Euro.

The USA is one of the largest investors among developed countries. In 2018, developers continued to bring projects forward to qualify for federal tax reliefs before these expire after 2020 – Production Tax Credit for wind, and the Investment Tax Credit for solar.

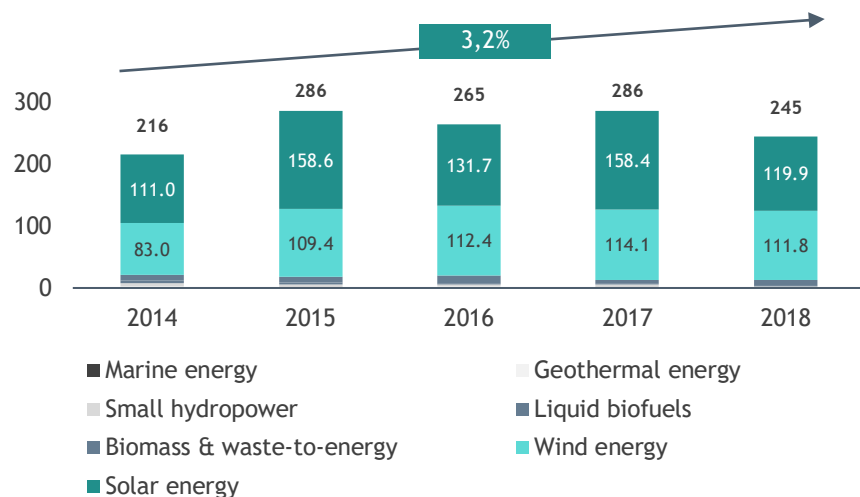
China saw capacity investment fall by 38%, with solar down a massive 56% to 32.2 Bn Euro and wind just 3% lower at 42.9 Bn Euro. Part of the drop in solar was due to lower unit costs per MW, but the main cause was Beijing's move in the middle of the year to restrict feed-in tariffs for new projects.

Source: IRENA website – Public investment trends in renewables

Notes: (1) Numbers are converted from USD to Euro due to average exchange rate by ECB

# During the decade both solar and wind energy sectors attracted more than 1 trillion Euro of investments

Global green bond sales across all currencies, Bn Euro



Between 2010 and 2019, cost-competitiveness of renewables was improved, with the levelised cost of electricity for solar photovoltaics down 81%, for the onshore wind down 46% and for the offshore wind down 44%. In many countries, the cheapest source of new generating capacity in 2019 is either solar or wind.

Despite the decline of investments, the world added a record 167 GW of new capacity for renewables excluding large hydro in 2018, with solar additions hitting their own record of 108 GW.

The prime reason for a decline in overall renewable energy investment in 2018 was a sharp decrease in solar funding due to the market oversaturation in some regions.

Source: IRENA website – Public investment trends in renewables

Notes: (1) Numbers are converted from USD to Euro due to average exchange rate by ECB



# M&A activity became more concentrated in wind and solar segments due to doubled value of deals during 2013-2019



## Regional M&A drivers:

- ▶ Renewables and emerging technologies drive the deal value in the Americas
- ▶ Renewable megadeals in offshore wind power shape the European M&A market
- ▶ Activity in the Asia Pacific region is led by China due to the privatisation process



## Trends shaping M&A activity:

- ▶ Demand for renewables drives deal value and volume
- ▶ Investment challenges for the fossil fuel industry create additional demand for alternative energy sources
- ▶ Interest in offshore wind power is on the rise
- ▶ Governments continue pushing the business to go green

## Largest corporate M&A deals in renewable energy in 2018, Mn Euro

Acquirer	Target	Country of target	Sector	Business model	Sum of deal, Mn Euro
TerraForm Power 	Saeta Yield 	Spain 	Solar 	Yieldco <sup>1</sup>	2,421
Renew Power Ventures 	Osto Energy Pvt 	India 	Wind 	Project developer	1,405
State Grid Brasil 	CPFL Energias Renovaveis 	Brazil 	Wind 	Project developer	883
Algonquin Power 	Atlantica Yield 	Spain 	Solar 	Yieldco	515
Orsted 	Lincoln Clean Energy 	USA 	Wind 	Project developer	492
Innergex Renewable Energy 	Alterra Power Corp 	Canada 	Geothermal 	Project developer	481

- ▶ In 2018, the largest deal transactions with over 1 Mn Euro investments were in solar and wind segments. The targeted companies were from Spain and India
- ▶ The biggest corporate transaction was valued at 2,4 Bn Euro and involved the purchase of Spain's Saeta Yield by TerraForm Power. The US-based TerraForm is owned by Brookfield Asset Management, Canada's largest alternative asset manager, while Saeta has 778 MW of recently constructed onshore wind and 250 MW of solar thermal capacity in Western Europe

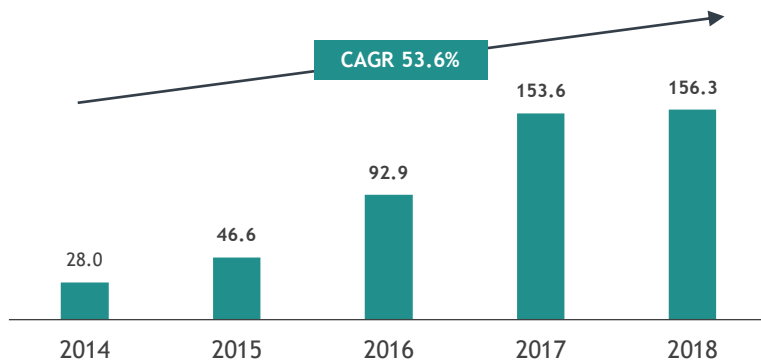
Source: Frankfurt school – Global Trends In Renewable Energy Investment – [2019]

Notes: (1) Quoted companies set up to own operating-stage renewable power projects and to return almost all the cash flow to investors

# Green bonds are meant to be used for climate and environmental projects financing

A green bond is a bond specifically earmarked to be used for climate and environmental projects. These bonds are typically asset-linked and backed by the issuer's balance sheet, and are also referred to as climate bonds.

Global green bond sales across all currencies, Bn Euro



## Green bonds by sector in 2018:

44%

Transport



23%

Energy



15%

Multi-sector



8%

Water



6%

Buildings



3%

Land use



1%

Waste



<0.01%

Adaptation & Industry



## Top-5 green bond markets in 2018:

29.9 Bn Euro

USA



27.3 Bn Euro

China



12.3 Bn Euro

France



6.7 Bn Euro

Germany



6.5 Bn Euro

Netherlands



## Top-5 green bond issuers in 2018:

17.9 Bn Euro

Fannie Mae, USA



8.4 Bn Euro

Industrial bank, China



5.3 Bn Euro

France (sovereign bonds)



4.8 Bn Euro

Belgium (sovereign bonds)



3.1 Bn Euro

NTMA, Ireland



Source: Bloomberg website; Climate Bonds Initiative – Green bonds: the state of the market – [2018]

# Public banks are focused on investments to solar energy and renewable hydropower in Africa and South America



## Export-Import Bank of China (CEXIM)

China Export-Import Bank is a state-funded and state-owned policy bank.

The bank aims to support China's foreign trade, investment and international economic cooperation.

### Main recipients location

- ▶ Africa
- ▶ South-East Asia
- ▶ Cuba

### Main investment segments

- ▶ Renewable hydropower
- ▶ Solar energy



## European Investment Bank (EIB)

The European Investment Bank is a EU public financial institution.

The bank provides long-term finance for investment projects in support of EU policy goals in Europe and beyond.

### Main recipients location

- ▶ Europe
- ▶ Africa
- ▶ South America
- ▶ India

### Main investment segments

- ▶ Multiple renewables
- ▶ Renewable hydropower



## World Bank Group (WBG)

The World Bank Group is an international financial organisation.

The aim of the institution is organising financial and technical assistance to developing countries.

### Main recipients location

- ▶ Africa

### Main investment segments

- ▶ Solar energy
- ▶ Bioenergy



## Brazilian Development Bank (BNDS)

The Brazilian Development Bank is a federal public company, which is the main financing institution for development in Brazil.

The aim of the bank is to provide long-term financing for endeavors that contribute to the country's development.

### Main recipients location

- ▶ Brazil

### Main investment segments

- ▶ Wind energy
- ▶ Solar energy



## China Development Bank (CDB)

China Development Bank is led by a cabinet minister, under the direct jurisdiction of the State Council.

CDB provides medium-to long-term financing facilities that serve China's major long-term economic and social development strategies.

### Main recipients location

- ▶ Pakistan
- ▶ Papua New Guinea
- ▶ South America

### Main investment segments

- ▶ Renewable hydropower



## Overseas Private Investment Corporation (OPIC)

OPIC is an institution under the US Government.

The OPIC goal is to assist American businesses in investing in new and emerging markets by providing loans and guarantees.

### Main recipients location

- ▶ Africa
- ▶ Asia

### Main investment segments

- ▶ Solar energy



## Kreditanstalt fuer Wiederaufbau (KfW)

KfW is a German state-owned development bank.

The Bank offers finance for investment and economic sectors, as well as advisory services.

### Main recipients location

- ▶ South America
- ▶ Asia

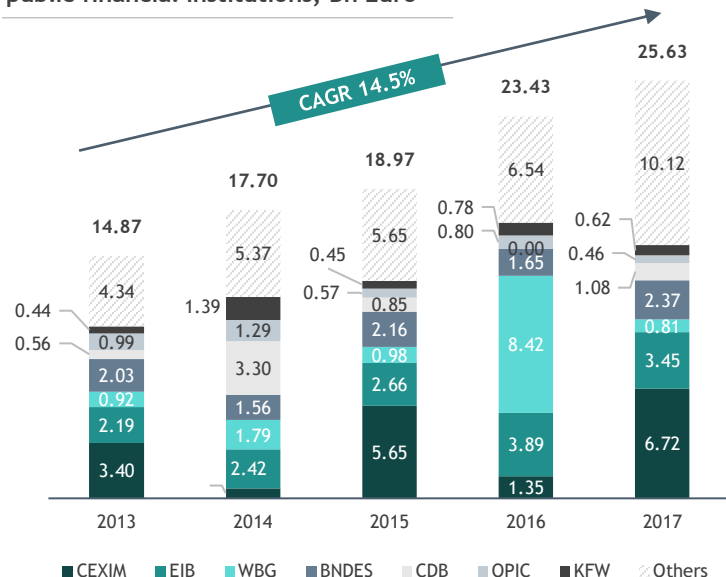
### Main investment segments

- ▶ Multiple renewables
- ▶ Wind energy

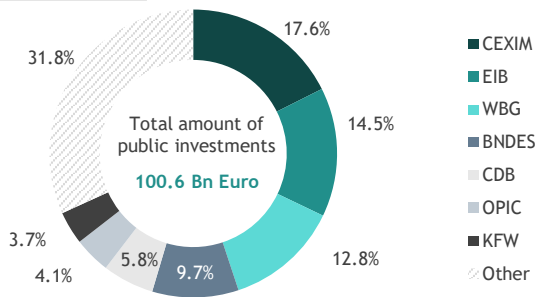
Source: IRENA website – Public investment trends in renewables (data represented as of 2017)

# The biggest investor between 2013 and 2017 was China Export-Import Bank with 6.72 Bn Euro investments in 2017

Renewable energy finance flows by public financial institutions, Bn Euro<sup>1</sup>



Financial flows split by public financial institutions in the 2013-2017 period



- ▶ During the 2013-2017 period, renewable energy finance flows by public financial institutions grew at a CAGR of 14.5% and reached 25.61 Bn Euro in 2017
- ▶ The biggest share of public investments – 17.6% – was provided by China Export-Import Bank (CEXIM), followed by the European Investment Bank (EIB) with 14.5% investments
- ▶ In 2017, CEXIM was a leading public financial institution investing in renewable energy projects, with investment value amounted to 6.72 Bn Euro, which was almost 397.8% higher compared to 2016

Source: IRENA website – Public investment trends in renewables

Notes: (1) Numbers are converted from USD to Euro due to average exchange rate by ECB

# Large pension funds and sovereign wealth funds solidly invest in on- and offshore wind and solar technology

Region	Investor	Country of origin	Total capacity of acquired assets during 2015-2018, Bn Euro	Type of investments
North America	CPP Investment Board 	Canada	6.2	Offshore wind, Onshore wind, Solar
	Caisse de dépôt et placement du Québec 	Canada	2.2	Offshore wind, Onshore wind, Solar
	OMERS 	Canada	1.5	Onshore wind
Europe	ABP 	Netherlands	1.3	Onshore wind, Solar
	PGGM 	Netherlands	0.8	Onshore wind, Solar
	PFA 	Denmark	0.6	Offshore wind
Asia	Abu Dhabi Investment Authority 	UAE	5.0	Onshore wind, Solar, Hydro
	Government of Singapore Investment Corporation 	Singapore	4.0	Onshore wind, Solar, Hydro
	Temasek Holdings 	Singapore	0.3	Solar

Source: IRENA website – Public investment trends in renewables

Notes: (1) Numbers are converted from DKK to Euro due to average exchange rate by ECB

# REGULATORY ENVIRONMENT



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# The Paris climate agreement<sup>1</sup> provides a global regulatory framework for countries to follow

## Temperature



- ▶ Long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels
- ▶ Aim to limit the increase to 1,5°C, since this would significantly reduce risks and the impacts of climate change

## Finance



- ▶ Developed countries intend to provide 90 Bn Euro per year from 2020 and extend this until 2025

## Differentiation



- ▶ The EU and other developed countries will continue to support climate action to reduce emissions and build resilience to climate change impacts in developing countries

## Review mechanism



- ▶ Review every five years: first world review will be in 2023



PARIS2015  
UN CLIMATE CHANGE CONFERENCE  
COP21·CMP11

Approved in **2015**  
by **195** countries

## Emissions objectives



- ▶ On the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries
- ▶ From 2050: rapid reductions of emissions

## Burden sharing



- ▶ Developed countries intend to provide financial resources to help developing countries
- ▶ Other countries intend to provide financial resources on voluntary basis

## Role of cities, regions and local authorities



- ▶ They are invited to scale up their efforts and support actions to reduce emissions, build resilience and decrease vulnerability to the adverse effects of climate change, uphold and promote regional and international cooperation

Source: European commission website; Media overview

Notes: (1) In November 2019, the USA began the process of withdrawal from the Paris Agreement

# Selected legislative acts affecting the renewables market of the European Union



## Directive 2009/28/EC

- ▶ Specifies national renewable energy targets for 2020 for each country (from 10% in Malta to 49% in Sweden)
- ▶ Establishes binding renewable energy target for 2020 of at least 20%
- ▶ Establishes 10% renewables target in transport by 2020



## Renewable Energy Directive 2018/2001/EU

- ▶ Part of the Clean Energy Package
- ▶ Helps the EU to meet its emissions reduction commitments under the Paris Agreement
- ▶ Directive establishes a new binding renewable energy target for 2030 of at least 32%



## Directive to reduce indirect land use change for biofuels and bioliquids (EU) 2015/1513

- ▶ An important element of EU's renewable energy policy
- ▶ Helps Europe keep its leadership role in the clean energy transition
- ▶ Obligation for the Member States to establish indicative national target of advanced biofuels for 202



## Clean energy for all Europeans package

- ▶ Consists of 8 legislative acts
- ▶ Energy rulebook aiming reducing greenhouse gas emissions
- ▶ Establishes a stable environment to stimulate the necessary investments in renewables

Source: EUR-Lex website — Directives 2018/2001/EU, 2009/28/EC, 2015/1513 EU — [2009-2018];  
United Nations Framework Convention on Climate Change website

# The USA decision to withdraw from the Paris Agreement creates additional challenges for the global environment



## USA

Climate Leadership and Community Protection Act (2019) sets critical environmental standards and the goal of:

- ▶ Reducing greenhouse gas emissions by 85% by 2050
- ▶ Having net zero emissions in all sectors of the economy
- ▶ Increasing the use of renewable energy in order to address and mitigate the effects of climate change

On 1 June 2017, President Trump made the decision to withdraw from the Paris Agreement. On 4 November 2019, the USA began this process. The publicly stated reason was unfair economic burden imposed on American workers, businesses, and taxpayers by the USA pledges made under the Agreement. This decision might have a negative impact due to a possible increase in the competitiveness of some goods produced in the USA. For example, the German car industry expressed concerns about its ability to remain competitive in light of the USA decision to withdraw.













## Asia Pacific legislative acts

- ▶ National Renewable Energy Bill, 2015 (India) provides legal framework to facilitate and promote the use of renewable energy
- ▶ Regulation of Minister of Energy and Mineral Resources № 50 of 2017 (Indonesia) establishes new tariff and procurement regime for renewable energy
- ▶ Renewable Energy Act and Electricity Business Act (Japan) is the main regulatory acts for production, procurement and use of renewable energy
- ▶ Act on the Development, Use and Diffusion of New and Renewable Energy and Electricity Business Act (South Korea) is a primary legislative instrument for the renewable energy sector in South Korea
- ▶ National Power Development Plan (Vietnam) is a legal framework and incentive for the development of renewable energy projects

Source: NY Assembly website; Linklaters website

# Top countries by CO<sub>2</sub> emissions in 2018 might be pushed further in terms of alignment with regulations

Rank <sup>1</sup>	Country	Targets
1	 China	Pledged to source 20% of its energy from lowcarbon sources by 2030 and to cut emissions per unit of GDP by 60-65% of 2005 levels by 2030.
2	 USA <sup>1</sup>	A 26-28% domestic reduction in greenhouse gases by 2025 compared to 2005.
3	 India	A 33-35% reduction in emissions intensity by 2030, compared to 2005 levels. Pledged to achieve 40% of cumulative electricity installed capacity from non-fossil fuel-based resources by 2030 and to increase tree cover, creating an additional carbon sink of 2,5 to 3 billion tonnes of CO <sub>2</sub> equivalent by 2030.
4	 Russia	25-30% domestic reduction in greenhouse gases by 2030 compared to 1990 levels. The Russian pledge includes the maximum possible account of the land sector.
5	 Japan	A 26% reduction in emissions on 2013 levels by 2030.

Rank <sup>1</sup>	Country	Targets
6	 Germany (EU)	At least a 40% domestic reduction in greenhouse gases by 2030 compared to 1990 levels.
7	 South Korea	A 37% reduction on business-as-usual (BAU) emissions by 2030. It was estimated that Korea's BAU emissions in 2030 will be 850,6 megatonnes of CO <sub>2</sub> equivalent.
8	 Iran	A 4% cut in emissions by 2030 relative to business-as-usual emissions, or a 12% cut conditional on international support of 31,5 Bn Euro.
9	 Saudi Arabia	Emissions savings of up to 130 million tonnes of CO <sub>2</sub> equivalent in 2030, relative to business-as-usual emissions.
10	 Indonesia	A 29% reduction in emissions by 2030, compared to business-as-usual emissions.

Source: CarbonBrief website

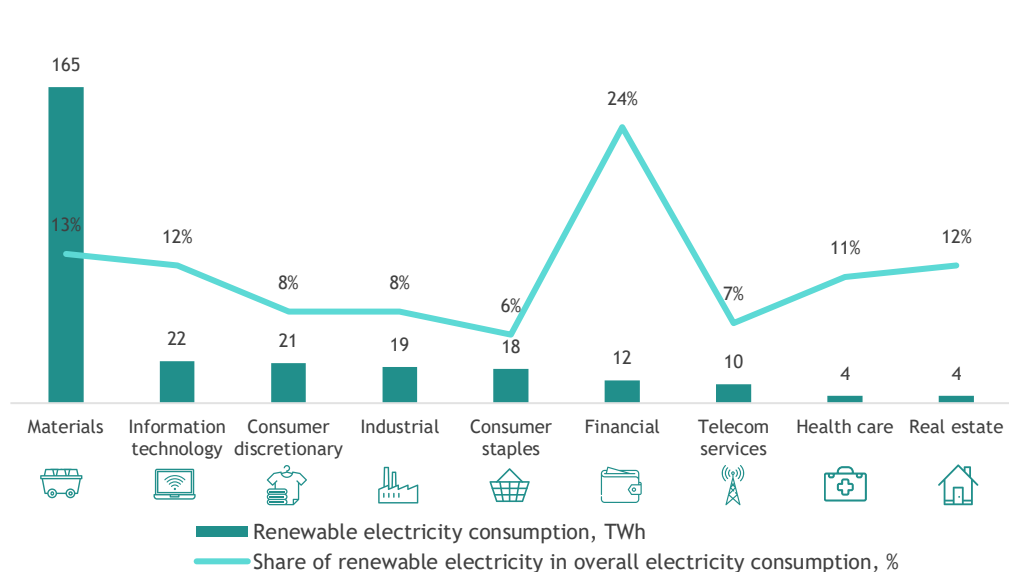
Notes: (1) The USA withdraws from the Paris Agreement



# INDUSTRIES RESPOND TO RENEWABLES TRENDS

# Financial and materials sectors have the largest share of renewable electricity consumption

Inter-sectoral comparison of renewable electricity sourcing in 2017<sup>1</sup>



**Materials sector** is the largest user of electricity (both renewable and non-renewable), since it includes some of the most energy-intensive industries, such as **mining** and **metals**, **chemicals**, and **pulp and paper**.



**Information Technology sector** is pioneering some of the most innovative corporate sourcing models, including different forms of PPAs<sup>2</sup> entered into to supply operations such as **data centres**.



**Financial sector** including banks, insurance providers and other financial institutions shows the largest share of renewable electricity consumption – **24%**.



**Real estate sector** responds to the current trends of the transition to renewable energy by implementing renewable technologies into the buildings and by developing **smart cities**.

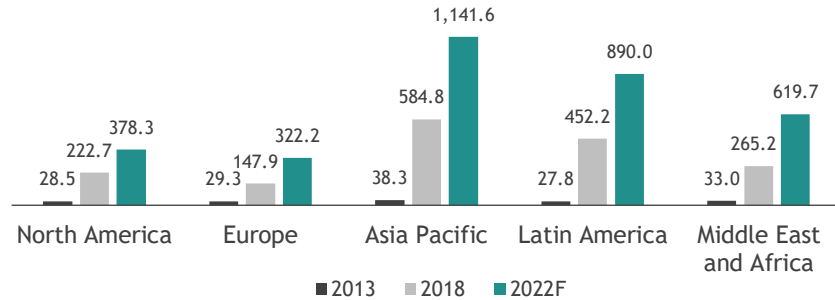
Source: IRENA – Corporate sourcing of renewables: market and industry trends – [2018]

Notes: (1) Based on the survey of 2,410 companies conducted by IRENA in 2018; (2) Power purchase agreement



# Although mining industry is mostly powered by fossil fuels, investments in renewables are expected to grow

Renewable energy investment in the mining industry, Mn Euro



- ▶ Growth is expected to be led by Asia Pacific, with the world's largest mining economies such as China, India, and Australia
- ▶ Latin America will also drive growth as economies like Chile seek to diversify generation sources due to dependence on fuel imports



## Drivers of transition to renewable energy in the mining sector:

- ▶ Energy security concerns in remote mines, where off-grid solutions are required
- ▶ Rising volatile energy prices and the need to manage costs sustainability
- ▶ A shift to a resource-efficient and low-carbon economy ensures community acceptance



## Challenges of transformation to renewable energy in the mining sector:

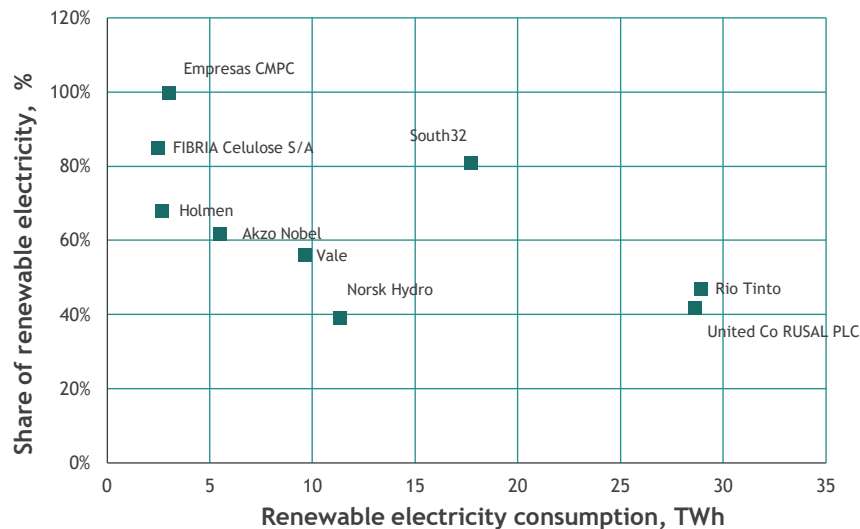
- ▶ Not utilising third parties to develop, fund and deliver renewable energy assets
- ▶ Renewables are seen not as main energy sources with significant internal resource and opportunity costs
- ▶ Limited divisional or regional energy strategy
- ▶ Lack of a strategic vision or response to approaches by renewable developers

Many of the world's largest mining companies are evaluating greater use of renewable energy plants as part of a broader strategy to lock in long-term fixed electricity prices and availability while minimising exposure to regulatory changes, and market pricing.

Source: EY – Mining: the growing role of renewable energy – [2014]

# Mining industry is a part of materials sector, which consumed 165 TWh of renewable energy in 2017

Corporate renewable electricity consumption matrix in 2017, Materials sector<sup>1</sup>



- ▶ About 13% of the total electricity in the materials sector came from renewable sources, amounting to 165 TWh of renewable electricity in 2016
- ▶ Top companies in terms of share of renewable electricity were pulp and paper companies Empresas CMPC (Chile), FIBRIA Celulose (Brazil) and Holmen (Sweden). In mining and metals the industry leader was South 32 (Australia); and in chemical – Akzo Nobel (Netherlands)
- ▶ In terms of absolute volume, the largest consumers of renewable electricity were mining and metals companies Rio Tinto (UK), South 32 (Australia) and Vale (Brazil) and aluminium producers United Co Rusal PLC (Russian Federation) and Norsk Hydro (Norway)
- ▶ In the mining and metal industries, the manufacture of basic metals from ores is one of the most electricity-intensive industrial processes. Therefore, several metal production sites have developed near low-cost hydroelectric power plants to ensure competitive supply

Source: IRENA – Corporate sourcing of renewables: market and industry trends – [2018]

Notes: (1) Based on the survey of 330 companies from materials sector conducted by IRENA in 2018

# Information Technology companies focus their sustainable activity on shifting data centres to 100% renewable energy

Selected information technologies companies participating in the REN100<sup>1</sup> initiative:



In April 2018, **Apple achieved 100% renewable electricity** powering its global facilities across 43 countries. Apple is also helping its manufacturing partners lower their carbon footprint, working with them to install more than 4 gigawatts of new clean energy worldwide by 2020.



**Microsoft** is on track to achieve its ambition of **powering its data centres with 100% renewable energy**. By the end of 2019, the company will meet its 2020 target of 60%, with the next milestone goal of 70% in sight for 2023.



**SAP** has already reached its **RE100 goal** of powering all facilities and **data centres by 100% renewable electricity**. The company is committed to become carbon-neutral by 2025.

Sustainable initiatives of selected information technologies companies:



**Alphabet** bought renewable energy to match the power needs of all its data centers and global operations, making it the biggest corporate buyer of renewable power in the USA. The company's energy purchase contracts had resulted in more than **2,6 Bn Euro<sup>2</sup> of investment in wind and solar farms globally**.



**Cisco Systems** implemented over 100 energy efficiency and renewable energy projects, used electricity generated from **renewable sources for 77% of its electricity demand** and launched an internal engagement platform called **Cisco Greenhouse**, on which employees can learn how to reduce their environmental footprint.



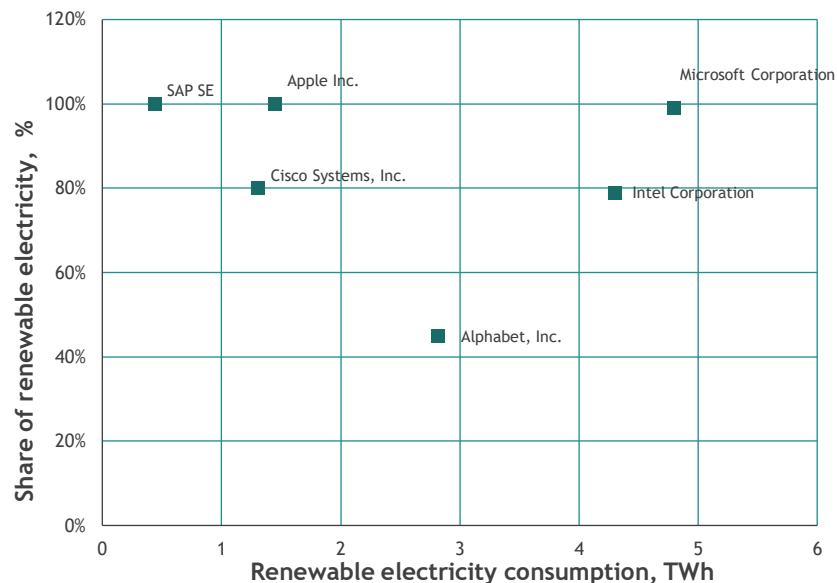
**Intel** will continue to move over to renewable power with the main target being that it operates on 100% green energy by 2020. Their commitment to going green comes with the installation of 3 million square feet of solar panels at sites in 9 countries.

Source: RE100 website; Companies websites; Media overview

Notes: (1) RE100 is a collaborative initiative of influential businesses committed to 100% renewable electricity, working to massively increase corporate demand for - and delivery of - renewable energy; (2) Numbers are converted from USD to Euro due to average 2018 exchange rate by ECB

# IT companies are increasingly using renewable electricity to reduce costs and mitigate electricity price volatility

Corporate renewable electricity consumption matrix in 2017, Information technology sector<sup>1</sup>



- ▶ The IT sector is one of the pioneers in the sourcing of renewable electricity, and it continues to account for the largest corporate purchases of renewable electricity from wind and solar PV sources
- ▶ Information technology sector has a relatively small share of overall electricity demand – 4%
- ▶ 17% of companies in the IT sector have renewable electricity targets, among which 17 companies have the goal to use 100% renewable electricity
- ▶ 50% of IT companies have the target to consume renewable electricity
- ▶ Apple itself produces 24% of renewable electricity it consumes

Source: IRENA – Corporate sourcing of renewables: market and industry trends – [2018]

Notes: (1) Based on the survey of 270 companies from information technology sector conducted by IRENA in 2018

# Companies from Financial sector actively participate in RE100 initiative to source 100% renewable electricity

RE100 initiative was created with a purpose to accelerate change towards zero carbon grids, at a global scale.

## RE 100



The initiative works to increase corporate demand for renewable energy by:

- ▶ Bringing together major companies committed to sourcing 100% renewable electricity globally by 2050 at the latest
- ▶ Setting the bar for corporate leadership on renewable electricity and celebrating their achievements to encourage others to follow
- ▶ Communicating a compelling business case for renewables to companies, utilities, market operators, policymakers and influencers
- ▶ Working with RE100 members and in partnership with others to address policy and market barriers to corporate sourcing of renewable electricity

Source: RE100 website



Selected financial institutions participating in the REN100 initiative

Goldman Sachs

The Goldman Sachs Group has set a RE100 target of being **100% renewable by 2020**.

BARCLAYS

The bank is 91% renewable and is committed to powering all of its operations **100% with renewable electricity by 2020**.

TD

TD Bank Group has **sourced renewable electricity equivalent to 100%** of its global operations since 2015.

CaixaBank

Caixa Bank has a goal of sourcing 100% renewable electricity by 2040. **Around 99% is already from renewable sources.**

CRÉDIT AGRICOLE

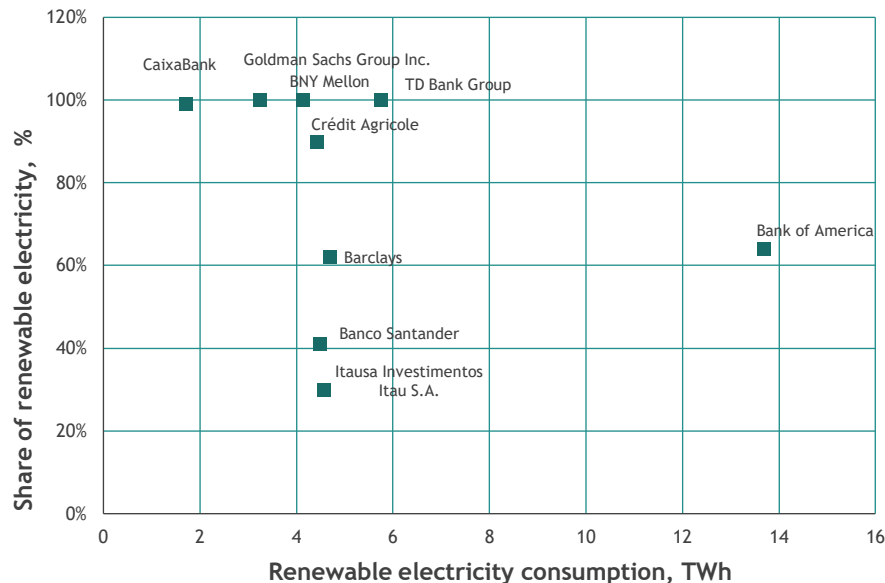
Crédit Agricole Group is already sourcing **100% renewable electricity** in France.

BANK OF AMERICA

Bank of America has set a goal to become **carbon neutral** and purchase 100% renewable electricity by 2020.

# Financial sector has the largest number of companies declaring renewable electricity targets

Corporate renewable electricity consumption matrix in 2017, financial sector<sup>1</sup>



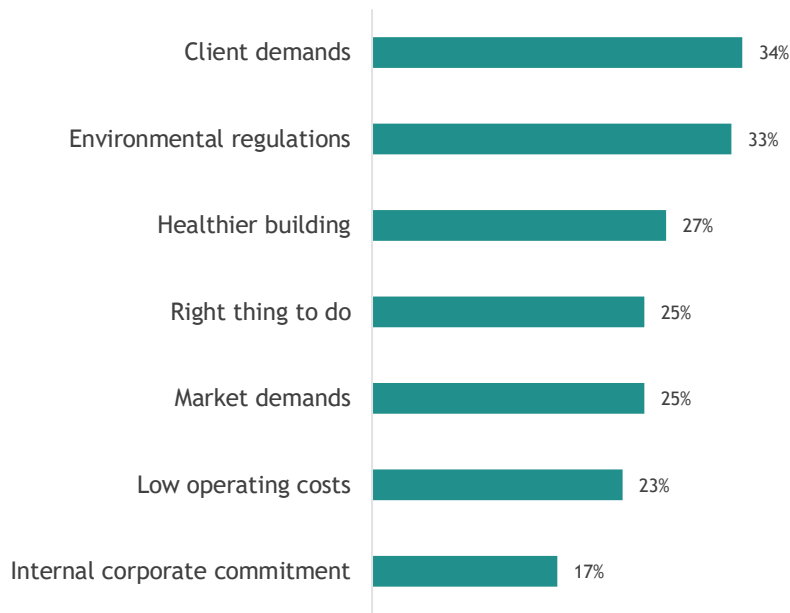
- ▶ Financial sector has a relatively small share of overall electricity demand – 2%
- ▶ In their roles as lenders and investors, companies in the financial sector play a critical part in enabling other companies to increase their share of renewable electricity consumption
- ▶ 21% of analysed companies have renewable electricity targets (over 70% of these targets are to achieve 100% renewable electricity) and about 43% of the consumed renewables
- ▶ Itaúsa Investimentos Itaú S.A. itself produces 6% of renewable electricity it consumes

Source: IRENA – Corporate sourcing of renewables: market and industry trends – [2018]

Notes: (1) Based on the survey of 342 companies from financial sector conducted by IRENA in 2018

# Client demands and environmental regulations are the main drivers of the future green building activity

## Triggers driving future green building activity<sup>1</sup>



### Renewable energy relevant to the building industry:

#### Electricity generation:

- ▶ Rooftop PV systems, which generate electricity directly from the sun using solar panels
- ▶ Building-integrated PV systems, which generate electricity using solar panels that are integrated into building structures, on the roof, walls or windows

#### Hot water systems:

- ▶ Solar thermal systems, which heat water directly from the sun
- ▶ Heat pumps, which heat water using warmth from the surrounding air, water or ground

#### Solar heating and cooling systems:

- ▶ Solar thermal cooling
- ▶ Solar heating systems such as heat pumps, which draw and boost heat from the surrounding air, water or ground

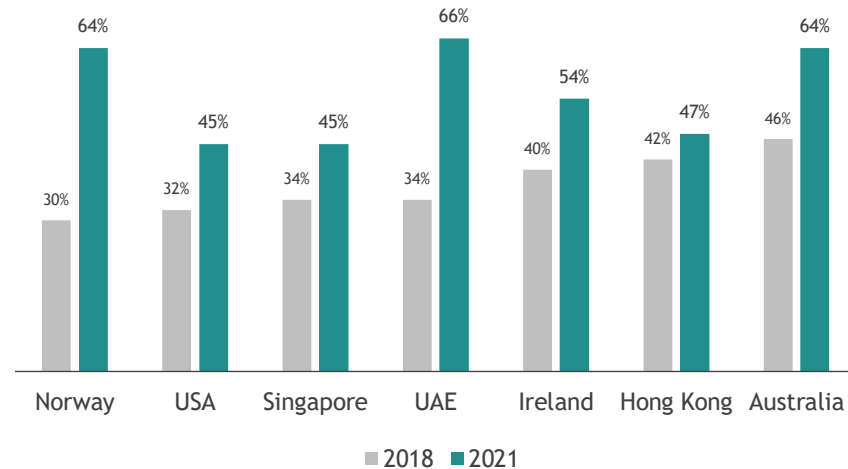
Source: Australian Government website; Dodge Data & Analytics – World green building trends – [2018]

Notes: (1) The total sample size of 2,078 benchmarks at a high degree of accuracy: 95% confidence interval with a margin of error of 2%



# By 2021, the UAE, Australia and Norway will have the highest percentage of green building projects

Percentage of firms that are doing / will do more than 60% green projects<sup>1</sup>



Selected real estate companies participating in the REN100 initiative



Having moved towards 100% fossil-free electricity in 2013, alstria has a goal to roll out 100% renewable electricity across its entire portfolio by 2020.



The Bozzuto Group has set a target of sourcing 100% renewable electricity for its entire global operations by 2040.



The Crown Estate has a target to source 100% renewable electricity by 2022.



Derwent has already reached its target to source 100% renewable electricity by 2020.



Gürmen Group is already powered by 100% renewable electricity.



NREP has a target to achieve 100% renewable electricity across all its operations by 2020.

Source: RE100 website; Dodge Data & Analytics – World green building trends – [2018]

Notes: (1) The total sample size of 2,078 benchmarks at a high degree of accuracy: 95% confidence interval with a margin of error of 2%

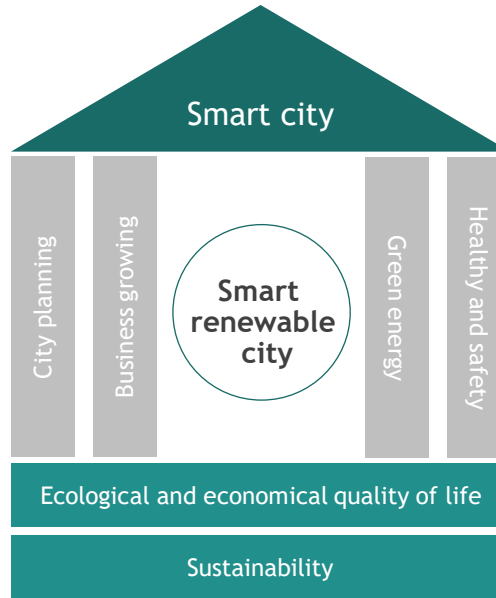
# Renewables are an important part of Smart Energy in the concept of Smart City



Renewable energy helps Smart cities to achieve the following goals:

- ▶ Foster economic growth due to its superiority over conventional sources, through creation of new working places and innovation
- ▶ Promote sustainability through renewable-powered buildings and electric mobility
- ▶ Improve quality of life via inclusive healthy environment
- ▶ Implement initiatives through an ecosystem of stakeholders, championed by utilities

## Smart city goals concept



## Amsterdam Smart City as an example



During 2012-2015, about 1.1 Bn Euro was invested in Amsterdam smart city programs related to smart energy.

The city is providing centrally controlled sustainable energy facilities, and also allowing citizens to produce and exchange energy between them.

**GridFriends:** A smart grid used for sharing energy. It stores and distributes power from sustainable energy sources according to demand.

**Zonstation 1:** Installation of solar panels on the roofs of tube stations.

**Comfort cooling:** a plant which utilizes the low temperature of the nearby river IJ for the cooling of buildings in the Amsterdam Houthaven district.

Source: AmsterdamCity website

# In 2018, in Diu (India) and Georgetown (USA) 100% of electricity generated came from renewables

## How renewables can contribute to smart city goals



### Sustainability

- ▶ Manage energy and natural resources wisely through **smart renewable-powered buildings**
- ▶ Recycle and reuse assets by pursuing **non-wire alternatives** to building new power plants
- ▶ Reduce carbon footprint through **zero-emissions energy**
- ▶ Move towards cleaner air and less noise by deploying renewable **distributed energy resources** and **cleaner-fuelled mobility**



### Economic growth

- ▶ Promote sustainable economic growth with the help of **affordable and reliable renewable power**
- ▶ Attract and retain **companies procuring renewables and providing green jobs**
- ▶ Encourage entrepreneurship and innovation via **renewable business incubators**



### Quality of life

- ▶ Foster **inclusivity** by providing access to renewables to lower-income households
- ▶ Improve public health and safety through **emission-free city centres**
- ▶ Enable constituent engagement via **renewable prosumers**

## Purest smart-cities in 2018

City, Country	Population, millions	Target	Current renewable share of electricity generated
Denton, USA	0.10	N/A	43.7%
Sonderborg, Denmark	0.27	National: 100% by 2030	65%
Copenhagen, Denmark	0.60	100% carbon-neutral by 2025	60%
Diu, India	0.05	Zero carbon by 2029	100%
Georgetown, USA	0.07	Shift to local generation of renewables	100%

Source: Deloitte – Renewables (em)power smart cities – [2019]

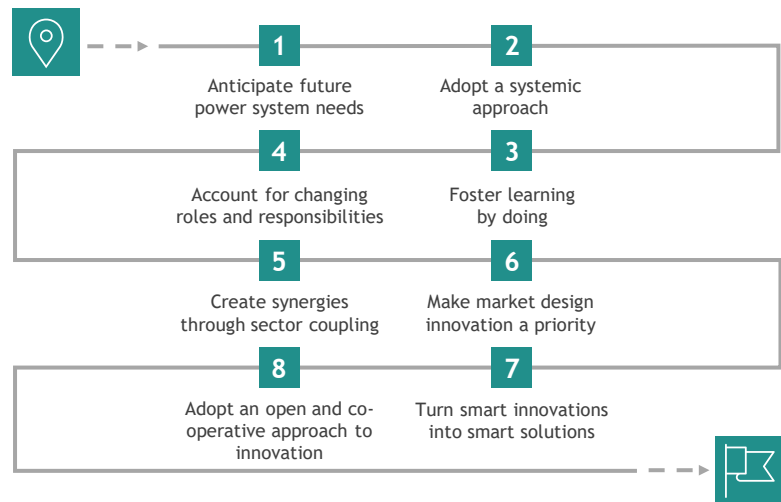


# ENERGY TRANSFORMATION PROCESS OVERVIEW



# Global energy transformation is a continuous process, influencing social and economic spheres

## Key steps to the innovative energy transformation



## The global energy transformation driven by renewables could:

- ▶ Reduce energy-related geopolitical tensions, improve food and water security, and enhance sustainability, climate resilience and equity
- ▶ Foster greater cooperation between states
- ▶ Mitigate social, economic and environmental challenges that are often among the root causes of geopolitical instability and conflict
- ▶ Help to deliver universal energy access, create jobs, power sustainable economic growth

The global energy transformation is forced by three main trends: **digitalisation, electrification and decentralisation**

Source: IRENA – Innovation landscape for a renewable-powered future – [2019]

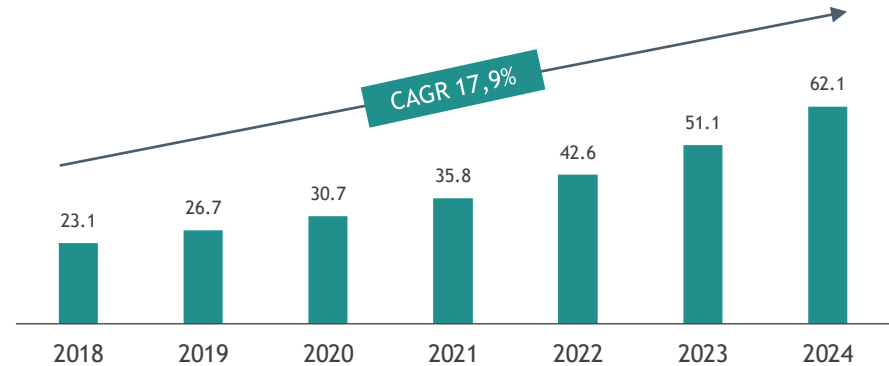
# Digitalisation is a key driver of the energy transformation



Digital technologies support the transformation of the power sector in several ways, such as:

- ▶ Better monitoring of assets and their performance
- ▶ More refined operations and control closer to real time
- ▶ Implementation of new market designs
- ▶ Emergence of new business models
- ▶ Provision of large amounts of data to the management
- ▶ Optimising systems with many small generation units
- ▶ Enhancing communication, control and, in the future, automated smart contracts based on IoT and blockchain technology

IoT-connected devices worldwide, billion connected devices



A big number of companies and corporations in the information and communications technology (ICT) domain are entering the energy sector, developing various new applications and providing new services to consumers, using IoT technologies

By 2024, over 62 billion electrical devices are expected to be connected and sharing data worldwide, providing a wealth of information to consumers, manufacturers and utility providers

Source: IRENA – Innovation landscape for a renewable-powered future – [2019]; Statista website

# When renewable energy generation is in abundance, electrification of end-use sectors is an emerging solution

## Innovations taking place in the electricity supply chain



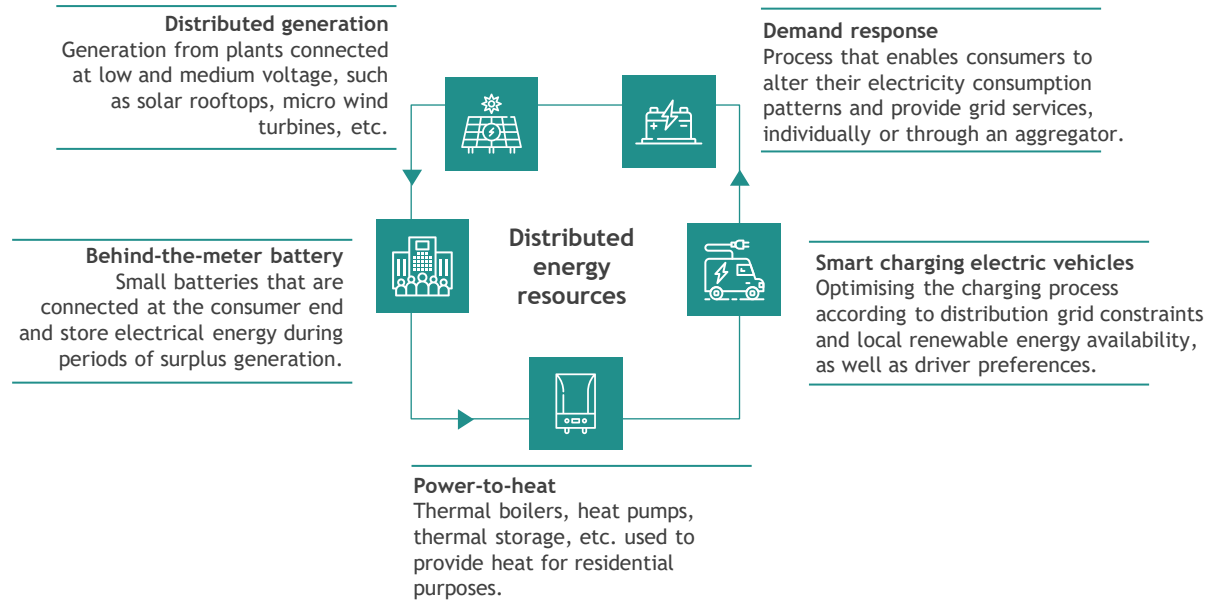
- ▶ Electrification of end-use sectors is a way to maintain renewable energy generation, avoid curtailment, and most importantly contribute to decarbonising heating and transport
- ▶ Active energy consumers, often called 'prosumers' because they both consume and produce electricity, are changing the dynamics of the sector, with great potential to unlock demand-side flexibility

Source: IRENA – Innovation landscape for a renewable-powered future – [2019]



# Deployment of distributed energy resources turns the consumer into an active participant in the power market

## Distributed energy resources that decentralise the power system



- ▶ Emerging distributed energy resources that are connected at the consumer end – such as rooftop solar PV panels, micro wind turbines, battery energy storage systems, plug-in electric vehicles and demand response – are decentralising the system
- ▶ Optimising the consumption of electricity that is now locally produced provides a great advantage for the system, decreasing the need for other costly flexibility measures

Source: IRENA – Innovation landscape for a renewable-powered future – [2019]



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