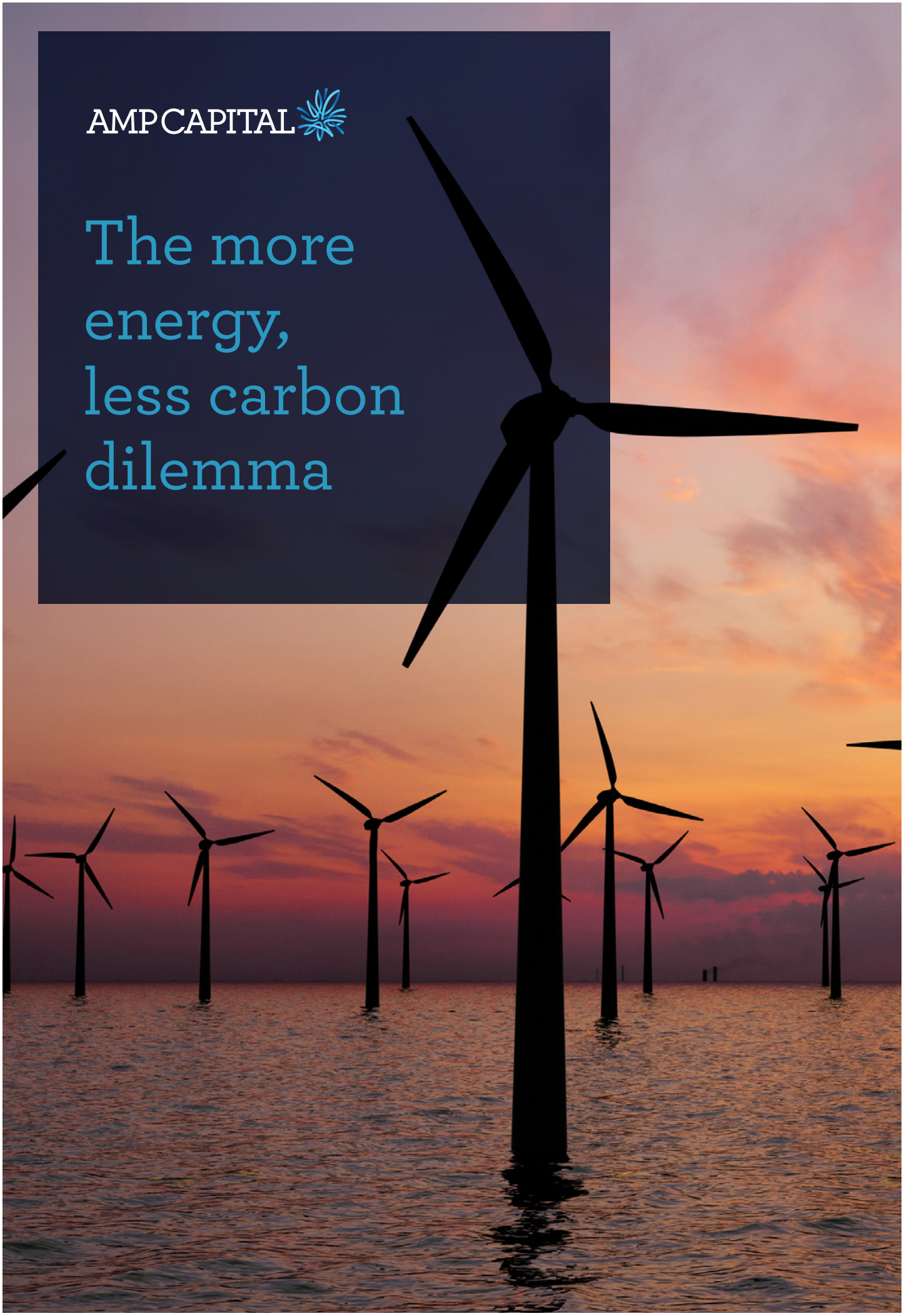
AMP CAPITAL

The more energy, less carbon dilemma



Contents

Introduction

Today, the centrepiece of the 2015 Paris Agreement, to limit temperature increases to less than 2 degrees above pre-industrial levels, is not on track.

While energy continues to grow in the next 20 years, energy supply is transitioning towards environmentally friendly sources. However, substantial carbon reductions depend on policy and technology.

It is broadly understood that today's energy mix is too dependent on fossil fuels, which makes up about 83% of the world's total fuel consumption. In our view, a solution which simply replaces fossil fuels with renewable sources of energy is bold and daring, but ultimately insufficient and unworkable. This solution deals with 'supply' of energy. Without addressing the 'demand' side of the equation, we are unlikely to be able to safeguard the planet for future generations.

Various surveys continue to suggest that addressing climate change is perceived as much more urgent in developed economies than emerging economies. This is important because increasing energy intensity is one of the hallmarks of economic development. In the developed world, whilst appreciating that more can be done, it is worth noting that per capita CO2 emissions have been on a downward trajectory for many years, whereas those in countries which will represent the bulk of global population/GDP growth in the next 20 years are two-to-seven times lower than developed economies. This means growth for energy demand, and potentially CO2 emissions, is almost a foregone conclusion.

Climate change is a global issue, CO2 does not respect human-made borders. A reduction of carbon emissions requires either the developed world asking the developing world to stall their trajectory of development, or to find some technological breakthrough that will be affordable and rapidly scalable.

Either way, a global approach is necessary, at a point in history where the political zeitgeist is increasingly turning inward to a nationalist view. Addressing climate change could be the catalyst to rebuilding and realigning supranational entities. We are optimistic that this topic is gathering enough focus to attract the political attention it deserves.

This paper sets out the state of play of both energy demand and energy supply. It utilises data on demographics, forces which are well entrenched and have a high degree of certainty. The conclusion offers some regional observations which will be the focus of subsequent papers, which dive into these regional issues in more detail.

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The growth of energy demand in the next 20 years

Energy demand continues to grow due to a growing population and a rising middle class. Economic growth leads to an increase in living standards, demand for household necessities and ultimately energy use. The world population reached 7.7 billion in 2019. China and India remain the two largest countries in the world, each with a population of 1.4 billion. The world population is expected to grow by 1% per year, adding 1.5 billion people over the next 21 years and reaching 9.2 billion by 2040. Most of this growth is expected to occur in African countries, with strong additions also in India, Pakistan, Indonesia, and the United States.

Evolution of the world's population (millions)

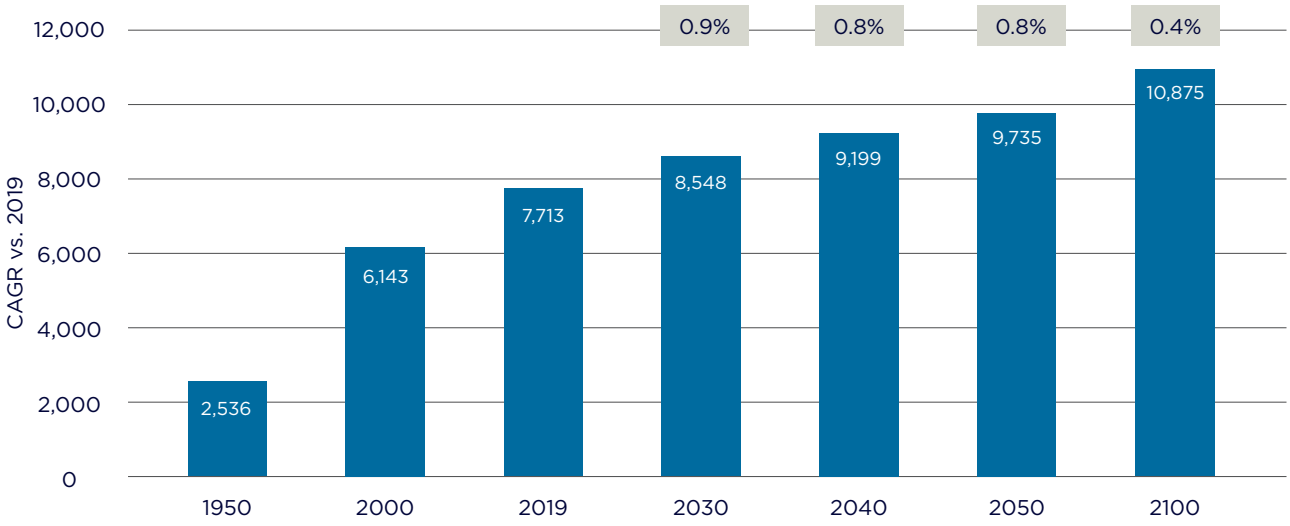


Chart 1.
Source: United Nations Department of Economic and Social Affairs; World Population Prospects 2019.

Population in top 10 countries (millions)

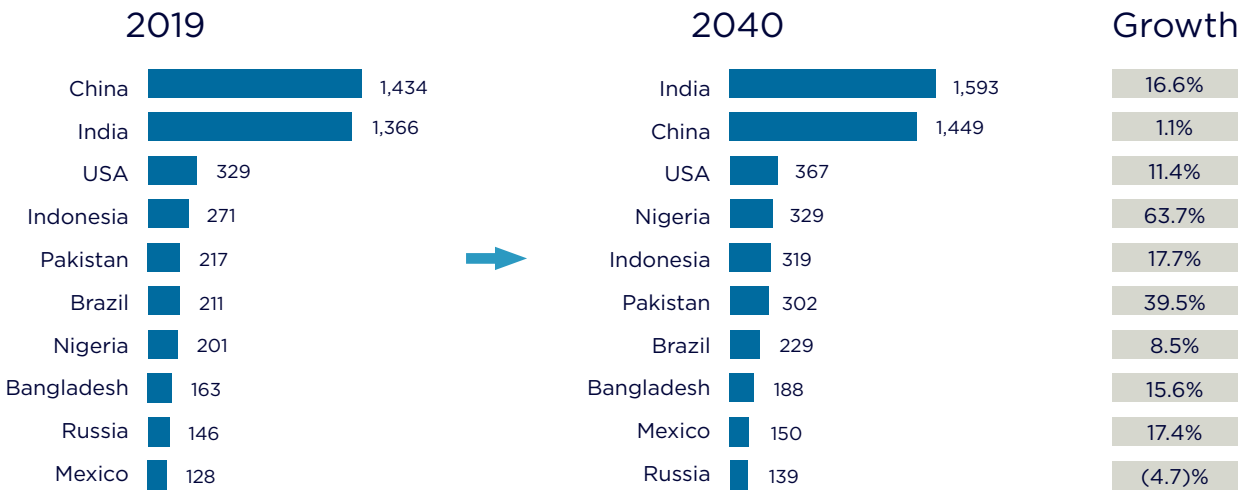


Chart 2.
Source: United Nations Department of Economic and Social Affairs; World Population Prospects 2019.

World GDP is expected to grow at an annual rate of 3%, approaching US$236 trillion in 2040 and doubling by then. China and India will account for half of the increase (US$61 trillion), followed by OECD countries (US$23 trillion). Notwithstanding its robust population growth, Africa is expected to face a limited increase in GDP per capita and therefore to account for only 7% of the increase in world GDP.

Evolution of world GDP (US$tr)

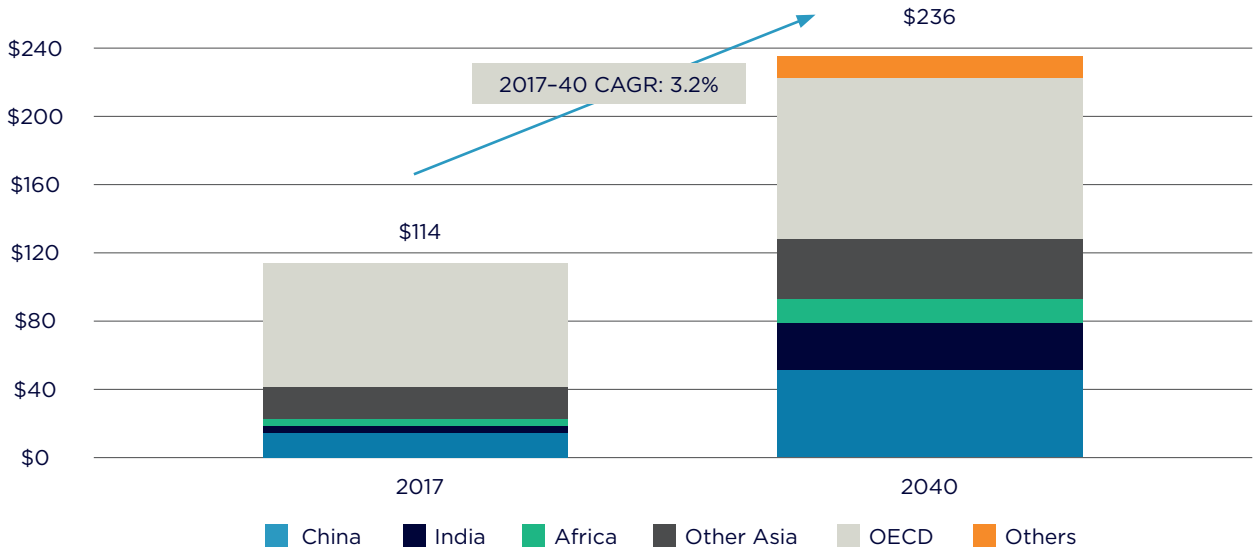


Chart 3.
Source: BP and ExxonMobil, 2019.

2017-40 GDP additions by region (US$tr)

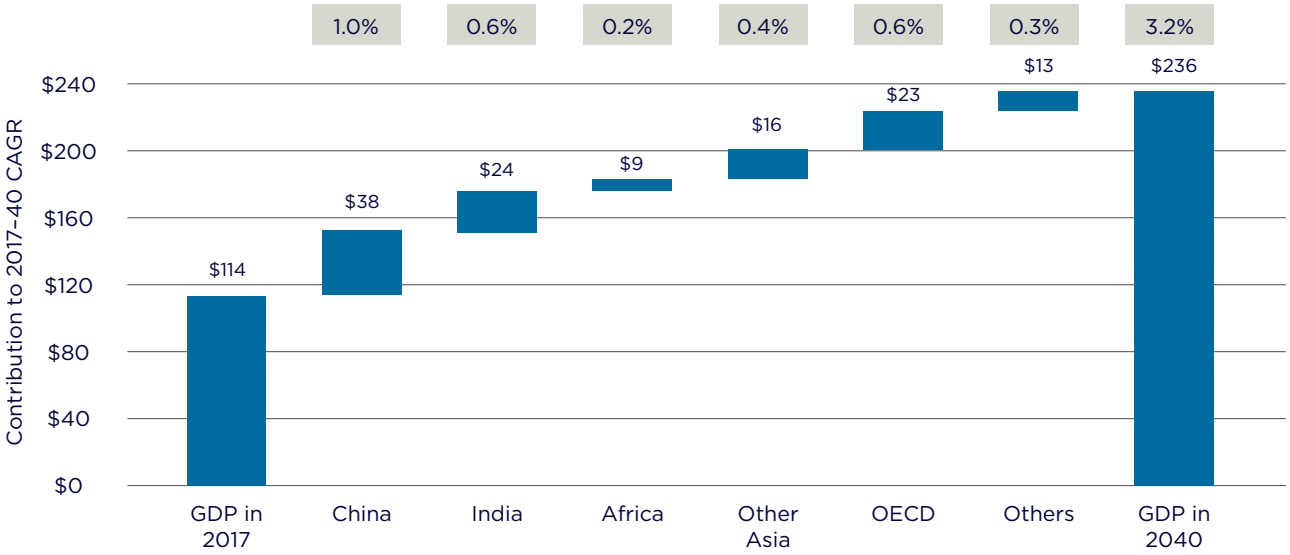
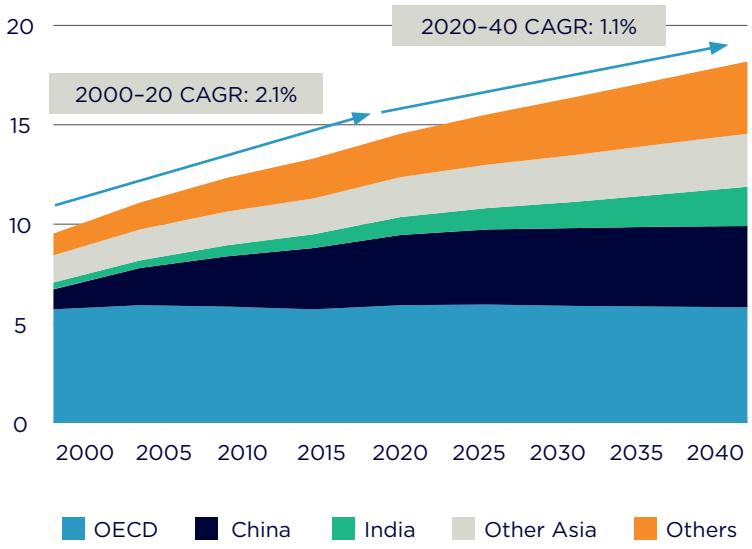


Chart 4.
Source: BP and ExxonMobil, 2019.

Energy demand is expected to grow over the long term, reflecting trends in population and GDP growth, however gains in energy efficiency will tend to moderate this increase given declining energy intensity. World energy consumption is expected to grow at an annual rate of 1% (compared to a 3% rise in GDP), approaching 18 Gtoe (Gigatonnes of oil equivalent) and increasing by almost 25% over the next 20 years. The impact of declining energy intensity is also reflected in the expected lower 2020-40 energy use growth rate of 1.1% relative to the historic 2000-20 rate of 2.1%. At the regional level, most of the consumption growth is expected to happen in emerging economies. China and India will represent 46% of the increase in energy consumption by 2040, while OECD countries will slightly decrease. Thus, the contribution of OECD countries to total world energy consumption is expected to decline from 41% in 2020 to 32% in 2040. At the sector level, the increase in energy consumption will be mainly due to power generation as electrification in emerging economies continues.

World energy consumption by region (Gtoe)



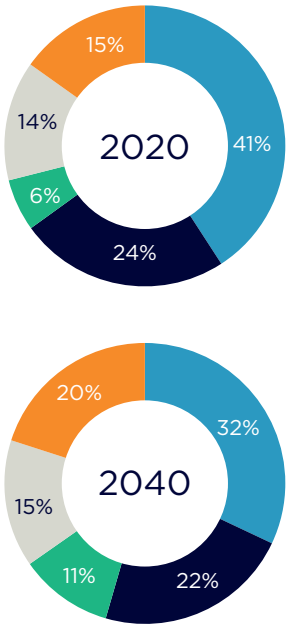
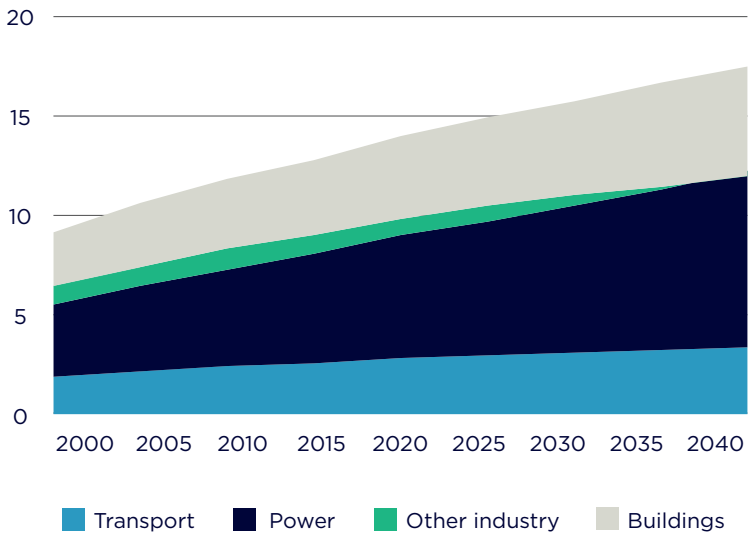


Chart 5.
Source: BP, 2019.

World energy consumption by sector (Gtoe)



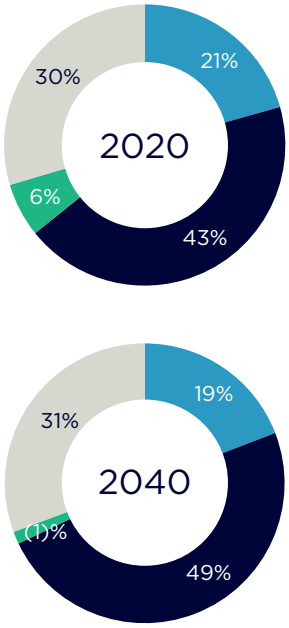
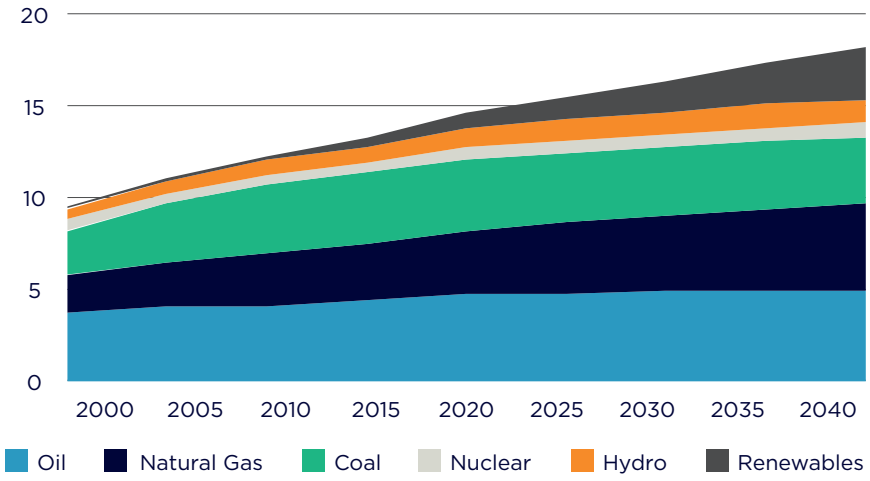


Chart 6.
Source: BP, 2019.

A major evolution in energy supply

The energy mix has been evolving over recent years. Fossil fuels (oil, natural gas and coal) have been the main source of energy, representing 83% share of today's overall energy mix. The share of oil consumption declined over the last 20 years, as coal consumption supported the bulk of the electricity generation growth in China. Renewables, mainly wind and lately solar, experienced significant growth, increasing their share from 1% to 6% of global energy consumption in the 2000-20 period. Given the pressing urgency to tackle carbon emissions, the energy mix will continue to evolve in the future. Renewables will play an increasingly important role, with their share of the overall energy mix rising to 15% in 2040. Fossil fuels remain the main source of energy in the global economy, though their share of the global energy mix is expected to decline materially. Natural gas will be the fastest growing fossil fuel with an increasing share of the overall energy mix (from 24% in 2020 to 26% in 2040), driven by a vast North American shale gas resource base. Meanwhile oil and coal will continue to lose market share. Fossil fuels' share of global energy use is expected to fall to 73% in 2040 from 83% in 2020.

Energy mix (Gtoe)



	CAGR	
Gtoe	**2000–20**	**2020–40**
Oil	1.2%	0.2%
Natural Gas	2.5%	1.6%
Coal	2.4%	-0.2%
Nuclear	0.7%	0.7%
Hydro	2.5%	1.1%
Renewables	13.9%	6.4%
Total	**2.1%**	**1.1%**

Chart 7.
Source: BP, 2019.

Energy mix breakdown (%)

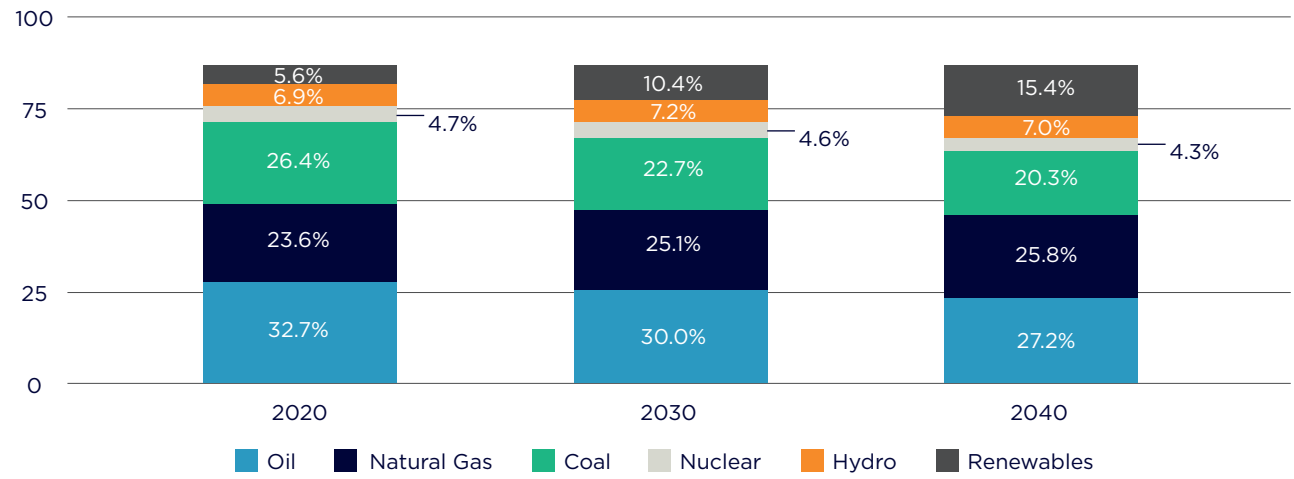


Chart 8.
Source: BP, 2019.

The decarbonisation of the power generation sector represents the most impactful opportunity to address climate change, and probably the most important swing factor on the speed of carbon emission reductions. The increase in renewables generation should offset coal plant shutdowns (10% share reduction over the next 20 years) and any additional capacity needs from developing economies. Renewables will be the largest source of energy in the 2040 power mix, with the share almost tripling and approaching ~1/3 of the global power generation mix. For instance, cost reductions and experience gained in the North Sea are creating a compelling growth opportunity for offshore wind, thanks to larger turbines and new technologies such as floating turbines.

The catch: substantial carbon reductions depend on policy and technology

Any direct policy actions (e.g. coordinated ban on new coal generation, global carbon tax, forced reforestation) and/or technological breakthrough (e.g. carbon capture and storage, clean nuclear, transmission grids able to run fully on renewables) could contribute to a further meaningful reduction of the carbon intensity of the power sector. Regulation will be the most important global warming mitigant in the short term, as prospects for carbon capture are still uncertain given the cost and scale needed to make these projects economical.

Fuel mix in power generation (%)

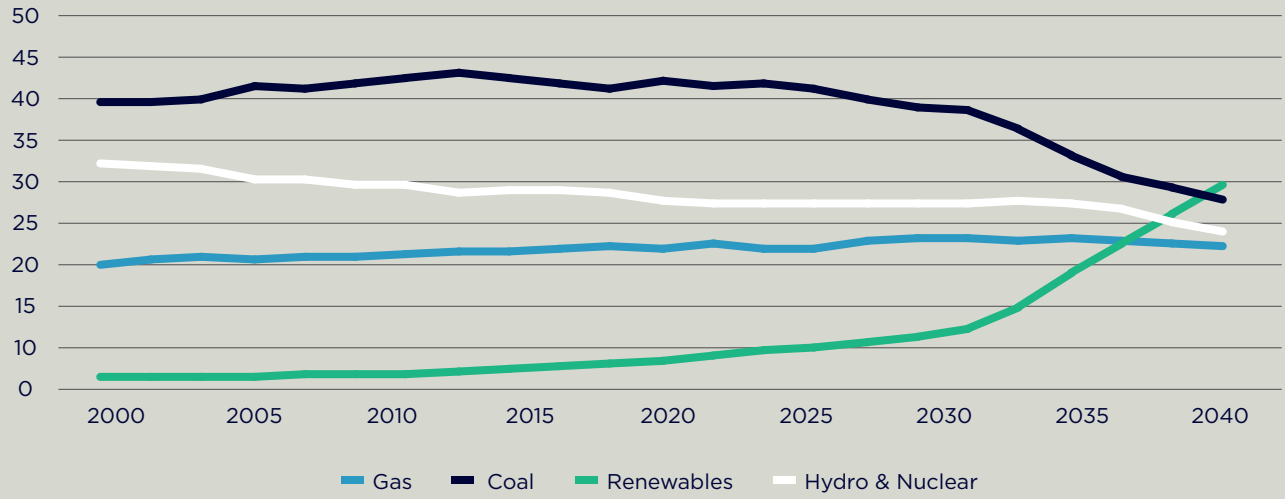


Chart 9.
Source: IEA, BP, 2019.

Fuel mix breakdown in power generation

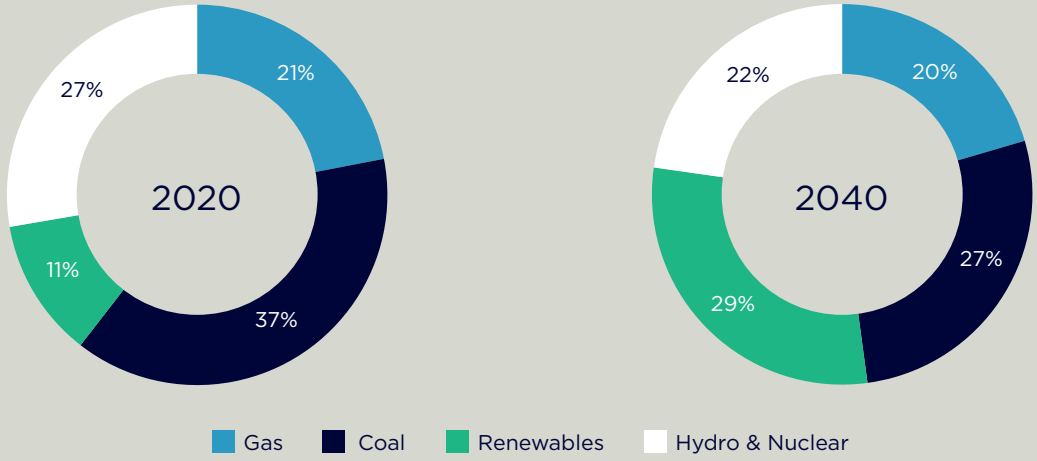


Chart 10.
Source: IEA, BP, 2019.

Carbon emissions tripled worldwide since 1965, with emerging markets representing the bulk of the increase. Emissions in North America and Europe have been on a declining path since 2000. In fact, emissions per capita decreased from 16.1 ton to 12.6 ton (-22%) in North America, and from 8.4 ton to 7.2 ton (-15%) in Europe since 2000. On the other end, China and India experienced an increase of emissions per capita of 154% (from 2.6 ton to 6.5 ton) and 101% (from 0.9 ton to 1.8 ton), respectively, over the same period.

CO2 emissions (billion tons)

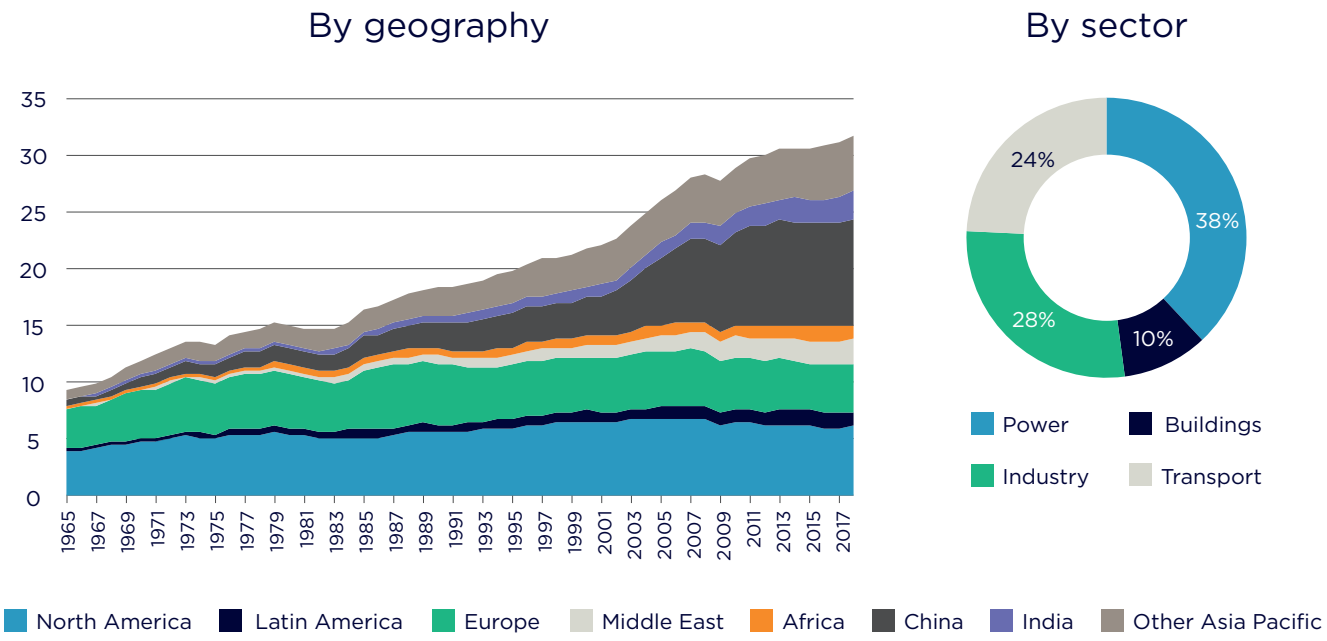
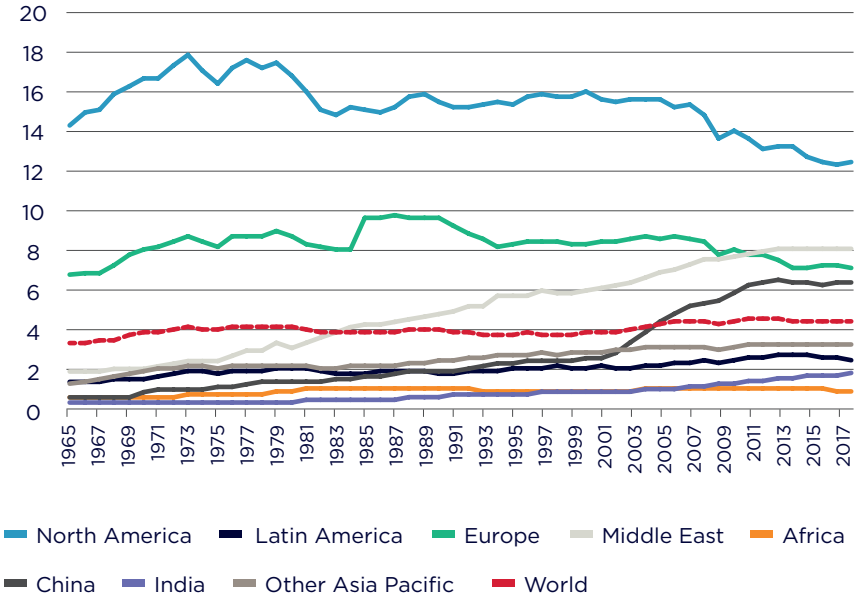


Chart 11.
Source: IEA, BP, United Nations Department of Economic and Social Affairs, 2019.

CO2 emissions per capita (tons/person)



Geography	tons/capita (2018)
North America	12.6
Latin America	2.5
Europe	7.2
CIS	9.5
Middle East	8.1
Africa	1.0
China	6.5
India	1.8
Other Asia Pacific	3.3
World	**4.4**

Chart 12.
Source: IEA, BP, United Nations Department of Economic and Social Affairs, 2019.

An additional 1.5bn people will inhabit the world by 2040. With carbon emissions per capita expected to continue edging higher from increasing prosperity in developing markets (2x / 7x catch-up effect between North America and China / India on a per capita basis), the increase in population will bring unparalleled challenges in addressing carbon emissions at a global level. Hence, policy will need to manifest itself relatively soon. Without any doubt, policy making efforts need to be extended to the entire spectrum of sectors with a continued focus on reducing all facets of the environmental footprint. Today's spotlight remains the decarbonisation of the power sector, representing almost 40% of global emissions, though viability and affordability of electric vehicles are required to address the impact of transport (almost 25% of global emissions). Furthermore, extensive regulation of industrial (manufacturing) and real estate sectors (heating and cooling) are needed as well.

As a reference point for developed economies, buildings contribute today 26% of overall carbon emissions in the UK. Given the distributed nature of real estate, the slow turnover of the building stock and the impact of improving living conditions on consumption trends, decarbonising residential and commercial real estate will be probably one of the most ambitious goals to achieve.

CO_2 emissions by final user in the UK

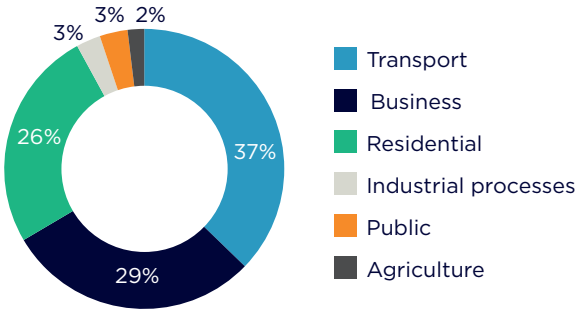


Chart 13.
Source: UK Department for Business, Energy & Industrial Strategy; US Energy Information Administration, 2018.

CO_2 emissions from buildings by end use

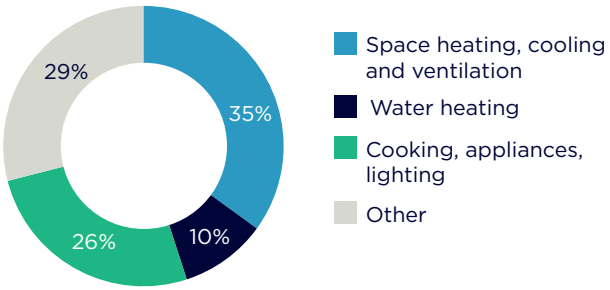


Chart 14.
Source: UK Department for Business, Energy & Industrial Strategy; US Energy Information Administration, 2018.

Energy-related CO_2 emissions and potential reductions (billion tons)

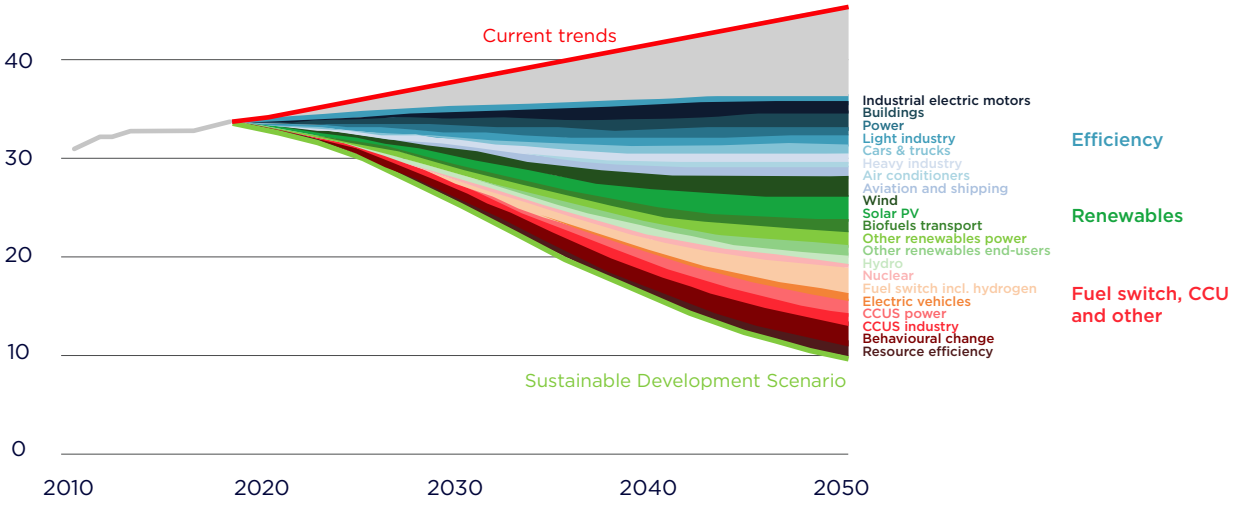


Chart 15.
Source: IEA, 2019.

Why is energy transition relevant for infrastructure?

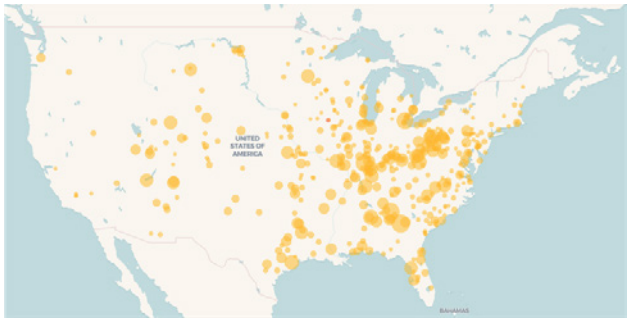
The transition to a decarbonised world is happening along a structural shift in the way energy is supplied and consumed. In developed economies, centralised generation and vertically integrated monopolies are going to eventually coexist with smaller decentralised sources supported by micro grids, digitalisation and various storage options. Emerging economies will progressively reduce their dependence on coal and continue to satisfy their growing energy demand relying more on natural gas and renewables.

Within the Global Listed Infrastructure team, we continue to carefully evaluate the impact of these trends on the infrastructure universe and have invested across a cohort of companies that have embraced the decarbonisation challenge while continuing to create value for shareholders.

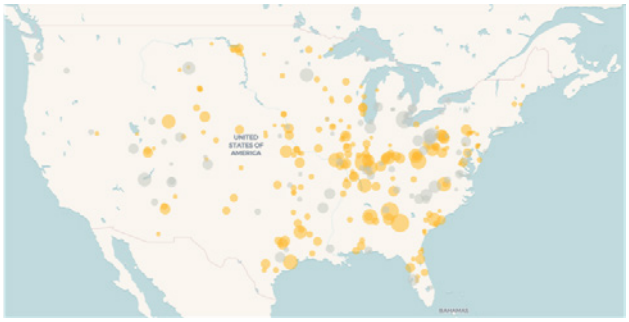
North America

The phase out of coal plants in the US has triggered ...

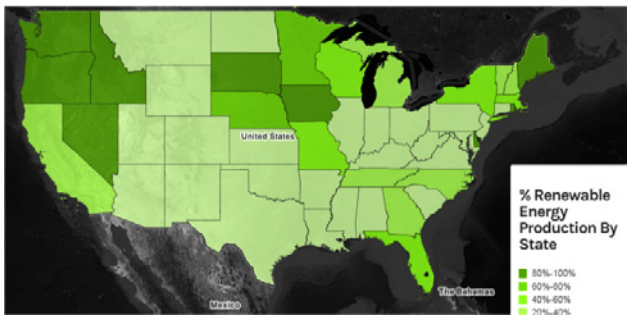
2000 (327 GW)



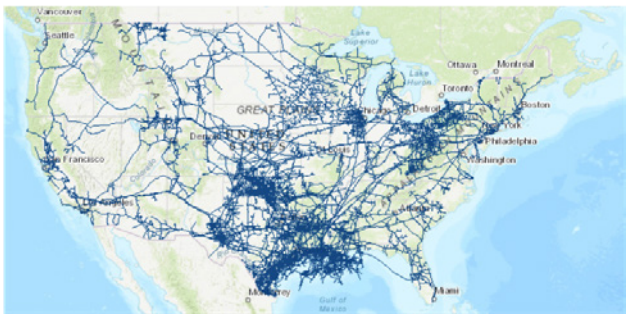
2018 (261 GW)



... significant growth in renewable energy production



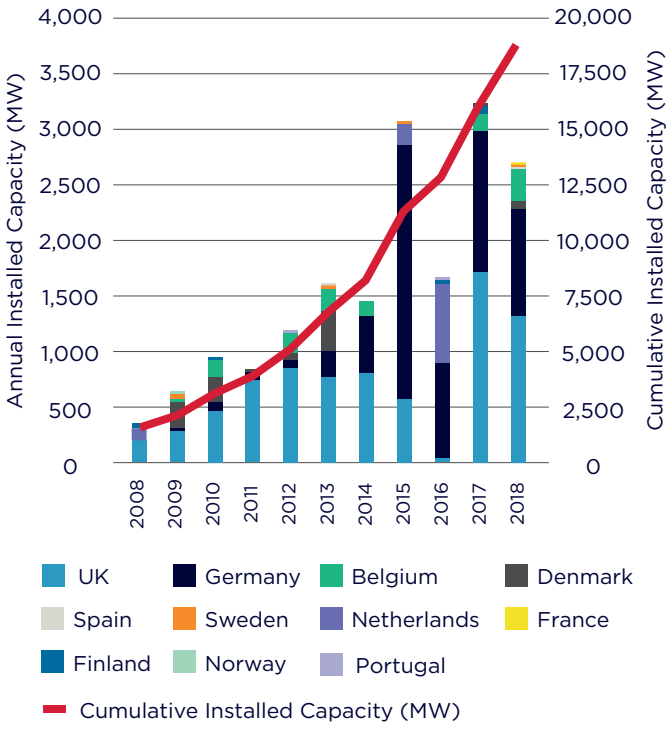
... a buildout of natural gas infrastructure



Source: US EIA, CarbonBrief, 2019.

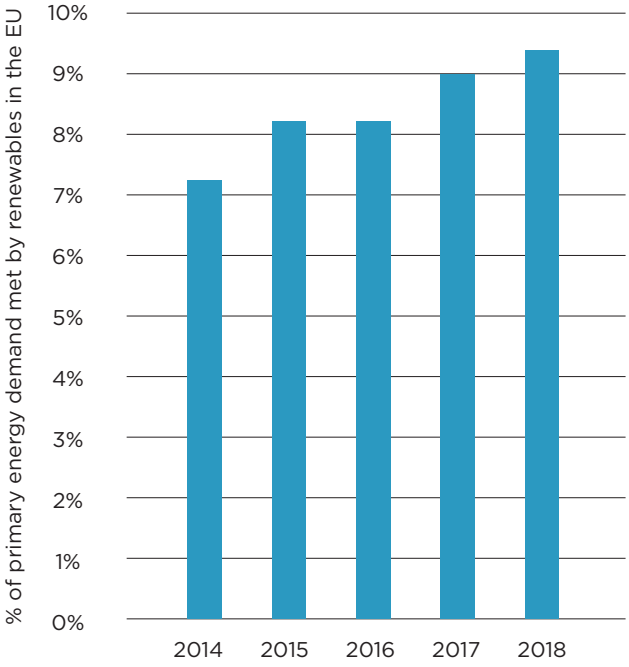
Europe

Although Europe is building renewables (offshore wind, shown below)



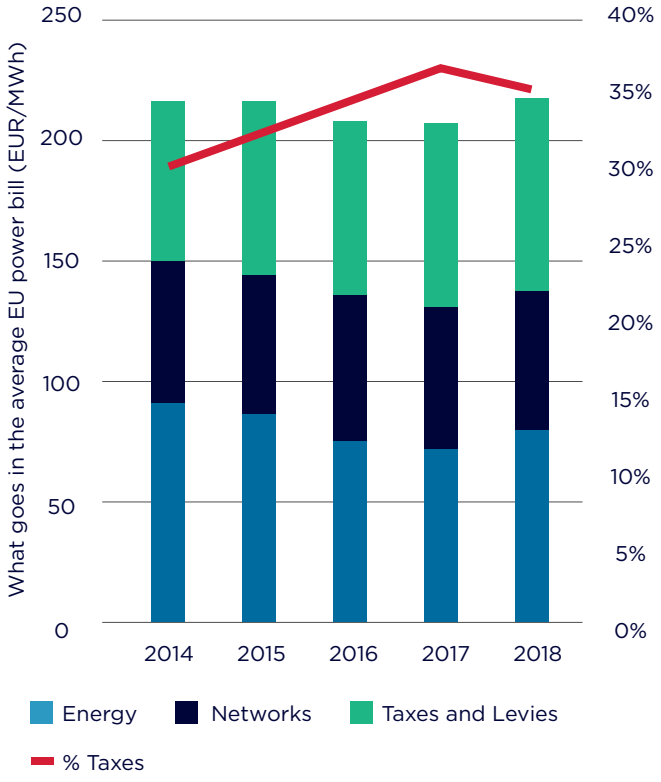
Source: WindEurope, BP, Eurostat, 2019.

... the share of renewables only grows slowly



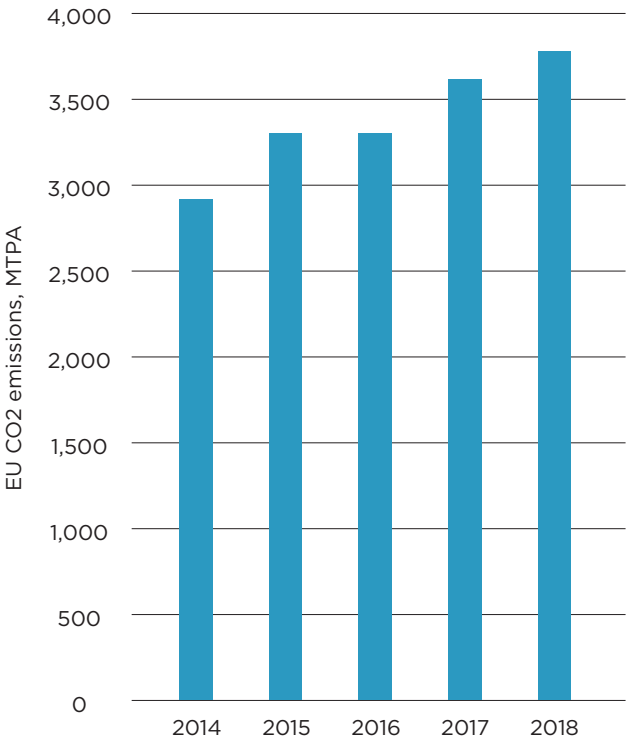
Source: WindEurope, BP, Eurostat, 2019.

That investment kept bills up despite falling energy prices ...



Source: WindEurope, BP, Eurostat, 2019.

... yet struggles to dent CO_2 emission

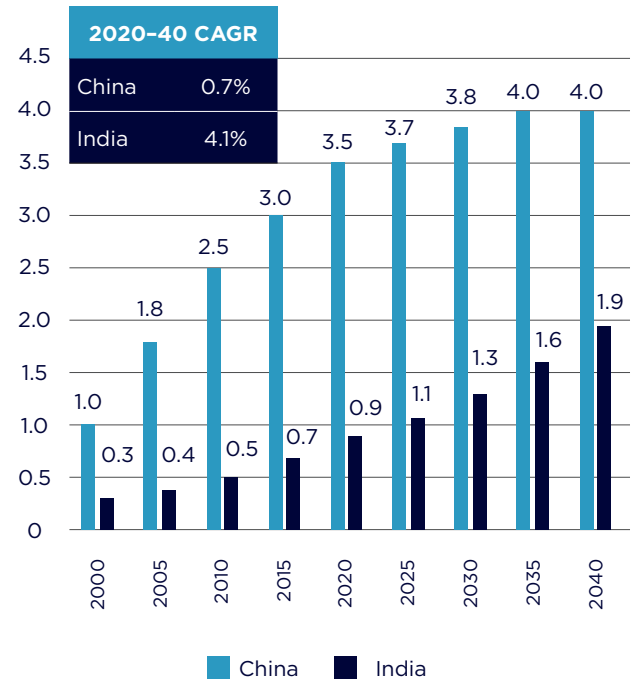


Source: WindEurope, BP, Eurostat, 2019.

Asia Pacific

China and India drive the region's trends ...

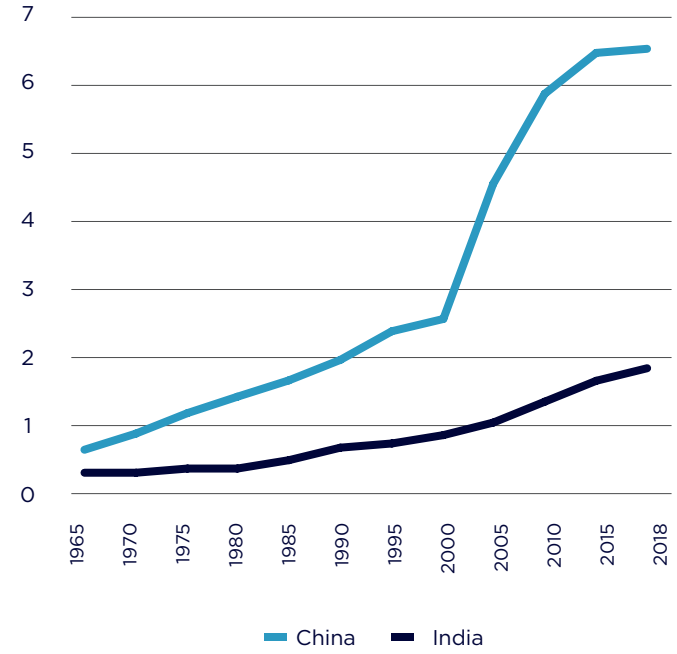
Primary energy consumption (Gtoe)



Source: IHS Markit, BP, Wall Street research, 2019.

... and their energy policy will have a global impact

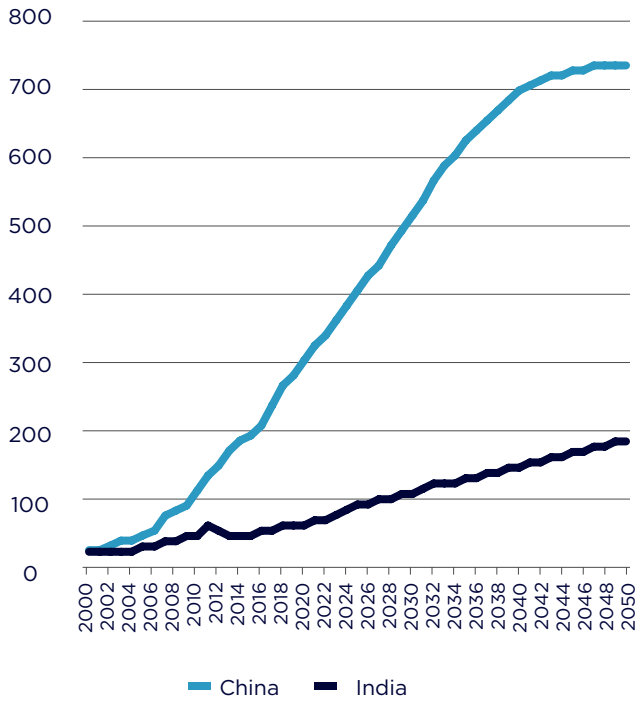
Emissions per capita (tons/person)



Source: IHS Markit, BP, Wall Street research, 2019.

As China and India consume more gas ...

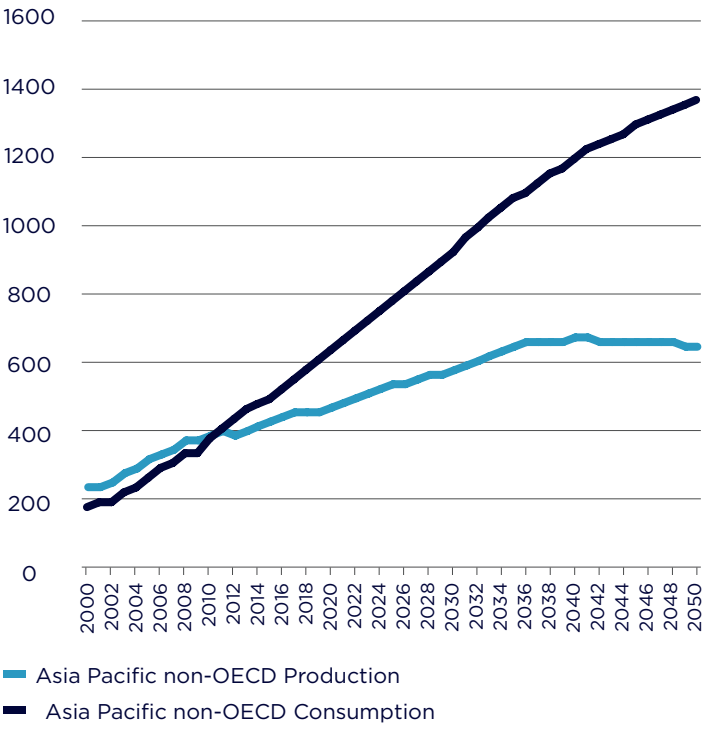
Natural gas demand (bcm)



Source: IHS Markit, BP, Wall Street research, 2019.

... imports into the region will grow

Natural gas production vs. consumption (bcm)



Source: IHS Markit, BP, Wall Street research, 2019.

What's next?

This paper is the first in a four-part series. We look forward to exploring the below themes throughout 2020.

North America	Europe	Asia Pacific
• Generation mix and impact on T&D spending • Renewables investments and virtual PPAs • Investments in natural gas and LNG export infrastructure • Implementation of carbon taxation	• Decarbonisation beyond the power sector • Investments in power grids • Demand management • Carbon capture and storage ("CCS") and hydrogen	• Fueling demographic growth and rising standards of living • Sourcing enough natural gas • Affordability of energy for industries • Leapfrogging 20th century infrastructure and technology