

# Global Energy Perspective 2019: Reference Case

January 2019



Summary



Energy Insights  
By McKinsey

## Editor's note

Energy systems around the world are going through rapid transitions that will bring important changes to the way we fuel our cars, heat our homes, and power our industries. These trends will have widespread implications for businesses, governments, and individuals in the coming decades.

We have made it our mission to help our clients navigate this energy transition. As a compass and tool to support these efforts, we have created a fundamental and granular outlook on global energy systems.

Our outlook is based on contributions from hundreds of McKinsey experts from around the world, from fields including oil and gas, automotive, renewable energy, and basic materials. Through this global network, we are able to incorporate a diverse set of views into one consensus: our Reference Case in front of you.

Many of the trends that shape the future of energy are in reality driven by a multitude of local trends, which will occur with different magnitudes and speeds in specific geographies and sectors. To capture this granularity, our model offers a detailed outlook across 146 countries, 55 energy types, and 30 sectors, and then aggregates these developments to establish a bottom-up global outlook as a basis for our insights.

Reflecting on our work on this outlook and numerous discussions with experts, we find that three important tipping points in the energy landscape will come within reach in the next few years:

- A** As the cost of renewables has come down further, many countries will reach a tipping point in the coming five years, where new-build solar or wind capacity is cost-competitive with the fuel cost of existing conventional plants. As a result, we see a further acceleration of the ramp-up of renewables
- B** Similarly, as the cost of batteries continues to decline, within the next 5-10 years, many countries will reach the point at which electric vehicles are more economic than internal combustion engine vehicles. This is true for passenger cars but also for most truck segments
- C** For the first time, we project a peak in global carbon emissions, despite continued economic growth and a growing global population. Triggered by a drop in global coal demand and flattening oil demand, carbon emissions are expected to start to decline by the mid-2020s

Comparing our Reference Case outlook to editions from previous years, we find that several developments in the energy transition have shown further acceleration. These technological advancements beyond the expected have been a common theme for forecasters in the past. For a perspective on potential further accelerations, we refer to our recent “Accelerated Transition” outlook.

The current Reference Case outlook is structured around five chapters. Chapter 1 provides a perspective on overall energy demand, followed by chapters 2-4 that dive into electricity, natural gas, and oil, respectively. Chapter 5 looks into greenhouse gas emissions, including projections of coal demand as an important driver.

We hope you have an interesting read that helps you shape your thinking on the energy transition and the implications for your organization.

# Our Global Energy Perspective provides a detailed demand outlook across these dimensions

## Key features of our Global Energy Perspective



### Granular coverage

Long-term projections to 2050 by country, sector, and energy product (146 countries, 30 sectors, and 55 energy products)



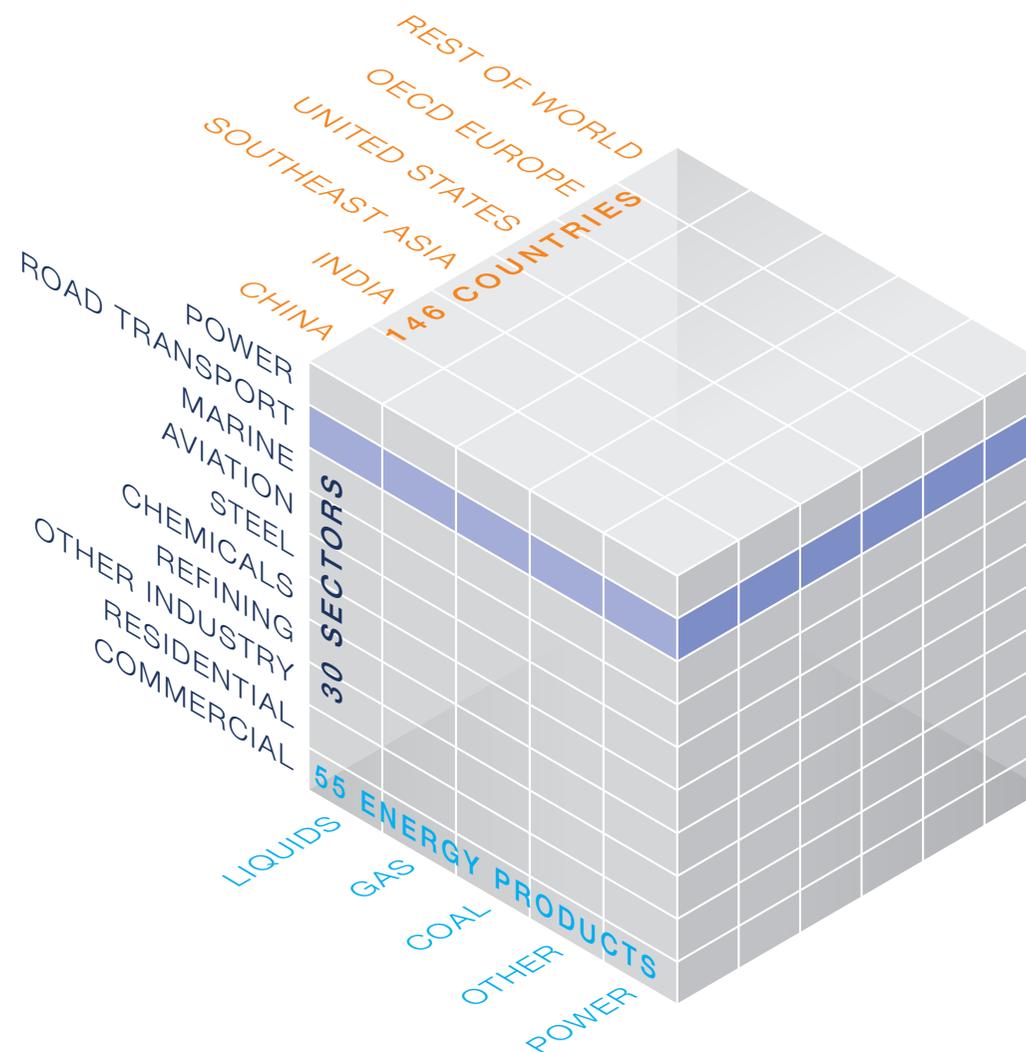
### Full transparency and flexibility

Access to all the detail of underlying demand drivers and ability to customize bespoke scenarios



### Global reach, local expertise

Access to McKinsey's expertise from across 100+ local offices, 400+ energy experts globally, and 20+ industry practices



## Illustrative level of detail

### Road transport

#### 5 vehicle segments

- Passenger cars
- 2- and 3-wheelers
- Vans and pickups
- Trucks
- Buses

#### 3x3 truck use cases

- 3 weight classes
- 3 distance classes (urban, regional, and long-haul)

#### 7 powertrains

- Gasoline
- Battery electric
- Plug-in hybrid
- Hybrid electric
- Natural gas
- Liquefied petroleum gas (LPG)
- Diesel

#### 5 fuels

- Gasoline
- Diesel
- LPG
- Natural gas
- Electricity

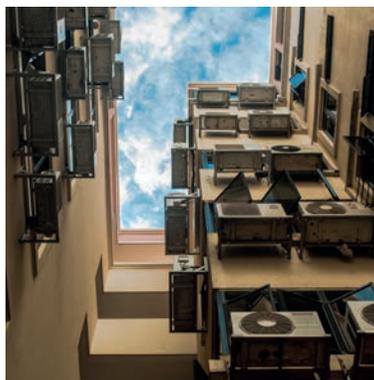
#### Annual projections

- For 146 countries
- 2016-2050

## Key insights



**1** Global primary energy demand plateaus after 2035 despite strong population expansion and economic growth



**2** Electricity consumption doubles until 2050, while renewables are projected to make up over 50% of generation by 2035



**3** Gas continues to grow its share of global energy demand—the only fossil fuel to do so—and then plateaus after 2035



**4** Oil demand growth slows down substantially, with a projected peak in the early 2030s



**5** Carbon emissions are projected to decline due to decreasing coal demand, yet a 2-degree pathway remains far away

## Executive summary

**1** Global primary energy demand plateaus after 2035 despite strong population expansion and economic growth

- After more than a century of rapid growth, global energy demand shows growth slowing and plateauing around 2030, primarily driven by the penetration of renewable energy sources into the energy mix
- In addition, a decline in the energy intensity of economies across geographies offsets the increase in energy demand needed to support a growing population with increasing income levels, especially in emerging markets
- Compared to other long-term energy outlooks, our Global Energy Perspective Reference Case projects slower energy demand growth, particularly because we anticipate a larger role for renewable resources in the energy system by mid-century

**2** Electricity consumption doubles until 2050, while renewables are projected to make up over 50% of generation by 2035

- Electrification across key end uses leads to a doubling of electricity demand by 2050. This is particularly driven by increased demand in buildings and a shift toward electricity as an energy source in road transport
- Wind and solar are rapidly gaining share in the capacity mix and already accounted for more than half of net capacity additions in the past few years
- Renewable generation is projected to account for more than 50% of total power generation post-2035. This marks a clear trend break from historical fossil fuel-based generation
- As the role of intermittent resources in total generation increases, power systems will see strong growth in balancing needs, particularly when solar and wind generation combined reach a share beyond 30%

**3** Gas continues to grow its share of global energy demand—the only fossil fuel to do so—and then plateaus after 2035

- Gas is the only fossil fuel which grows its share of total energy demand until 2035, albeit at declining growth rates, and then plateaus; even when considering significant sensitivities, gas demand remains robust within a +/-3% range
- In the long term (post-2035), gas demand declines overall. It is particularly under pressure in the power sector, where the share of total demand drops to 33% from 41% between 2015-50
- This long-term effect is robust under various gas price scenarios; given the increasing competitiveness of renewables vs. gas, even halving gas prices will only enable marginal incremental demand

## 4 Oil demand growth slows down substantially, with a projected peak in the early 2030s

- Despite stable historical growth of more than 1% per annum, oil demand growth is projected to slow down in the coming decade. This leads to an expected peak in demand in the early 2030s at a volume of 108 million barrels per day
- In an accelerated transition scenario, with increased electrification of transport and plastics recycling, this peak is pulled forward further to before 2025. In this scenario, demand is half of today's levels by 2050
- Even in an accelerated transition scenario, there is a need for new oil barrels. Nevertheless, some regions would no longer be as profitable compared to the Reference Case

## 5 Carbon emissions are projected to decline due to decreasing coal demand, yet a 2-degree pathway will stay far away

- Global energy-related emissions peak in 2024 and fall by ~20% from 2016 to 2050. This pattern is primarily driven by a reduction in coal use, especially in China and the power sector
- A 1.5-degree or even 2-degree scenario remains far away. To get to a 1.5-degree scenario, far-reaching decarbonization or demand reduction is needed across all sectors
- Hydrogen can play a role in such a world if retail prices drop to USD3.5/kg or below. It can play an important role in decarbonizing some of the hardest-to-abate sectors

# Global primary energy demand plateaus after 2035 despite strong population expansion and economic growth



## Summary

### Global total primary energy demand plateaus after 2035 despite strong population expansion and economic growth

- After more than a century of rapid growth, global energy demand plateaus at around 2030, primarily driven by the penetration of renewable energy sources into the energy mix
- Also, falling energy intensity offsets the effects of a growing population with increasing income levels, leading to a slow-down in energy demand growth
  - Energy intensity falls as service industries take up a larger share of the global economy, and end use segments continue to become more efficient
  - More efficient technologies become available across sectors, driving down energy consumption even in large industrial countries like China
- Energy demand development reflects local dynamics; while most Organisation for Economic Co-operation and Development (OECD) countries see a decline, demand in Africa and India roughly doubles until 2050
- Our Global Energy Perspective Reference Case projects slower energy demand growth than comparable long-term energy outlooks

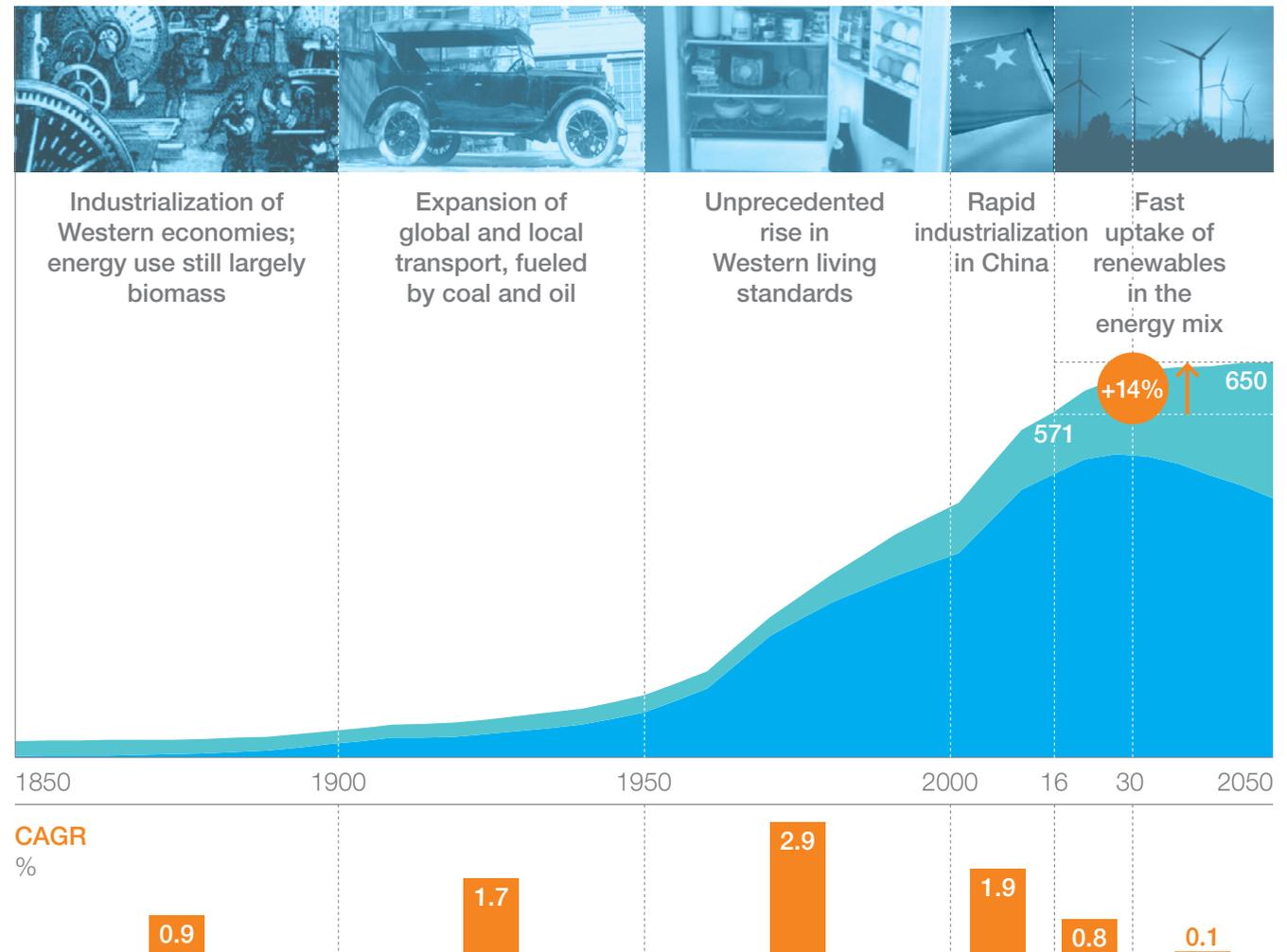
## After more than a century of rapid growth, global primary energy demand plateaus around 2030, primarily driven by the penetration of renewable energy sources into the energy mix

- Despite a doubling of global GDP (in real terms) between 2016 and 2050, global primary energy demand only grows 14%
- It is the first time in history that growth in energy demand and economic growth are “decoupled”
- The fast uptake of renewables is a key driver, as they often substitute fossil fuel-based generation technologies with low efficiency
- Renewables, complemented by nuclear, will almost double their share in the overall energy mix from now until 2050 (from 19% to 34%) and will provide more than half the electricity by 2035

### Global primary energy demand

Million terajoules (TJ)

■ Renewables ■ Fossil fuels



Source: McKinsey Energy Insights' Global Energy Perspective, January 2019; IEA Energy Balances (Historical); Smil, V. (Historical)

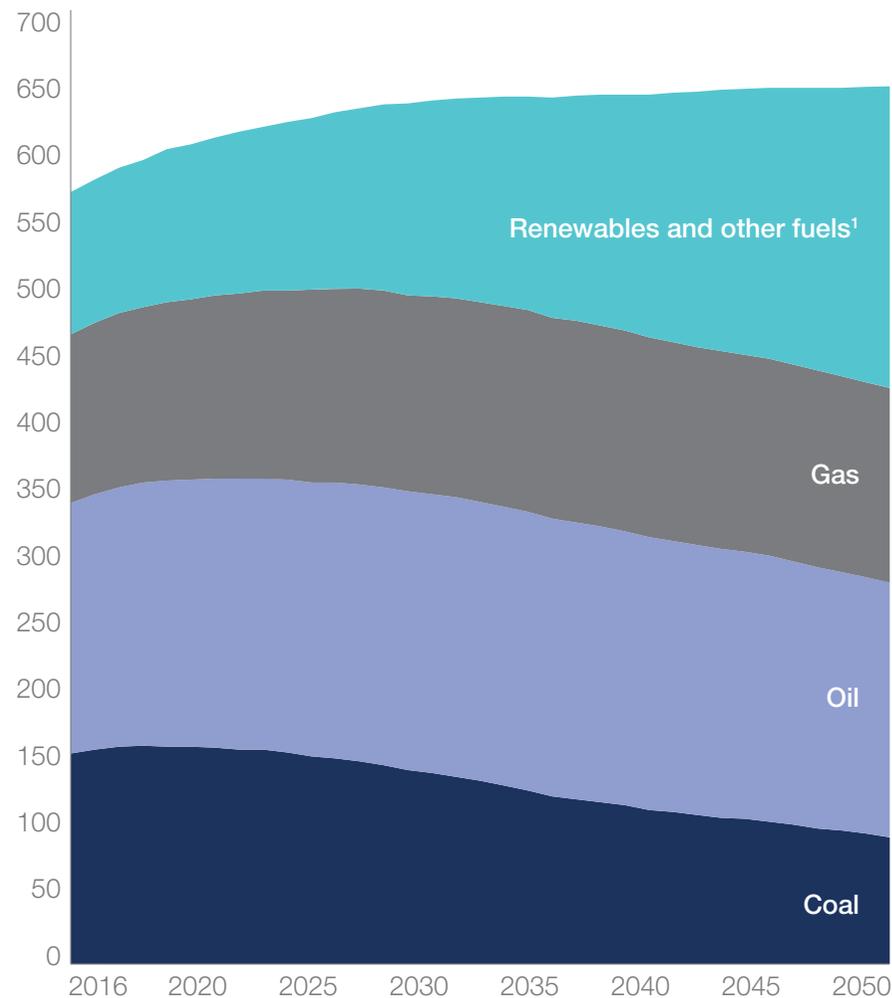
## In the following chapters, we discuss main developments for each of the fuels

Insights in the following chapters:

- 2 **Electricity** consumption doubles until 2050, while renewables make up over 50% of generation by 2035
- 3 **Gas** continues to grow its share of global energy demand—the only fossil fuel to do so—and then plateaus after 2035
- 4 **Oil** demand growth slows down substantially, with a projected peak in the early 2030s
- 5 **Carbon emissions** are projected to decline due to decreasing **coal** demand, yet a 2-degree pathway by 2050 remains far away

### Primary energy demand per fuel

Million TJ



<sup>1</sup> Includes biomass, hydro, and nuclear

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## 2 Electricity consumption doubles until 2050, while renewables are projected to make up over 50% of generation by 2035



## Summary

### Electricity consumption doubles until 2050, while renewables are projected to make up over 50% of generation by 2035

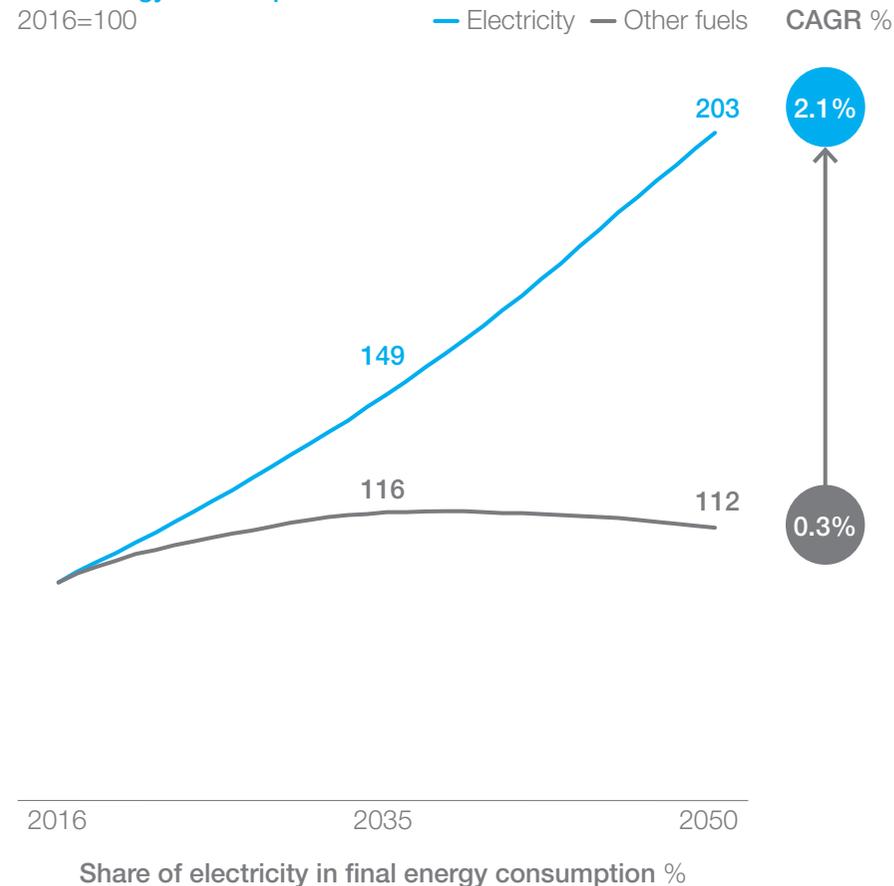
- Electrification across key end uses, particularly in buildings and road transport, drives a doubling of electricity demand by 2050
  - In transport, electrification is driven by rapid improvements in economics of electric vehicles (EVs), reaching cost parity with conventional fuel vehicles in the early 2020s
  - For buildings, higher living standards in non-OECD countries (mainly China and India) support fast-rising demand for space cooling and appliances
  - In industry, at-scale electrification of industry requires electricity prices well below USD50 per megawatt hour (MWh)
- Wind and solar are rapidly gaining share in the capacity mix and accounted for more than half of net capacity additions from 2015 to 2017
  - Renewables will become cheaper than existing coal and gas in most regions by 2030
  - As a consequence, by 2035 nearly half of global total capacity will be in solar and wind, with China and India as the main contributors
- Renewable generation accounts for more than 50% of the power supply post-2035, a clear break from historical fossil fuel-based generation
  - As a result, global coal demand will halve between ~2040 and 2050, depending on the level of technology improvement and market structure
  - As solar and wind generation combine to reach a 30-50% share of total generation, power systems will see strong growth in balancing needs
    - In particular, new flexibility options will play a larger role post-2030, when their capacity additions will reach ~80% of the flexible installations

# Electrification across key end uses, particularly in buildings and road transport, drives a doubling of electricity demand by 2050

- Electricity demand doubles until 2050 and grows its share in total final energy consumption from 19% today to 29% by 2050, as demand for other fuels combined flattens
- Uptake of EVs accelerates in all road segments as cost parity of EVs is reached by the early to mid-2020s
- Higher living standards in non-OECD countries—mainly China and India—support fast-rising demand for space cooling and appliances
- Further electrification in industry is limited as electrification of medium- and high-temperature heat requires low electricity prices. Electrification of low-temperature heat in industry is partially economical today

## Final energy consumption

2016=100



19%

23%

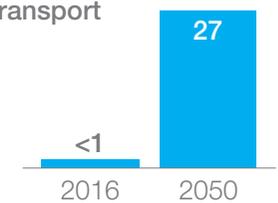
29%

Share of electricity in final energy consumption %

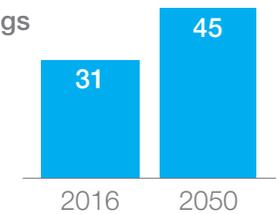
## Electrification<sup>1</sup>

% of final energy consumption

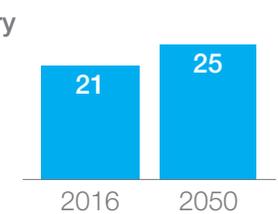
### Road transport



### Buildings



### Industry



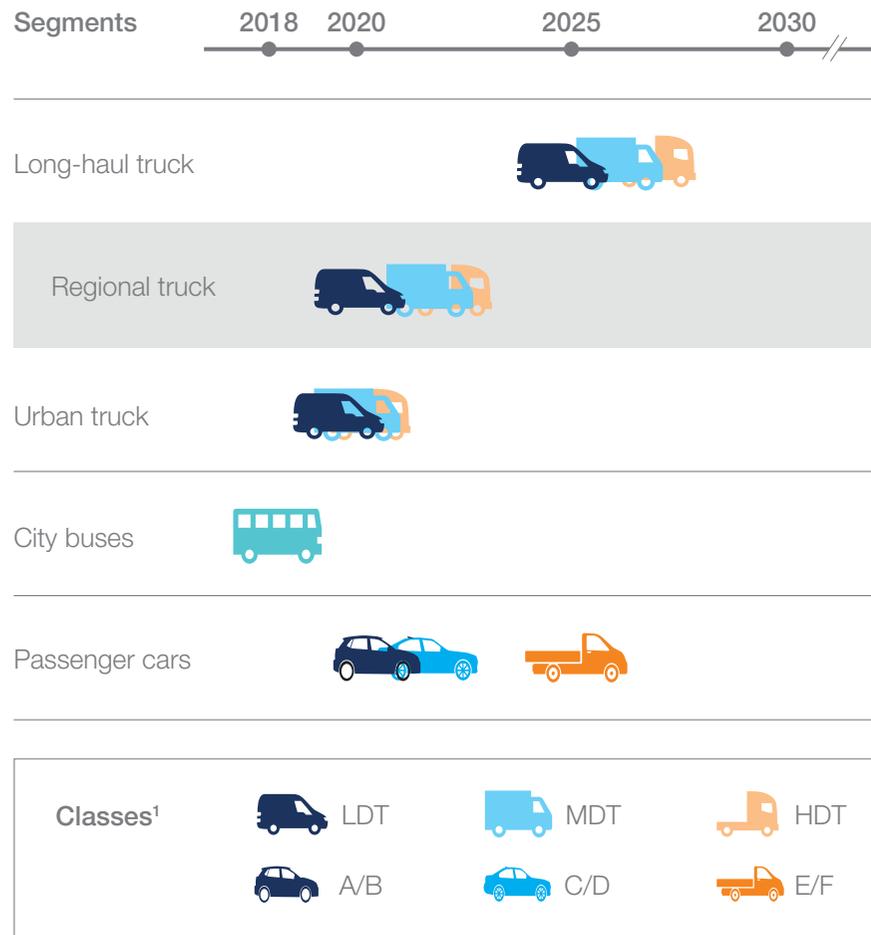
<sup>1</sup> Buildings includes residential buildings in OECD Europe and OECD Americas; transport includes passenger cars, trucks, vans, buses, and 2- and 3-wheelers

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## In transport, electrification is driven by strong improvements in economics of EVs, reaching cost parity with conventional fuel vehicles in the early 2020s

- Across segments, EVs will become the lower cost option in the coming 5-10 years
- EV costs will go down rapidly, mainly driven by a decrease in costs for battery packs (from USD220 to USD73 per kilowatt hour (kWh) between 2017-30)
- The timing of total cost of ownership (TCO) parity in the US and China is comparable to Europe, with China slightly earlier and the US slightly later, reflecting differences in fuel taxation and subsidies for electric vehicles
- Future improvements in battery technology (e.g., density) will enable the electrification of the heavy duty segments, which are currently the hardest to electrify

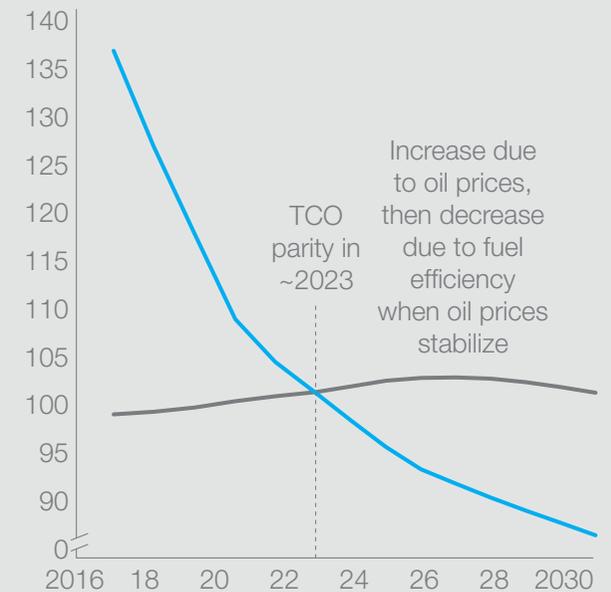
### Timing of cost-parity of electric vehicles with fuel vehicles, based on TCO in the EU



### EU TCO for medium-duty truck, regional application

Cost per kilometer normalized to 2016 ICE, %

— ICE  
— BEV

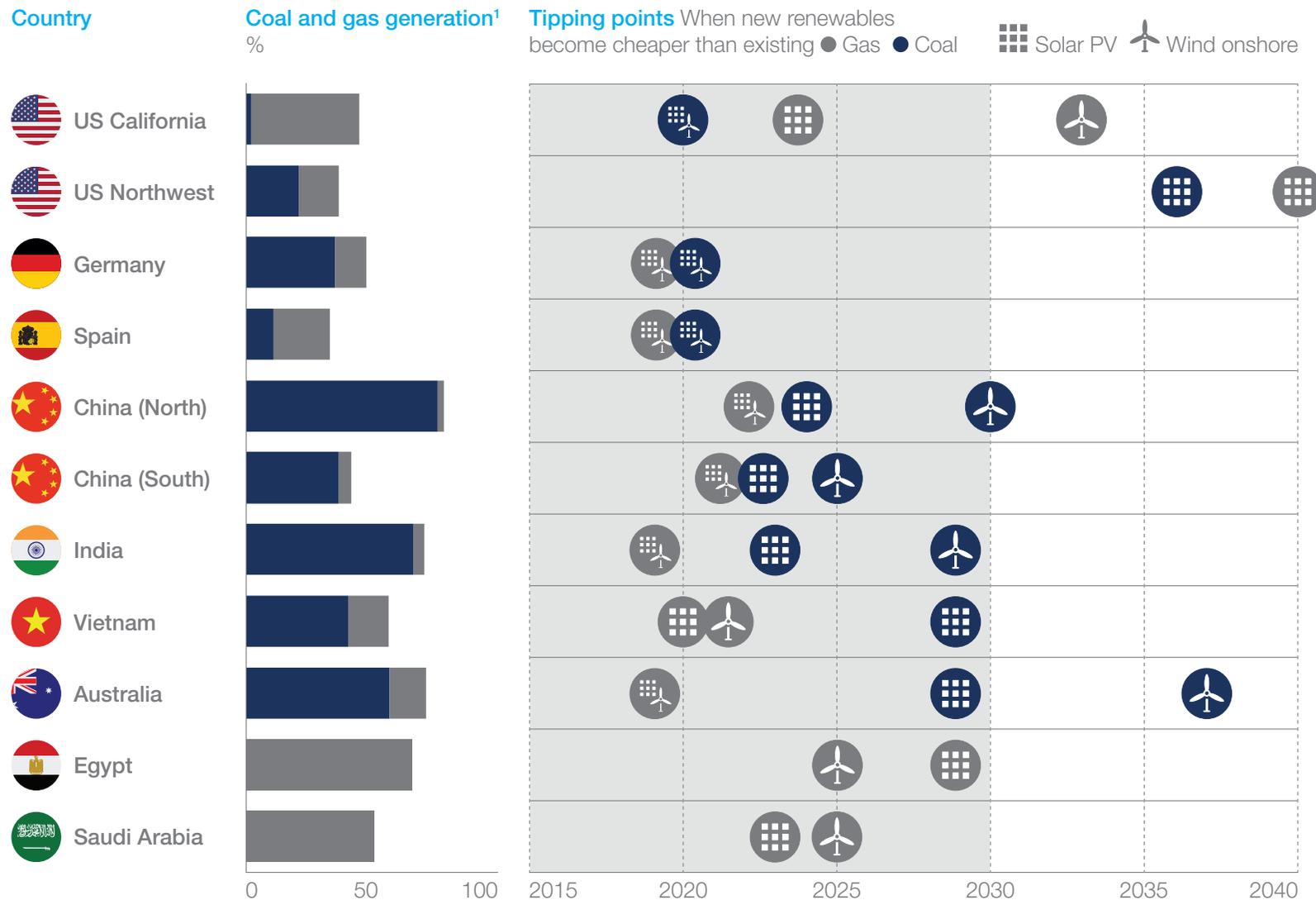


<sup>1</sup> Class definitions in EU are defined in weight for trucks (Heavy duty transport (HDT) >16t, Medium duty transport (MDT): 7.5-16t, Light duty transport (LDT): 3.5-7.5t) and in size/ICE price for passenger cars: (A/B < 4 m and below 20k CHF, C/D: 4-5 m, 28-55k CHF, E/F > 4.5 m, >50k CHF)

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

# Renewables will become cheaper than existing coal and gas in most regions before 2030

- By 2030, new-build renewables will outcompete existing fossil fuel generation on energy cost in most countries—one of the key tipping points in the energy transition
- The majority of countries will reach this tipping point in the next ~5 years
- US Northwest is the exception to this with tipping points post-2035, driven by relatively low fossil fuel prices as well as low solar potential



● A tipping point represents a year when new renewables (solar PV, onshore wind, or both) become cheaper than existing fossil fuel plants

<sup>1</sup> Power generation from existing coal and gas power plants in 2018, as share of total  
Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

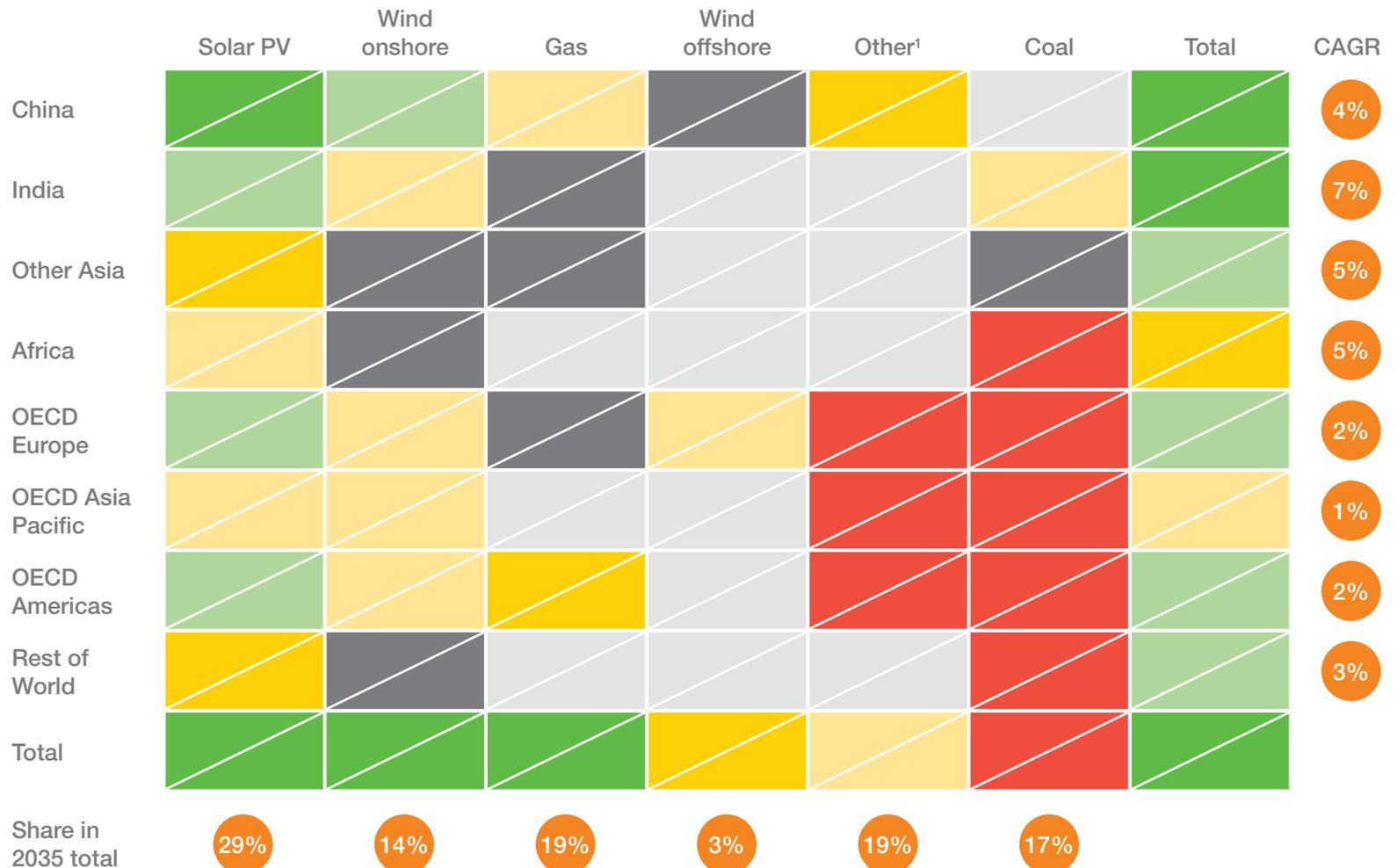
## As a consequence, by 2035, nearly half of global total capacity will be in solar and wind, with China and India the main contributors

- Solar and wind account for close to half of global capacity by 2035. China, India, and OECD countries are the major contributors to the build-out of renewables
- Gas sees further capacity additions, particularly in North America and China. Global net additions of ~675 GW until 2035 are equal to 3x the current installed gas capacity in OECD Europe
- Global coal capacity declines in most regions reflecting unfavorable economics and increasing regulation
  - China sees continued expansion compared to 2016, but the rate of growth is much lower than in the recent past
- In India, the role of coal to supply and the rapid uptake in demand is much smaller than in earlier projections, as solar, in particular, becomes a more attractive alternative

Global power capacity in 2016 and 2035

GW

■ >600 
 ■ 300-600 
 ■ 150-300 
 ■ 100-150 
 ■ 50-100 
 ■ 0-50 
 ■ <0 
 2016-35 delta, GW



<sup>1</sup> Other here includes biomass and oil

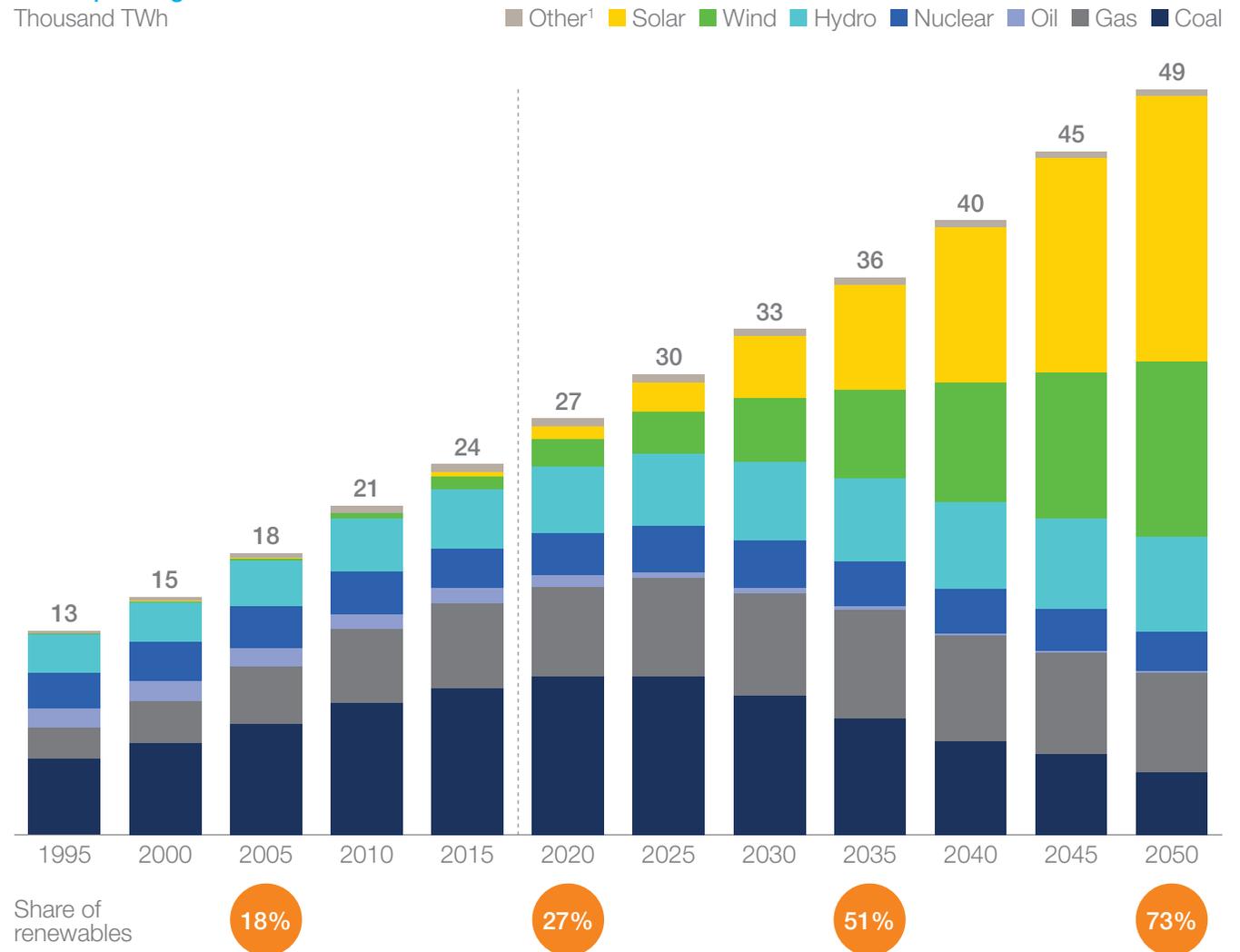
Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## Renewable generation accounts for more than 50% of power supply post-2035, a clear trend break from historical fossil fuel-based generation

- The role of renewable resources in power generation grows at an accelerated pace. From around 25% today, renewables will grow their share of global generation to around 50% by 2035 and to close to 75% by mid-century
- Coal and oil generation decrease rapidly, partially substituted by renewables, partially by gas-based alternatives with lower cost or lower carbon emissions
- Gas generation often remains to act as a stable baseload and dispatchable capacity provider in a renewable-heavy system but does see a peak around 2035

### Global power generation

Thousand TWh



<sup>1</sup> Other includes biomass, geothermal, and marine

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

# 3 Gas continues to grow its share of global energy demand—the only fossil fuel to do so—and then plateaus after 2035



## Summary

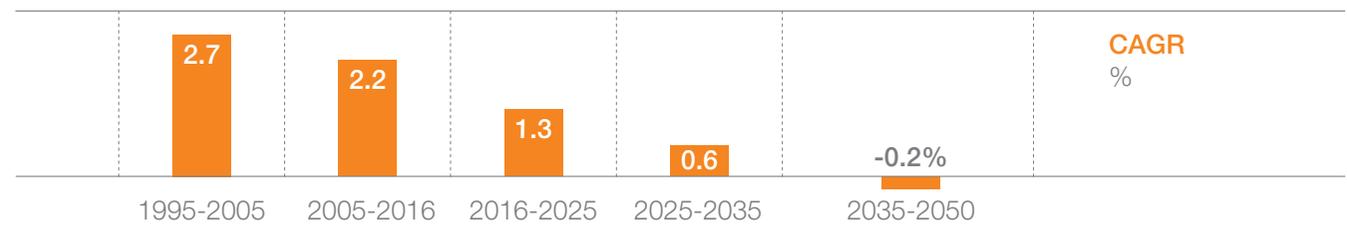
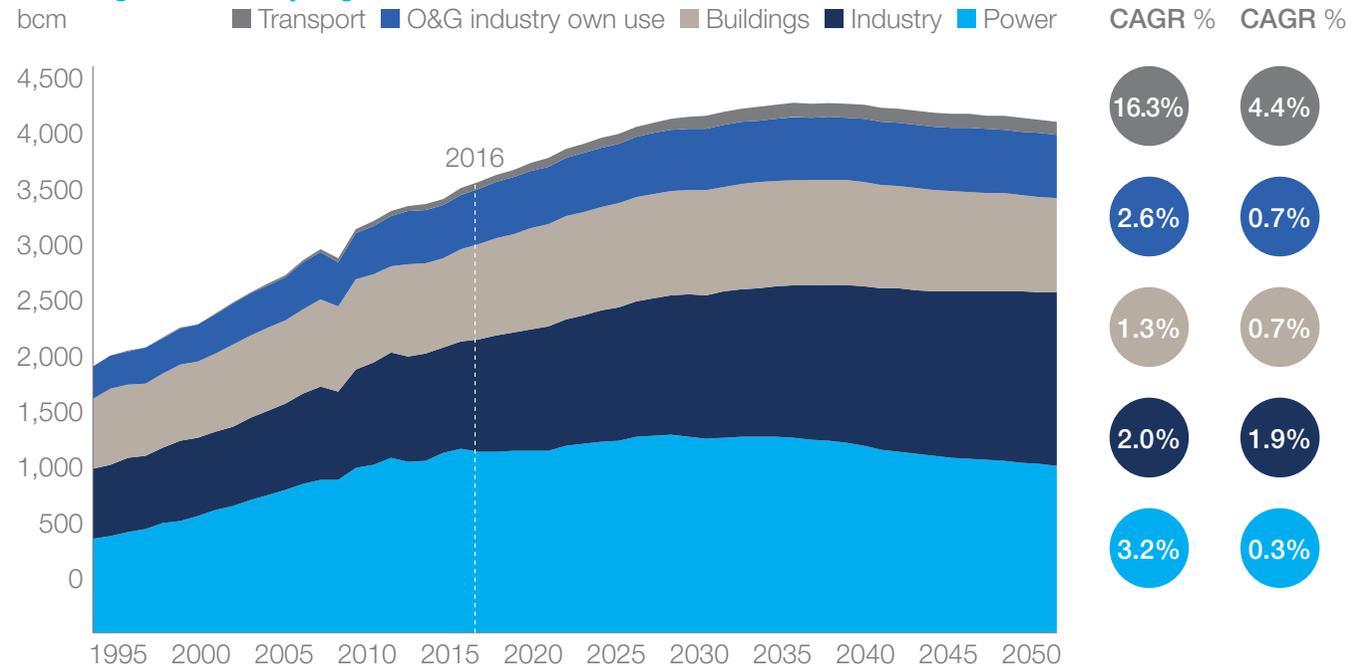
### Gas is the only fossil fuel which grows its share of total energy demand until 2035—albeit at declining growth rates—and then plateaus

- Four major shifts and one continuity are shaping gas demand until 2035
  - **Renewables in power:** Further gas capacity additions in power will be limited due to the increasing competitiveness of renewables
  - **China:** China's gas demand growth is greater than that of the next 10 largest growth countries, including the US, and represents nearly half of demand growth through 2035
  - **Middle East:** Gas demand in the Middle East peaks before 2030 despite industry growth, primarily driven by improving economics of renewables in power and opportunity cost of exporting gas
  - **Chemicals:** The fundamental growth of chemicals demand, in combination with feedstock prices in key markets like the US, Russia, and Iran, enable accelerated growth that adds ~200 bcm to demand
  - **Transport:** We continue to see very high growth rates in transport, however the small base means transport cannot offset the trends in all other sectors
- Even considering significant sensitivities, gas demand remains robust within a +/-3% range
- In the long term (post-2035), gas demand declines overall, driven by a steeper reduction in power which drops by 228 bcm from 2035-50
- Given the increasing competitiveness of renewables vs. gas, even halving gas prices will only enable marginal incremental demand

## Gas is the only fossil fuel which grows its share of total energy demand until 2035—albeit at declining growth rates—and then plateaus

- Fueled by the power sector, gas demand growth has been well above 2% per annum (p.a.) over the past two decades, adding more than half to its 1995 level
- Particularly in the short term (until 2025) and then mid term (until 2035), gas demand continues to grow across all sectors, led by industrial demand. Overall, this leads to a 2035 gas demand ~20% higher than today
- The plateauing of demand after 2035 is driven largely by increasing competition from renewables
- Transport maintains high growth rates due to adoption in the marine segment. Yet the small base limits the impact on the overall trend
- Additional growth is limited by slow uptake of liquefied natural gas (LNG) for bunkering and economics vs. EVs in road transport
- The oil and gas (O&G) industry's own use of gas is expected to remain in-line with total gas demand

Natural gas demand by segment<sup>1</sup>



<sup>1</sup> Transport segment in many other reports also includes gas use for pipeline transport. This is included in oil and gas industry's own use above (73 bcm in 2016) Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## Four major shifts and one continuity are shaping gas demand until 2035

- Power:** Further gas demand growth in power will be limited to less than 100 bcm due to increasing competitiveness of renewables. Investments in new renewable generation capacity outpaces gas by roughly a factor of 4
- China:** China's gas demand growth is greater than that of the next 10 largest growth countries combined, including the US, and represents nearly half of global demand growth through 2035. This growth is driven by an ambitious 5-year plan of the Chinese government that is focused on pushing gas across sectors to replace coal (e.g., boiler switches in buildings)
- Middle East:** Previously the growth region, gas demand in the Middle East peaks before 2030 despite continued industry growth, primarily driven by the improving economics of renewables in power and the opportunity cost of exporting gas rather than using it for domestic power generation
  - The current growth of gas demand as it replaces oil in power is thus short-term in the 2020s
- Chemicals:** The fundamental growth of chemicals demand, in combination with low gas prices in key markets like the US, Russia, and Iran, enable accelerated growth that adds ~200 bcm—significant growth from gas as feedstock for ammonia and methanol
- Transport:** We continue to see very high growth rates in transport demand enabled by emissions regulation for marine fuels. However, the small base means transport cannot offset the trends in all other sectors

Global gas demand change between 1997-2016 and 2016-35

bcm

■ >120 ■ 50-120 ■ 15-50 ■ -15-15 ■ <-15

▽ 1997-2016

▾ 2016-2035

	China	India	Other non-OECD Asia	Middle East	Other non-OECD	OECD Americas	OECD Europe	OECD Asia Pacific	Total
Power	1 2			3					677 89
Buildings									149 110
Industry									136 167
Chemicals	4								134 199
Transport	5								48 63
O&G own use <sup>1</sup>									170 63
<b>Total</b>	<b>179</b>	<b>31</b>	<b>143</b>	<b>340</b>	<b>210</b>	<b>214</b>	<b>91</b>	<b>106</b>	<b>1,313</b> <b>691</b>
	<b>322</b>	<b>48</b>	<b>101</b>	<b>26</b>	<b>152</b>	<b>121</b>	<b>-48</b>	<b>-31</b>	

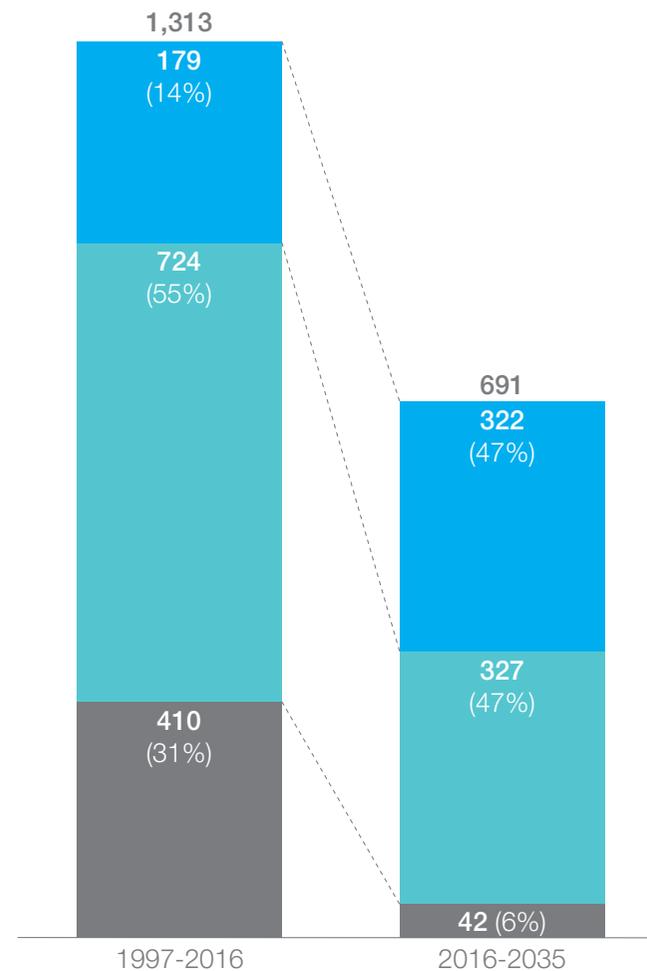
<sup>1</sup> The decline in growth of O&G own use is following largely the development of production levels in the respective countries

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

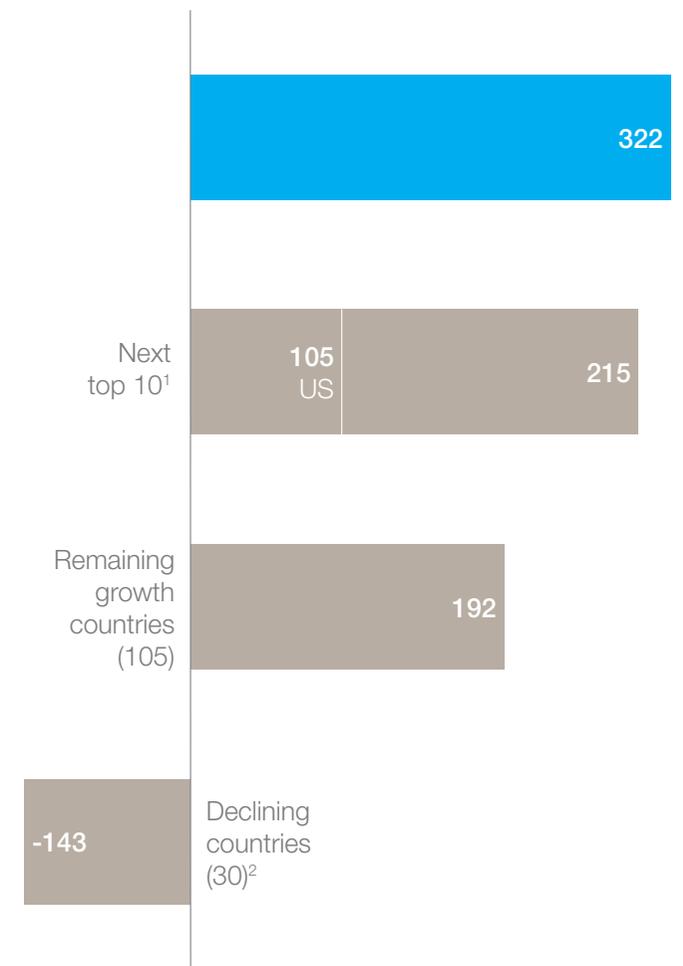
## China's gas demand growth is greater than that of the next 10 largest growth countries, including the US, and represents nearly half of demand growth through 2035

- The pace of global growth is significantly changing; while the last two decades added more than 1,300 bcm, growth over the next two decades will be only half as much
- The growth in OECD gas demand practically disappears, despite a continued growth of more than 100 bcm in US demand
  - China counters the trend of declining growth; it is doubling the speed of its growth and adding more than 300 bcm of demand in the next 20 years. This means China's demand growth is greater than that of the next 10 largest countries combined, including the US. As a consequence, almost half of the total growth through 2035 comes from China
  - Chinese demand developments will increasingly dominate the signaling for traded gas markets globally, especially given that most of the other big growth markets are not importers
- More than 70% of gas demand decline stems from only four countries: Japan, Italy, the UAE, and the UK

Natural gas demand growth past vs. future by region  
bcm



Top growth regions for natural gas demand 2016-35  
bcm



<sup>1</sup> Besides the US, top 10 include Egypt, India, Indonesia, Iran, Nigeria, Pakistan, Qatar, Russia, and Ukraine

<sup>2</sup> Main demand declines in France, Italy, Japan, United Kingdom, and United Arab Emirates

Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## 4 Oil demand growth slows down substantially, resulting in a peak in the early 2030s



## Summary

### Oil demand growth slows down substantially, with a projected peak in the early 2030s

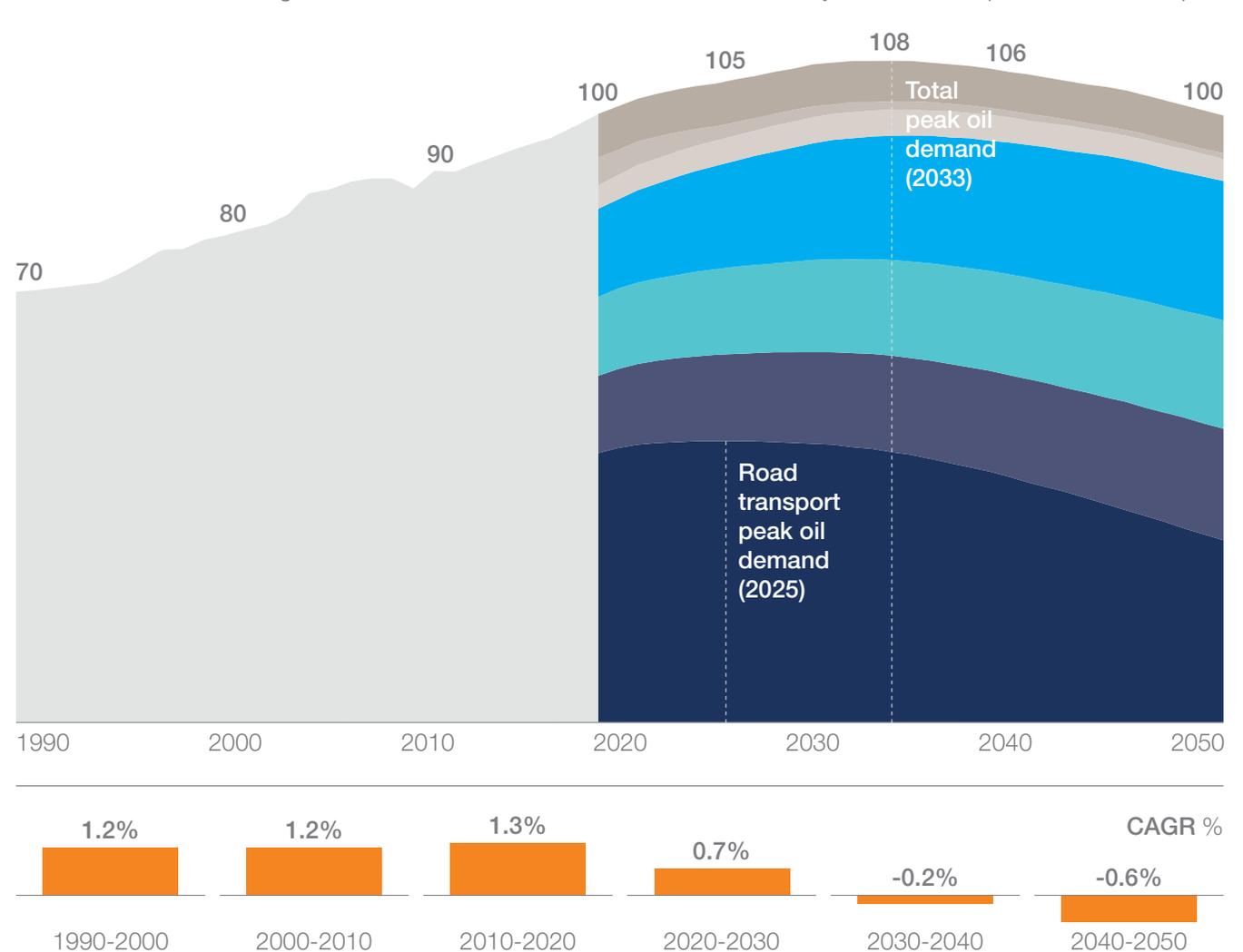
- Despite stable historical growth of more than 1% p.a., oil demand growth is projected to slow, followed by a peak in the early 2030s at 108 MMb/d
- The chemicals sector accounts for more than half of the growth in the next 15 years, while the strongest declines in demand happen in power and road transport
  - The chemicals sector is the main driver of oil demand growth, but is expected to slow down after 2030 driven by slower plastics demand growth and increased plastic recycling
- Global annual EV sales are expected to exceed 100 million by 2035, triggering a decline in oil demand for road transport
- In the case of an accelerated transition, oil demand could peak before 2025 and reach roughly half of today's level by 2050
- Even in an accelerated transition scenario, there is a need for new investment in oil production
- Lower oil prices caused by lower demand would delay cost parity for electric vehicles by a few years, but are not expected to reverse the trend

## Despite stable historical growth of more than 1% p.a., oil demand growth is projected to slow, followed by a peak in the early 2030s at 108 MMb/d

- Oil demand has grown at more than 1% p.a. over the last three decades, but this growth is expected to slow down significantly from 2020 onward
- In our Reference Case, we project a peak in global oil demand in 2033, which is four years earlier than in last year's edition of our outlook
- Oil demand for road transport is a key driver. Triggered by an increasing adoption of EVs, oil demand for road transport peaks in 2025 and declines afterwards. By 2050, demand is projected at ~30 million barrels per day (MMb/d), which is one third below today's demand levels
- The chemicals sector, an important engine of growth for oil demand, shows a slow down in demand especially post-2030, as a result of increased recycling rates of plastics

Global oil demand by sector

MMb/d



Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## The chemicals sector accounts for more than half of the oil demand growth in the next 15 years, while the strongest declines in demand happen in power and road transport

- Until 2035, chemicals is the biggest demand growth sector, driven by increased demand for plastics, particularly in emerging economies
- Oil use in power is the largest declining sector in the coming years. As oil is the least efficient fuel for power generation, it will be pushed out by increasingly competitive renewables. Particularly in the Middle East, countries are rapidly replacing oil with gas or renewables
- The decline in oil demand for road transport is modest, as the EV transition in OECD countries and China is partially offset by continued use of ICE vehicles in the rest of the world
- Aviation growth is most prominent in non-OECD Asia and hub countries such as Dubai

Oil demand 2018-2035 increase by sector

MMb/d



Source: McKinsey Energy Insights' Global Energy Perspective, January 2019

## 5 Carbon emissions are projected to decline due to decreasing coal demand, yet a 2-degree pathway remains far away



## Summary

Carbon emissions are projected to decline due to decreasing coal demand, yet a 2-degree pathway remains far away

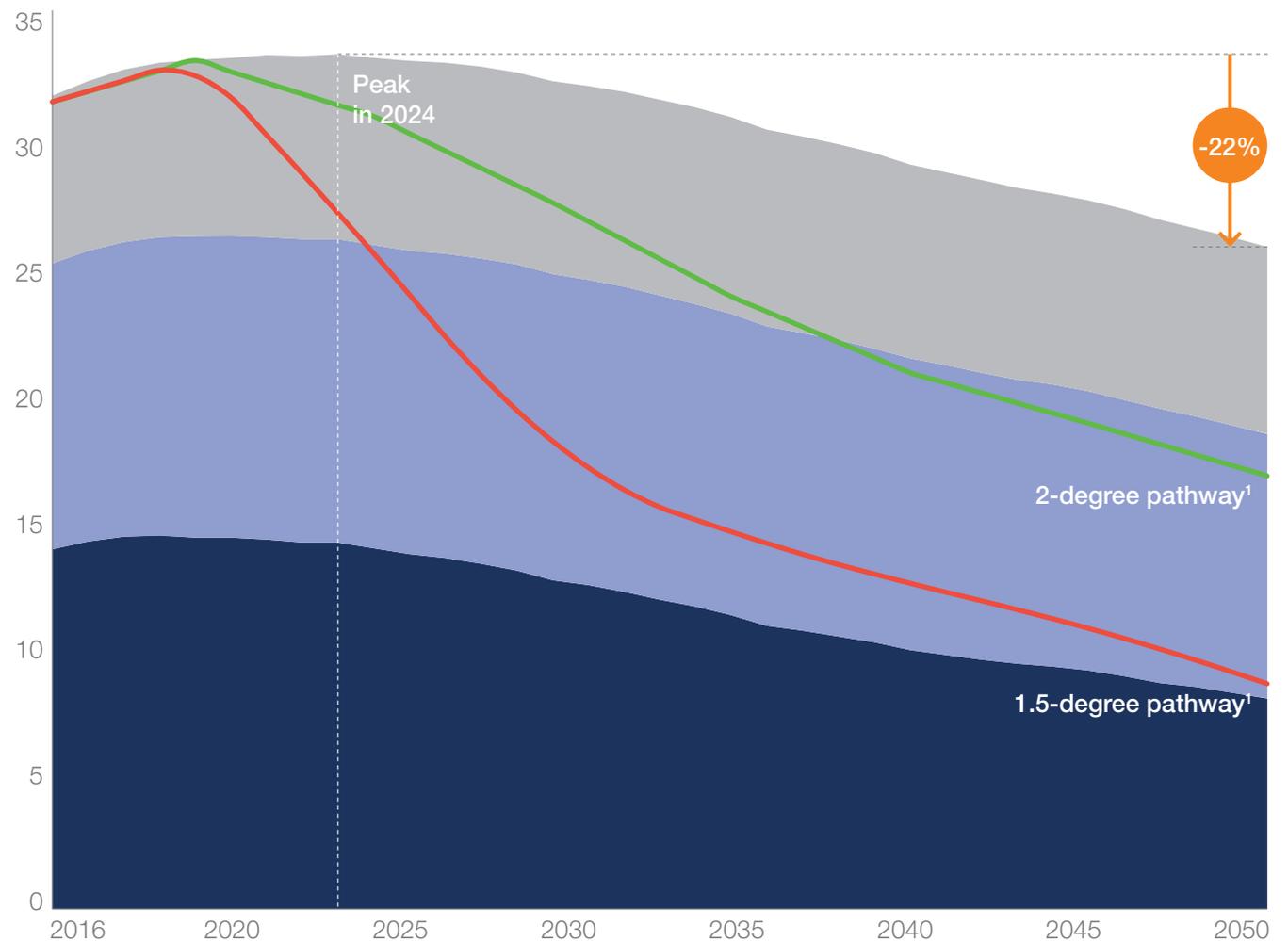
- Global carbon emissions peak in 2024 and fall by ~20% by 2050, primarily driven by a reduction in emissions from coal
- Coal demand is set to fall by 40% by 2050, primarily driven by a reduction of demand in the Chinese power sector
- Far-reaching decarbonization initiatives are needed across all sectors to get to a 1.5-degree scenario
- To reach a 1.5 degree scenario, hydrogen might be needed to decarbonize otherwise hard-to-abate sectors
- However, hydrogen production by electrolysis and SMR+CCS (steam methane reforming + carbon capture and storage) needs strong cost reductions to become competitive
- In a progressive scenario, grid-powered electrolysis for hydrogen production could become competitive with SMR+CCS before 2030

## Global carbon emissions peak in 2024 and fall by ~20% by 2050, primarily driven by a reduction in emissions from coal

- Energy-related carbon emissions (around 60% of total global emissions) will increase until 2024 but afterward show a steady decline
- The decrease is driven by a relatively rapid phase-out of coal in the power sector, which will lead to a reduction of 6 gigatons (Gt) of CO<sub>2</sub> (roughly 20%), equivalent to today's total emissions of the US and Japan combined
- This outlook nonetheless remains far from a 2-degree pathway, as defined by the median of all scenarios included in IPCC<sup>1</sup>

Global energy-related CO<sub>2</sub> emissions per fuel

GtCO<sub>2</sub> p.a.



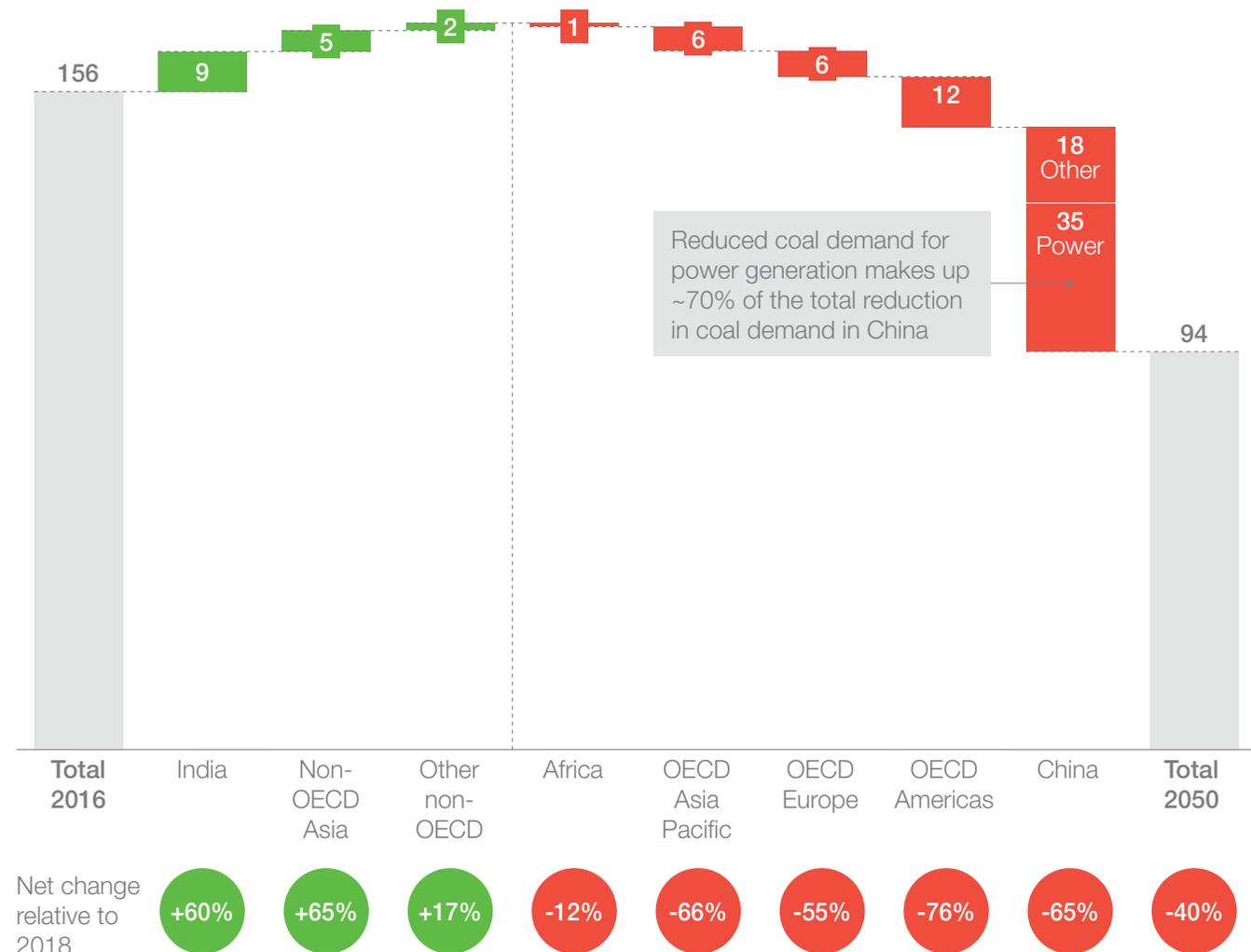
<sup>1</sup> Median of all Intergovernmental Panel on Climate Change (IPCC) scenarios that lead to 1.5 or 2 degree warming or less  
Source: McKinsey Energy Insights' Global Energy Perspective, January 2019; IEA; IPCC/IAMC 2-degree and 1.5 degree scenarios

## Coal demand is set to fall by 40% by 2050, primarily driven by a reduction of demand in the Chinese power sector

- The 40% decline in coal demand happens despite the substantial growth of coal use in India and non-OECD Asia (+60-65% until 2050)
- This is driven by China's decline in coal use; with a decline of 53 million TJ, this is equal to two thirds of today's total demand in China

### Coal demand by region

Million TJ



Source: McKinsey Energy Insights' Global Energy Perspective, January 2019



## Get in touch

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