McKinsey & Company

Global Energy Perspective 2021

January 2021

Editor's note

We publish this long-term energy outlook at the start of 2021, after a year that has brought extraordinary challenges. Economies worldwide have experienced profound effects of the global health crisis, triggered by widespread public-health responses aiming to control the virus.

Energy markets have reflected the uncertainty and shown exceptional movements. At the beginning of the crisis, plunging fuel demand in many key markets was reflected by prices: by the end of March 2020, the price of gas hit a 30-year low, whereas the price of oil, also affected by supply shocks, showed the largest single-day decline in the past 22 years. As economies have reopened, energy commodities have shown a partial rebound: for example, by the end of third quarter 2020, oil demand in China was back at pre-COVID-19 levels, and 50 percent of the decline was recovered in Europe and North America.

In this volatile environment, long-term scenarios are more important than ever. To address the various pathways for the energy transition, our Global Energy Perspective presents four energy scenarios, which are based on contributions from hundreds of McKinsey expert practitioners worldwide.

- The **Reference Case** is a forward-leaning "continuation of existing trends" outlook. This scenario reflects our expectations of how current technologies will evolve and incorporates current policies and an extrapolation of key policy trends.
- The **Accelerated Transition** case assesses ten conceivable shifts that could happen at an accelerated pace.
- The **McKinsey 1.5°C Pathway** offers a view on the shifts required to limit global warming to 1.5°C in hopes of stabilizing the climate.
- The **Delayed Transition** case mirrors the Accelerated Transition case and assumes that at a global scale, COVID-19 recovery measures fail to go hand in hand with green policies to stimulate the energy transition.

The introductory chapter describes these four energy scenarios in further detail. In addition, we detail two economic scenarios that reflect the uncertainty of economic recovery.

We use these scenario outlooks—and the underlying models—to support hundreds of clients around the world and across a broad range of sectors, helping leaders navigate the transitions in energy systems.

Reflecting on the work for our Global Energy Perspective and discussions with many experts, we identified some common themes that stand out in this year's edition:

(A) **As the world rapidly exhausts its carbon budget, there is growing momentum toward decarbonization of the global economy.** Policy makers, business leaders, investors, and consumers are showing increasing levels of ambition to reshape energy systems. Yet the CO_2 emissions projected in our Reference Case and even in our Accelerated Transition case remain far from the 1.5°C Pathway. This shows that to further reduce emissions, significant additional action is needed, and more ambitious initiatives and policy measures must be specified and implemented.

(B) **Fundamental trends shaping the energy transition in the coming decade remain in place and appear resilient to the COVID-19 crisis.** Renewable resources continue to decline in cost. When combined with battery technology, they become cost competitive with fossil-fuel-based power generation in many parts of the world. Similarly, electric vehicles (EVs) are likely to become the most economic choice in the next five years in many parts of the world. In the case of hydrogen, a further acceleration in ramp-up plans and commitments is likely.

(C) **Fossil fuels continue to play an important role in the energy system in our Reference Case.** Fossil fuels will remain relevant despite a peak in oil demand in the late 2020s and a peak in gas demand in the mid-2030s. Yet even if oil and gas demand returns to pre-COVID-19 levels in a few years, it will not return to its pre-COVID-19 growth path.

(D) **This year's report includes several new elements and deep dives.** Specifically, we have dedicated full chapters to hydrogen, the demand outlook for coal and its role in the power sector, a perspective on the 1.5°C Pathway, and an outlook for energy investments and value pools.

This report is structured into five parts: Part one provides a perspective on the development of fundamental drivers for the global energy system. Part two provides an outlook for power systems, addressing the development of power demand as well as the evolution of power supply. Part three presents outlooks per energy type and carrier, including natural gas, oil, coal, and hydrogen. Part four discusses carbon emissions and offers a detailed perspective on the McKinsey 1.5°C Pathway. And the final part reflects on implications for business leaders and policy makers, including a view on value pools and an energy-investment outlook.

We hope this report is an interesting read that helps shape your thinking on the energy transition.

Key insights from the Global Energy Perspective Reference Case

1

Long-term demand impact of COVID-19 is modest

Energy demand rebounds quickly post-COVID-19, and the impacts of behavioral changes due to the crisis are small compared with fundamental shifts such as electrification

Stimulus packages shape energy systems in the decades to come

2

Power wins and hydrogen changes the landscape

Electricity demand grows significantly through direct electrification and the uptake of green hydrogen

Renewables quickly ramp up and account for half of power generation by 2035

3

Peaks in fossil-fuel demand continue to occur earlier

Peaks in demand for hydrocarbons occur earlier than projected (oil peaks in 2029 and gas in 2037)

Yet fossil fuels continue to play a major role in the energy system by 2050, driven by growth in areas such as chemicals and aviation

4

Change is too slow to reach the 1.5°C Pathway

Despite rapid shifts in the Reference Case, global greenhouse gas (GHG) emissions decline by only around 25 percent by 2050, implying a 3.5°C pathway

Moving to the 1.5°C Pathway requires stronger ambitions and accelerated implementation at a global scale

5

Investment flows remain stable over the next 15 years

Renewables in the energy-investment mix grow at the expense of conventional power generation, but fossil fuels maintain a large share

Several tipping points lie ahead in the energy transition; tracking signposts will help business leaders assess the direction and pace of change in the years to come

Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

Executive summary

1

Long-term demand impact of COVID-19 is modest

After a decade of rapid technological and policy shifts in energy sectors, 2020 has brought unprecedented disruption across the energy landscape. In our Reference Case, a rebound to pre-COVID-19 demand levels takes one to four years for power and oil and gas, whereas coal demand does not return to 2019 levels.

As a result of COVID-19, government policies are more important in the energy transition. Given the unparalleled size of many economic-recovery packages, the focus of the stimulus measures plays a key role in shaping energy systems in the decades to come.

In the longer term, fundamental shifts in the energy system continue, and the coming decades will see a rapidly changing landscape. In our Reference Case, demand for fossil fuels peaks in 2027, as electrification increases and the role of renewables in power systems grows rapidly.

These shifts accelerate in the coming years, as decarbonization and climate change are increasingly important on the agendas of global policy makers and business leaders, and as the consequences of climate change play out and prompt greater action. As the speed and magnitude of these shifts remain uncertain, this report covers four long-term scenarios for the decades to come: the Reference Case, the Accelerated and Delayed Transition cases, and the McKinsey 1.5°C Pathway.

2

Power wins and hydrogen changes the landscape

Power consumption doubles as energy demand electrifies, increasing its share of final energy consumption from 19 to 30 percent in 2050. COVID-19 has limited impact on long-term power-demand growth.

At the same time, low-cost renewables dominate power markets, outcompeting existing fossil assets in most regions before 2030. By 2036, half of the global power supply comes from intermittent renewable sources.

As green hydrogen becomes cost competitive in the 2030s, “indirect” power demand for electrolysis accounts for approximately 40 percent of electricity demand growth from 2035 to 2050, primarily in industry and transport.

To enable this shift to intermittent resources, both traditional capacity and new, flexible capacity are needed to ensure system security. Batteries play an important role, but gas peakers also remain relevant to cover longer spells of low output for renewables.

3

Peaks in fossil-fuel demand continue to occur earlier

Oil-demand growth slows in the current decade and peaks in the late 2020s, driven by the decline in road transport and the impact of COVID-19. Demand in major markets, such as the United States and the European Union, has already peaked and shown gradual decline for more than a decade. Continued demand growth is driven by chemicals and aviation, as well as by emerging economies. Despite significant decline, new oil supply is still needed in the foreseeable future.

Gas demand continues to grow until the late 2030s. Sectors with the largest growth include chemicals, other industry, and buildings in non-OECD Asia and the Americas. Following the peak, declining demand for gas is driven by the power sector, as gas shifts its role from baseload provider to flexibility provider.

Coal continues its decline. In the power sector, gas and, increasingly, renewables are more economical alternatives. Until 2035, heavy industry, particularly iron and steel and cement, is expected to show net growth driven by economic growth in India and the Association of Southeast Asian Nations (ASEAN)[1]

Despite the long-term decline in demand for all three fossil fuels, each continues to play a key role in the global energy landscape in the Reference Case. Without further decarbonization policies, more than half of all global energy demand comes from fossil fuels by 2050.

In the Accelerated Transition case, both coal and oil demand will be 22 percent lower compared with the Reference Case in 2050 (and 52 and 27 percent lower versus 2019, respectively).

[1] Includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.
Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

4

Change is too slow to reach the 1.5°C Pathway

The projected CO_2 emissions in the Reference Case are far from pathways that would limit global warming to 1.5°C. In addition, global energy-related emissions in the Reference Case remain flat until 2030, followed by a gradual, approximately 25 percent decline until 2050.

By contrast, CO_2 emissions need to reach net zero by 2050 to move to the 1.5°C Pathway. The coming decade is particularly crucial, requiring a decline in global emissions of more than 50 percent by 2030. This requires substantial and rapid changes in how societies around the globe fuel their economies.

Despite the increased momentum toward decarbonization, many governments still need to translate ambitious targets into specific policies. Furthermore, the Reference Case can be interpreted as a sign that additional ambitious initiatives and policy measures are needed to move closer to the 1.5°C Pathway. In other words, not enough is being done.

5

Investment flows remain stable over the next 15 years

Following recovery from the COVID-19 shock, investments in the energy system steadily grow toward 2035. Despite some fundamental shifts in underlying drivers, such as the rapid growth in renewables and peaking oil demand, the energy-investment mix remains remarkably stable, as shifts in volumes are offset by further declines in the cost of renewables and increasingly expensive oil and gas supply.

In the Reference Case, oil and gas still represent 50 percent of energy investments by 2035. Investments in power-generation assets remain nearly flat, as strong growth in installed capacity is matched by a strong decline in capital expenditures for renewable technologies. Oil and gas investments grow by an average of 3 percent a year through 2030 versus 2020 lows, despite slowing demand growth driven by increasingly expensive projects to replace depleting existing production. Given the growing attention of governments, investors, and customers to the energy transition, the profitability of all energy segments continues to vary significantly among countries and through cycles.

Thus, in light of these substantial shifts, business leaders and investors face important strategic questions. To navigate the transition, they must identify and track key signposts that indicate the direction and speed of change.

Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

Our Global Energy Perspective offers a detailed demand outlook across key dimensions.

Our report assesses energy systems across countries, sectors, and energy products

Illustrative examples

30 sectors

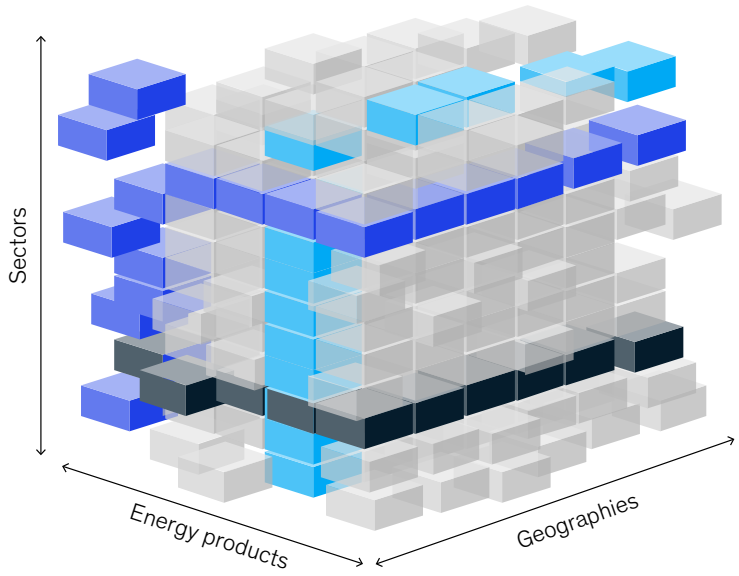
Transport
- Road transport (including buses, trucks, and cars)
- Rail
- Aviation
- Marine
- Other transport

Buildings
- Residential buildings
- Commercial buildings

Heat

Industry
- Iron and steel
- Chemicals
- Manufacturing
- Construction
- Mining
- Agriculture
- Refining
- Other industry

Power
- Electricity generation
- Hydrogen production



55 energy products
- Natural gas
- Coal
- Electricity
- Hydrogen
- Oil products (including gasoline, diesel, and HFO)
- Renewable resources (solar, wind, and hydro)

146 countries
- 45 in Asia
- 43 in Europe
- 31 in Africa
- 27 in Americas

Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

GEP builds on more than 20 state-of-the-art McKinsey assets, including:

McKinsey Hydrogen Model
Combines energy- and hydrogen-demand projections with country-specific supply-cost dynamics. Models detail cost outlooks for underlying technologies such as electrolyzers; steam methane reforming; renewables cost decline; and carbon capture, utilization, and storage (CCUS)

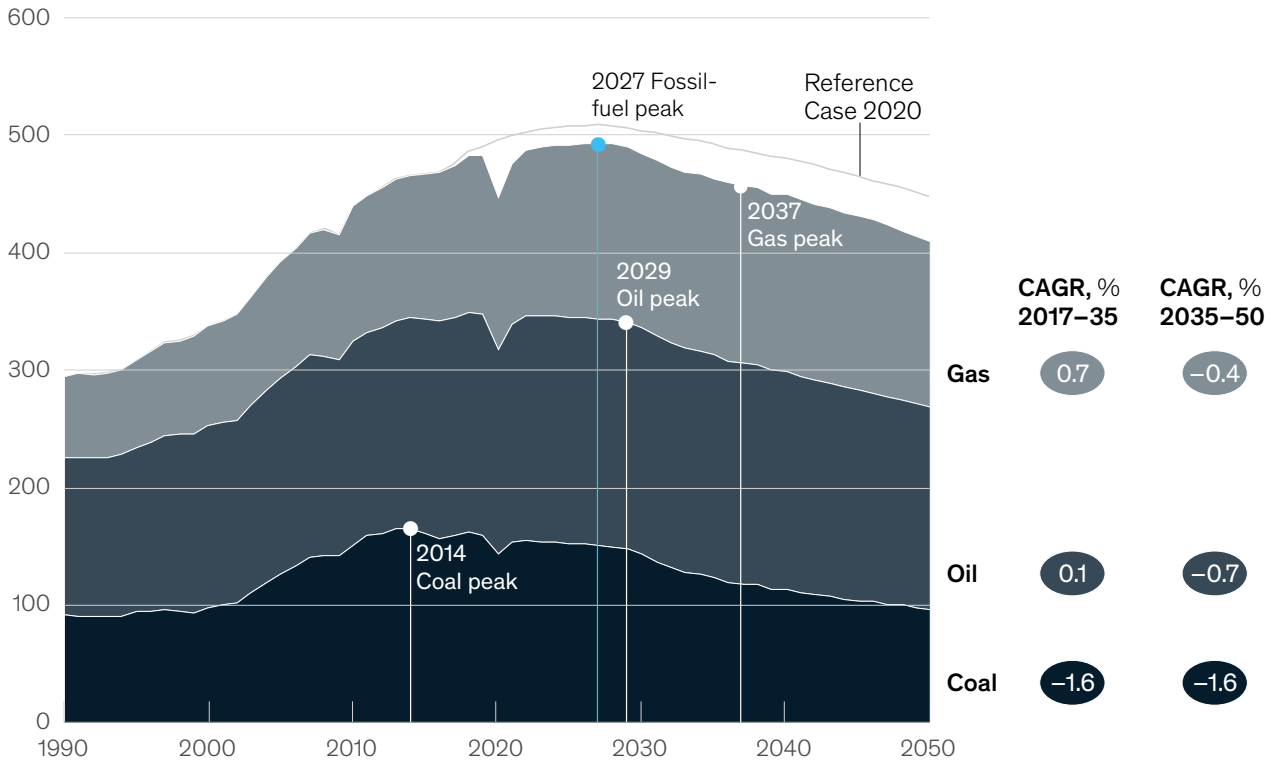
McKinsey Power Model
Projects capacity additions in the power sector and simulates dispatching decisions based on system-cost optimization. Captures more than 80 percent of global power demand at the country and subcountry level and models at hourly granularity

McKinsey eTrucks TCO Model
Assesses future evolution of commercial car parks by country and vehicle class and projects powertrain-mix development based on total cost of ownership. Incorporates views on the cost decline of battery and hydrogen-fueled engines for eTrucks and efficiency improvements of internal-combustion-engine (ICE) trucks

In the Reference Case, fossil fuels continue to play an important role in energy systems.

Oil demand peaks in the late 2020s and gas in the 2030s, whereas coal shows a steady decline

Primary energy demand per fossil fuel, million TJ



Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

In 2020, total energy demand drops by 7 percent due to reduced (economic) activity as a result of COVID-19. It takes until late 2021 to see energy demand return to pre-COVID-19 levels

Gas continues to increase its share of global energy demand in the next ten to 15 years—the only fossil fuel to do so—and then peaks in the late 2030s. Still, gas demand in 2050 is 5 percent higher versus today's level

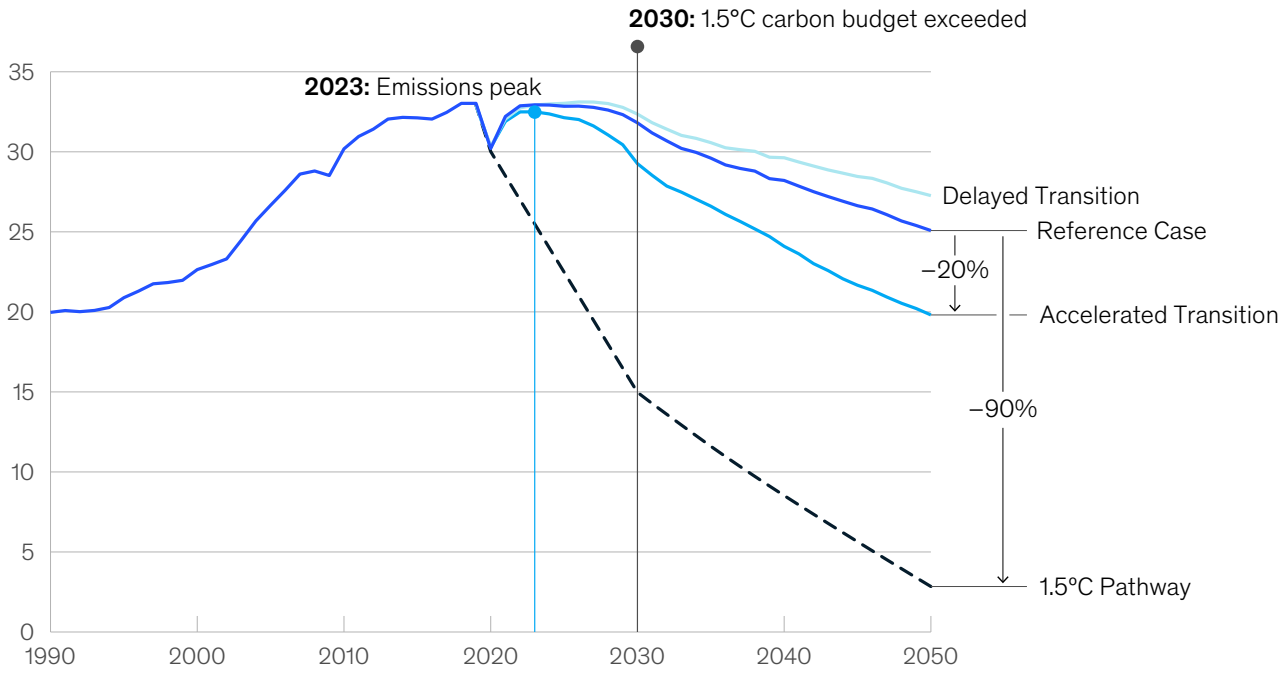
Oil-demand growth slows substantially, with a projected peak in the late 2020s followed by a 10 percent decline by 2050, mainly driven by slowing car-park growth, enhanced engine efficiency in road transport, and increased electrification

Coal demand decreases almost 40 percent from 2019 to 2050, driven mainly by the phaseout of coal plants in the power sector across regions

Global CO_2 emissions peak at around 33 $GtCO_2$ in 2023, but the trajectory remains far from the 1.5°C Pathway.

In the Reference Case, the global carbon budget for 1.5°C Pathway is exhausted by 2030

Global energy-related CO_2 emissions, $GtCO_2$ p.a.



Source: McKinsey Energy Insights Global Energy Perspective 2021, December 2020

COVID-19 has triggered a drop in global CO_2 emissions of around 7 percent. In the Reference Case, energy-related CO_2 emissions peak by 2023, followed by a steady decline of approximately 25 percent until 2050

In the Accelerated Transition scenario, emissions by 2050 are 20 percent lower than in the Reference Case, reflecting a more rapid shift to renewable sources for power generation as well as an accelerated uptake of new, lower-carbon technologies in end-use segments, such as road transport and industry

However, Reference Case CO_2 emissions, and even Accelerated Transition emissions, remain far from the 1.5°C Pathway. CO_2 emissions by 2050 need to drop by 90 and 85 percent versus projected levels, respectively, to comply with the requirements for the 1.5°C Pathway. In fact, CO_2 emissions need to show an annual decrease similar to the drop in 2020 for the next 30 years to reach the target by 2050

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About us

We are a global market intelligence and analytics group focused on the energy sector. We enable organizations to make well-informed strategic, tactical, and operational decisions, using an integrated suite of market models, proprietary industry data, and a global network of industry experts. We work with leading companies across the entire energy value chain to help them manage risk, optimize their organizations, and improve performance