

# World Energy Outlook 2021

Technical note on the  
emissions and temperature  
implications of COP26 pledges

International  
Energy Agency

# INTERNATIONAL ENERGY AGENCY

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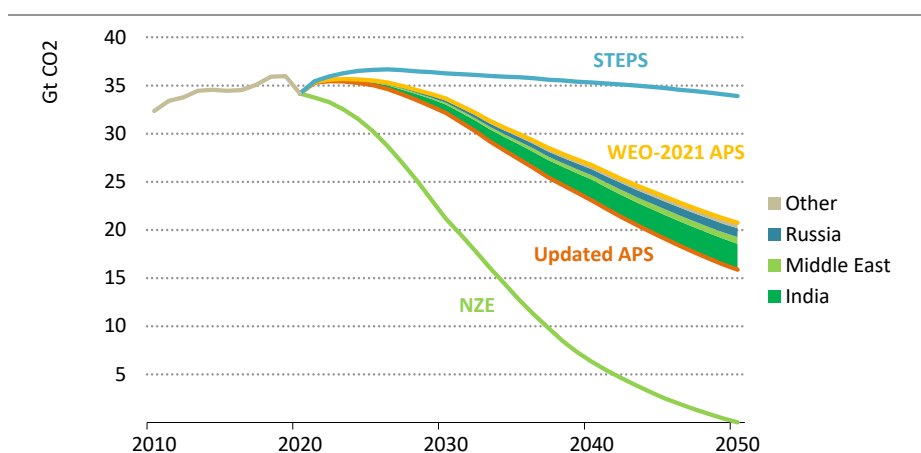
## 1.1 Summary

The [World Energy Outlook](#) (WEO) is the flagship publication of the International Energy Agency (IEA). It is usually published in November, but [this year's edition](#) was released one month earlier than usual to ensure that it could help inform decision makers and the wider public at the 26th Conference of the Parties (COP26) meeting in Glasgow. A key aim of this year's WEO was to provide a detailed picture of how far countries have come in their clean energy transitions, and how far they still have to go to limit the rise in global average temperatures this century to 1.5 °C.

In the run-up to COP26, many countries had put new commitments on the table, detailing their contributions to the global effort to reach international climate goals. The WEO-2021 introduced a scenario, called the Announced Pledges Scenario, which showed that the pledges made at the time of publication – if they were to be implemented on time and in full – would have profound impacts on energy markets, and global carbon dioxide (CO<sub>2</sub>) emissions would start to decline.

A number of notable new announcements were made after the publication of the WEO-2021 in mid-October. As a result, we updated our assessment in order to understand the potential implications of these announcements for emissions and the global temperature rise, taking into account all net zero emissions pledges made by governments as of 3 November 2021, as well as other commitments made at COP26, including the Global Methane Pledge. Temperature outcomes were derived using the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC): the same climate model used in the WEO-2021 and in the [Sixth Assessment Report](#) of the Intergovernmental Panel on Climate Change (IPCC). This note explains the results and methodology of the update to our Announced Pledges Scenario that was published on 4 November in [an online commentary](#) by the IEA Executive Director.

**Figure 1.1** ▶ CO<sub>2</sub> emissions in the WEO-2021 scenarios and emissions reductions from recent pledges



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Note: Other = net zero pledge by Australia and commitment to the Global Coal to Clean Power Transition Statement by Indonesia. Middle East = net zero pledges by Saudi Arabia and the United Arab Emirates.

## 1.2 The WEO-2021 scenario structure

The energy sector is responsible for almost three-quarters of the emissions that have already pushed global average temperatures 1.1 °C higher since the pre-industrial age, with visible impacts on weather and climate extremes. The energy sector has to be at the heart of efforts to mitigate climate change. The *WEO-2021* describes the key decision points through which the energy sector can help can move the world towards safer ground.

The *WEO-2021* explores various scenarios, each of which is built on a different set of underlying assumptions about how the energy system might evolve. These scenarios are not predictions: the IEA does not have, and has never had, a single view about what the long-term future might hold. Instead, what the scenarios seek to do is to enable readers to compare different possible versions of the future, and the levers and actions that produce them, with the aim of providing insights about the future of global energy.

The update to the Announced Pledges Scenario analysed in this note builds on the *WEO-2021* APS and adds the new pledges announced since mid-October.

### Box 1.1 ► Scenarios included in the WEO-2021

The *WEO-2021* contains three main scenarios. One scenario is designed to achieve a specific outcome and shows a pathway to reach it; the other two scenarios are exploratory, in that they define a set of starting conditions and then see where they lead. The detailed sector-by-sector and country-by-country list of policy assumptions in each scenario is available in Annex B of the *WEO-2021*, which can be [downloaded for free](#).

- **The Net Zero Emissions by 2050 Scenario (NZE).** This is a normative IEA scenario that shows a narrow but achievable pathway for the global energy sector to achieve net zero CO<sub>2</sub> emissions by 2050, with advanced economies reaching net zero emissions ahead of others. This scenario also meets key energy-related United Nations Sustainable Development Goals (SDGs), in particular by achieving universal energy access by 2030 and major improvements in air quality. The NZE does not rely on emissions reductions from outside the energy sector to achieve its goals, but assumes that non-energy emissions will be reduced in the same proportion as energy emissions. It is consistent with limiting the global temperature rise by 2100 to 1.5 °C (with a 50% probability).
- **The Stated Policies Scenario (STEPS)** does not take for granted that governments will reach all announced goals (this applies both to Nationally Determined Contributions (NDCs) and longer term net zero targets). Instead, it provides a more granular, sector-by-sector analysis of what has actually been put in place to reach these and other energy-related objectives, based on an assessment of existing policies and measures and those that are under development. The STEPS explores where the energy system might go without a major additional steer from policy makers.

- The **Announced Pledges Scenario (APS)** appears for the first time in the *WEO-2021*. The version published in the *WEO-2021* takes account of all of the climate commitments made by governments around the world up to early October 2021, including NDCs and longer-term net zero targets, and assumes that they will be met in full and on time. The remaining difference in global emissions between the outcome in the APS and the normative goals in the NZE shows the “ambition gap” that needs to be closed for pledges to align with the temperature goal included in the Paris Agreement.

### 1.3 The Announced Pledges Scenario in the WEO-2021

By early October 2021, countries accounting for between 60% and 70% of global CO<sub>2</sub> emissions had announced net zero emissions pledges. The APS in the *WEO-2021* included all of these net zero pledges, as well as national announcements of 2030 targets, regardless of whether these were anchored in implementing legislation or mentioned in updated NDCs. It also included all commitments made in new and updated NDCs. Some of the major pledges included in the *WEO-2021* APS were:

- China’s pledge to achieve carbon neutrality by 2060
- The United States’ updated NDC and pledge to reach net zero emissions, economy wide, by 2050
- The European Union’s updated NDC and pledge to reach climate neutrality by 2050
- The pledge by Japan to become carbon neutral by 2050
- The pledge by South Korea to reach carbon neutrality by 2050
- Brazil’s objective of reaching net zero emissions by 2060, as described in its updated NDC of 2020

In the *WEO-2021* APS, total CO<sub>2</sub> and methane emissions reach 36 gigatonnes of CO<sub>2</sub> equivalent (Gt CO<sub>2</sub>-eq) in 2030 (down from around 38 Gt CO<sub>2</sub>-eq in 2020). This compares with 39 Gt CO<sub>2</sub>-eq in the Stated Policies Scenario, and 22 Gt CO<sub>2</sub>-eq in the NZE.

The *WEO-2021* examined in detail the energy sector transformation in the APS as well as what is required to achieve a faster transition, as in the NZE. As analysed in detail in Chapter 3 of the *WEO-2021*, some of the key findings were:

- Over 40% of the gap between the APS and the NZE pathway could be bridged with cost-effective technology measures, and an additional 25% could come from measures to temper demand, including materials efficiency and digitalisation.
- Accelerating the decarbonisation of the electricity sector provides 35% of the emissions reductions between the APS and NZE in 2030; it is the single most important way to close this gap. This requires doubling solar photovoltaics (PV) and wind deployment relative to the APS, a major expansion of other low-emissions generation, and a huge building out of electricity infrastructure and all forms of system flexibility. Stopping all

new investment decisions in coal-fired power plants would avoid the construction of 200 GW in new capacity, saving 0.8 Gt CO<sub>2</sub> in 2030.

- Energy efficiency in end-use sectors and measures to reduce demand could together fill nearly 20% of the gap between the APS and the NZE. Almost 80% of the energy efficiency potential in the NZE could be achieved cost-effectively by 2030.
- Electrification, hydrogen and carbon capture, utilisation and storage (CCUS) could cut around 15% of the emissions gap between the APS and NZE in 2030. But they all play an increasingly important role in maintaining momentum post-2030 towards a net zero energy system. Clean energy innovation remains vital to address emissions from iron and steel, cement and other energy-intensive industrial sectors, as well as from long-distance transport. As a whole, announced net zero pledges included in the APS lag far behind key NZE milestones related to the deployment of hydrogen-based fuels, advanced electrification and CCUS.

## 1.4 Updating the Announced Pledges Scenario

Since the publication of the *WEO-2021*, a number of new net zero pledges were announced by countries, as were pledges to phase out the use of coal, reduce methane emissions and eliminate deforestation. We assess the implications of these pledges for global emissions and the global temperature rise in an updated APS. To be consistent with the APS published in the *WEO-2021*, we again assume that the pledges are achieved on time and in full, even if they are not yet backed up by the policy frameworks that will be essential for them to be achieved.

### 1.4.1 New net zero pledges

Some of the major pledges that were announced after the beginning of October include:

- On 12 October, the United Arab Emirates announced a goal of reaching carbon neutrality by 2050
- On 13 October, the Russian President announced that Russia aims to become carbon neutral by 2060
- On 23 October, Saudi Arabia announced that the country is targeting net zero CO<sub>2</sub> emissions by 2060
- On 26 October, Australia announced a goal of reaching net zero by 2050
- On 1 November, the Prime Minister of India announced that India will aim to reach net zero emissions by 2070, and announced enhanced policy targets for 2030

In updating the APS, we take into account the target dates and sectoral coverage of all new pledges. We also include a strengthened commitment from Indonesia to decarbonise its power sector, in line with the terms of its endorsement of the Global Coal to Clean Power Transition Statement on 4 November.

## 1.4.2 The Global Methane Pledge

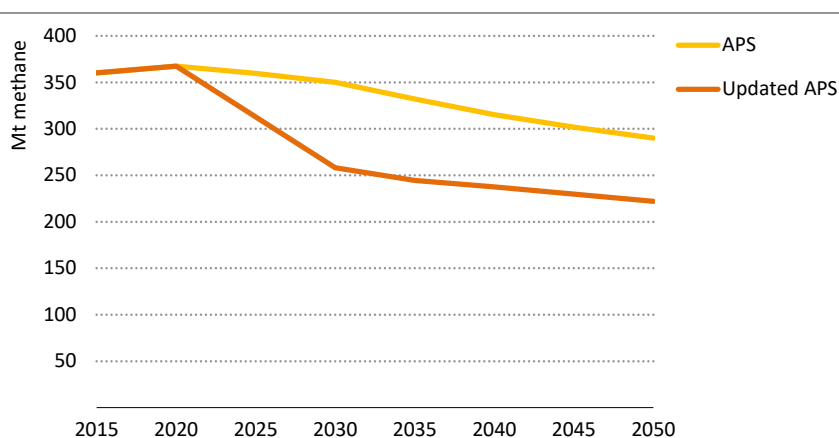
Methane emissions are the second-largest cause of global warming today after CO<sub>2</sub> emissions. The recent IPCC Sixth Assessment Report highlighted that rapid and sustained reductions in these emissions are key to limit near-term warming. Estimates of methane emissions are subject to a high degree of uncertainty, but [the most recent comprehensive estimate](#) suggests that annual global methane emissions are around 570 megatonnes (Mt). This includes emissions from natural sources (around 40% of emissions) and those originating from human activity (the remaining 60%). Of emissions from human activity, the latest assessments suggest that nearly 250 Mt of methane is emitted each year from agriculture, waste and bioenergy; oil and gas operations emit around 75 Mt; and coal operations emit 40 Mt.

In the *WEO-2021 APS*, there are efforts to reduce emissions from fossil fuel operations, mainly in countries that have net zero pledges (and that included methane as part of their pledges). Methane emissions from fossil fuel operations fall by around 20% to 2030 in this scenario; emissions from non-energy sources were assumed to increase very slightly to 2030, offsetting some of these reductions.

On 2 November, more than 100 countries signed the Global Methane Pledge. Signatories pledged to a collective goal of reducing global methane emissions by at least 30% from 2020 levels by 2030, alongside moves towards using best available inventory methodologies to quantify methane emissions. We interpret this goal as applying to all human sources of methane globally, meaning that methane emissions would fall from around 365 Mt in 2020 to 260 Mt in 2030. This is included in the update to the APS.

Methane emissions from fossil fuels operations, especially from the oil and gas sector, are typically easier and more cost effective to avoid than emissions from agriculture. As a result, the majority of the reductions from Global Methane Pledge are likely to come from fossil fuel operations. This leaves fewer opportunities to reduce methane emissions after 2030 and therefore the post-2030 rate of decline in methane emissions in the updated APS is slower than in the mid-October version.

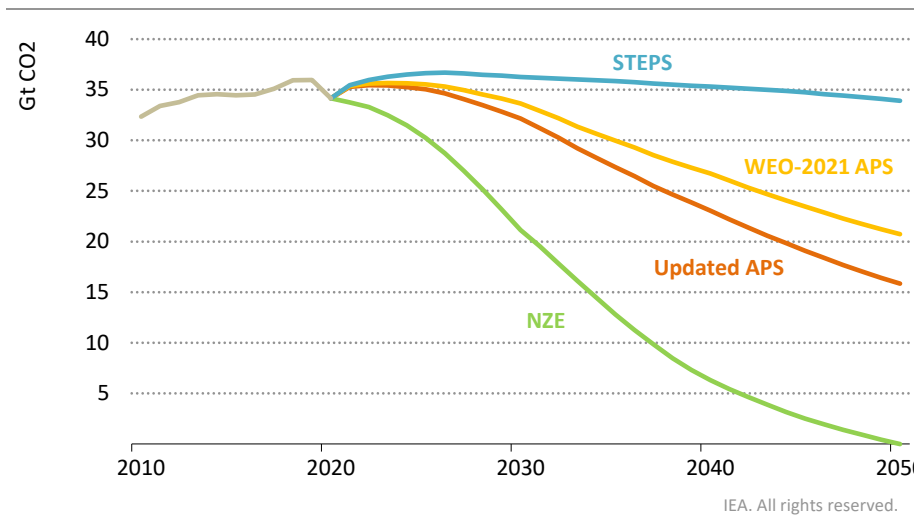
**Figure 1.2** ▶ Global methane emissions from energy, agriculture and waste in the *WEO-2021 APS* and updated APS



### 1.4.3 CO<sub>2</sub> emissions in the scenarios

Incorporating the new pledges made up to 3 November means that global energy-related CO<sub>2</sub> emissions would peak in the next few years, falling to around 32 Gt in 2030 and to 16 Gt in 2050. Compared with the *WEO-2021 APS*, this is around 1.5 Gt lower in 2030 and 5 Gt lower in 2050. If all net zero pledges made to date were to be fully achieved, emissions in 2050 would therefore be less than half what they are today. The annual rate of decline across the three decades from 2020 to 2050 would be almost twice as fast as the annual rate of increase in global CO<sub>2</sub> emissions from 1990 to 2020.

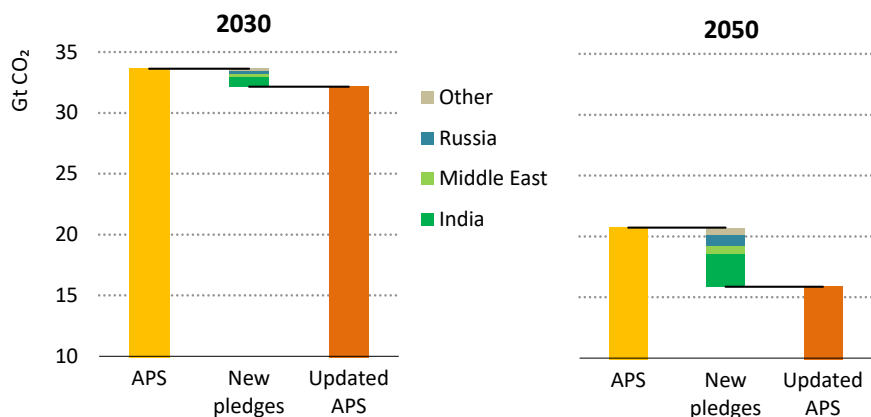
**Figure 1.3** ▶ Energy CO<sub>2</sub> emissions from 2010 to 2050 in the WEO-2021 scenarios and the updated Announced Pledges Scenario



India's announced net zero pledge is responsible for the majority of the difference in emissions between the WEO-2021 APS and the updated APS. As discussed further below, the combined effect of new net zero pledges and the methane pledge would lead to a temperature rise of around 1.8 °C in 2100 (with a 50% probability). This is the first time that governments have come forward with targets of sufficient ambition to hold global warming to below 2 °C.



**Figure 1.4** ▶ Breakdown by country or region of the difference between the WEO-2021 Announced Pledges Scenario and updated Announced Pledges Scenario in 2030 and 2050



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Note: Other = net zero pledge by Australia and commitment to the Global Coal to Clean Power Transition Statement by Indonesia. Middle East = net zero pledges by Saudi Arabia and the United Arab Emirates.

The new pledges are undoubtedly significant, but the assessment needs to be accompanied by two important elements of context. First, it cannot be taken for granted that governments will implement their pledges on time and in full. In many cases, pledges have not yet been backed up by the strong and credible near-term policies needed to make them a reality. A scenario based only on today's policy settings (a sector-by-sector analysis of policies in place and those under development, as in our Stated Policies Scenario in the *WEO-2021*) leads to a plateau in global energy-related emissions, rather than a rapid reduction. In this scenario, the global average temperature hits 2.6 °C above pre-industrial levels in 2100 and continues to rise thereafter.

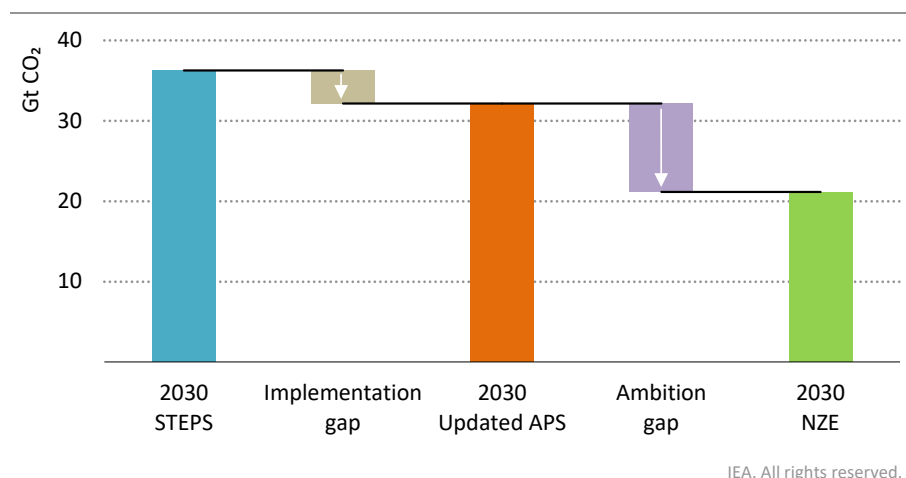
Second, the pledges themselves – even if implemented in full – do not yet put the world on track for a 1.5 °C stabilisation in global average temperatures. Full delivery of announced pledges to date would close only about 30% of the gap in 2030 between the Stated Policies Scenario and the pathway for 1.5 °C. This leaves an ambition gap of about 11 Gt CO<sub>2</sub> in 2030.<sup>1</sup> This is smaller than the ambition gap left by the *WEO-2021* APS (more than 12 Gt) but shows that net zero pledges made to date are, for the most part, still not yet backed up by shorter-term policies.

<sup>1</sup> The *WEO-2021* introduced the concepts of the implementation gap and the ambition gap. The implementation gap, the difference between the STEPS and the APS, shows the extent to which current pledges are not yet backed up by the necessary policy frameworks. The ambition gap, the difference between APS and the NZE, represents the divergence between current ambitions and the pathway to achieve net zero emissions by 2050.

In 2050, full delivery of announced pledges in the updated APS would close more than 50% of the gap between the STEPS and the pathway to net zero emissions by 2050. This compares with less than 40% of the gap that was closed in 2050 with the *WEO-2021* APS.

As set out in our report [Net Zero by 2050](#), achieving net zero emissions by 2050 requires a transition of unprecedented speed and scale. Current ambitions – as expressed in the updated APS – fall short of what is needed to achieve the goals. However, the APS trajectory itself cannot be taken for granted, and the difference in emissions between the STEPS and the APS illustrates very starkly the size of challenge of implementing the commitments that are now on the table.

**Figure 1.5** ▶ The CO<sub>2</sub> implementation and ambition gaps in 2030



## 1.5 The global temperature rise in WEO-2021 scenarios

### 1.5.1 The MAGICC climate model

Analysis using the Model for the Assessment of Greenhouse Gas Induced Climate Change (“MAGICC”) has been carried out to assess the impacts of emissions trajectories on the average global surface temperature rise. MAGICC climate models have been used extensively in assessment reports written by the IPCC. MAGICC 7, the version used in this analysis, is one of the models used for scenario classification in the IPCC’s Sixth Assessment Report. Emissions of all energy-related GHG from the *WEO-2021* scenarios and the updated APS are supplemented with commensurate changes in non-energy-related emissions based on the scenario database published as part of the IPCC [Special Report on Global Warming of 1.5 °C](#).<sup>2</sup> On 1 November, around 100 countries pledged to halt and reverse deforestation and land degradation by 2030. The *WEO-2021* APS assumes a 20% reduction in CO<sub>2</sub> emissions from

<sup>2</sup>All changes in temperatures are relative to 1850-1900 and match the IPCC 6th Assessment Report definition of warming of 0.85 °C between 1995-2014.

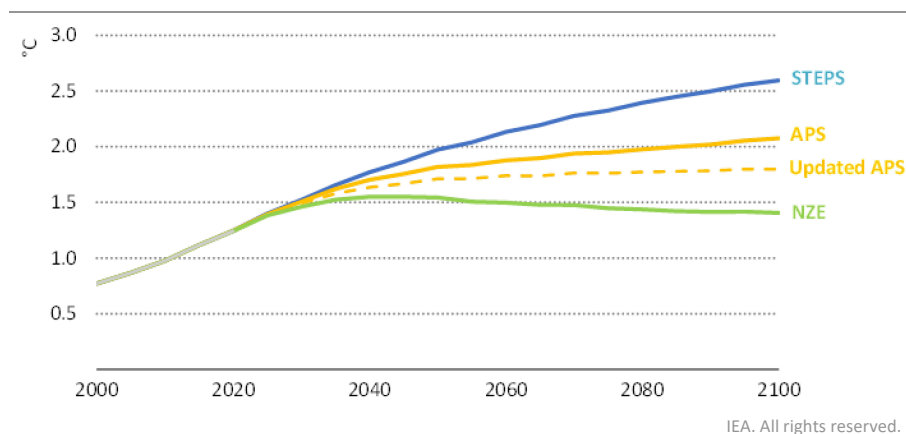
agriculture, forestry and other land use (AFOLU) between 2020 and 2030. It is not yet clear how the new commitment will materially change this existing assumption, so we therefore did not change it in the updated APS.

### 1.5.2 Temperature outcomes in WEO-2021 scenarios and the updated APS

In the STEPS, CO<sub>2</sub> emissions are 36 Gt in 2030 and around 34 Gt CO<sub>2</sub> in 2050. If emissions continue this trend after 2050, and if there are similar changes in non-energy-related GHG emissions, the rise in temperature in 2100 would be around 2.6 °C. The temperature would continue to rise after 2100 because total CO<sub>2</sub> emissions are still well above zero.

In the WEO-2021 APS, CO<sub>2</sub> emissions fall to 34 Gt in 2030 and 21 Gt in 2050. Assuming that emissions continue this trend after 2050, then the rise in temperature in 2100 would be around 2.1 °C (with a 50% probability).<sup>3</sup>

**Figure 1.6** ▶ Global median surface temperature rise over time in WEO-2021 scenarios and the updated APS



Notes: IEA analysis based on the outputs of MAGICC 7.5.3.

In the updated APS, CO<sub>2</sub> emissions fall to around 32 Gt in 2030 and 16 Gt in 2050. This is around 25% lower than in the WEO-2021 APS in 2050, and methane emissions from human activity are also around 25% lower in 2050. If emissions in the updated APS continue their trends after 2050, we estimate that this would lead to temperature rise in the updated APS of around 1.8 °C in 2100. The temperature would continue to rise after 2100 because CO<sub>2</sub> emissions are still above zero in 2100.

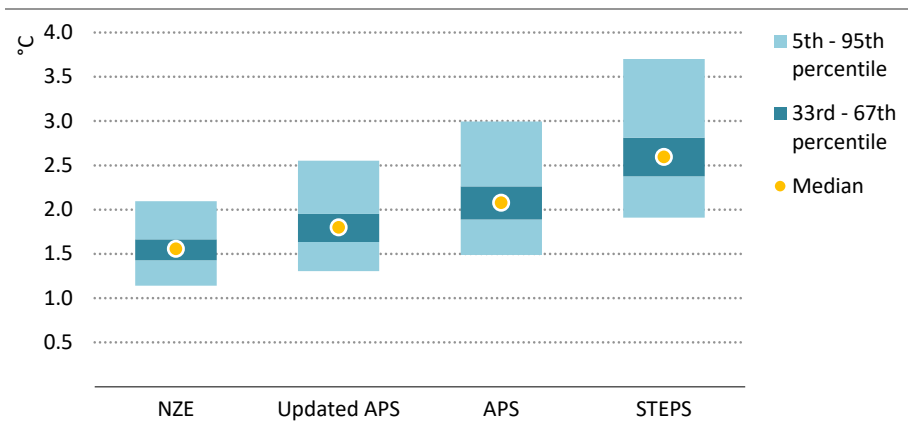
In the NZE, CO<sub>2</sub> emissions are net zero in 2050 globally and there are rapid reductions in all non-CO<sub>2</sub> emissions. The rise in temperature reaches a maximum level of just over 1.5 °C

<sup>3</sup> Unless otherwise stated, temperature rise estimates quoted in this section refer to the median temperature rise, meaning that there is a 50% probability of remaining below a given temperature rise.

around 2050. The temperature then starts to decline slowly as a result of continued reductions in non-CO<sub>2</sub> emissions. By 2100, the rise in temperature has fallen to around 1.4 °C.

Relating GHG emissions from the energy sector to future temperature rises is a subject of myriad complexities, and climate change can therefore only be discussed in terms of the probability of staying below a specific temperature rise. The above temperatures are given with a 50% probability, but temperature rises are occasionally reported at different probabilities. The updated APS has a 67% chance of the average global temperature rise remaining below 1.95 °C in 2100.

**Figure 1.7** ▶ **Peak temperature rise in the WEO-2021 scenarios and the updated APS**



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Notes: IEA analysis based on the outputs of MAGICC 7.5.3.

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