INEVITABLE POLICY RESPONSE

- Inevitable Policy Response Forecast Policy Scenario 2021 (IPR FPS 2021):
- Energy and Land Use System Results Summary

Preparing financial markets for climate-related policy and regulatory risks

December 2021

IPR is commissioned by the Principles for Responsible Investment (PRI), supported by world class research partners and joined by leading financial institutions

PRI Principles for Responsible Investment

PRI commissioned the Inevitable Policy Response in 2018 to advance the industry's knowledge of climate transition risk, and to support investors' efforts to incorporate climate risk into their portfolio assessments

:vivideconomics putting economics to good use

Energy Transition Advisors ETA

A research partnership led by Energy Transition Advisors and Vivid Economics conducts the initiative's policy research and scenario modelling and includes 2Dii, Carbon Tracker Initiative, Climate Bonds Initiative, Quinbrook Infrastructure Partners and Planet Tracker

The consortium was given the mandate to bring leading analytic tools and an independent perspective to assess the drivers of likely policy action and their implications on the market

Planet Tracker

quinbrook infrastructure PARTNERS

2° Investing Initiative

Carbon Tracker Initiative

Climate Bonds Initiative

Who supports the Inevitable Policy Response ?

Leading financial institutions joined the IPR as Strategic Partners in 2021 to provide more in-depth industry input, and to further strengthen its relevance to the financial industry

BLACKROCK · FitchRatings · nuveen A TIAA Company · ROBECO The Investment Engineers · BNP PARIBAS ASSET MANAGEMENT · Goldman Sachs Asset Management · NewForests

Core philanthropic support since IPR began in 2018. The IPR is funded in part by the Gordon and Betty Moore Foundation through The Finance Hub, which was created to advance sustainable finance and the ClimateWorks Foundation striving to innovate and accelerate climate solutions at scale

GORDON AND BETTY MOORE FOUNDATION · THE FINANCE HUB · climateworks FOUNDATION

The IPR helps the financial sector navigate the climate transition

Markets inconsistently price transition risk

- Policies will continue interacting with new technologies to deeply disrupt established industries and economies
- Financial institutions need to deepen their understanding of this unfolding environment to manage their assets effectively
- Yet the scenarios currently available provide limited intelligence about the realistic risks and opportunities most critical to the financial sector, and omit the land sector

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The IPR offers a range of applications

IPR Policy Forecast

A **high-conviction policy-based forecast** of forceful policy response to climate change and implications for energy, agriculture and land use

IPR Forecast Policy Scenario (FPS)

A **fully integrated climate scenario** modelling the impact of the forecasted policies on the real economy up to 2050, tracing detailed effects on all emitting sectors

IPR 1.5°C RPS Scenario

A **'1.5°C Required Policy Scenario'**(1.5°C RPS) building on the IEA NZE by deepening analysis on policy, land use, emerging economies, NETs and value drivers. This can be used by those looking to align to 1.5°C

IPR value drivers

A set of publicly available **outputs from the FPS and 1.5°C RPS** that offer significant granularity at the sector and country level allowing investors to assess their own climate risk

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IPR's FPS value add

A high conviction policy-based forecast, anchored in realistic policy and technology expectations rather than hypothetical 'optimal' pathways

Fully integrating land-use to examine the full system impacts of policies, and highlight the critical role of land

Transparent on expectations for policy and deployment of key technologies, such as Negative Emission Technologies

Covers all regions of the world, with specific policy forecasts for key countries and regions

Applicable to TCFD reporting and regulatory stress testing

Complete forecast includes macroeconomic, energy and land use models linking crucial aspects of climate across the entire economy

A '**1.5°C Required Policy Scenario**' (1.5°C RPS) has been developed, building on the IEA NZE, deepening analysis on land use, and deriving polices required to reach a rapid net zero 2050 outcome

Note: IPR does not model physical risk

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IPR 2021 Reports

A series of new IPR reports have been released in 2021. Please visit the PRI website here for more information.

Glossary

- AgTech - Agriculture technology
- BECCS - Bioenergy with carbon capture and storage
- BNEF - Bloomberg New Energy Finance
- CAGR - Compound average growth rate
- CCS - Carbon capture and storage
- CDR - Carbon dioxide removal
- CH_4 - Methane
- CO_2 - Carbon dioxide
- CPS - Current Policies Scenario
- DAC - Direct air capture
- LT-DAC - Low temperature solid sorbent
- EV - Electric vehicle
- FPI - Food Price Index
- FPS - Forecast Policy Scenario
- GHG - Greenhouse gas
- ICE - Internal Combustion Engine
- IEA - International Energy Agency
- IPR - Inevitable Policy Response
- N_2O - Nitrous oxide
- NDC - Nationally determined contributions
- NEO - New Energy Outlook
- NETs - Negative emission technologies
- NPS - New Policies Scenario
- P1 - An IPCC 1.5°C scenario
- P2 - An IPCC 1.5°C scenario
- 1.5°C RPS - 1.5°C Required Policy Scenario
- SDS - Sustainable Development Scenario
- STEPS - Stated Policies Scenario
- TCFD - Task Force on Climate-related Financial Disclosures
- ULEV - Ultra low emission vehicles
- WEO - World Energy Outlook

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- Global emissions trajectory in context
- IPR FPS 2021 energy system results
- IPR FPS 2021 land use system results

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- Policy forecast update

What's new since March 2021

The IPR seeks to better drive investor action to avoid and manage climate-related policy risks by providing a high-conviction policy-based forecast of forceful policy response to climate change and implications for energy, agriculture and land use across major global economies

- In March 2021 we published a thoroughly revised and updated set of policy forecasts (IPR 2021 Policy Forecast – Detailed Resource), reflecting detailed research on current and proposed policies, with input from a global survey of experts to form the basis for the new Forecast Policy Scenario released in October 2021
- Since we published our main updates to our policy forecasts in March 2021 there have been a number of policy announcements and other considerations (e.g. assessment of level of ambition in updated NDCs) we have incorporated into our Forecast Policy Scenario results
- Notably, we believe that for many emerging and developing countries 2060 is the more likely date for full 100% clean power deployment and coal phase out, in line with any 2060 net zero year targets if they emerge
- Of our Top 10 Forecasts, only the phase out of coal in the US has been extended to 2035 from 2030 on further reflection. There is no significant impact on emissions
- At the time of publishing, the outcome of the US budget reconciliation is still in the balance. We believe if it is watered down, regulatory and state level action as well as cost competitiveness of key technologies (e.g. renewables and electric vehicles) still support our overall expectations for the US pathway to net zero

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IPR 2021 top ten policy forecasts: 1-5 have seen one change - US coal phase shift from 2030 to 2035

Carbon pricing	1.	Carbon Border Adjustments Mechanisms (CBAMs) for carbon will become increasingly a policy option. This could lead the United States to announce a national carbon pricing system by 2025 and signal a strong carbon price path to reach a backstop of $65 by 2030
	2.	The European Union's evolving commitments will deliver substantial carbon prices. By 2030, we expect EU policy to backstop an EU ETS carbon price of $75/tCO2 to ensure long-term action toward decarbonization in heavy emitting sectors
Coal	3.	In India, rapidly evolving Indian policy and prospects for market reforms and pricing has already ended further investment in new coal
	4.	China will end construction of new coal fired power production after 2025, driven by new policies to facilitate its 2060 net zero target, geopolitical trends and risk considerations*
	5.	The United States will end all coal-fired power generation by 2035, through a combination of emission performance standards and carbon pricing at the Federal and State levels, combined with market forces

*Reinforced by China's recent announcement, along with Japan and Korea, to end financing of overseas coal projects

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IPR 2021 top ten policy forecasts: 6-10 remain unchanged since March 2021 Policy Forecast update

Clean power	6.	The United States will implement a binding and credible 100% clean power standard for 2040 ending unabated fossil electricity generation
Zero emission vehicles	7.	China, France, Germany, Italy and Korea will end the sale of fossil fuel cars and vans in 2035. Jointly these large markets will accelerate the auto industry transition to electric drive, and precipitate further policy action internationally
Industry	8.	All major industrial economies including the US, Germany, Japan and China will require all new industrial plants, led by steel and cement, to be low-carbon by 2040, through a combination of emissions performance standards and carbon pricing
Agriculture	9.	The US, Canada, Australia and other major agricultural producers will have comprehensive mitigation policy in place by 2025 to reduce emissions from production of crops and livestock
Land use	10.	Major tropical forest countries will end deforestation by 2030, with domestic policy responding to international climate finance and corporate supply chain pressures

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A focus on US clean energy / climate policy legislation

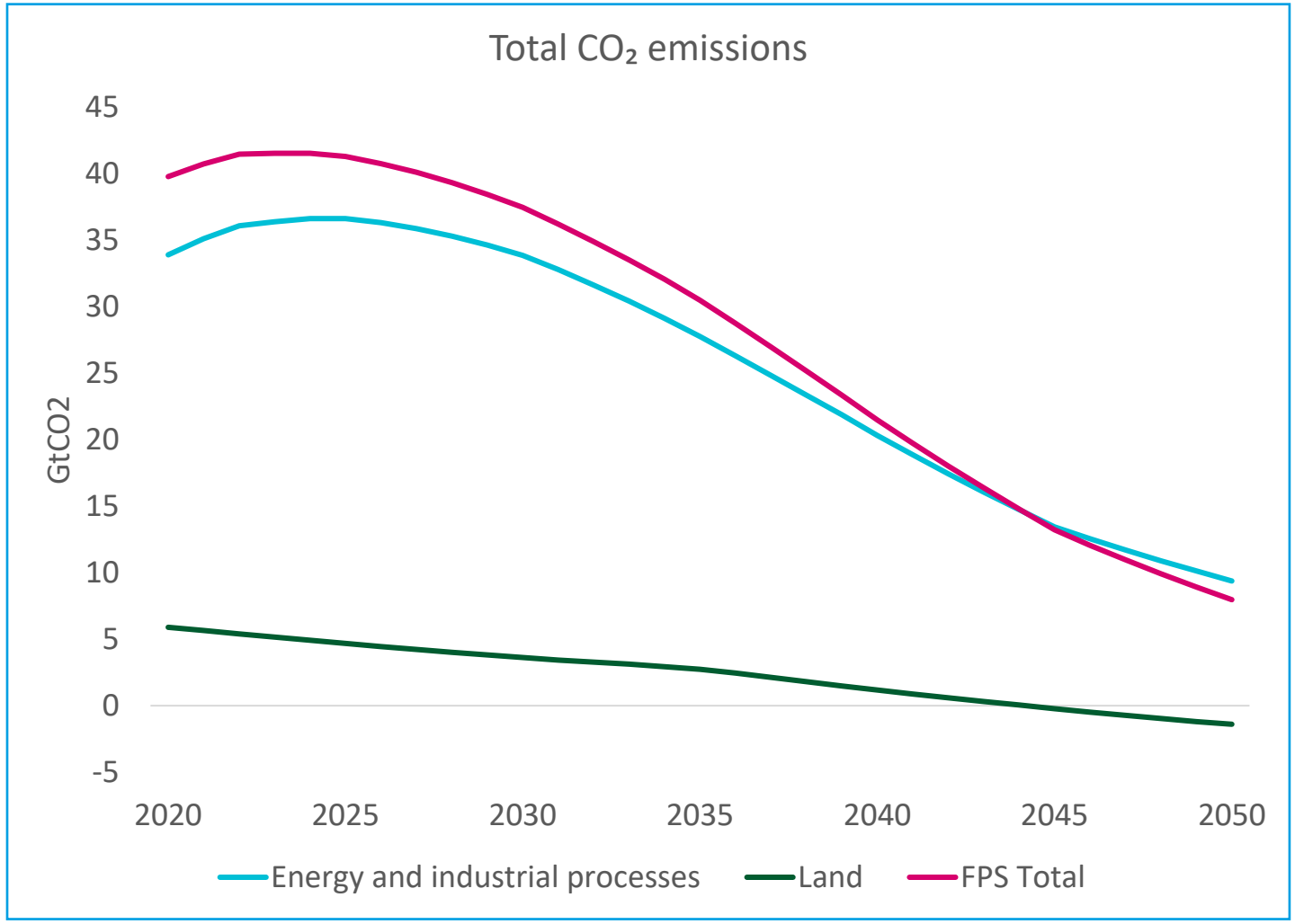
The $3.5 trillion Build Better Act (US Budget Reconciliation bill) includes several climate policies that reinforce IPR forecasts. Under a less ambitious bill, a handful of key proposals if preserved (e.g. a ten-year extension of renewable energy tax credits) could still deliver the bulk of forecast emissions reduction in the US.[1] In the absence of U.S. legislation, IPR FPS 2021 assumes federal regulation plus efforts at the state level alongside cost reduction in low carbon technologies (e.g. renewable electricity and electric vehicles) will deliver forecast outcomes.

Policy Forecast (March 2021)		Key Build Back Better Act Proposals
Clean Power 100% clean power by 2040	• President Biden objective to decarbonize power sector by 2035 • Announcement of 2050 net zero target by 2023 • Tax incentives up to 60% for output from renewable projects • 30 states adopting renewable portfolio standards • Federal tax credits extended by **up to two years**	• Restore PTC and ITC to full original value and extend **through end of decade** • Clean Electrification Payment Program targeting 80% clean electricity by 2030 through grants/fines
ICE sales bans 100% ZEV sales from 2040	• Federal tax credit/tax incentives in 16 states • 11 states joining ZEV alliance (with 2050 target of ZEVs) • 14 states adopting California ZEV mandate (22% ZEV sales in 2025)	• Revive/expand EV tax credit, removing limits by manufacturer (e.g., for a domestically produced EV purchased in 2022, total available credit would be $12,500)
Low carbon buildings End installation of fossil heating systems by 2035-40	• 18% space heating from low-carbon heating systems currently, federal residential renewable energy tax credit offers 26% tax credit for renewable heat technologies • USA forecast to announce a net zero 2050 target by 2023	• Introduce subsidy of $3000 per heat pump ($6-7000 for low-income projects)
Industry Decarbonisation Zero emissions production processes by 2040	• Policies in place to support industrial decarbonization (2018 45Q tax credit, extended to 2025)	• Extend 45Q tax credit to 2030

1 https://www.economist.com/united-states/2021/10/12/one-policy-accounts-for-a-lot-of-the-decarbonisation-in-joe-bidens-climate-plans

- Global emissions trajectory in context

IPR FPS 2021 total (energy and land) CO_2 emissions fall from around 40 Gt in 2020 to 8 Gt in 2050, with the land sector becoming a net carbon sink before 2050



- Total CO_2 emissions fall from around 40 Gt in 2020 to 8 Gt in 2100
- This fall is driven by reduction in emissions across both energy and land
- Energy sector emissions fall from around 34 $GtCO_2$ in 2020 to 9 $GtCO_2$ in 2100
- Land sector emissions fall from around 6 $GtCO_2$ in 2020 to zero in 2045
- Beyond 2045 the land sector becomes a net carbon sink and removes around 1 $GtCO_2$ per year by 2050

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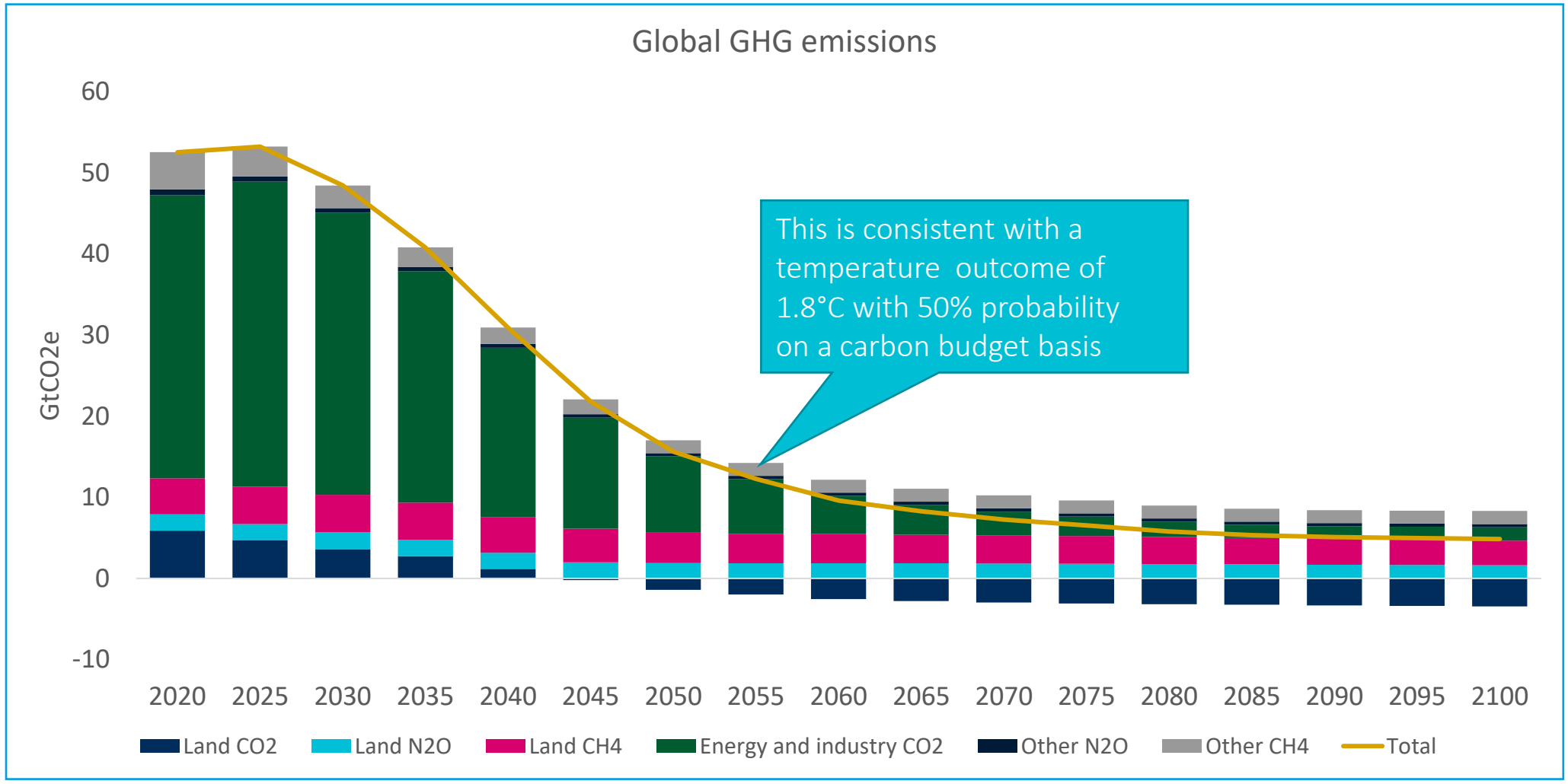
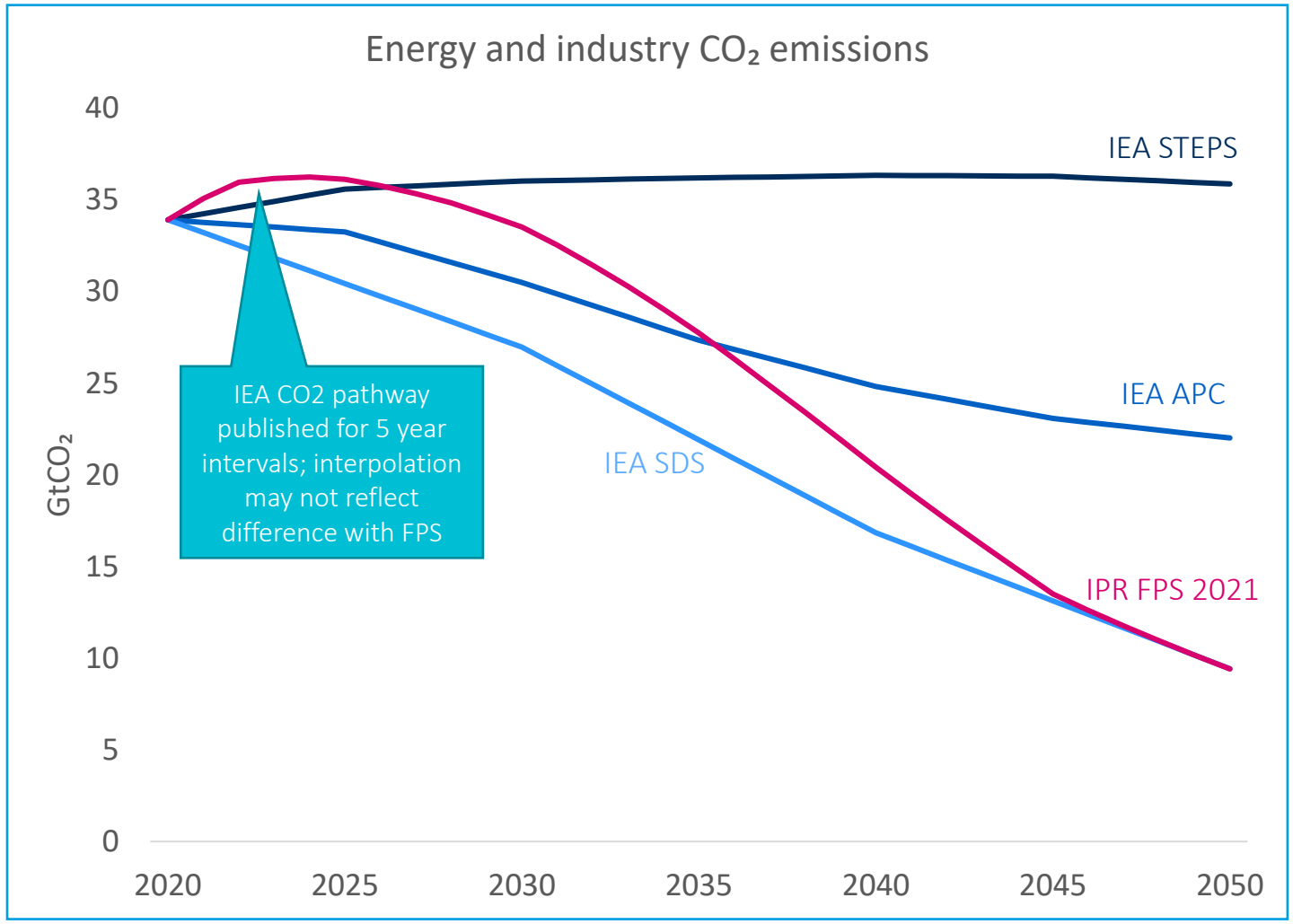
Global GHG emissions



IPR FPS 2021 energy related CO_2 emissions vs IEA APC and IEA SDS



- Between 2020 and 2030, energy-related CO_2 emissions fall only slightly, as new policies begin to take effect
- By 2035 emissions are comparable to the IEA Announced Pledges Case (APC)
- Over this period emissions are well above those in IEA Sustainable Development Scenario (SDS), which represents immediate climate action
- From around 2035, emissions fall well below APC levels as more ambitious IPR 2021 forecast policies take effect
- By around 2045, emissions are line with those in IEA SDS

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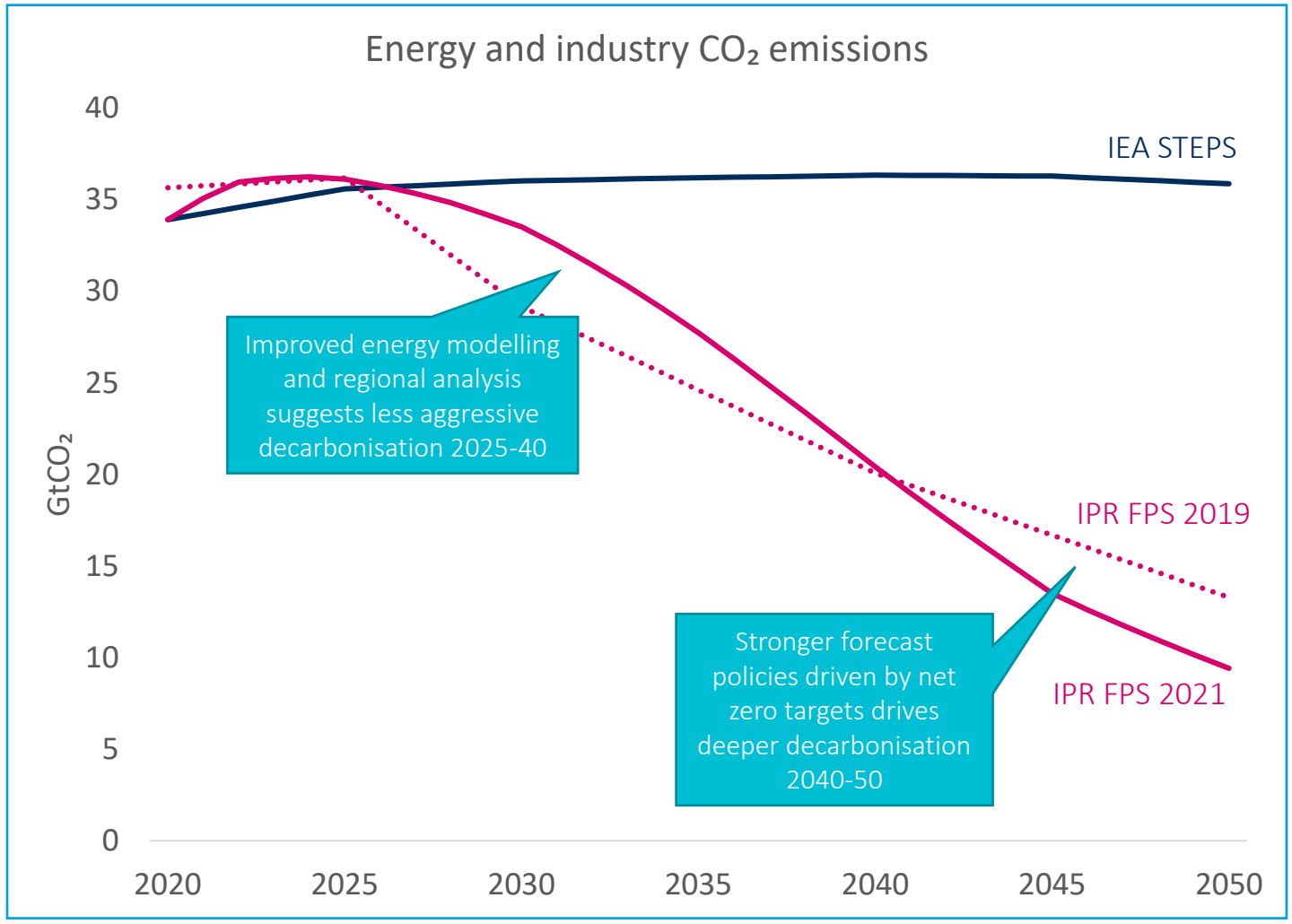
* Data on IEA CO2 pathways are published in 5-year intervals ** IPR FPS 2019 was modelled in 5-year increments
Note: IEA scenario data based on May 2021 Net Zero Emissions report; in WEO2021, IEA APC is renamed Announced Pledges Scenario (APS), with a slightly modified emissions pathway

IPR FPS 2021 energy related CO_2 emissions vs STEPS and IPR FPS 2019



- Energy-related CO_2 emissions follow a similar pathway to IEA STEPS to 2025*, before declining to 2050
- Between 2025 and 2040, energy-related CO2 emissions are above the IPR 2019 forecast**
- Emissions reduction projections have been revised upwards following more detailed modelling at the regional level
- From 2040, energy-related CO_2 emissions fall below the IPR 2019 forecast, as more ambitious IPR 2021 forecast policies take effect

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* Data on IEA CO2 pathways are published in 5-year intervals ** IPR FPS 2019 was modelled in 5-year increments
Note: IEA scenario data based on May 2021 Net Zero Emissions report

- IPR FPS 2021 energy system results

Key findings

Sweeping transformation across major sectors

As key regions and countries will be pushed to stock-take and convert commitment into action, every major sector will be transformed, deeply disrupting established industries and economies:

- Rapid transformation of the energy system
- Global use of all fossil fuels (Oil, coal, and natural gas) will fall 60% by 2050
- Oil demand is already near its all-time peak, and will drop after the mid-2020s, driven by the mass transition to electric vehicles and improving vehicle efficiency
- Demand for coal will fall by 75% by 2050, due to less use by the power industry
- CO_2 emissions from the power sector will decline rapidly and steadily until 2050
- Wind and solar power will represent over 30% of electricity generation by 2030, and will be the primary power generation sources (accounting for over 60% of the mix) by 2050

Seismic shift in transport within this decade

- Fossil fuel-powered vehicles peak in 2025 , and fall out of production by 2050 as people rapidly switch to zero emission vehicles, which account for 30% of all cars on the road by 2030
- Global truck fleet will decarbonise more slowly, but will still be almost fully decarbonised by 2050 as the fleet transitions to electric and hydrogen fuelled vehicles

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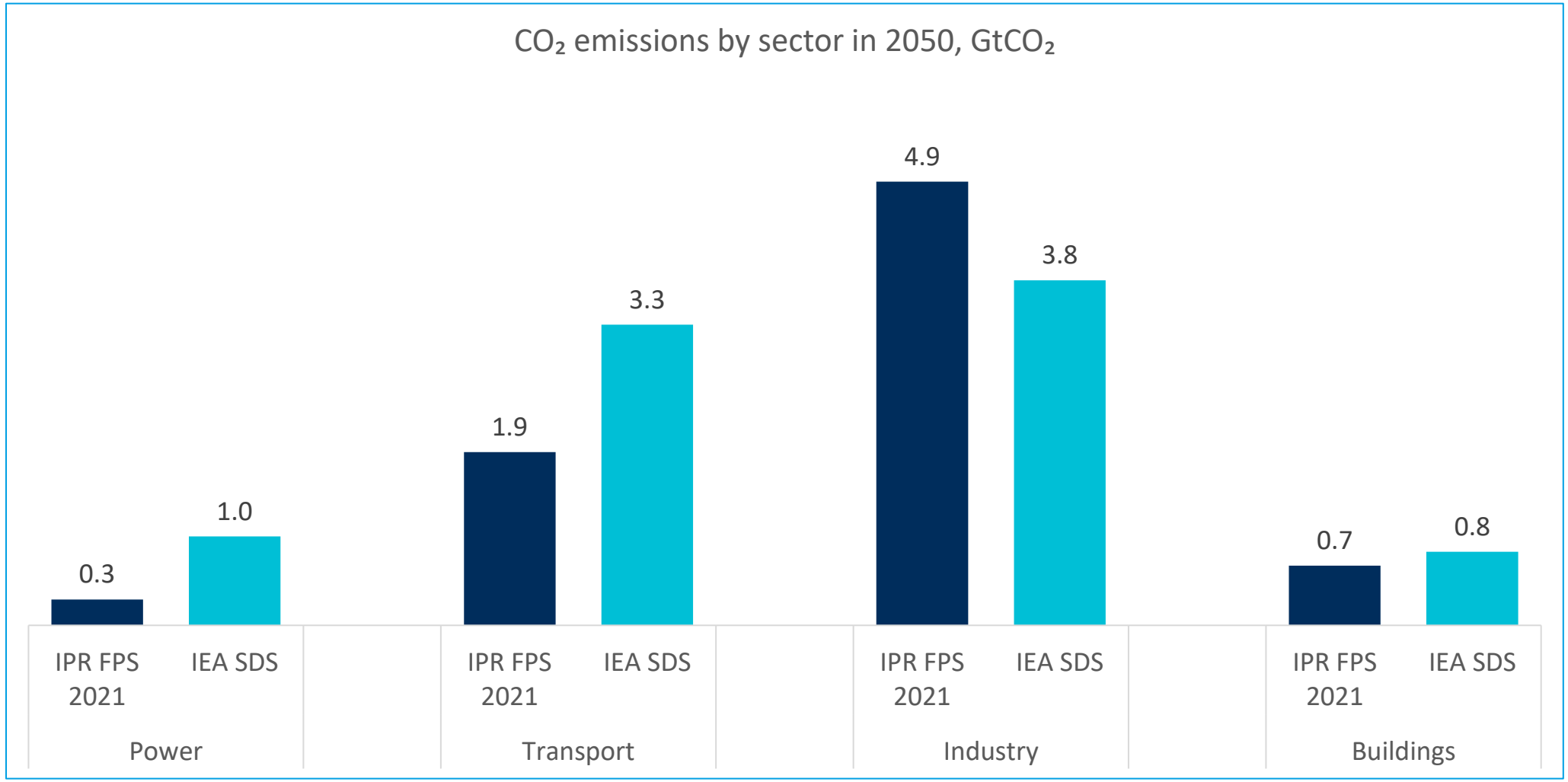
By 2050, IPR FPS 2021 decarbonises more rapidly than IEA SDS in power and transport, but more slowly in industry



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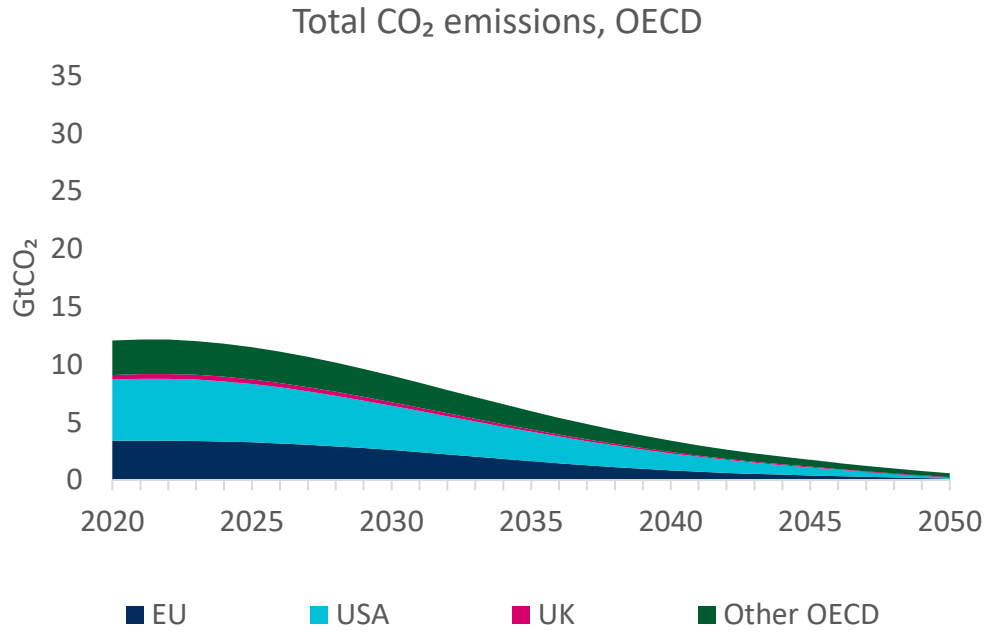
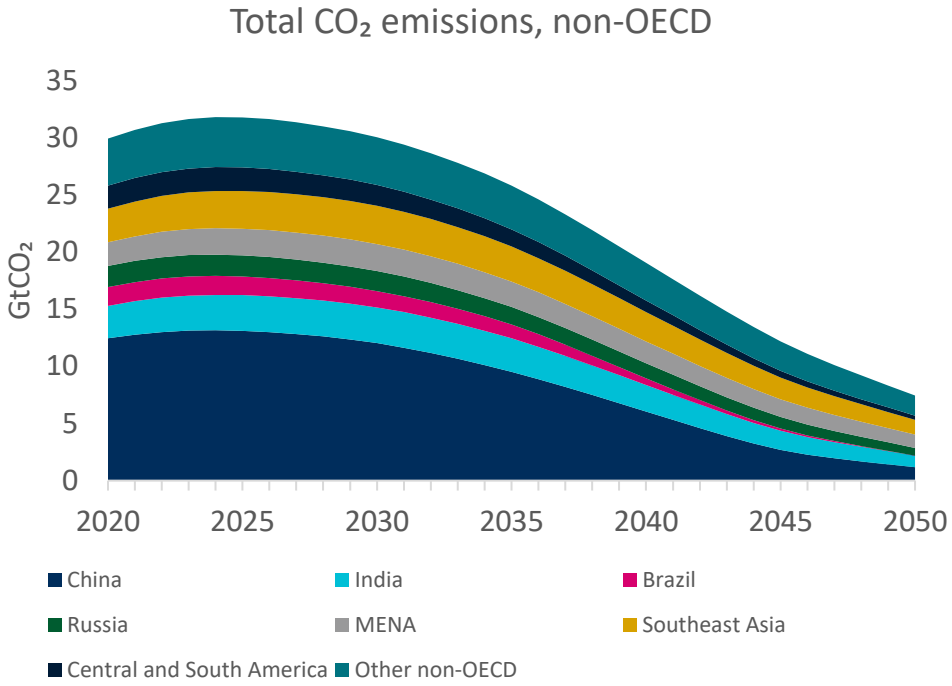
IPR FPS 2021 total CO_2 emissions (on a production basis) reach near zero in OECD countries, though remain substantial in non-OECD countries





- In OECD countries, emissions reductions are rapid due to 2050 net zero targets
- Total (energy and land) CO_2 emissions countries fall from around 12 Gt in 2020 to 9 GT in 2030 and near zero in 2050, with virtually no international offsets required

- In non-OECD countries, emissions reductions are slower due to rapid growth in energy demand, later net zero targets in China, India and Brazil, and lack of net zero targets elsewhere
- Total CO_2 emissions rise in the 2020s and fall back to 2020 levels of 30 Gt by 2030, before declining substantially and falling to 8 Gt in 2050

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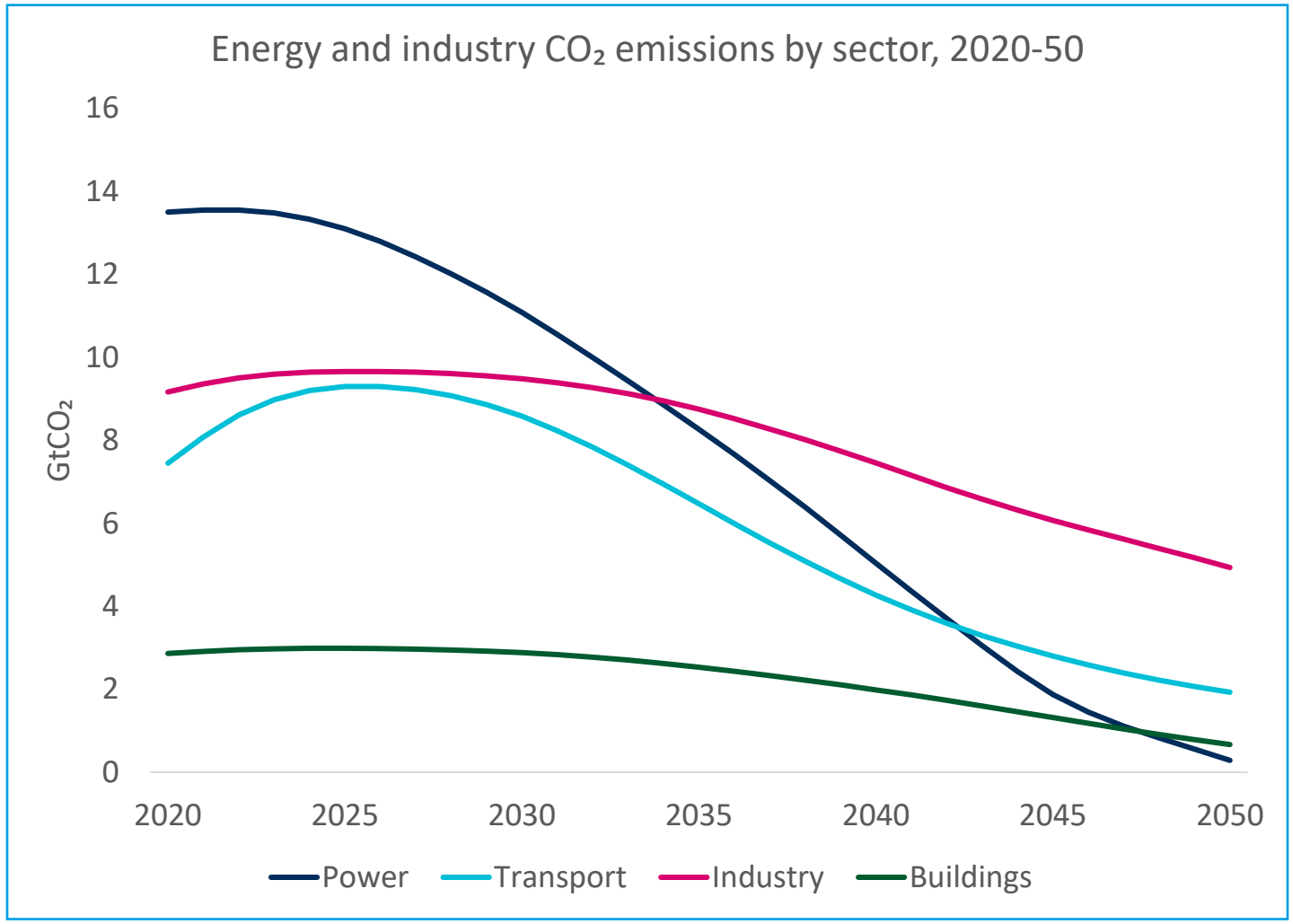
Emissions reductions are most rapid in the power sector, followed by transport and buildings, while industry is slower to decarbonise



- CO_2 emissions fall most rapidly in the power sector, with a 20% fall to 2030 and near 100% by 2050
- In the transport sector, emissions rise to around 2025 as demand grows, before falling to around a quarter of 2020 levels by 2050
- In buildings, emissions also fall to around a quarter of 2020 levels by 2050
- In industry the fall in emissions is less rapid; by 2050 CO_2 emissions fall around 45% and account for the largest share of remaining emissions

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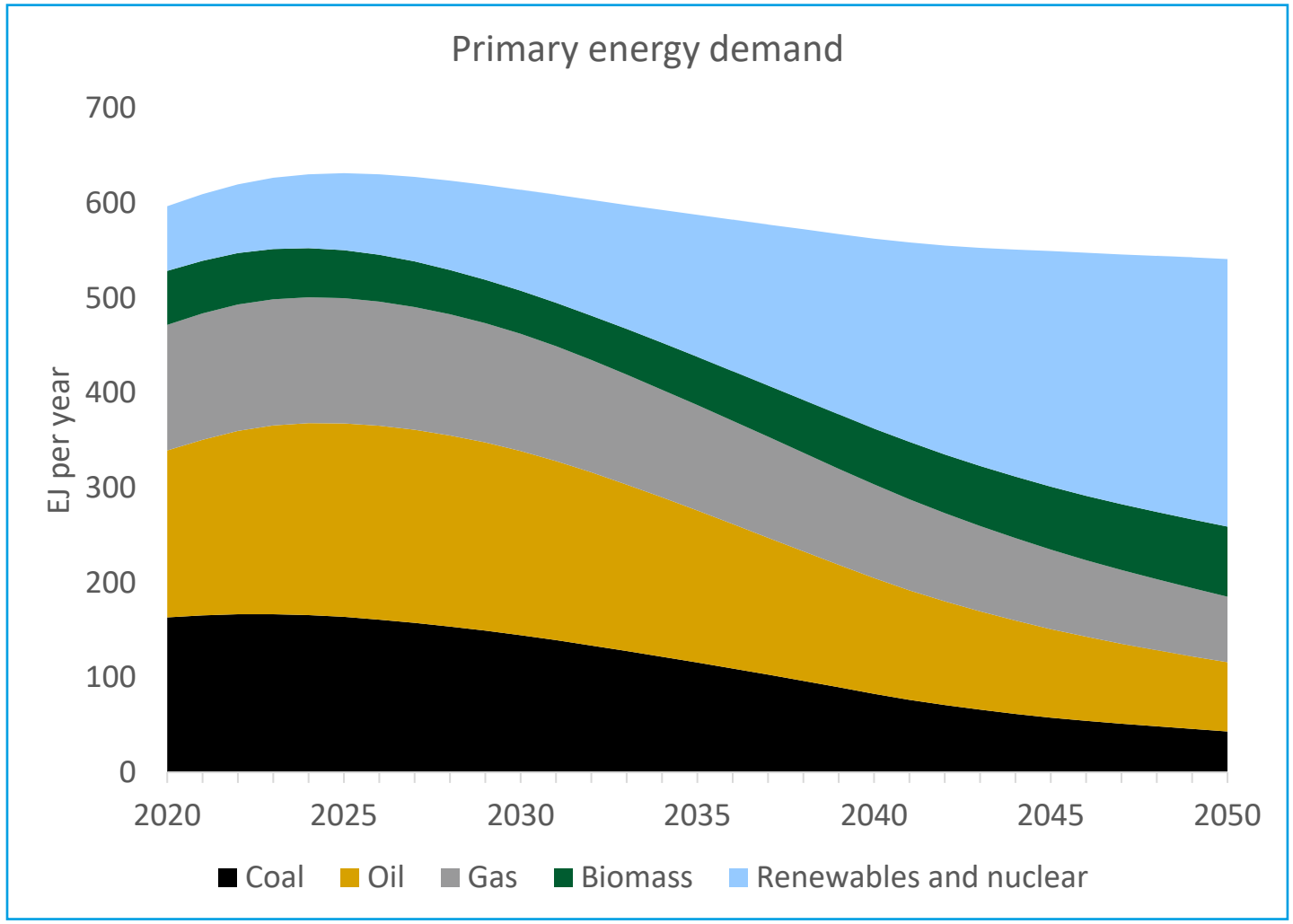
Biomass, renewables and nuclear grow from around 20% of primary energy in 2020 to around 65% in 2050



- The share of fossil fuels in primary energy falls from around 80% in 2020 to below 40% in 2050
- In contrast, the share of biomass, renewables and nuclear rises substantially
- These low-carbon fuels account for the majority of primary energy by the mid-2040s and for around 65% by 2050
- Overall, around 15% of primary energy is used to produce hydrogen

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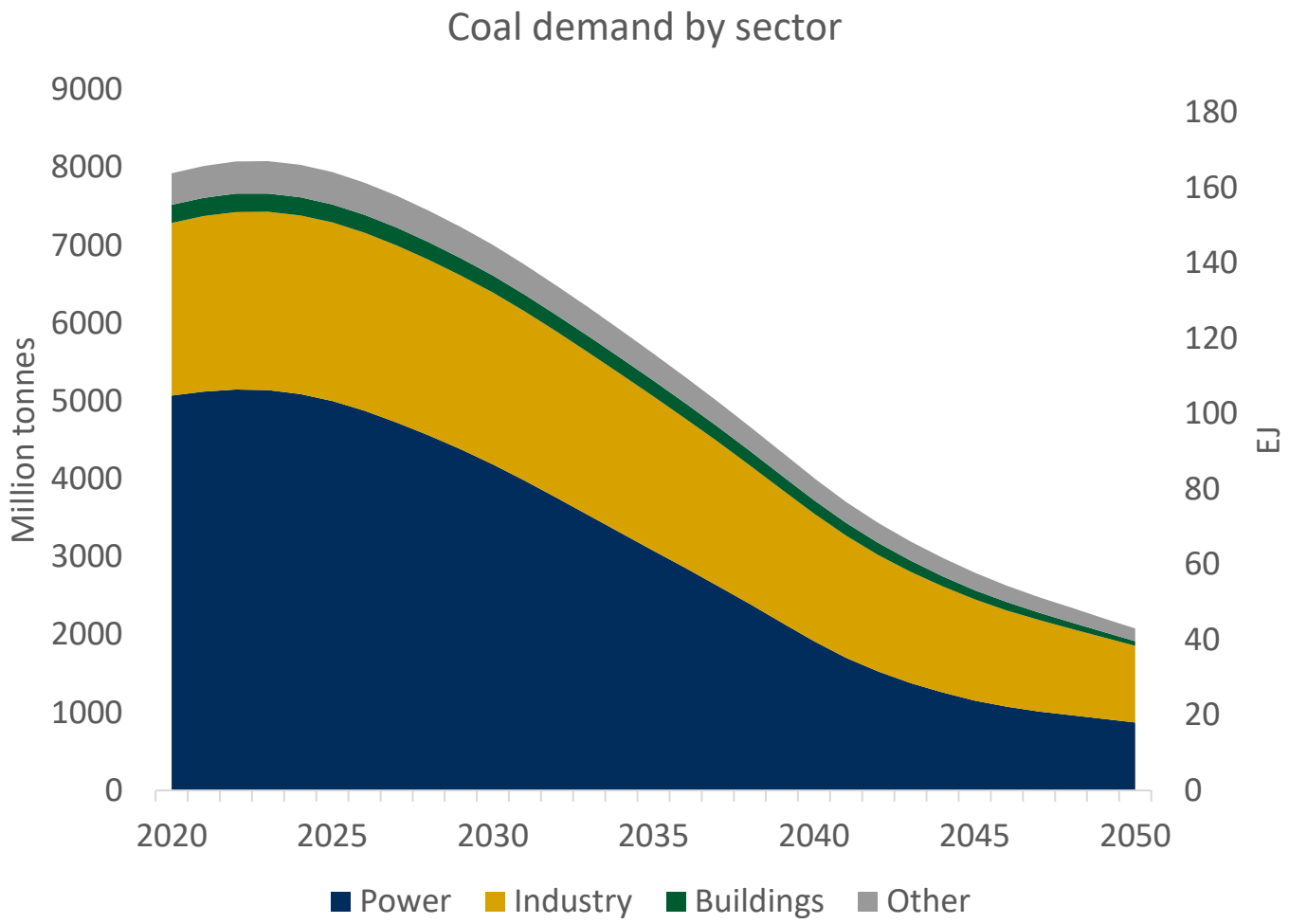
Coal demand falls 70%, driven primarily by a reduction in demand in the power sector; by 2050 industry accounts for the largest share of coal demand



- Coal demand falls around 75% between 2020 and 2050
- Demand from power falls rapidly, with around an 85% reduction 2020-50
- As a result, the share of power in total coal demand falls from over 60% in 2020 to around 40% in 2050
- Demand from industry falls less rapidly, with around a 45% reduction 2020-50
- By 2050 industry accounts for almost half of total coal demand, up from around 30% in 2050

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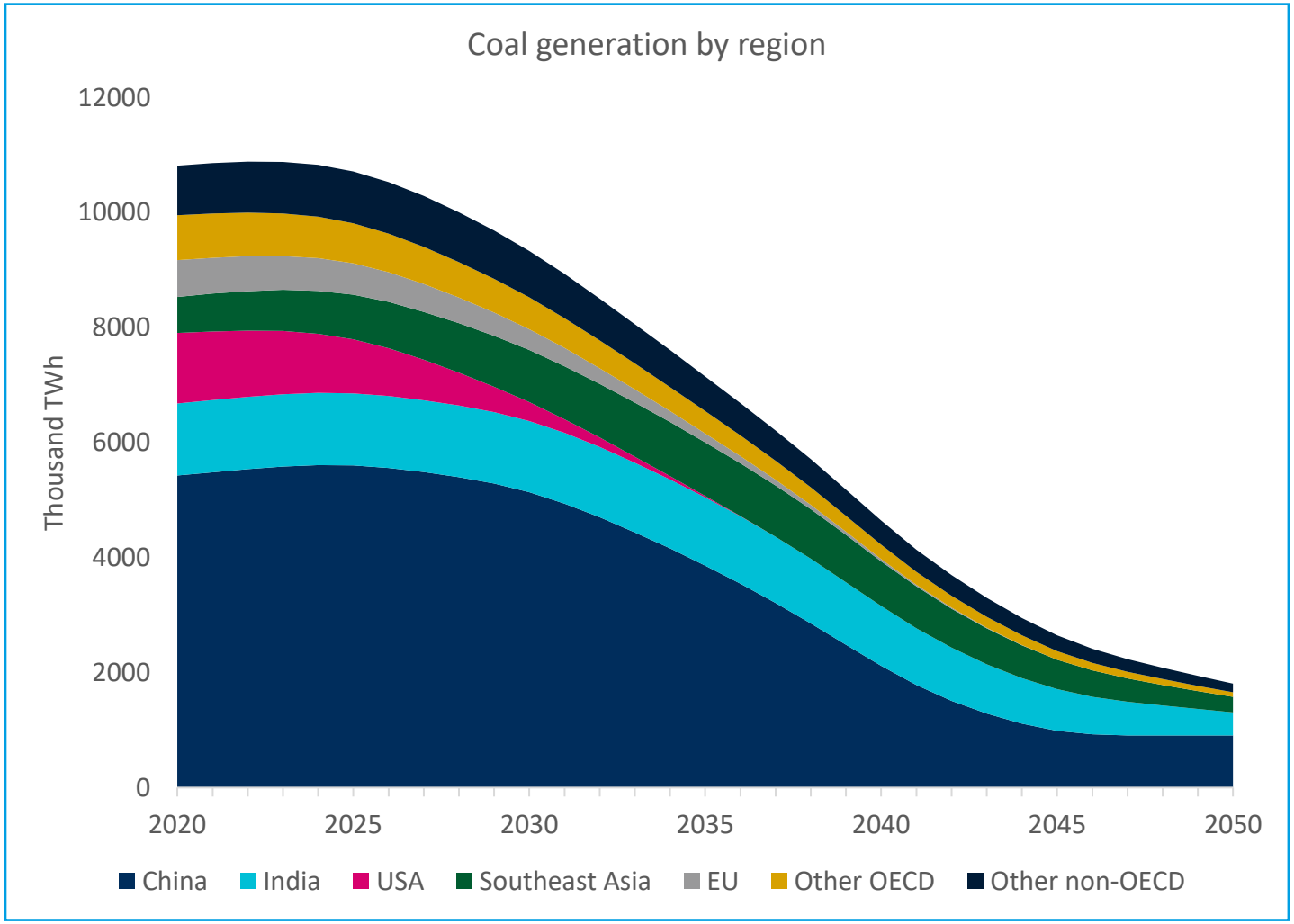
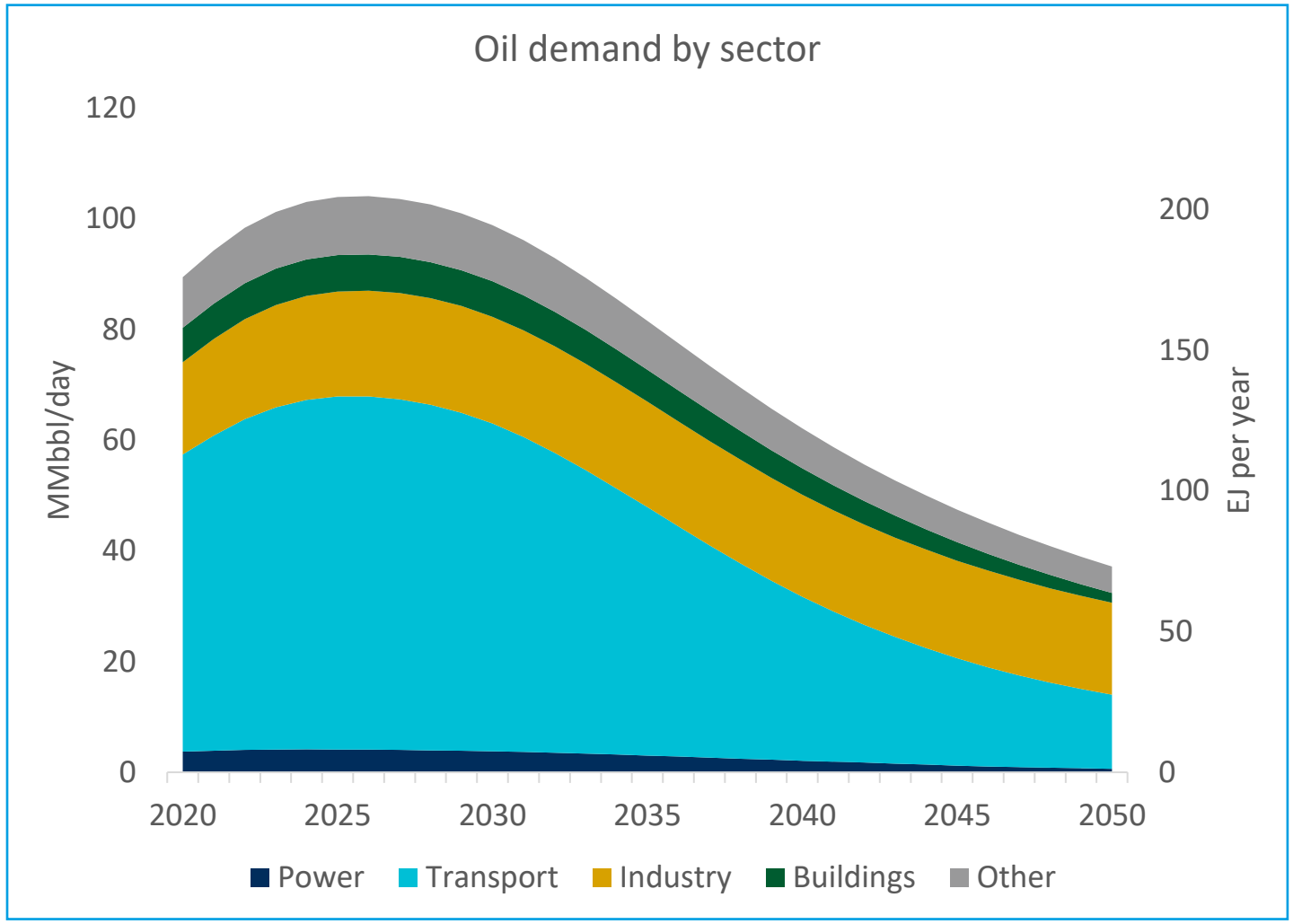
Coal-fired power generation declines around 80% to 2050, with non-OECD countries accounting for all coal generation post-2040



- Coal-fired power generation declines around 80% between 2020 and 2050
- Coal generation in the USA, EU and other OECD countries falls to zero by 2040 as they phase out unabated coal and rely on gas CCS and hydrogen for dispatchable low-carbon power. From 2040, all coal generation is located in non-OECD countries
- Coal generation in China falls over 80% between 2020 and 2050, driven by the phase out of unabated coal. From 2045, residual coal generation in China is retrofitted with CCS to reduce emissions

Note: chart shows total coal, both with and without CCS

Oil demand peaks in 2025, and falls around 60% between 2020 and 2050



- Oil demand grows until the mid-2020s, driven by recovery from the COVID-19 pandemic and further economic growth
- Oil demand peaks around 2025, as transport and other sectors reduce use of fossil fuels. Overall oil demand falls around 60% between 2020 and 2050 as fossil vehicles exit the fleet
- Transport accounts for the majority of the demand reduction; oil demand in transport falls around 75% between 2020 and 2050. By 2050, transport accounts for under 35% of oil demand
- Demand in industry falls only slightly, due to continued use of oil as a petrochemical feedstock, where the carbon content is largely embedded in the products. By 2050, industry accounts for over 45% of oil demand

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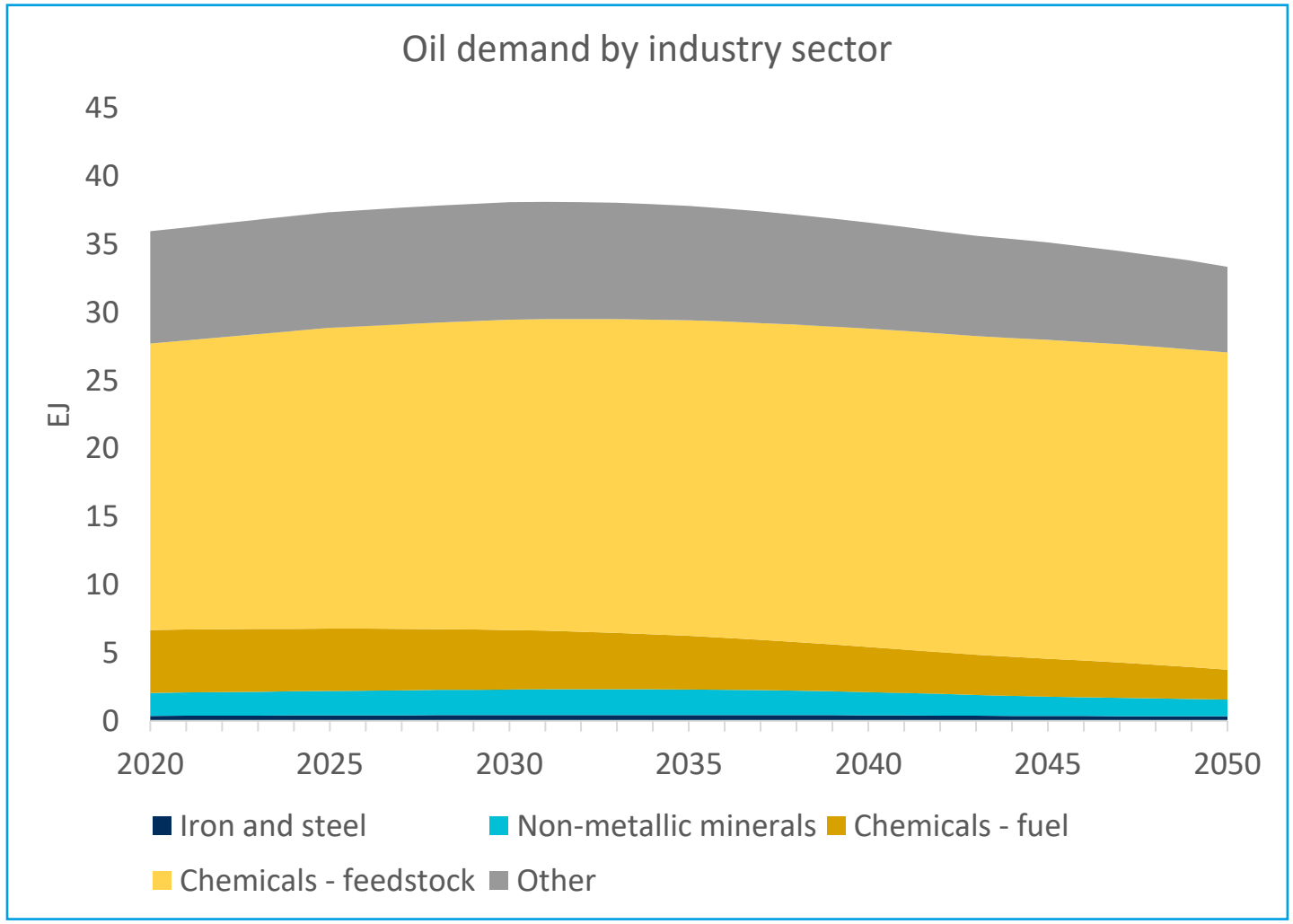
Oil demand in industry remains broadly flat, though it is used primarily as feedstock for chemicals where carbon is embedded



- Oil in industry is used primarily as a feedstock for chemicals, and as a fuel in light industry
- Use of oil as a fuel declines slightly to 2050 as electric and hydrogen heating replace it in many regions; but oil remains in use in countries without net zero targets
- Oil continues to be used as a feedstock for plastics and other high value chemicals, where the carbon is embedded
- Policy moderates but does not eliminate the growth in demand for plastics and other high value chemicals

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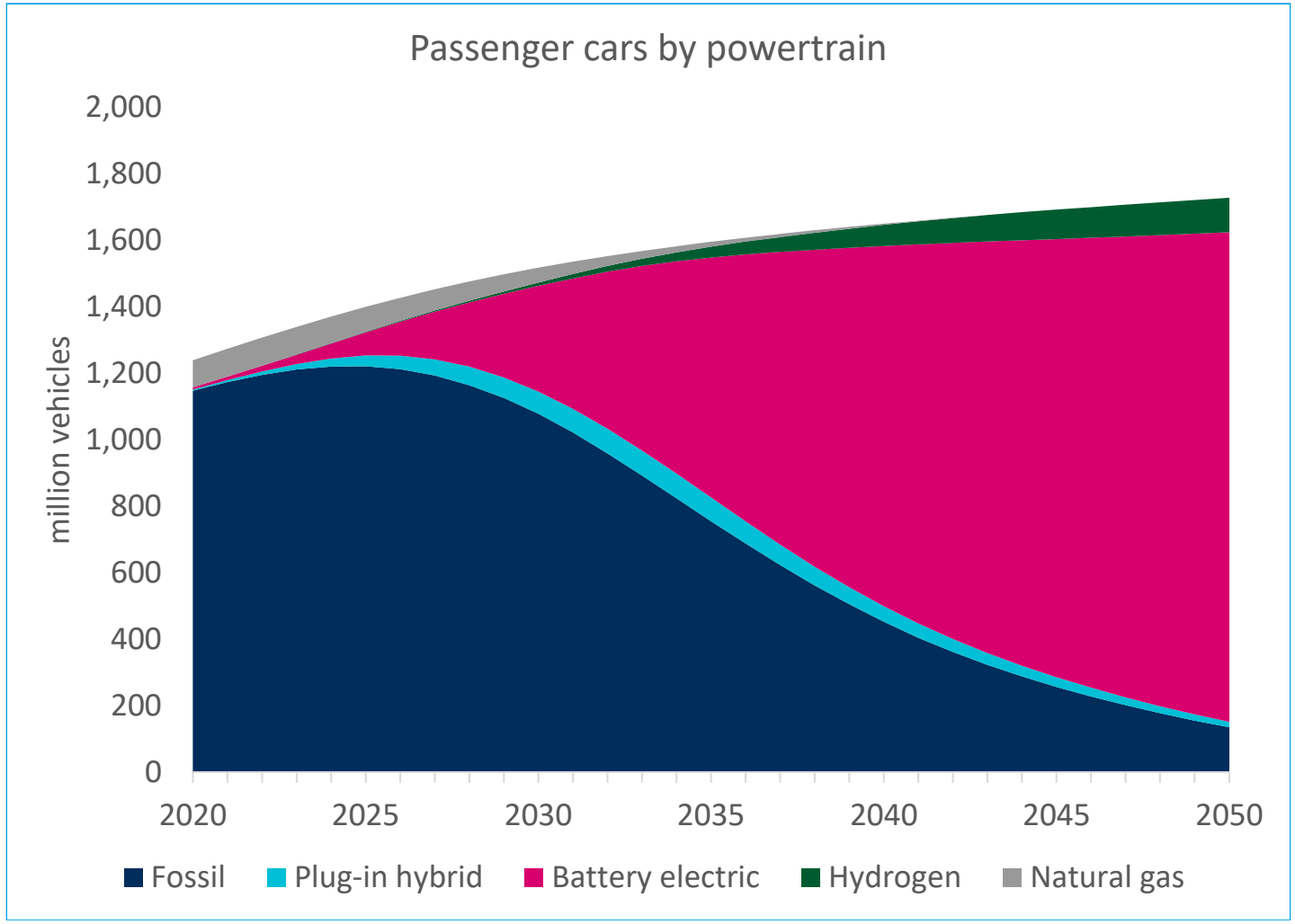
Electric vehicles quickly dominate in light duty vehicles, making up the majority of the vehicle fleet by 2035



- The share of fossil cars and vans in the fleet falls from almost 100% today to under 75% in 2030, and near-zero by 2050
- In contrast, electrified cars and vans grow rapidly, to over 25% of the fleet by 2030 and almost 100% by 2050
- The majority of electrified vehicles are pure battery electric; however plug-in hybrid vehicles and later, hydrogen fuel cell vehicles gain some market share for market segments with large travel distances

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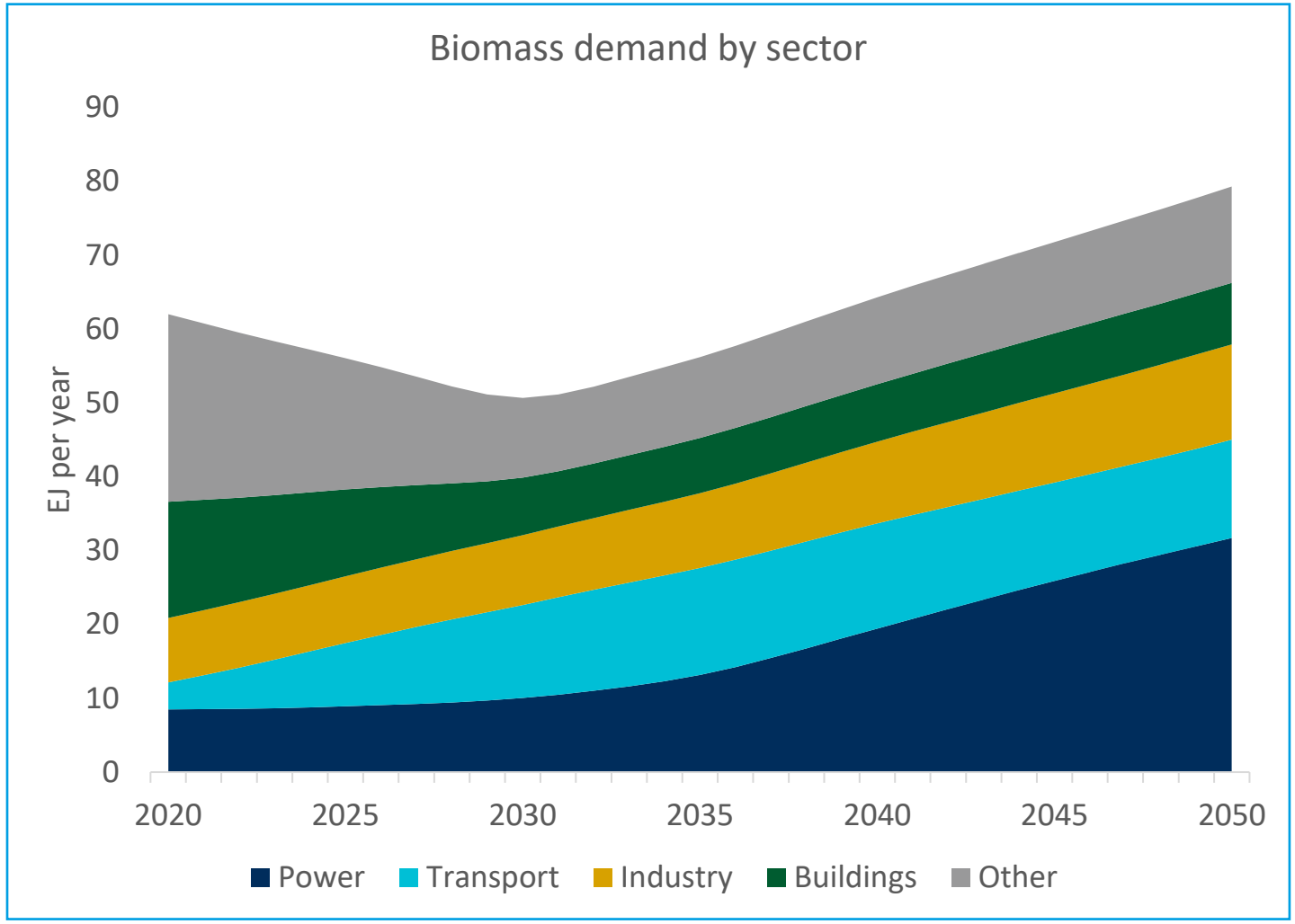
Biomass plays an important role in reducing fossil fuel use across the power, transport and industry sectors



- Biomass is currently used in most sectors. Around half of all biomass use is as traditional biomass for cooking and heating in developing and emerging economies
- Traditional biomass is phased out between 2020 and 2030 as income growth and public health policy drives adoption of modern methods of cooking and water heating
- Between 2030 and 2050, biomass demand rises to almost 80 EJ, reducing fossil fuel use in the power, transport and industry sectors
- The largest growth is in the power sector, where biomass provides baseload generation as well as some opportunities for BECCS

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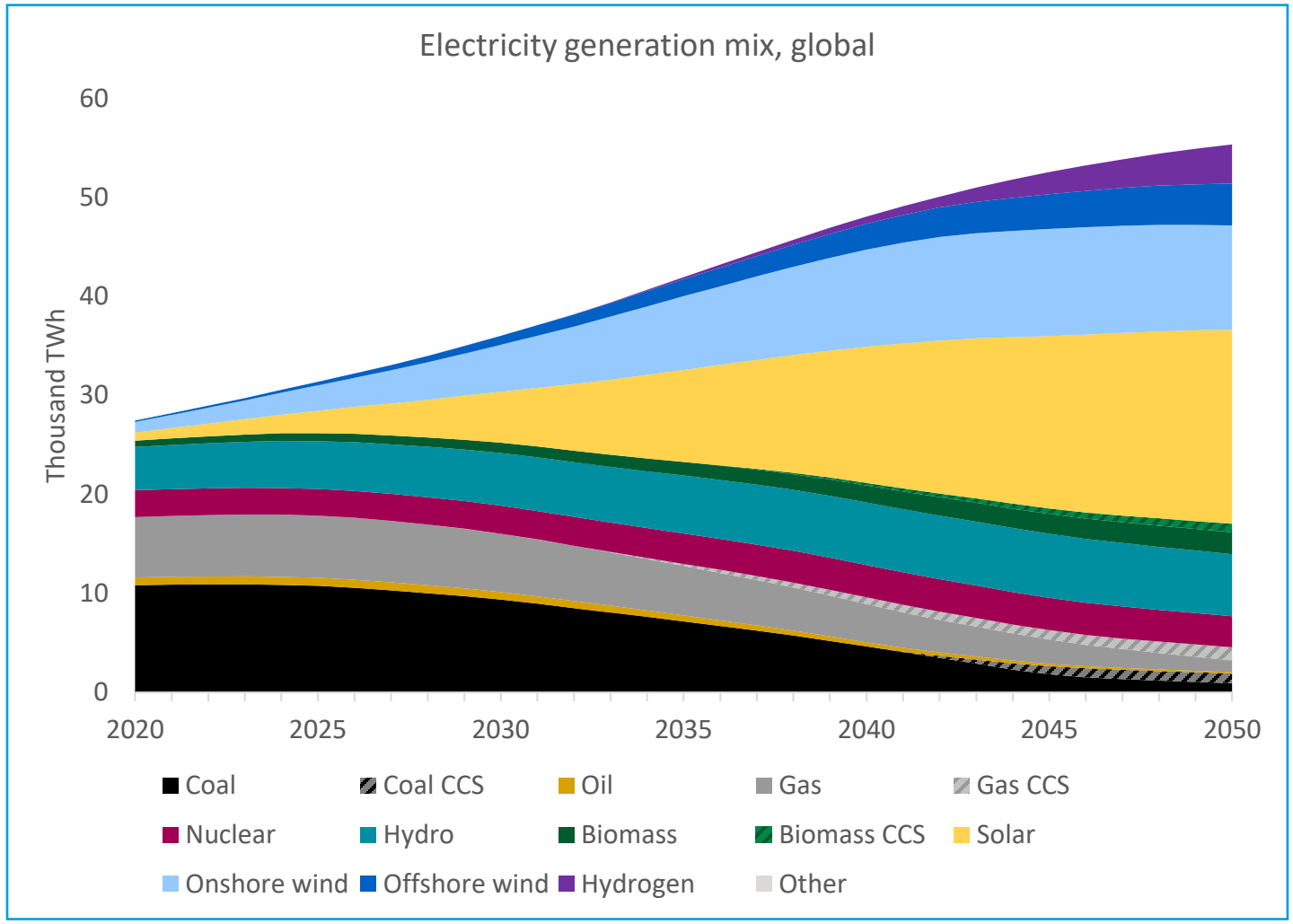
Electricity is almost fully decarbonized by 2050, with renewables accounting for almost 80% of generation



- Fossil generation falls from around 65% of the mix in 2020 to 45% in 2030 and under 10% by 2050. By 2050, CCS accounts for around half of remaining fossil fuel use
- Wind and solar grow from under 10% of the mix in 2020 to over 30% in 2030 and over 60% in 2050
- Including biomass and hydro, renewables account for almost 80% of generation by 2050
- Towards 2050, hydrogen emerges as an important balancing technology
- By 2050, over 95% of generation is low-carbon

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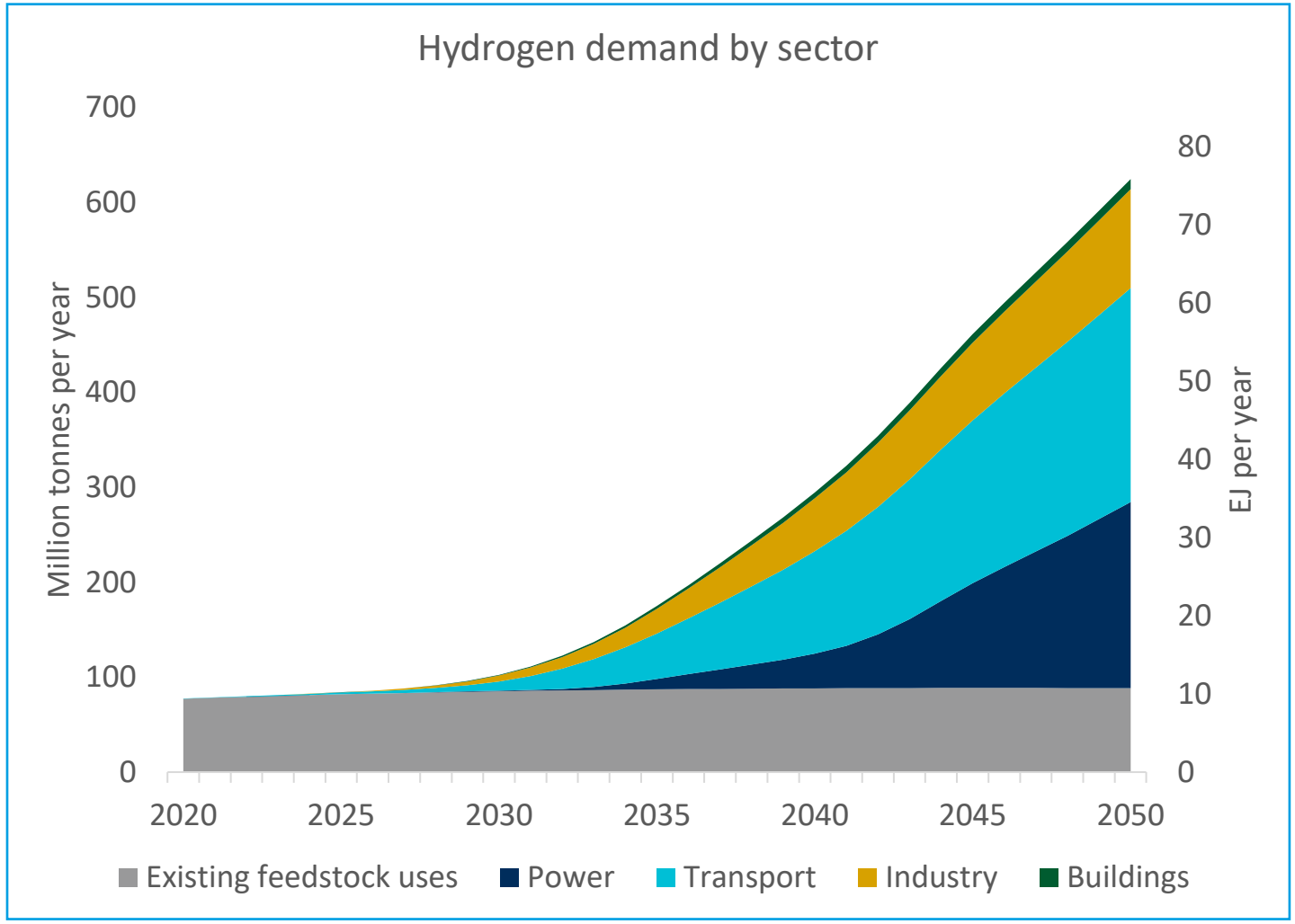
Hydrogen emerges as an important fuel in power, transport and industry, with around 15% of primary energy used for hydrogen production by 2050



- Hydrogen emerges as an important fuel across multiple sectors
- Power accounts for the largest share of demand, as hydrogen plays an important role in balancing supply and demand
- In transport, hydrogen is used as a fuel in the road freight, aviation and shipping sectors
- In industry, hydrogen is used as a reducing agent in iron and steel production, and as an alternative to fossil fuels in generating high temperature heat in a range of industries
- In buildings, hydrogen plays a small role as a low-carbon heating fuel
- Overall, around 15% of primary energy demand is used to produce hydrogen

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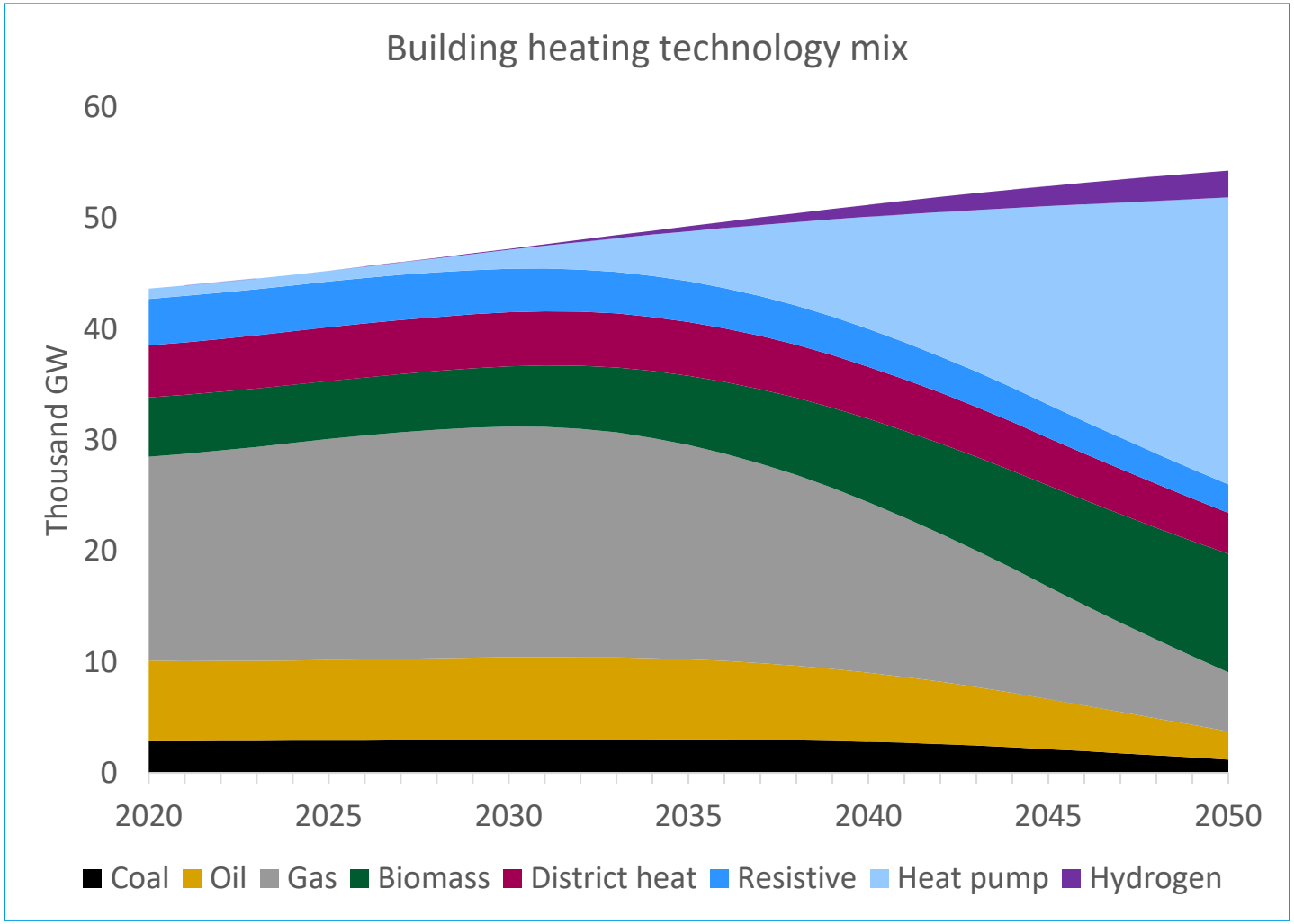
In buildings, electric heat pumps displace fossil heating systems to become the dominant heating technology by 2050



- Policy phases out new fossil heating systems between 2035 and 2050
- Driven by policy, heat pumps begin to dominate heating mix by 2050
- Remaining coal, oil and gas demand is in countries with later phase outs; coal and oil continue to be used in areas not connected to the gas grid
- Hydrogen meets a share of heating demand in regions with an existing gas grid, and a less efficient building stock

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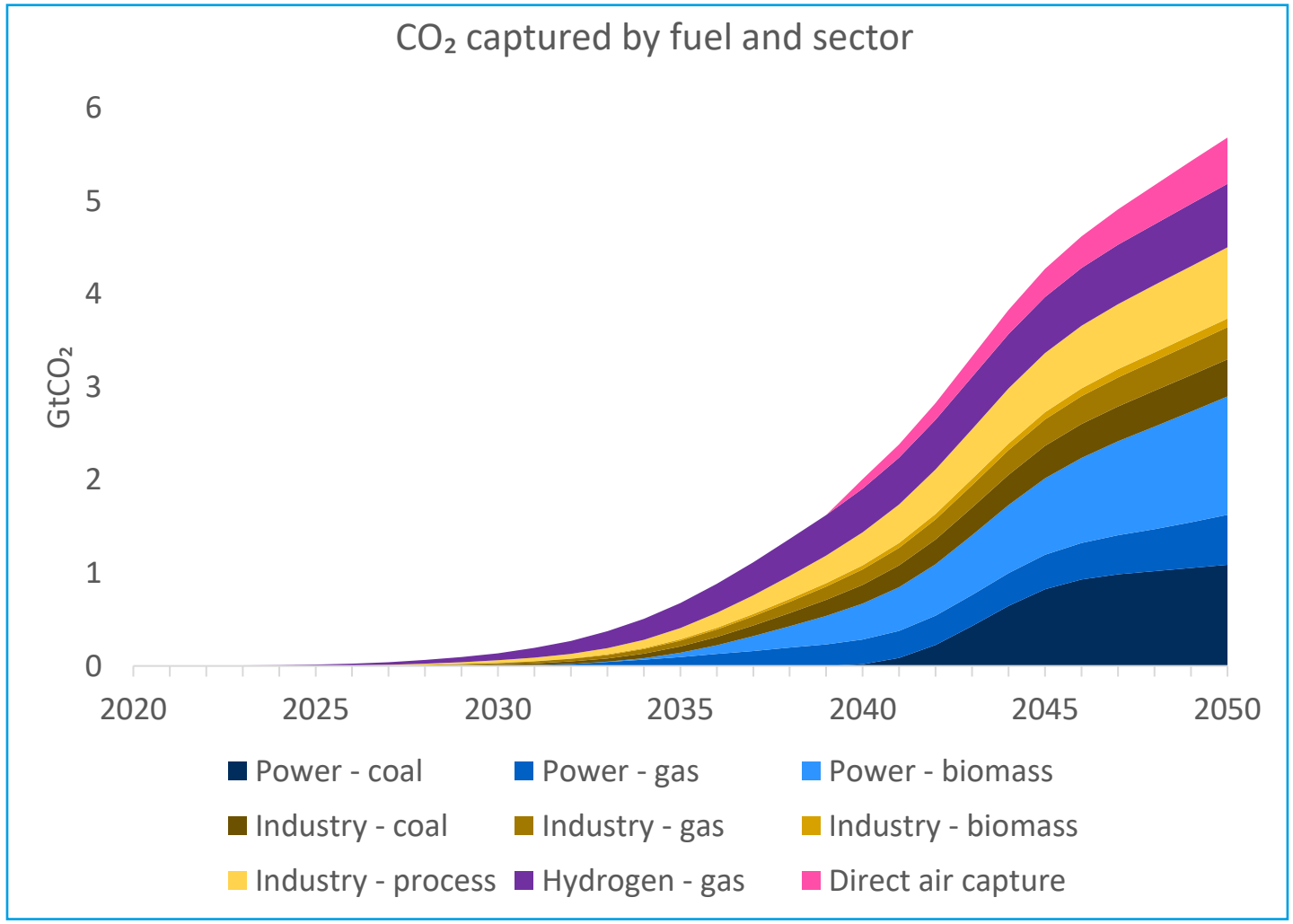
Carbon capture and storage (CCS) reduces emissions by 5 $GtCO_2$ across energy sectors



- Overall around 5 $GtCO_2$ are captured and stored in 2050
- Of this, around 2.5 Gt is captured in the power sector, and 1.5 Gt in the industry sector, where process emissions are otherwise hard to reduce
- A further 0.7 Gt is captured in the production of blue hydrogen
- Finally, 0.5 Gt is captured through Direct Air Capture
- Of the total 5 Gt CCS, around 3.5 Gt of CO_2 is from fossil fuels or industrial processes, while around 1.5 Gt is from biomass or DAC, generating negative emissions

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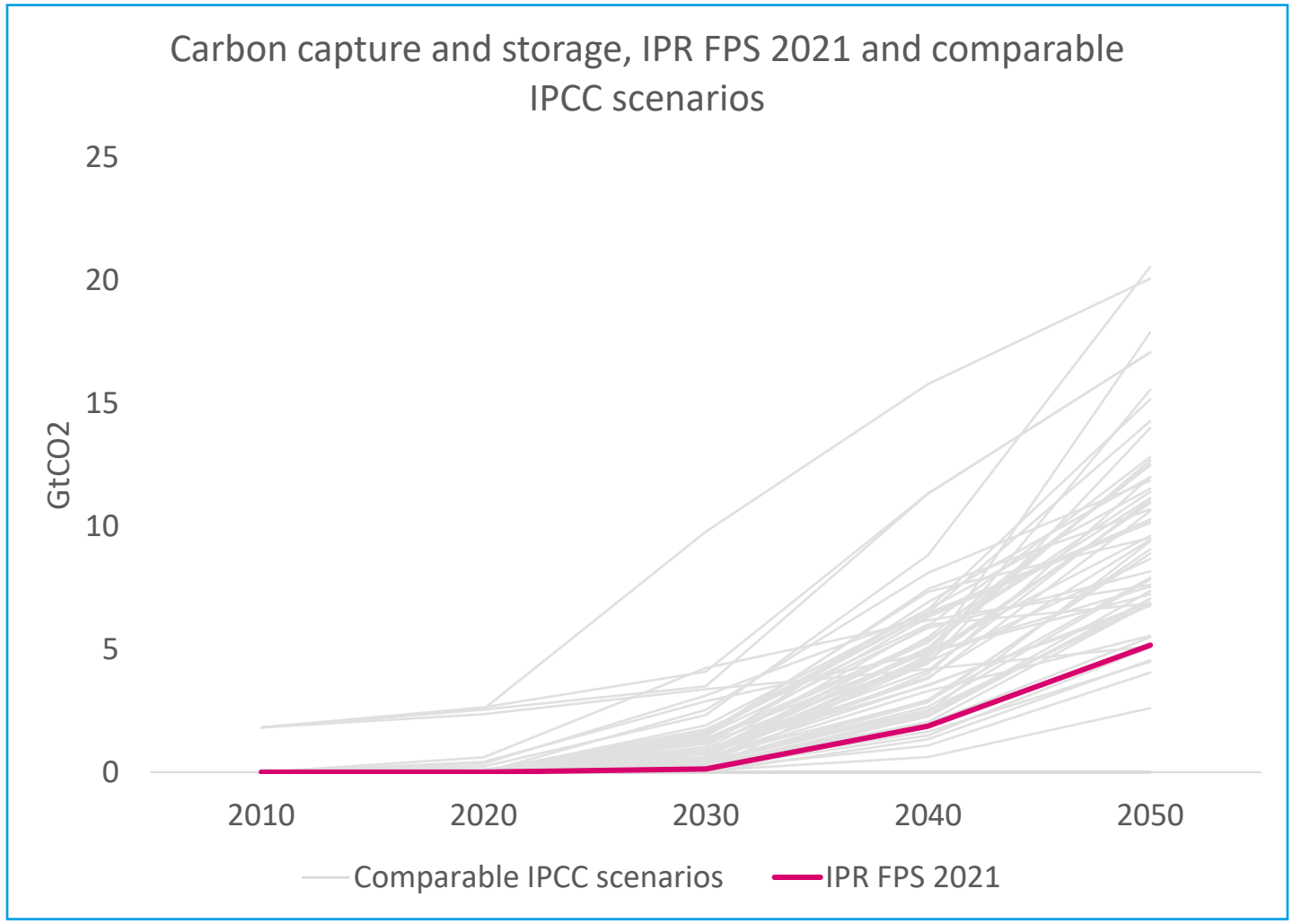
CCS Comparisons



- Almost all scenarios that achieve a below 2 degree climate outcome require CCS
- Across a range of 57 comparable IPCC scenarios (with temperature outcomes between 1.7 and 1.9 degrees), CCS captures between 2.5 and 20.5 $GtCO_2$ by 2050
- In IPR FPS, around 5 $GtCO_2$ are captured and stored in 2050, lower than levels in over 90% of comparable IPCC scenarios

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- IPR FPS 2021 land use system results

Key findings food and land use

Unlike many scenario models, IPR addresses a major gap by integrating greater detail on the food and land use system in modelling its interaction with the energy system and economy. This reveals how critical often-overlooked assumptions on food and land use emissions and Nature-Based Solutions (NBS) are to achieving climate goals. The analysis finds:

- Meat consumption will peak by 2030 globally and will rapidly decrease after alternatives become cost competitive by 2035. Current pasture and rangelands will be replaced with forests, cropland, and other NBS
- These changes mean land will be a net CO2 sink before 2050 and will yield 7Gt of emissions reductions by 2050. 4,7 Gt will come from NBS that remove carbon from the atmosphere, and the rest will come from avoiding deforestation
- Together removal and avoided deforestation projects will lead to an industry with an estimated 167bn annual revenue by 2050, with China having the highest cumulative NBS deployment to 2050 potential

Note: The Model of Agricultural Production and its Impact on the Environment (MAgPIE) is the main source of insight for the calculations in this chart section (unless indicated otherwise). More info on the model can be found here: https://www.pik-potsdam.de/en/institute/departments/activities/land-use-modelling/magpie

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The land use transition will play a significant role in economic decarbonization, driving both risks and opportunities for financial institutions

	Mitigation potential ($GtCO_2e$/year in 2050) in IPR FPS 2021
Forestry – The forestry sector grows enormously in order to provide carbon sequestration service – Re/afforestation are high-potential, low-cost mitigation sources, with ~3.4 Gt CO_2/year of annual carbon sequestration achievable for less than USD 150/tCO_2 by 2050.	3.4 Gt
Low carbon agriculture – New techniques to sustainably intensify production and to reduce agricultural emissions are deployed to make agriculture more GHG efficient – Major improvements are possible in developing countries, particularly in the tropics where forest carbon stocks are dense. More broadly, options exist to reduce methane reduction of remaining ruminant production.	1.3 Gt
Bioenergy – Land availability and demand for bioenergy as a low-carbon fuel source will drive increased production of second-generation bioenergy - including the use of bioenergy with carbon capture and storage.	1 Gt
Food production change – Food production transforms away from products and production processes with high GHG costs – Shifting away from animal protein sources, particularly beef and lamb, will reduce non-CO_2 (methane and nitrous oxide) GHGs associated with livestock and fertilizer for feed. Importantly, this includes a tipping point toward alternative meat products.	0.8 Gt*

Note: *Calculated as the difference between agricultural emissions in 2050 and 2020 in the FPS scenario.
Source: Vivid Economics

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IPR FPS 2021 is based on a number of regulatory, behavioral and technological drivers of change that are expected to accelerate in the land-use sectors

Key policy, behavioral and technological shifts in the IPR FPS 2021 related to land use

Regulation:

- Carbon prices will increase the cost of high emitting products and incentivize Nature-based Solutions (NBS)
- Government forestry policy, including creation and enforcement of controls on deforestation and directed re/afforestation programs will lead to a growth in forest land
- Fertilizer taxation will encourage a reduction in fertilizer use, reducing N20 emissions

Shifts in food production:

- Government regulation will increase the cost of animal protein and encourage the production of alternative meat
- Consumer preferences will shift away from animal meat and towards alternative meat due to concerns over sustainability and health
- Technology development will reduce the cost and improve the taste of alternative meat

Bioenergy demand: global demand for bioenergy will increase globally, with regulation implemented to ensure the sustainability of bioenergy and reduce competition with food for land use.

Macroeconomic drivers are also critical to the long-term trajectory of the land system – both global population and GDP are expected to increase significantly over the next 30+ years, putting major pressure on land and food demand.

Source: IPR Forecast Policies

Food production shifts in response to climate policy and technology changes with demand shifting to ruminant meat substitutes

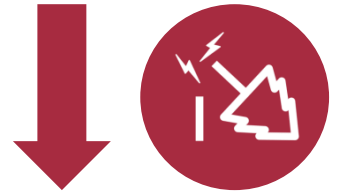
- **Growing alternatives – Companies producing beef substitutes** (both lower emitting meats and animal meat substitutes) will experience substantial benefits from the introduction of stricter climate policies.

Lower-emitting meats and animal meat substitutes

- **Demand declines – animal meat consumption is forecast** to decline by 2050 due to consumer concerns over sustainability, emerging health dietary guidelines (halving of per capita consumption imposed in China), and the increasing price competitiveness of animal meat substitutes

Beef, lamb and pork

- **Supplier risks – stricter regulations and greater consumer awareness are increasing regulatory and reputational risks for companies that contribute to deforestation** and land degradation, particularly around biodiversity hotspots and large carbon sinks, such as the Amazon rainforest. For example, recent fines to AgroSB and JBS in Brazil*



Deforestation-based agriculture

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Note: *AgroSB, a Brazilian cattle producer, and JBS, a Brazilian meat-processing company, were fined USD 25 million as their activities were linked to deforestation in protected areas on the Amazonian agricultural frontier. Source: Phillips et al., (2019)

Policy changes, consumer behaviour, and technology drives a change in food production, which varies by region

Demand shape	Consumer preferences	Food technology	Policies
Peak animal meat 2030, 30% fall to 2050	• Consumers already demonstrating willingness to substitute animal meat with alternative meat • Adoption will vary by region, depending on price sensitivity as well as food culture trends	• Technological progress leading to early plant-based meat price and taste parity in lower quality meat markets • Cell-based meat becoming price competitive 2035-2040	• Global support for cellular agriculture with effective policy framework emerging gradually, starting with a few leading countries • Financial incentives for the production of alternative meat

Source: Vivid Economics

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Different animal meat consumption is forecasted depending on the region and type of product (peak year)

Meat type	Europe, North America, Aus and NZ	Brazil, Latin America, Developed East Asia	Mainland China, DPRK, Taiwan, HK and Macau	Sub-Saharan Africa
Non-structured meat e.g. burgers, mince	2025 Saturated markets	2030 Slow-growing markets	2030 Plant-based meat consumption to slow growth	2040 High growth potential
Structured meat e.g. steak, chops	2030 Saturated markets	2030 Slow-growing markets	2035 Market growth as inco mes rise	2040 High growth potential

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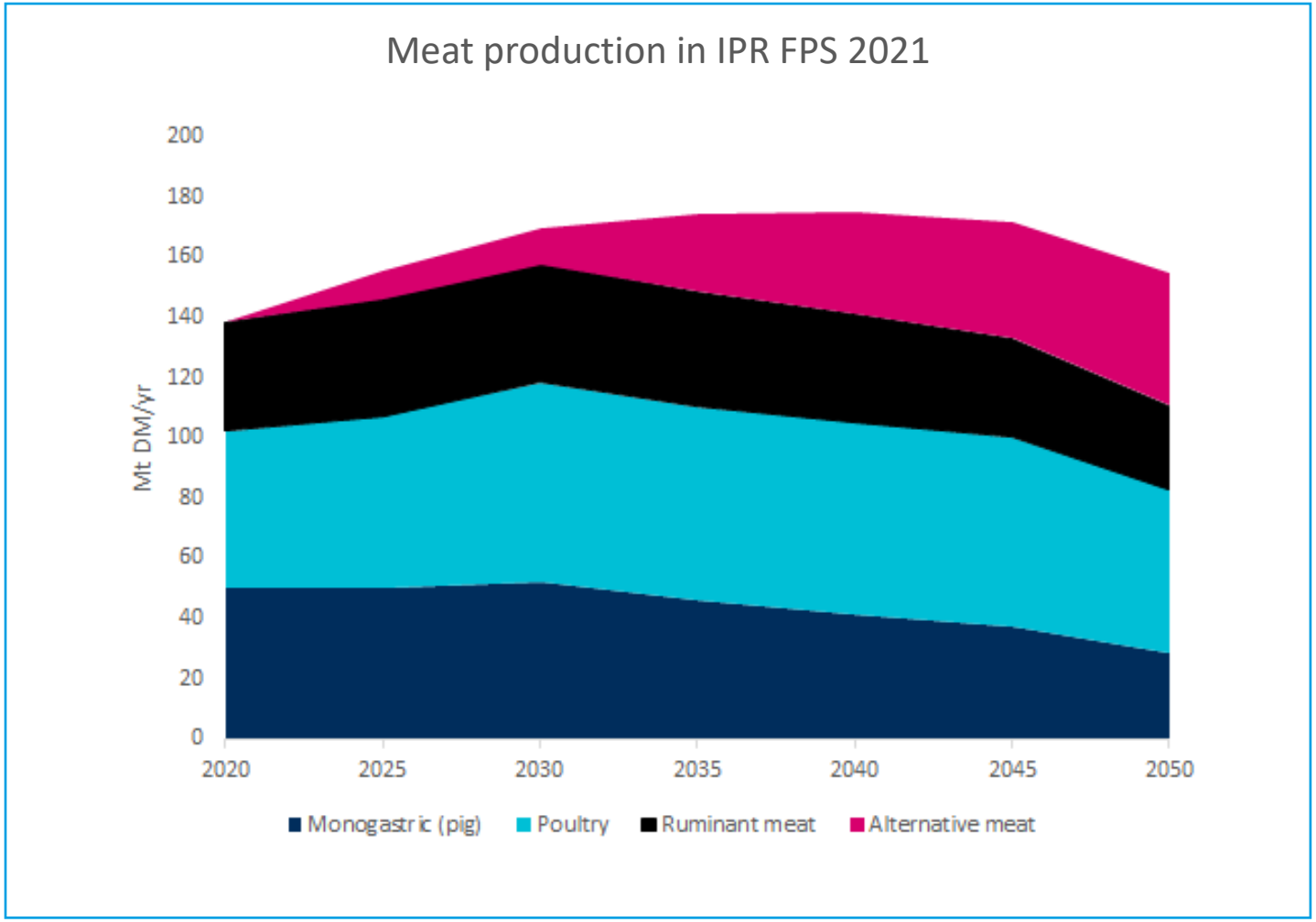
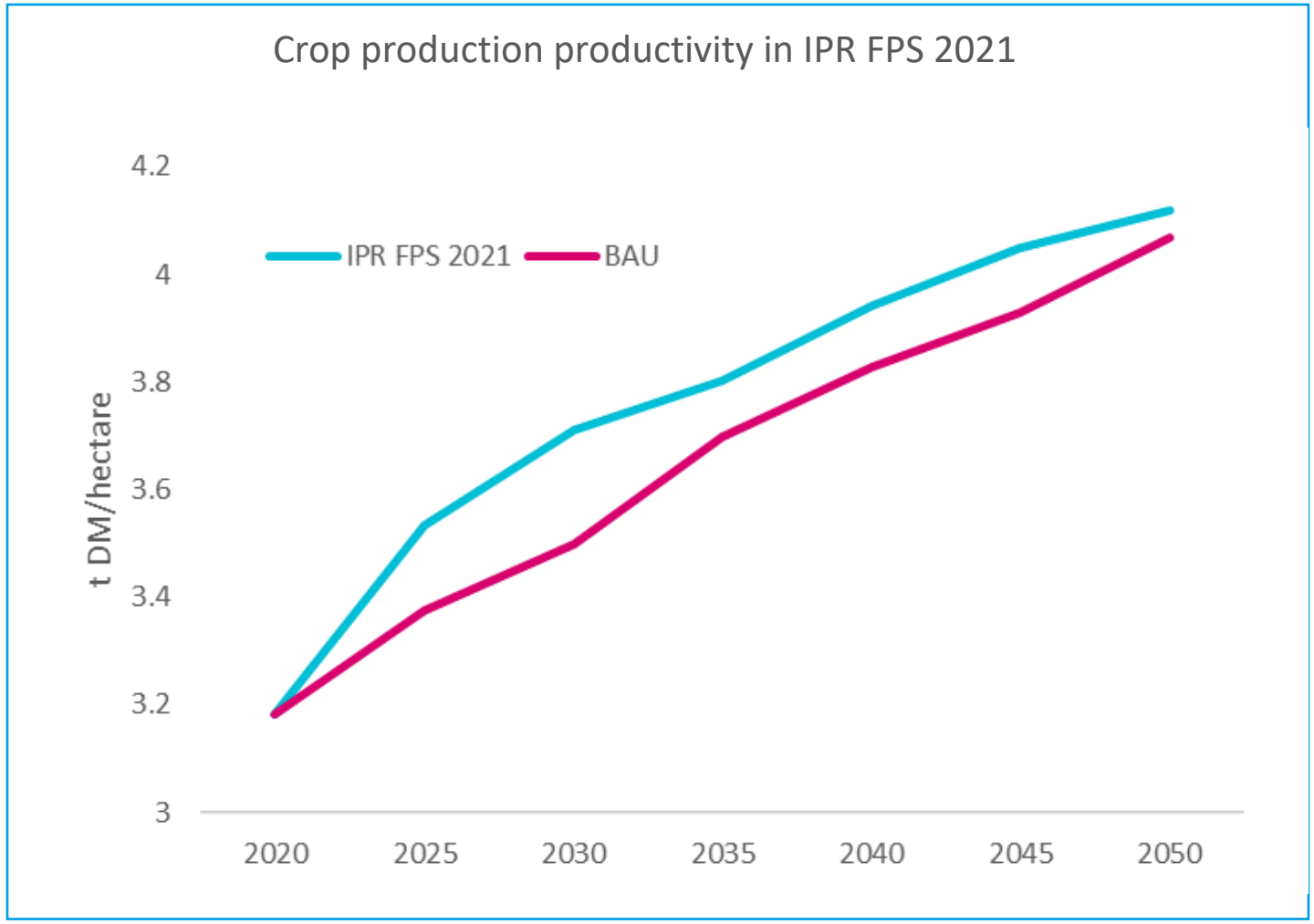
Decline in ruminant meat consumption will give way for alternative meats like plant-based and cell-based meat



- **30% reduction in animal meat production between 2030 and 2050**, as a result of rising prices and changing consumer preferences
  - ◊ Reduction in per capita meat consumption led by tier 1 countries, in addition to China and Brazil
  - ◊ BAU foresees a 28% increase in animal meat production over the same period
  - ◊ Relatively small decline in poultry production due to lower emissions costs
- Production of alternative meat increases, reaching a 28% market share by 2050
  - ◊ Material market share reached as the cost of cell-based meat becomes more competitive in the 2030s and 2040s

Source: Vivid Economics with components from FAO

Carbon economics will drive more efficient land use and agricultural practices by raising the cost of land conversion

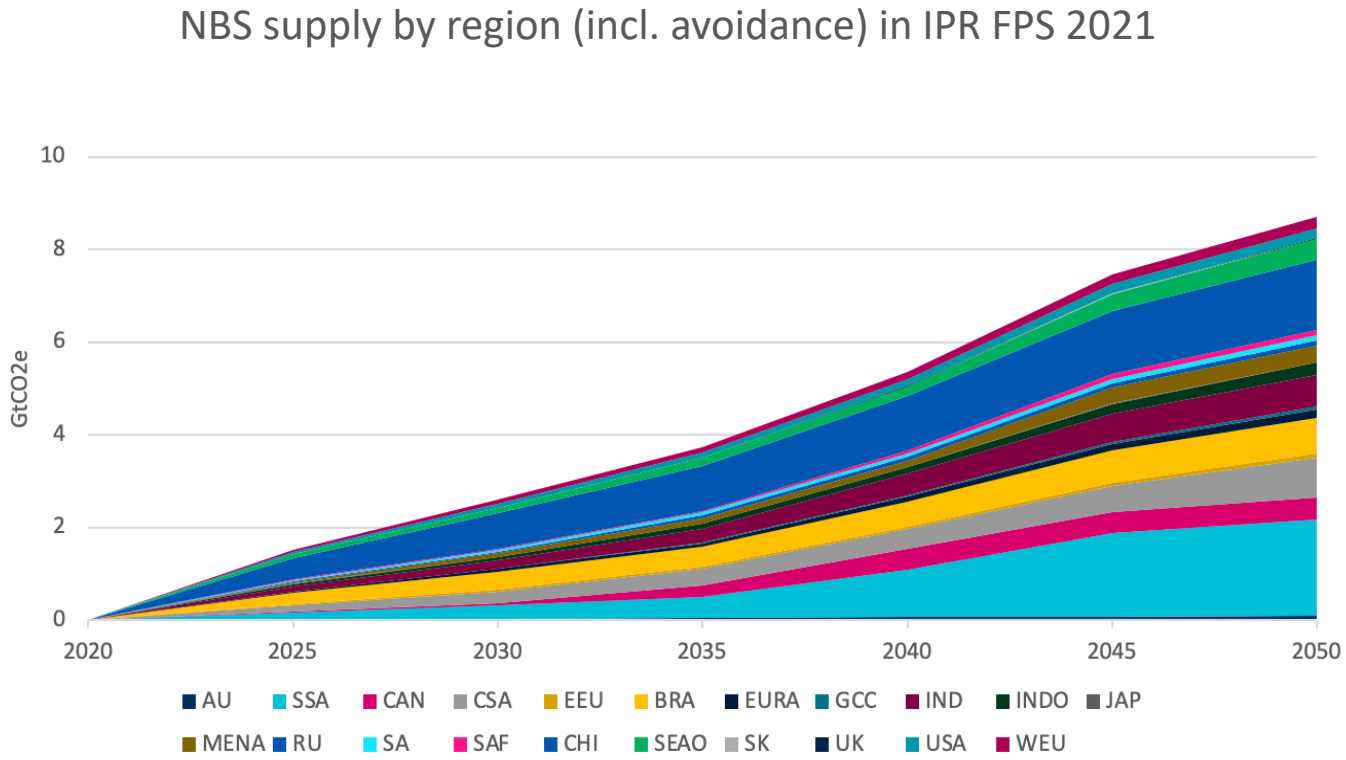


Producers of commodities that have relied on extending crop and pastureland will need to increase productivity per hectare, while reducing the emissions per unit of production. The winners will be:

- Producers that apply more sustainable practices, including better fertilizer application, regenerative agriculture, and ruminant meat production with reduced methane emissions
- Producers able to sustainably manage water inputs and waste outputs
- Companies that supply technologies that increase productivity while managing emissions
- Midstream and downstream companies able to manage their producer suppliers to improve techniques, especially smaller producers in tropical countries

Source: Vivid Economics

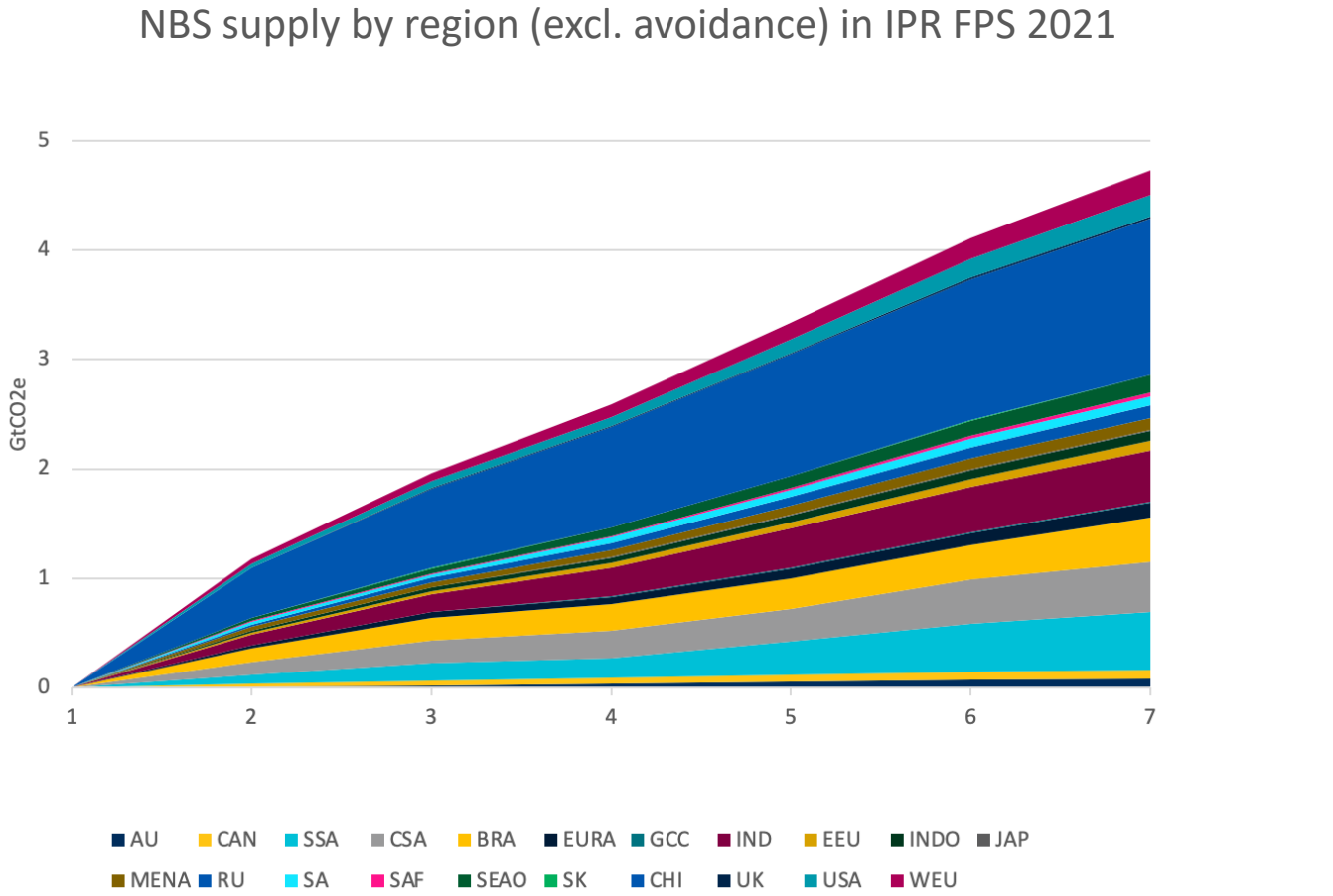
Global abatement of GHG with NBS is expected to reach almost 8.7 GtCO2eq in 2050, including avoided deforestation



- IPR FPS 2021 expects NBS to ramp up significantly from 2035, with sequestration rising from 3.7 $GtCO_2e$ in 2035 to 8.7 $GtCO_2e$ in 2050
- **The largest contribution is from a broad set of NBS** that aim primarily to remove CO_2 from the atmosphere, creating negative emissions
- **Large abatement opportunities exist in avoided deforestation**, which is expected to lead to 4 $GtCO_2e$ fewer emissions versus BAU in 2050
- Improved timber management practices are expected to contribute 1 $GtCO_2e$ of abatement in 2050

Source: Vivid Economics

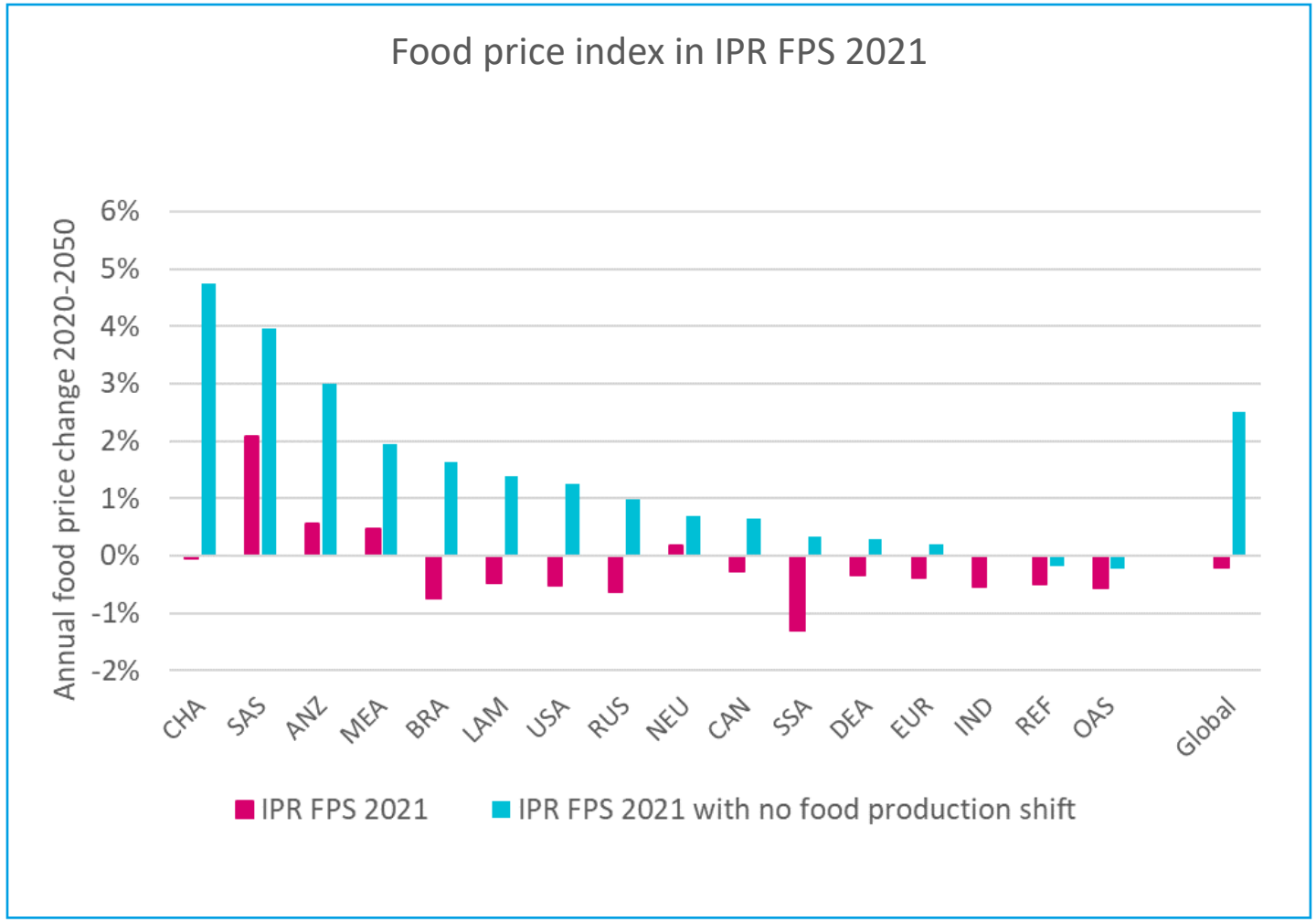
Global removal of GHG with NBS is expected to reach 4.7 GtCO2eq in 2050, with the greatest sequestration potential occurring in China



- The greatest sequestration (1.4 Gt) is expected to occur in **China** through **reforestation in the form of NDC and timber plantations**
- **Sub-Saharan Africa** (0.5 Gt) and **Brazil** (0.4 Gt) realise significant GHG removals by deploying **private and governmental reforestation NBS**
- **NDC reforestation and agricultural solutions** drive **India's** NBS supply of 0.5 Gt
- **Europe** will deploy around 0.25 Gt of NBS predominantly in the **agricultural and forestry sectors**

Source: Vivid Economics

Changes in food production reduce food price pressure and open up resource availability for increased biomass production



- Competition for land between food and biomass production for energy will decrease, once the food system shifts away from ruminant meat, requiring less land
- Shifts in food production will reduce food price inflation - incorporating a shift in food production reduces food price inflation to -0.2% pa, compared to 2.5% pa in the case of no shift in food production
- Australia and New Zealand (ANZ), China (CHA) and South Asia (SAS) show the highest food price increases driven by bioenergy production

Source: Vivid Economics

Second generation, more sustainable bioenergy production will grow in response to climate policy

- Regulation will increase the cost of fossil fuels and promote investment in alternative fuel sources
- Hard-to-abate sectors that can not transition to electrification easily (e.g. heavy industry) will rely on bioenergy as part of their decarbonization plans
- The introduction of emissions pricing in the land use sector will incentivize a shift away from first-generation and toward second-generation energy crops, and particularly toward producers that can demonstrate very high-standards for the sustainability of production
- Governments are scaling up support for bioenergy as a low-carbon fuel source
  - The US Department for Energy announced USD 61.4m in support for the development and demonstration of bioenergy projects in April 2021[1]

Source: [1] Biomass Magazine (2021)

IPR FPS 2021 includes detailed analysis of 10 types of Nature based Solutions

Which NBS are covered in IPR FPS 2021?						
	Forestry	Peatland	Mangroves	Seagrass	Agroforestry	Soil
New deployments	Managed afforestation (NPI and non-NPI); new timber plantations	Peatland restoration	Mangrove restoration	Seagrass restoration		
Avoided impacts	Avoided deforestation of primary and secondary forests	Avoided peatland degradation	Avoided mangrove degradation	Avoided seagrass degradation		Avoided grassland conversion
Improved practices	Switch to sustainable management of timber plantations				Trees in cropland; silvopasture	Cover crops; Legumes and optimal grazing in pasture lands

What are Nature-Based Solutions (NBS)?

- The European Commission defines NBS as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. […]"[1].

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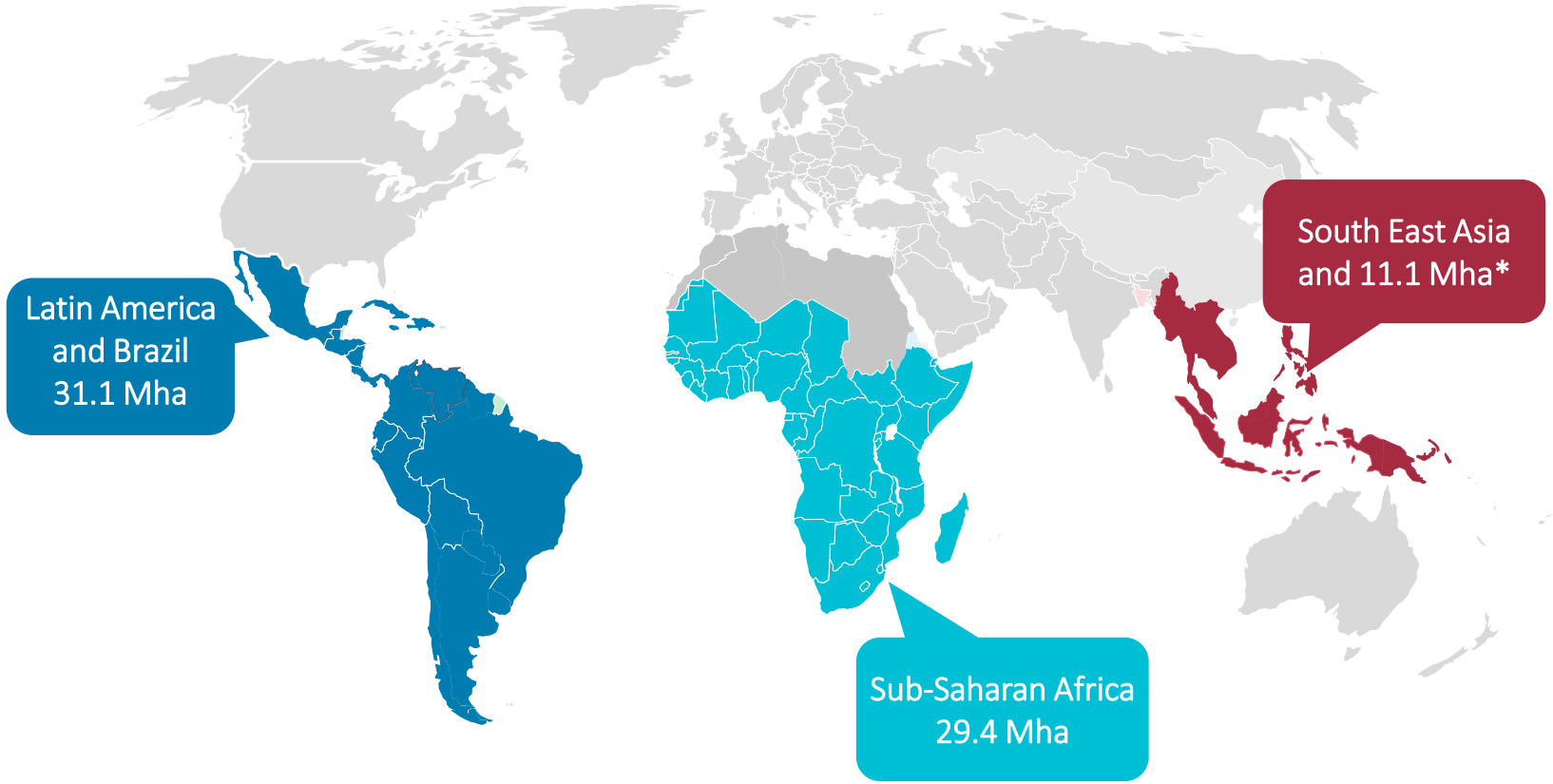
Source: [1] European Commission (no date)

In the forestry sector, tropical afforestation and reforestation offer inexpensive sequestration at large scale up to 1Gt CO_2



Carbon prices

Under IPR FPS 2021, a **carbon price of around USD 90** could incentivize re/afforestation of 72 Mha in Latin America, Sub-Saharan Africa and South East Asia

Tropical rainforests

NBS opportunities are geographically concentrated in regions with both dense carbon sinks and high existing rates of deforestation

Note: *South East Asia includes territories located in Oceania, except for Australia and New Zealand. Regional values represent reforestation and afforestation between 2020 and 2050
Source: Vivid Economics

Directed government reforestation programs, the gradual extension of offset markets, and increase in carbon prices drive a major shift toward nature-based solutions, and carbon sequestration as a valuable forestry sector commodity

- NBS[1] will generate an investible universe worth **USD 898 billion** (in present value terms) by 2050. This number includes NDC and non NDC related investments
- NBS will also generate revenue streams worth **USD 167 billion** by 2050
- This opens up enormous new opportunities for both project developers and investors

billion USD 2021	2025	2030	2035	2040	2045	2050
Cumulative cost of assets (market size)	140	303	462	639	785	898
Annual total revenue	21	40	73	94	161	167

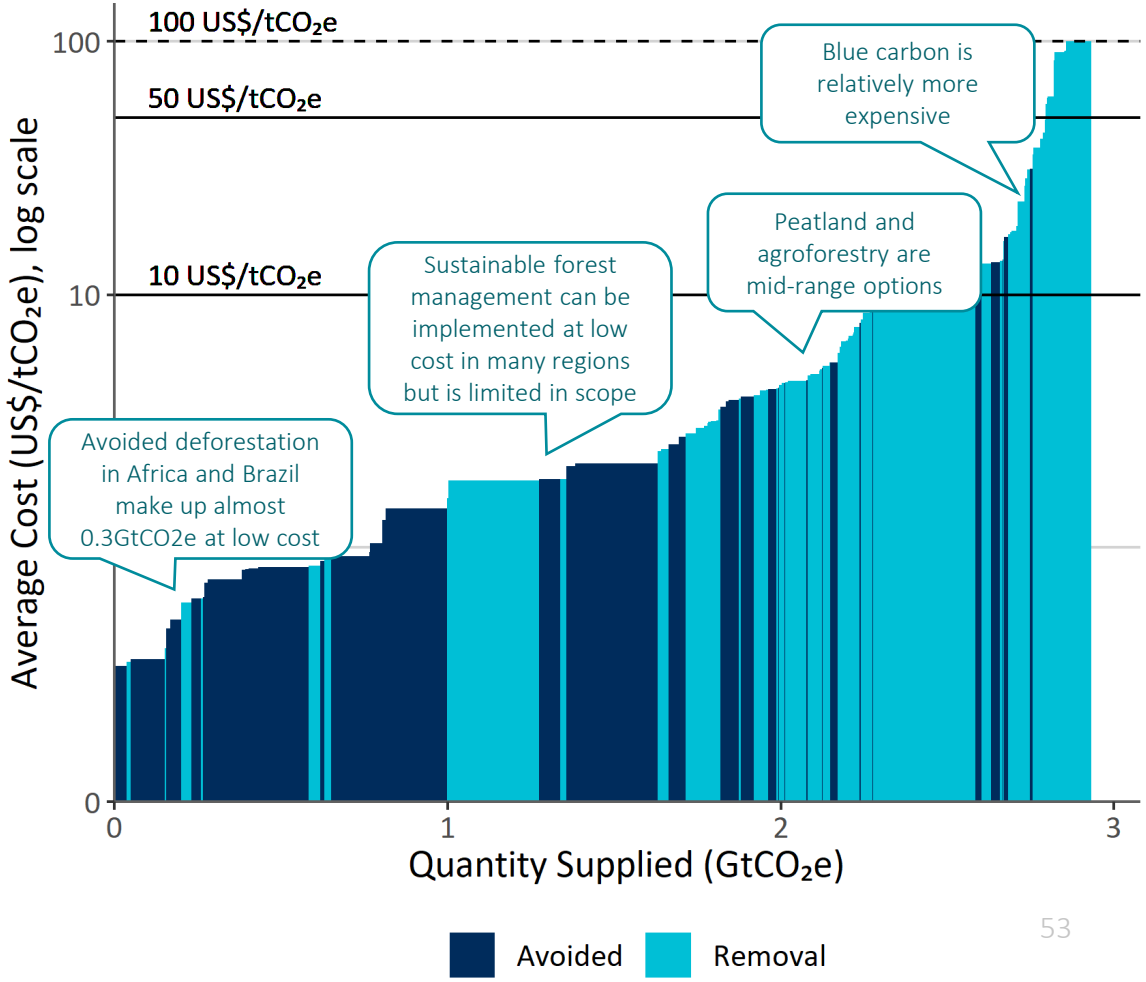
Source: Vivid Economics

Note: The cumulative cost of assets is the amount of money required to meet the equilibrium quantity demanded in each year. Figures are discounted to 2021 using regional discount factors. Market revenue is calculated as the undiscounted price multiplied by quantity sold.

Source:[1] The European Commission defines NBS as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. […]"

Forest based solutions in Africa, Brazil and Asia-Pacific have most options below USD 10 USD per tCO_2e, while blue carbon (seagrass) has less volume and higher costs

NBS average cost curve in 2030 in IPR FPS 2021



Main message

- **NBS can supply substantial sequestration (in GtCO2e) at relatively low cost**, while higher-cost options offer relatively less abatement potential
- A variety of NBS options can be offered at **very low cost**, particularly **avoidance** projects and **sustainable forest management** practices.
- **Mid-range options** are likely to be feasible as well, for example **peatland** and **agroforestry** projects.
- Depending on demand, **more costly** options may be considered. These include **blue carbon (seagrass)** restoration and avoidance options.

Note: Costs are in USD 2005 terms
Source: Vivid Economics

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In comparison to a business-as-usual scenario, there is very large growth potential for investments in NBS

	Scenario description	Net change in forest cover (2020–50)	Annual market value of NBS
4C Business as Usual	• Currently implemented policies only • Value realization from carbon sequestration is minimal • Extensive expansion of agriculture based on relatively cheap land availability • Consistent with a 3–4°C global temperature increase	–200Mha Deforestation continues up to 2100	Negligible
Inevitable Policy Response (IPR) Forecast Policy Response (FPS)	• High carbon prices (USD 150/tCO_2e in 2050 in tier 1 countries) • Greater ramp-up of NBS in 2030–40s, accompanied by an end to deforestation and changes in food production • Improvements in agricultural productivity, following returns on technological investments similar to past • Consistent with temperatures stabilizing at c.2°C	+168Mha Deforestation stops by c.2030	USD$ 898 billion by 2050

Note: The cumulative cost of assets (or investible universe) is the amount of money required to meet the equilibrium quantity demanded in each year. Figures are discounted to 2021 using regional discount factors. Market revenue is calculated as the undiscounted price multiplied by quantity sold.

Source: Vivid Economics

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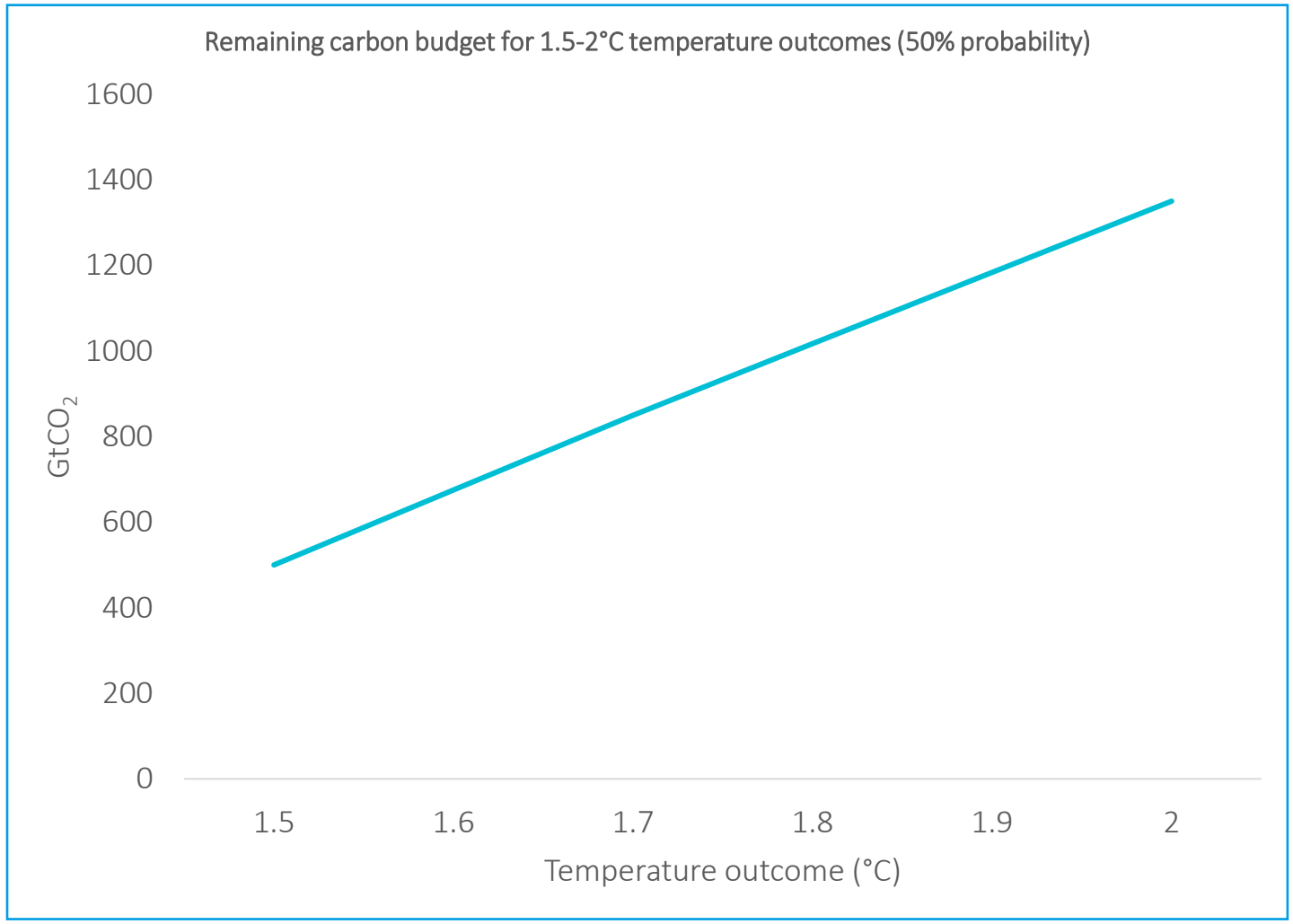
Annex: calculation of temperature outcome



- The IPCC estimate the remaining carbon budgets for different temperature outcomes, and at different probabilities
- Carbon budgets refer to CO_2 emissions, while accounting for the global warming effect of non-CO2 emissions
- The temperature outcome in IPR FPS is estimated based on the IPCC's carbon budgets, at 50% probability
- CO_2 emissions in IPR FPS are within the carbon budget required to achieve a 1.8 degree temperature outcome in 2100

Source: IPCC (2021) Climate Change 2021: the Physical Science Basis Summary for Policymakers

Thank you!

Please see PRI website for further details:

https://www.unpri.org/climate-change/what-is-the-inevitable-policy-response/4787.article

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Annex: IEA Announced Pledges Scenario

Scenario emissions (GtCO2)

Scenario	2020	2030	2040	2050
Announced Pledges Case (APC) May 2021	33.9	30.5	24.8	22.0
Announced Pledges Scenario (APS) October 2021	34.1	33.6	26.7	20.7

- This report has compared emissions in IPR FPS to the IEA Announced Pledges Case (APC) scenario from the May 2021 Net Zero Emissions report
- In WEO 2021, IEA APC is renamed Announced Pledges Scenario (APS), with a slightly modified emissions pathway

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