THE ENERGY TRANSFORMATION SCENARIOS

David Hone
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#ShellScenarios

Warning: Uncertainties Ahead

Shell's scenarios are not intended to be projections or forecasts of the future. Shell's scenarios, including the scenarios contained in this presentation, are not Shell's strategy or business plan. When developing Shell's strategy, our scenarios are one of many variables that we consider. Ultimately, whether society meets its goals to decarbonise is not within Shell's control. While we intend to travel this journey in step with society, only governments can create the framework for success. The **Sky 1.5** scenario starts with data from Shell's **Sky** scenario, but there are important updates. First, the outlook uses the most recent modelling for the impact and recovery from COVID-19 consistent with a **Sky 1.5** scenario narrative. Second, it blends this projection into existing **Sky** (2018) energy system data by around 2030. Third, the extensive scale-up of nature-based solutions is brought into the core scenario, which benefits from extensive new modelling of that scale-up. (In 2018, nature-based solutions required to achieve 1.5°C above pre-industrial levels by the end of this century were analysed as a sensitivity to **Sky.** This analysis was also reviewed and included in the IPCC Special Report on Global Warming of 1.5°C (SR15).) Fourth, our new oil and natural gas supply modelling, with an outlook consistent with the **Sky 1.5** narrative and demand, is presented for the first time. Fifth, the **Sky 1.5** scenario draws on the latest historical data and estimates to 2020 from various sources, particularly the extensive International Energy Agency energy statistics. As with **Sky**, this scenario assumes that society achieves the 1.5°C stretch goal of the Paris Agreement. It is rooted in stretching but realistic development dynamics today, but explores a goal-oriented way to achieve that ambition. We worked back in designing how this could occur, considering the realities of the situation today and taking into account realistic timescales for change. Of course, there is a range of possible paths in detail that society could take to achieve this goal. Although achieving the goal of the Paris Agreement and the future depicted in **Sky 1.5** while maintaining a growing global economy will be extremely challenging, today it is still a technically possible path. However, we believe the window for success is quickly closing.

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, Shell's operating plans, outlooks, budgets and pricing assumptions do not reflect our net-zero emissions target. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans, outlooks, budgets and pricing assumptions to reflect this movement. Also, in this presentation we may refer to Shell's "Net Carbon Footprint", which includes Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Footprint" is for convenience only and not intended to suggest these emissions are those of Shell or its subsidiaries.

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", "anticipate", "believe", "could", "estimate", "expect", "goals", "intend", "may", "objectives", "outlook", "plan", "probably", "project", "risks", "schedule", "seek", "should", "target", "will" and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, or delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell's Form 20-F for the year ended December 31, 2019 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation **April 13th, 2021.** Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

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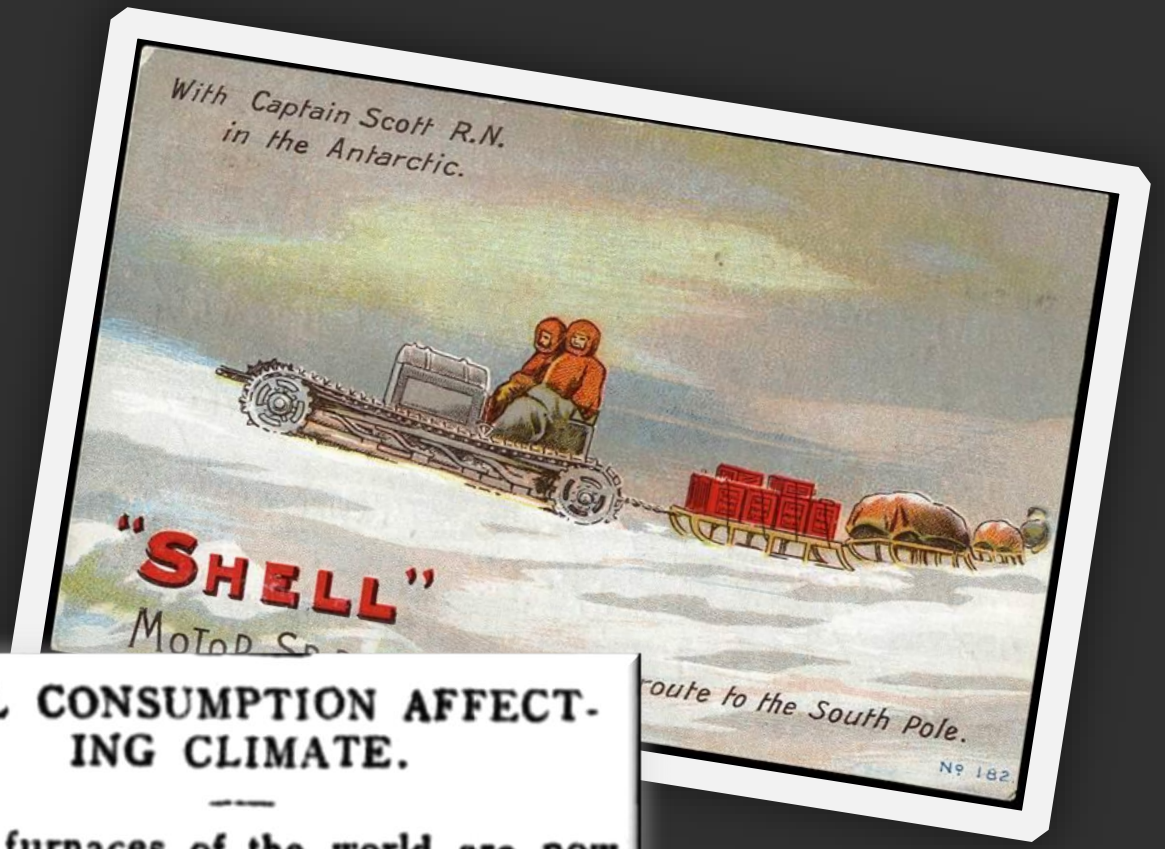
Back in 1912 . . . . .

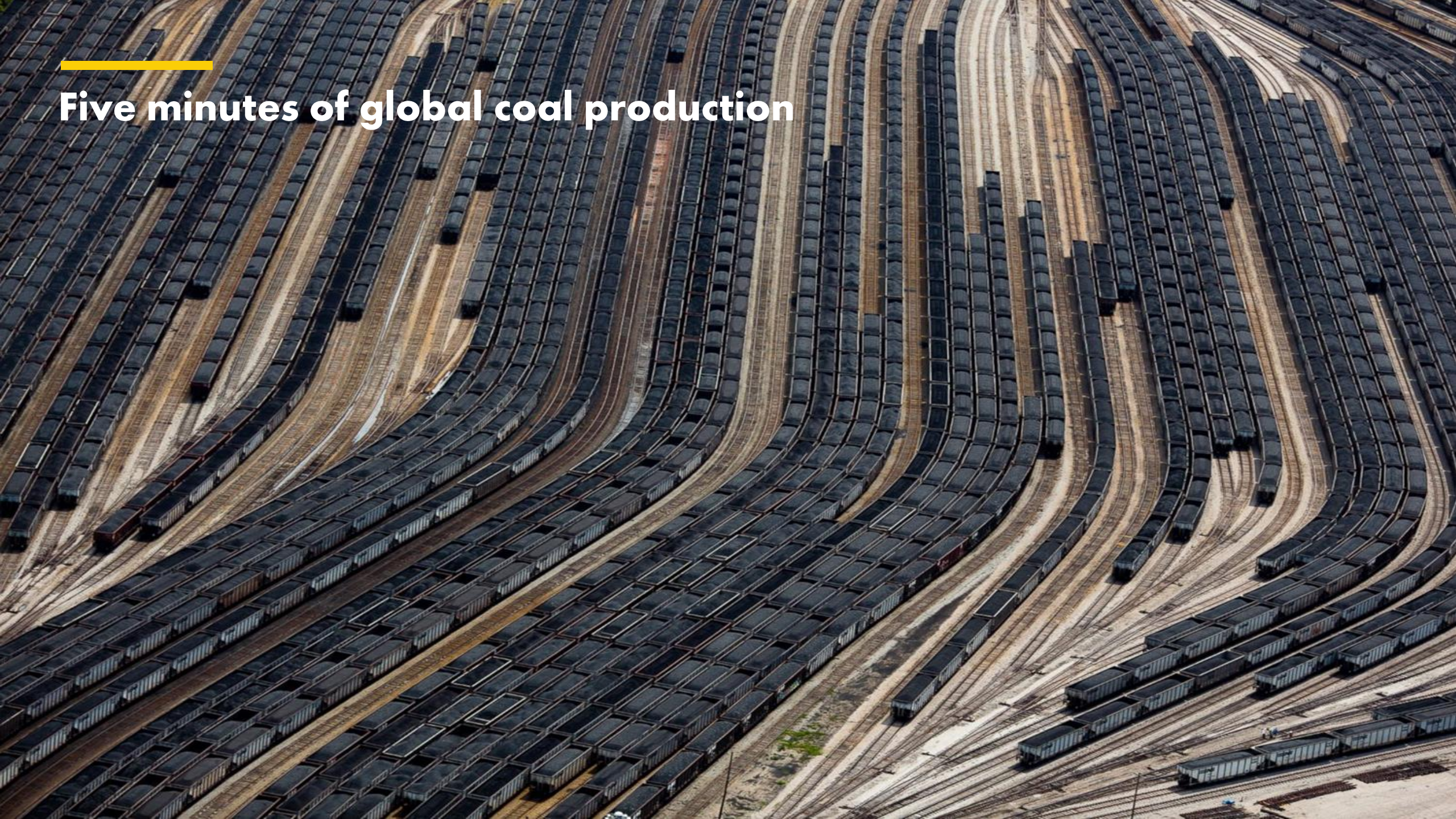

The Braidwood Dispatch
AND MINING JOURNAL.
FURNER BROTHERS AND JONES.
THE PREMIER STORES
TAILORING DEPARTMENT.
THE DRAPERY DEPARTMENT.
THE GROCERY DEPARTMENT.
THE PREMIER STORES, AUBURN STREET, GOULBURN.
A Merry Christmas.
Charles Rogers and Company,
DINNEFORD'S MAGNESIA
SHOPPING BY POST



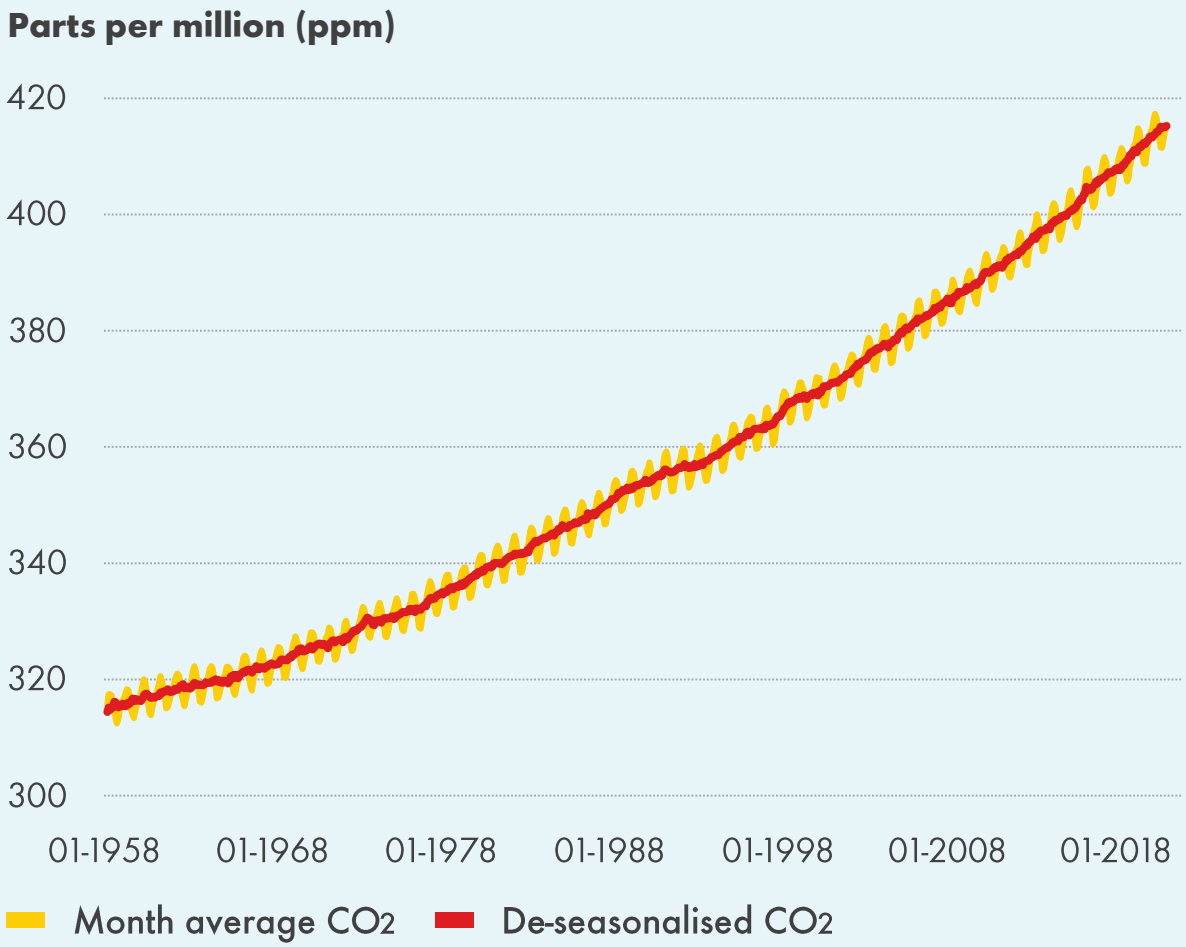
COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

Five minutes of global coal production

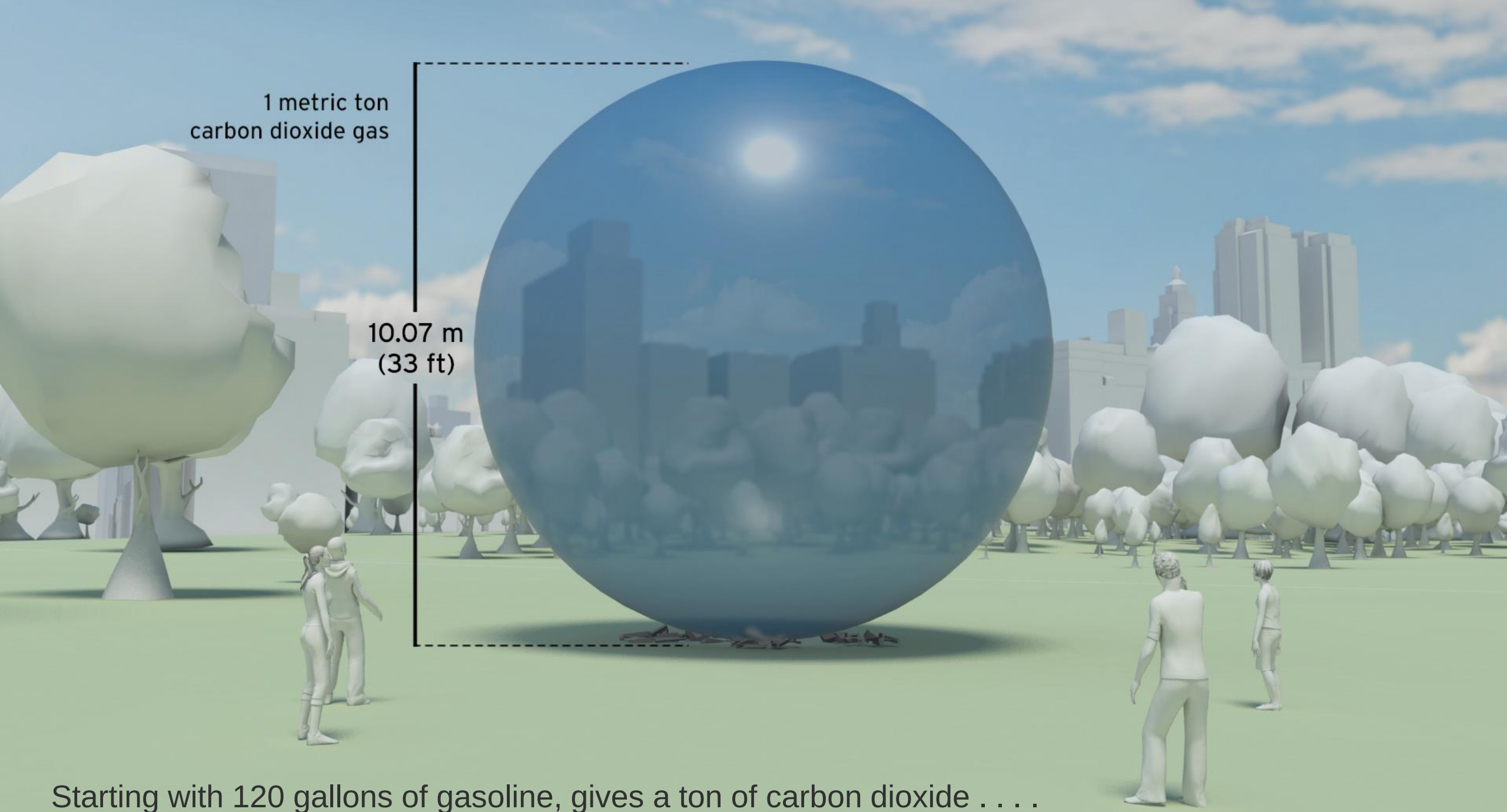


Atmospheric CO_2 record at Mauna Loa Observatory

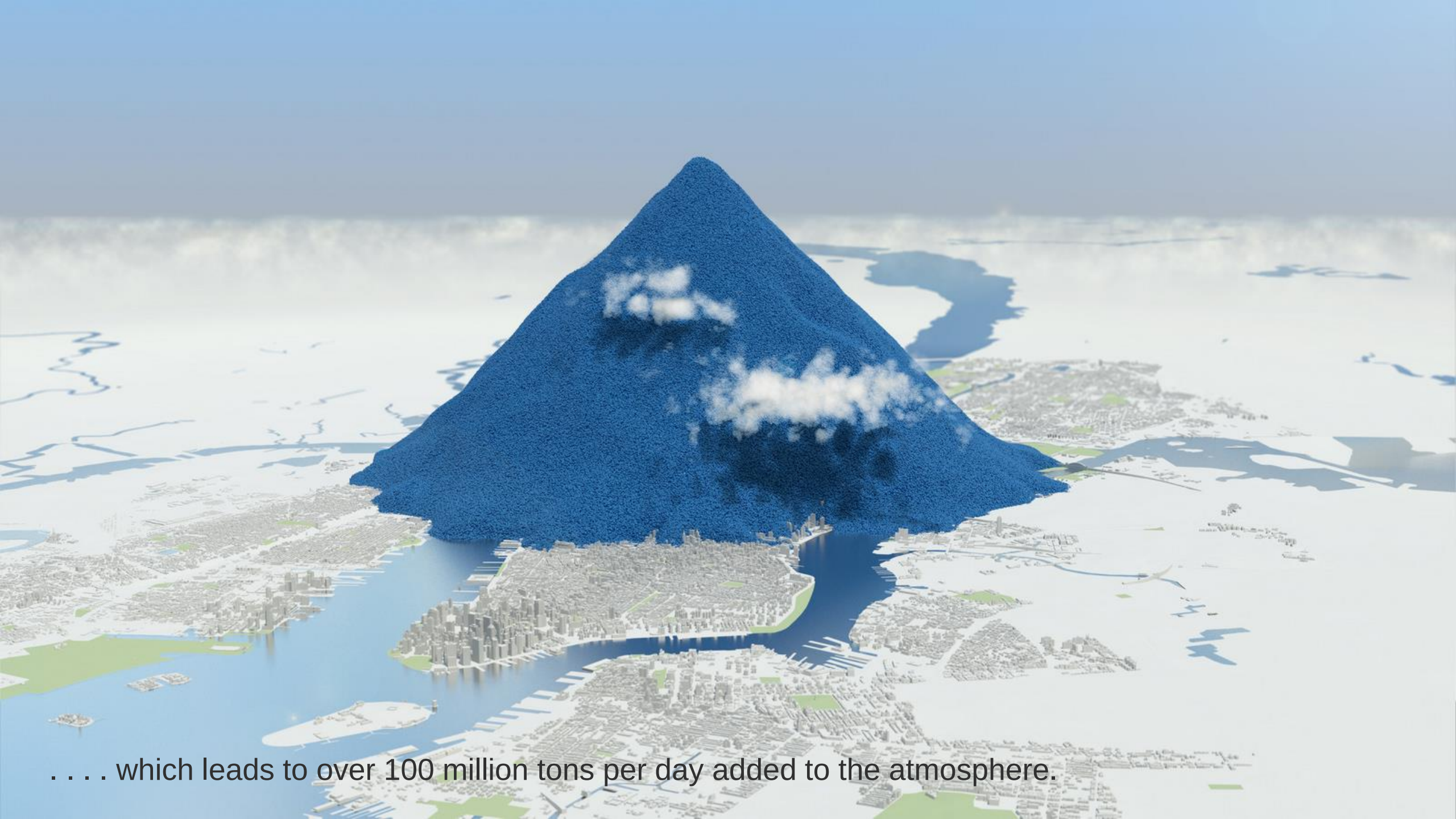


January 2021

Source: Scripps Institution of Oceanography, NOAA Global Monitoring Laboratory



Starting with 120 gallons of gasoline, gives a ton of carbon dioxide . . . .



. . . . which leads to over 100 million tons per day added to the atmosphere.

Sources and sinks of anthropogenic carbon (as CO_2)

Net emissions of ~41 Gt CO_2 per year

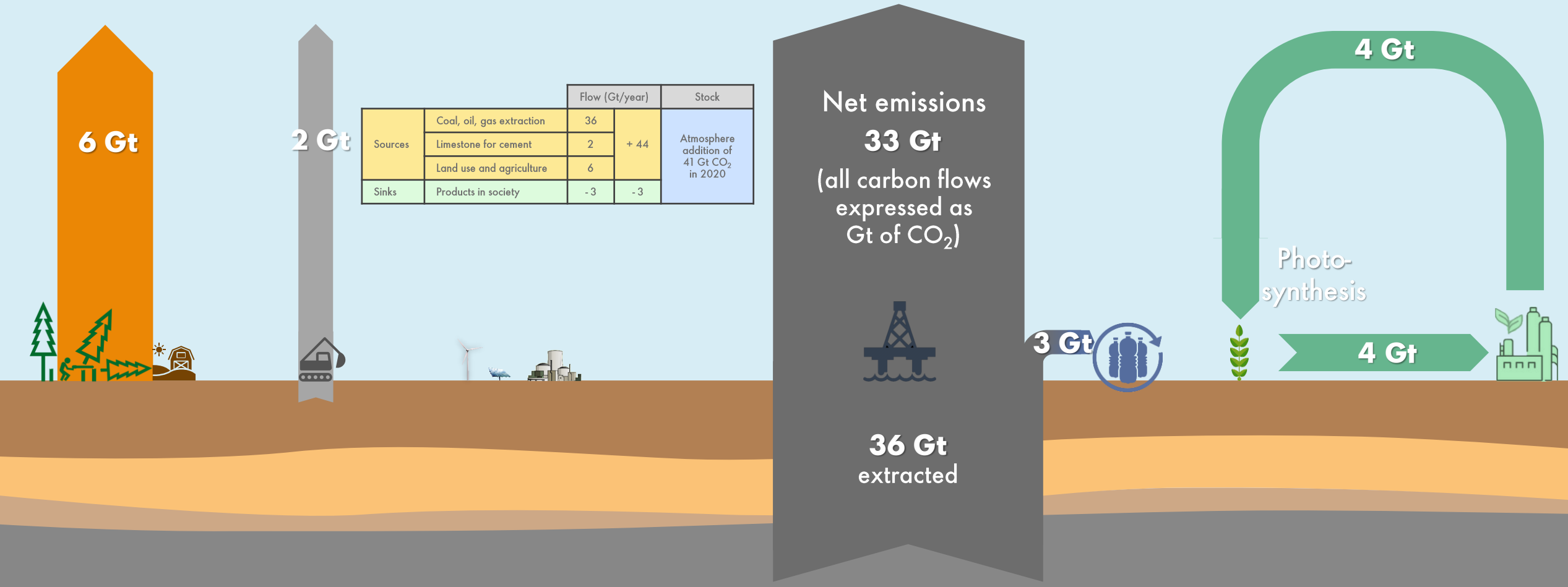
2020

Land use change & agriculture

Process CO_2 (e.g. cement)

Coal, oil & gas extraction and use

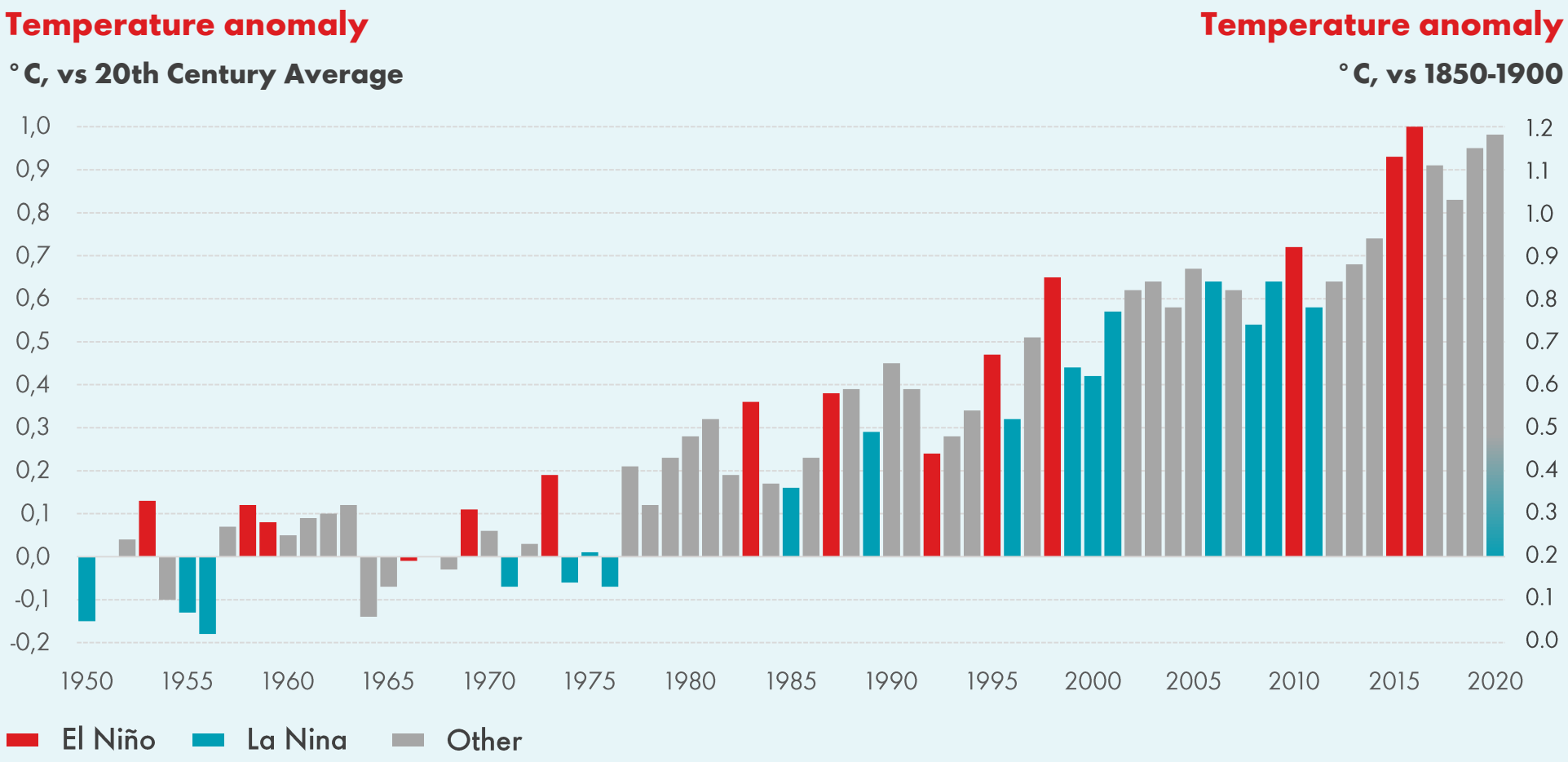
Bioenergy production and use



		Flow (Gt/year)		Stock
Sources	Coal, oil, gas extraction	36	+ 44	Atmosphere addition of 41 Gt CO_2 in 2020
	Limestone for cement	2		
	Land use and agriculture	6		
Sinks	Products in society	- 3	- 3	

Source: Shell analysis, Sky 1.5 scenario

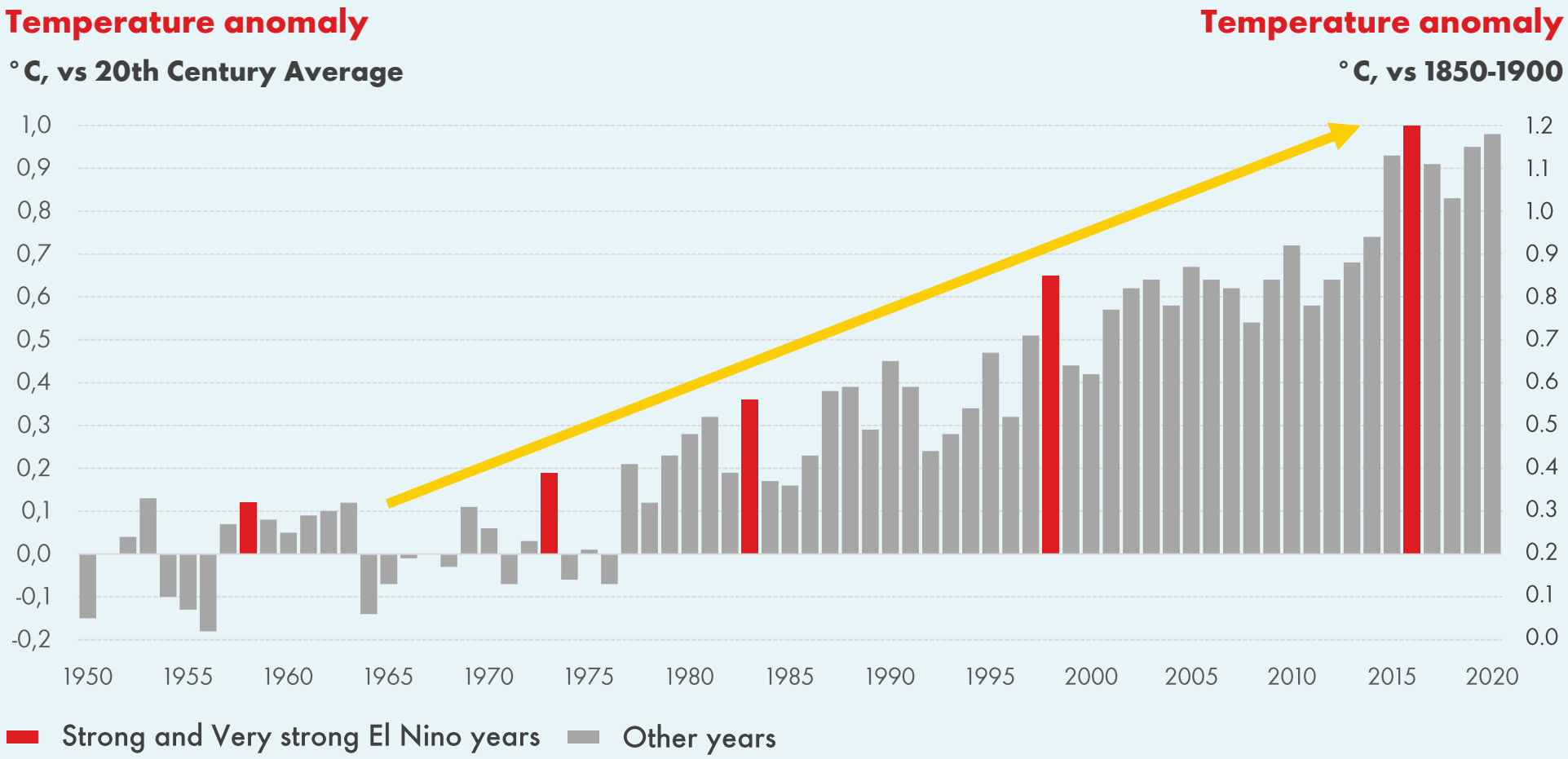
2020: The second warmest year despite a growing La Nina (cooler)



Annual global temperature anomalies (1950-2020 NOAA NCDC vs. 20th Century Average and IPCC 1850-1900)

Source: NOAA NCDC

A worrying long-term trend of ~0.2°C per decade

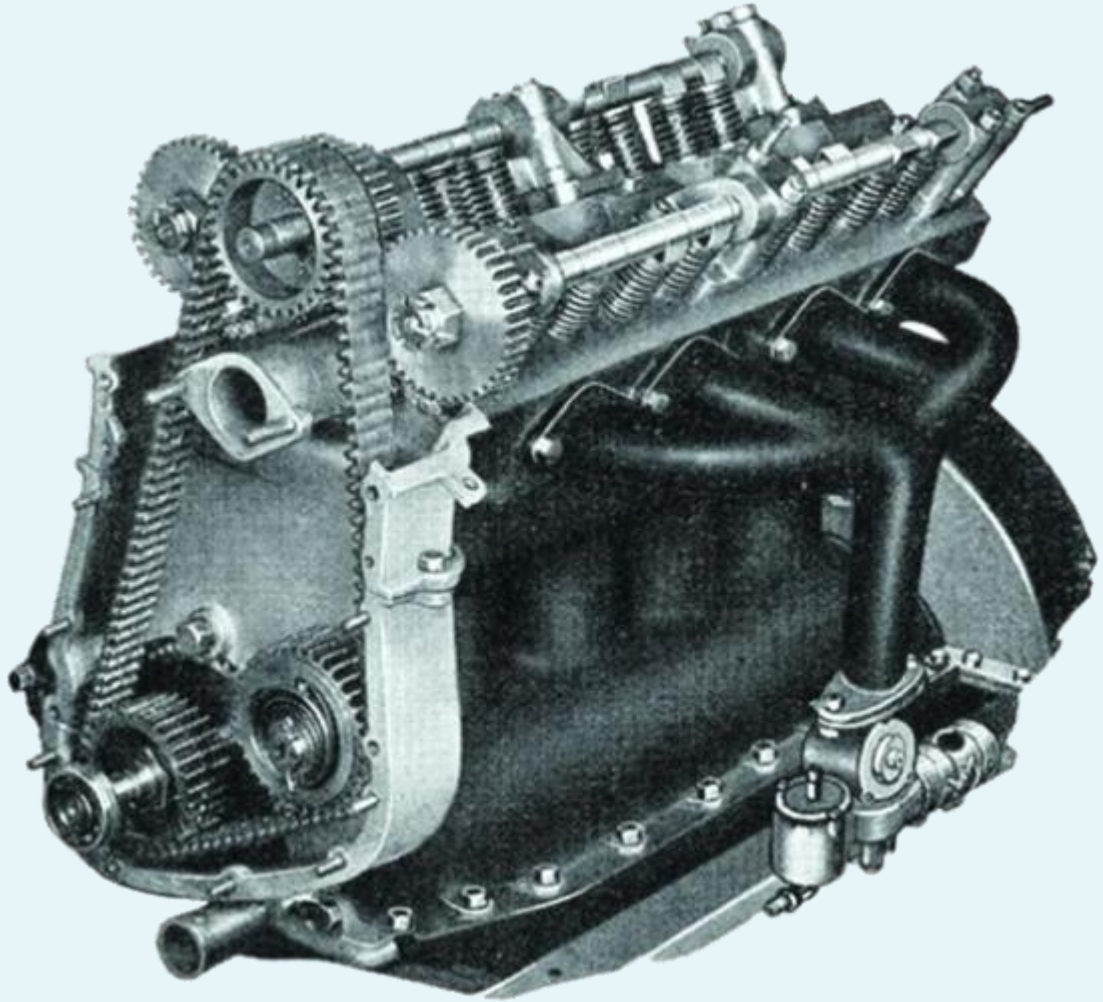


Annual global temperature anomalies (1950-2020 NOAA NCDC vs. 20th Century Average and IPCC 1850-1900)

Source: NOAA NCDC

The external landscape is changing rapidly

Some things never seem to change - 100 years of progress?



Not all technology pathways have been a success

- By 1900, in the United States, 38% of US automobiles, 33,842 cars, were powered by electricity (40% were powered by steam, and 22% by gasoline).

The 100 Mile Fritchle Electric

The Only Electric Guaranteed to Go 100 Miles on One Charge.

MODEL "A" VICTORIA PHAETON.

The Victoria Phaeton shown here, is an ideal lady's carriage for city and country use. Its artistic and impressive body design, its superb painting and upholstering make it the most attractive lady's car ever offered to the public.

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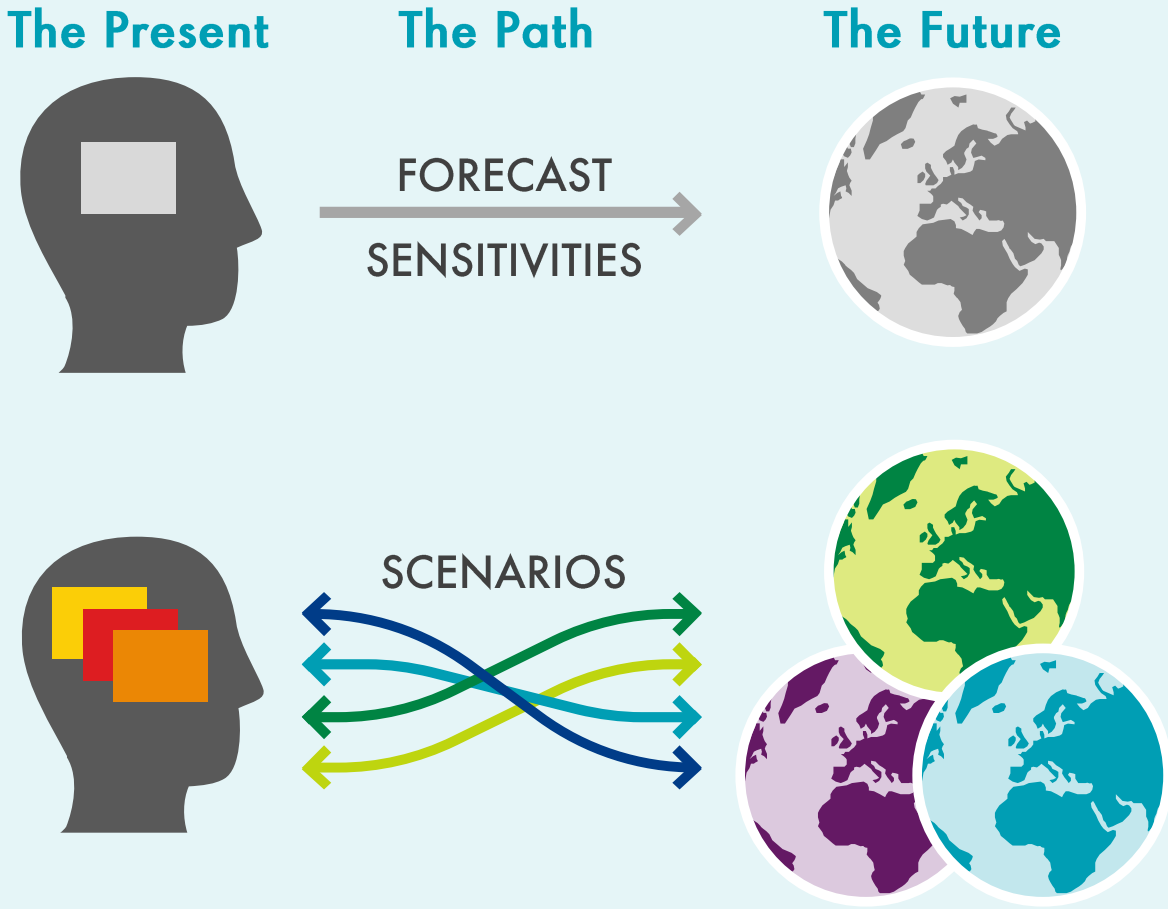
Why scenarios?

- Forecasts and sensitivities are insufficient
- Grapple with genuine breadth of possibilities
- Stretch mindsets for better-informed decisions
- Learn and prepare

"Scenarios deepen our understanding of alternative futures in times of uncertainty."



What might COVID-19 mean for the world in the coming years?

- 3 dramatic tensions at play – what governments and people prioritise will shape the future
- Implications for energy, energy transition and climate

The Energy Transformation Scenarios

Waves Late, but fast decarbonisation

- Wealth first – repair the economy
- Surge in energy use and emissions
- Growing inequality and more frequent and extreme weather events
- Social pressures; issues intensify
- Backlash forces rapid policy-driven reductions in fossil fuels
- 2.3°C above pre-industrial levels by the end of this century

Islands Late and slow decarbonisation

- Security first – growing nationalism
- Frictions in collaboration and trade
- Economies stagnate; growth in energy demand stalls
- Global climate action slows
- Cleaner technology makes slow progress
- 2.5°C above pre-industrial levels by 2100, and still rising

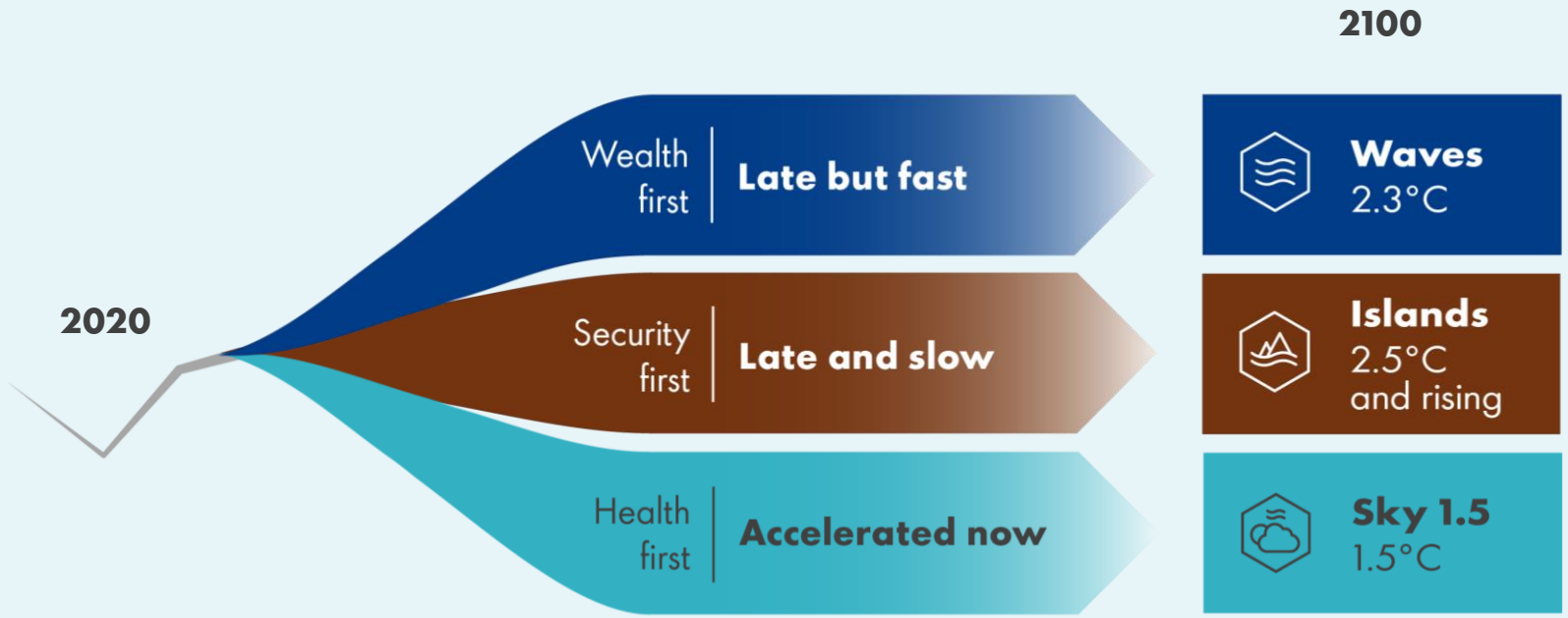
Sky 1.5 Accelerated decarbonisation now

- Health first – well-being is the priority
- People proceed cautiously, economies reopen slowly but steadily
- Recognition of value in alignments
- Green investment reshapes energy system
- Deep structural changes lower emissions
- 1.5°C above pre-industrial levels this century, in line with Paris goal

Energy needs will grow, and the system decarbonises

The issue is speed

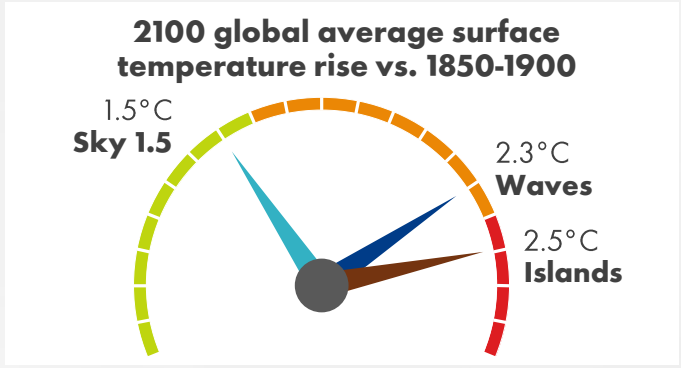
Pace of decarbonisation

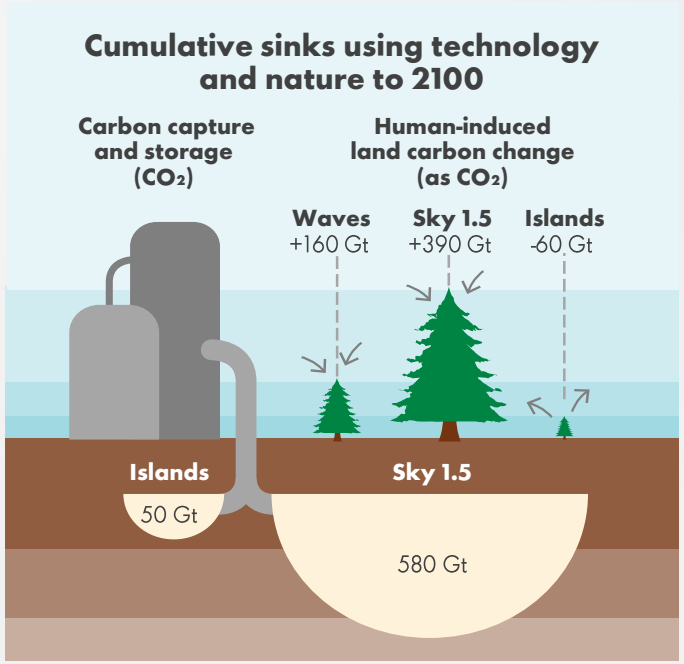


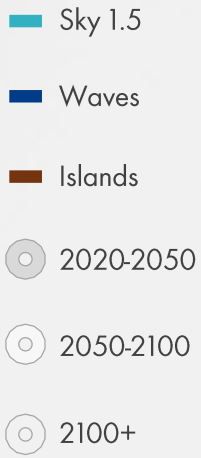
Source: Shell analysis, MIT joint program on Global Change

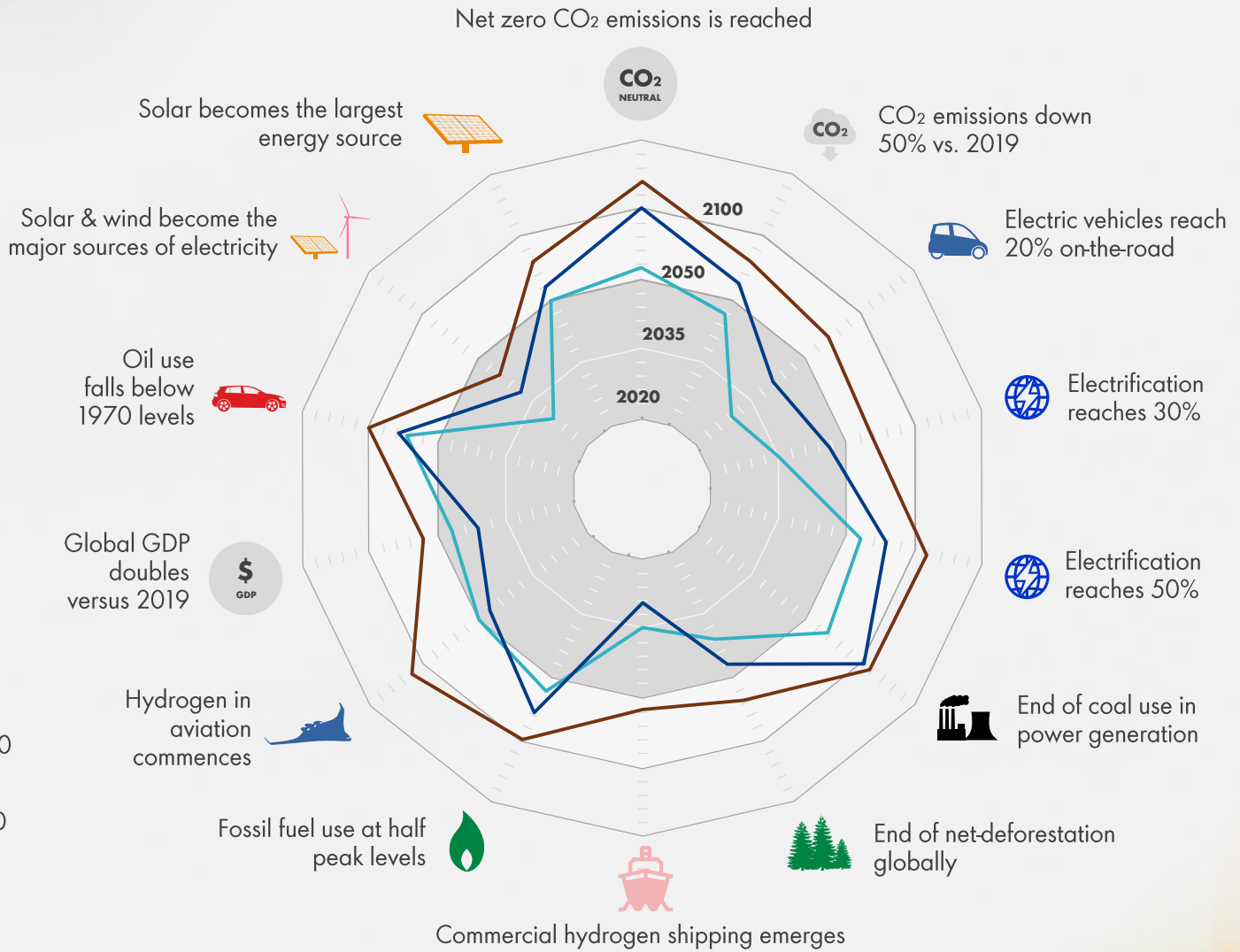
SHELL ENERGY TRANSFORMATION SCENARIOS

ALL THREE PATHWAYS DECARBONISE: THE ISSUE IS SPEED



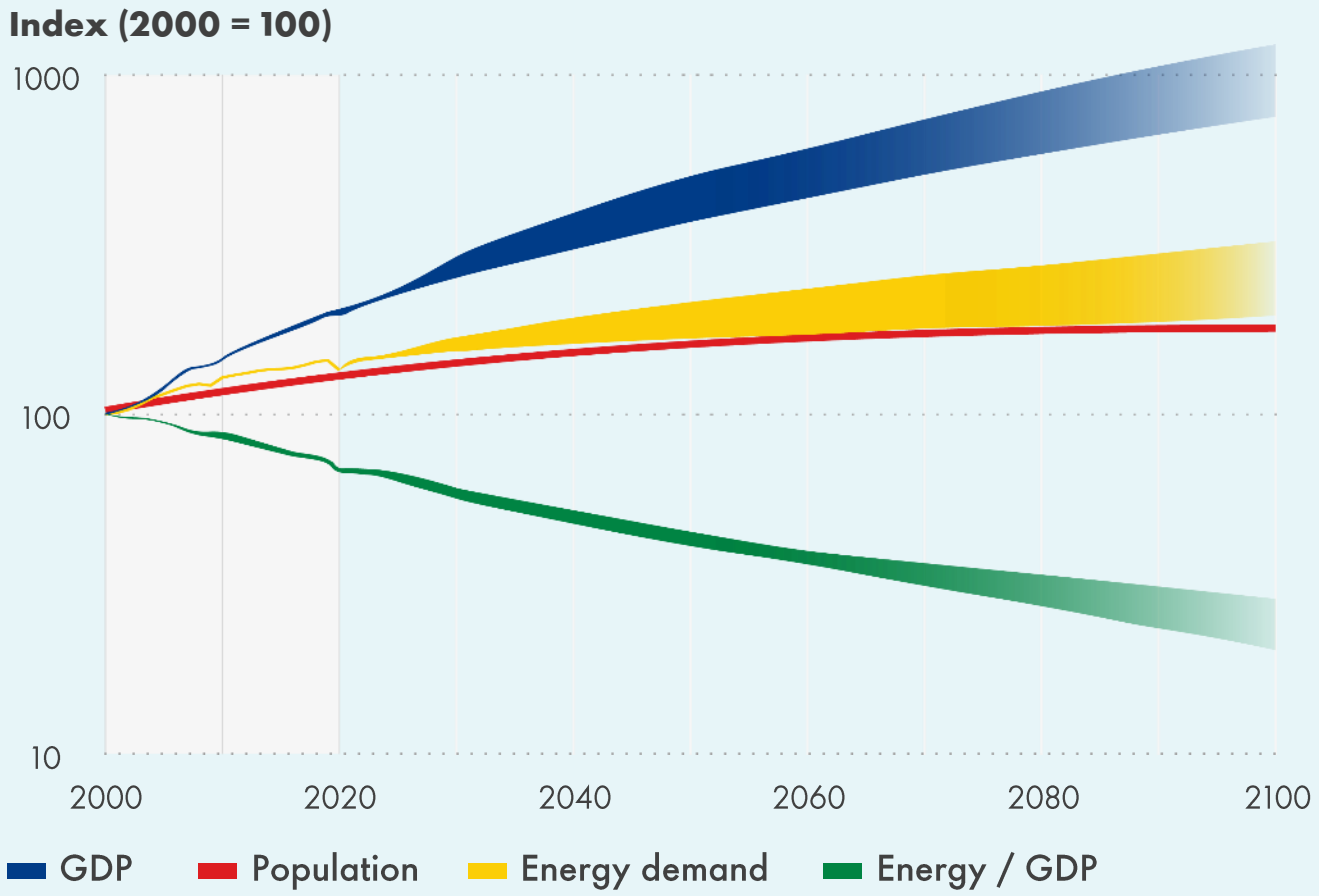






The world will become much more energy-efficient, but energy consumption will still grow

World trends



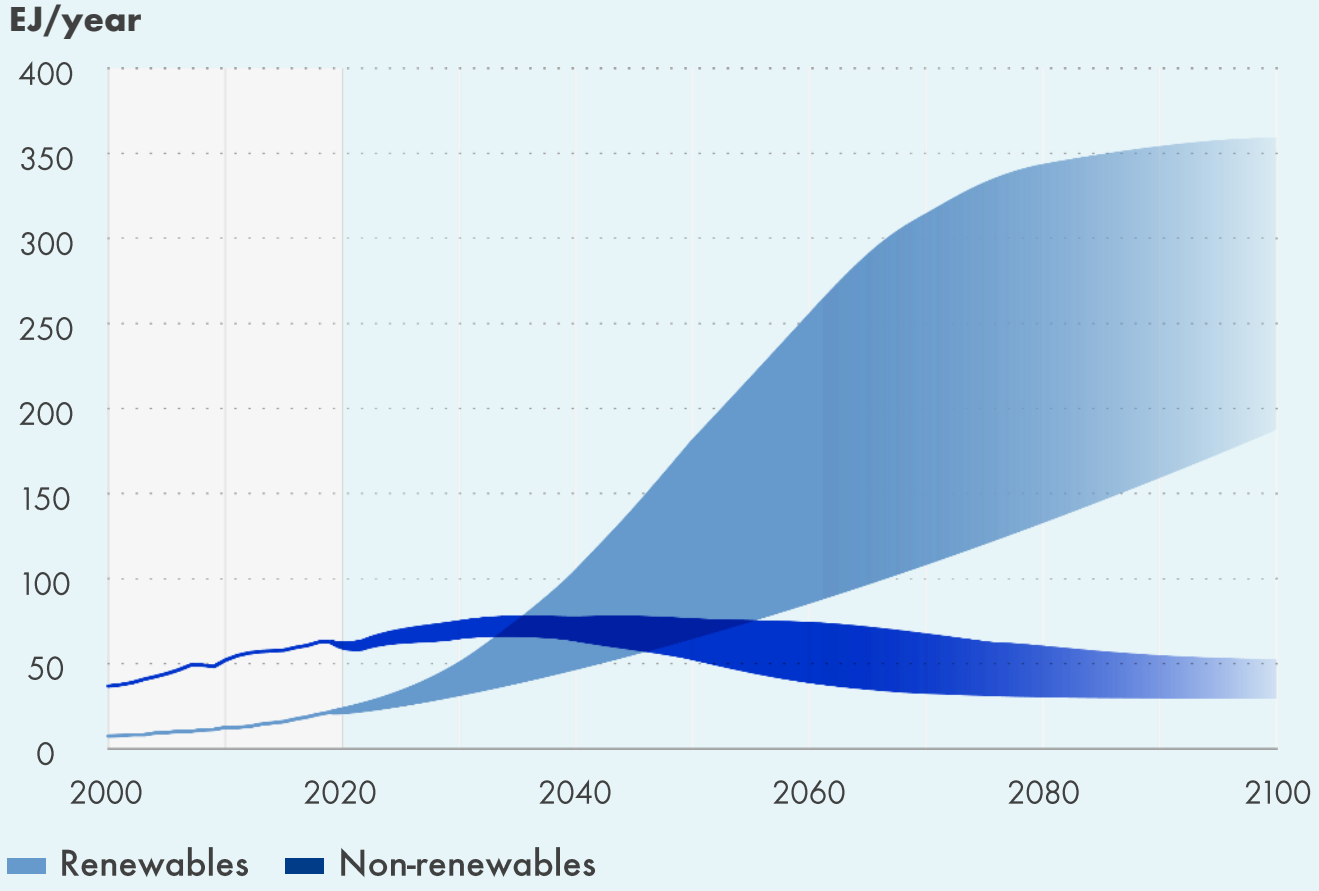
Source: Scenario ranges from Shell analysis based on data from UN Population Division (2019), US Conference Board (GDP) and the IEA (2020) World Energy Balances (**Link**), all rights reserved

In all scenarios energy demand increases:

- Structural changes and efficiency improvements allow the global economy to grow 2-3 times more than energy demand
- People seek a decent quality of life, energy enables this
- The OECD stabilize energy consumption
- Non-OECD still need to grow substantially to provide a decent quality of life for their citizens
- Improved efficiency and the shifting balance of economies towards service sectors reduces the average energy intensity of economic activity.

Renewable electricity demand grows rapidly in all scenarios, increasing power generation by up to four times by 2100

Electricity from renewables and non-renewables

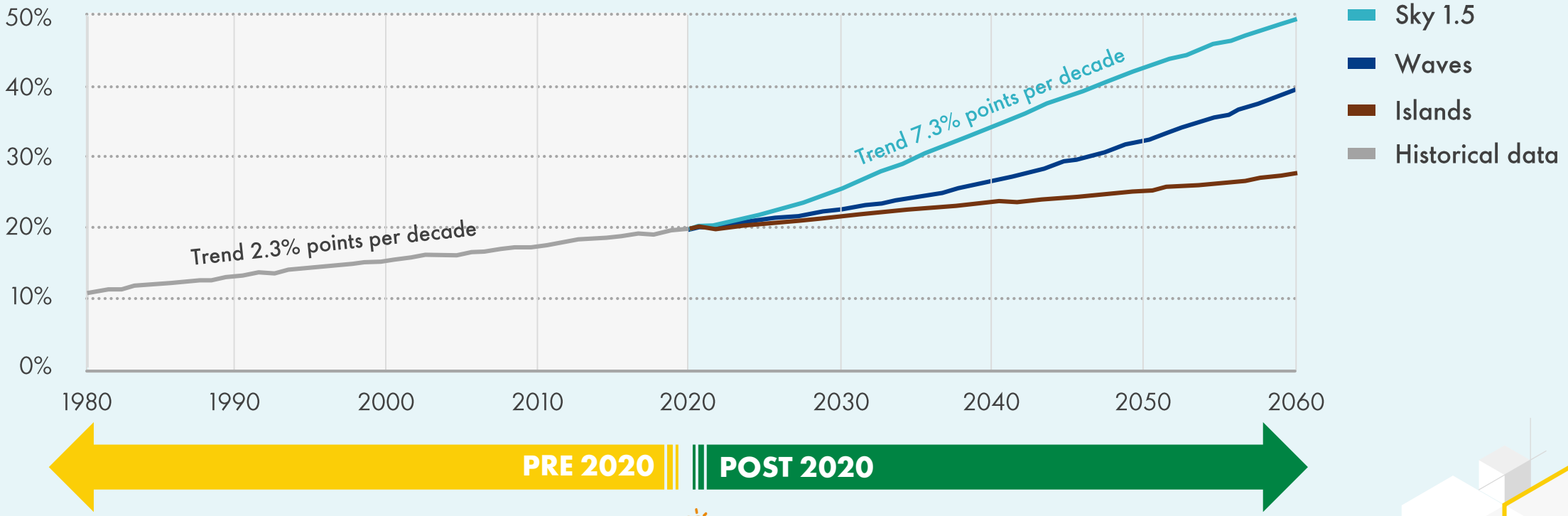


Source: Scenario ranges from Shell analysis based on data from the IEA (2020) World Energy Balances (**Link**), all rights reserved

Solar PV combined with energy storage becomes the key 21st century energy technology

All scenarios see expansion of the electricity system and electrification of energy services, but it is very rapid in Sky 1.5

Share of electricity in final energy



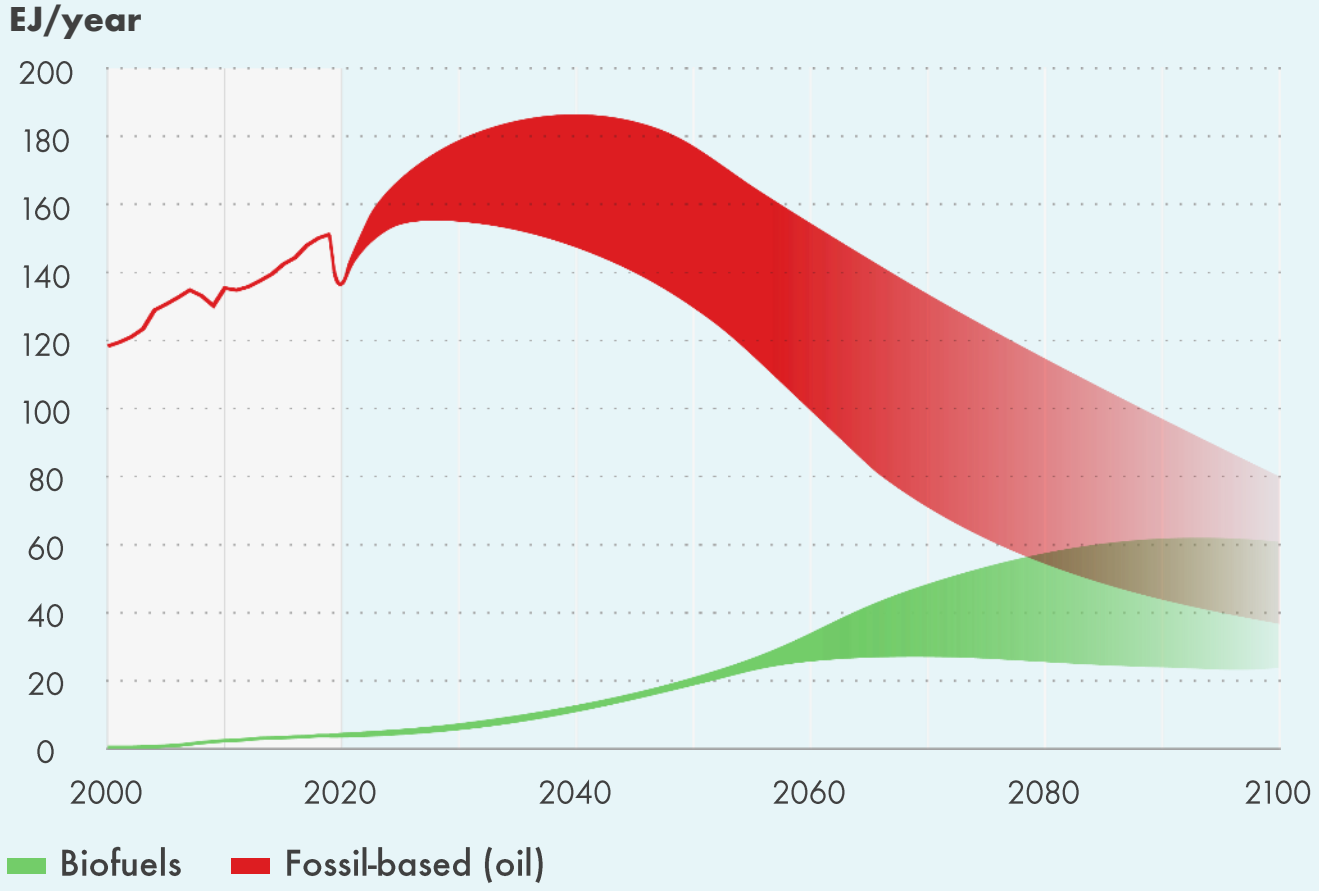
600 GW of solar installed in 2010s — 3000 GW of solar installed in 2020s

~150,000 3 MW turbines built during the 2010s, mainly onshore — 70,000 10 MW turbines during the 2020s, off-shore focus

No real growth since the turn of the century — Increase by a third in the coming decade and double by 2040.

Oil demand will peak in the next two decades, then decline as it is replaced by electricity and biofuels

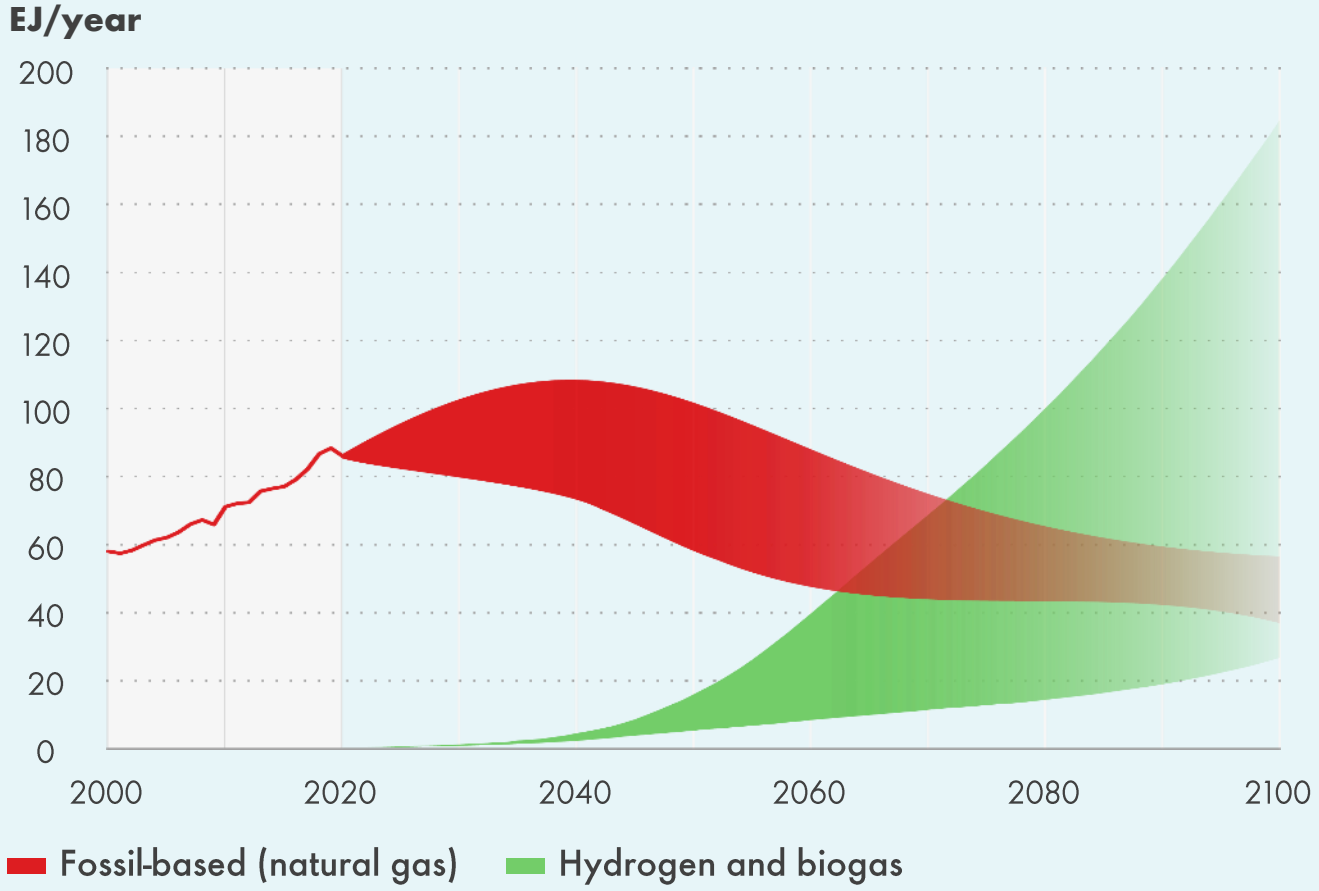
Liquid fuels demand



Source: Scenario ranges from Shell analysis based on data from the IEA (2020) World Energy Balances (**Link**), all rights reserved

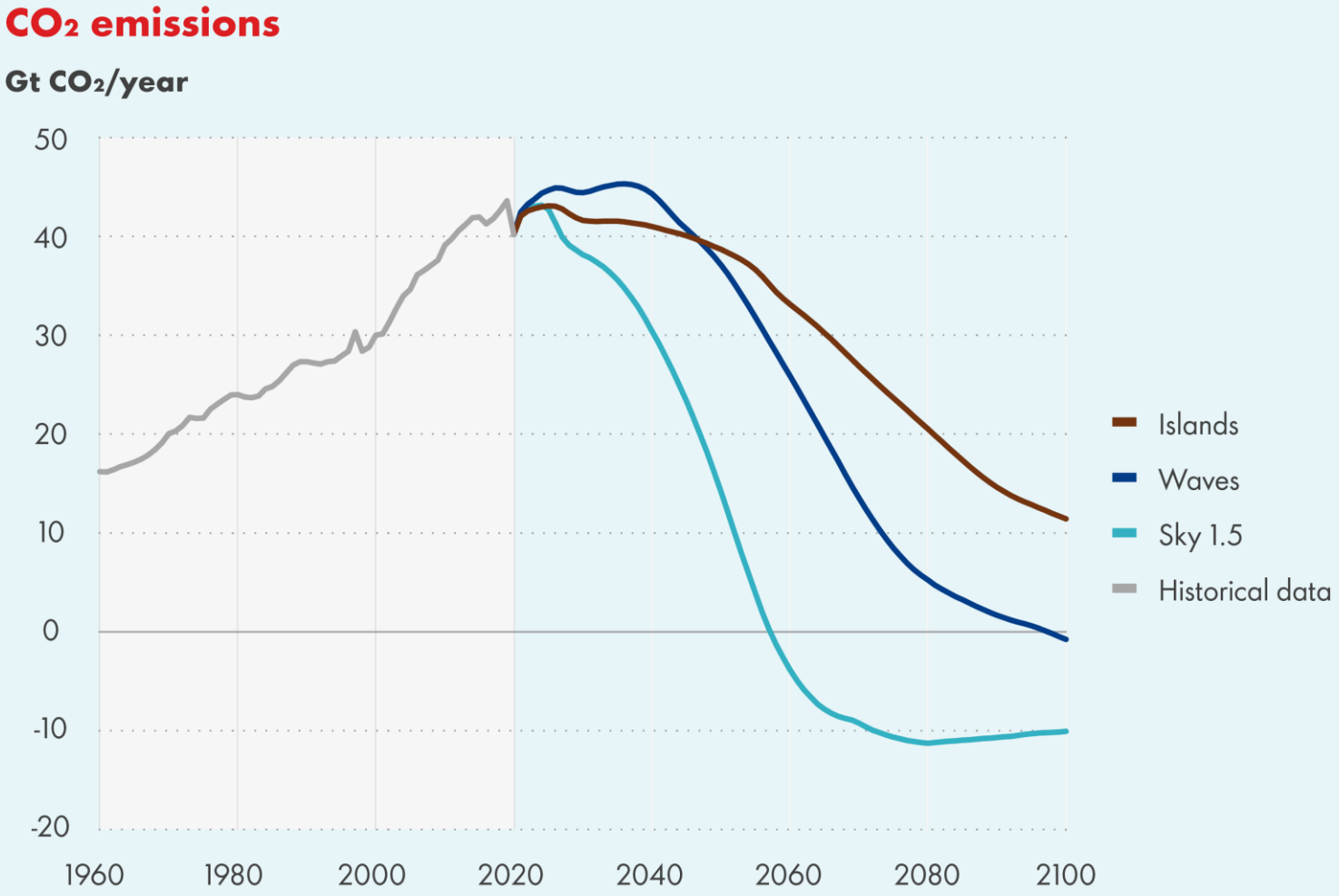
Gaseous fuels will remain important for longer as they are decarbonised with hydrogen and biomethane

Gaseous fuels demand



Source: Scenario ranges from Shell analysis based on data from the IEA (2020) World Energy Balances (**Link**), all rights reserved

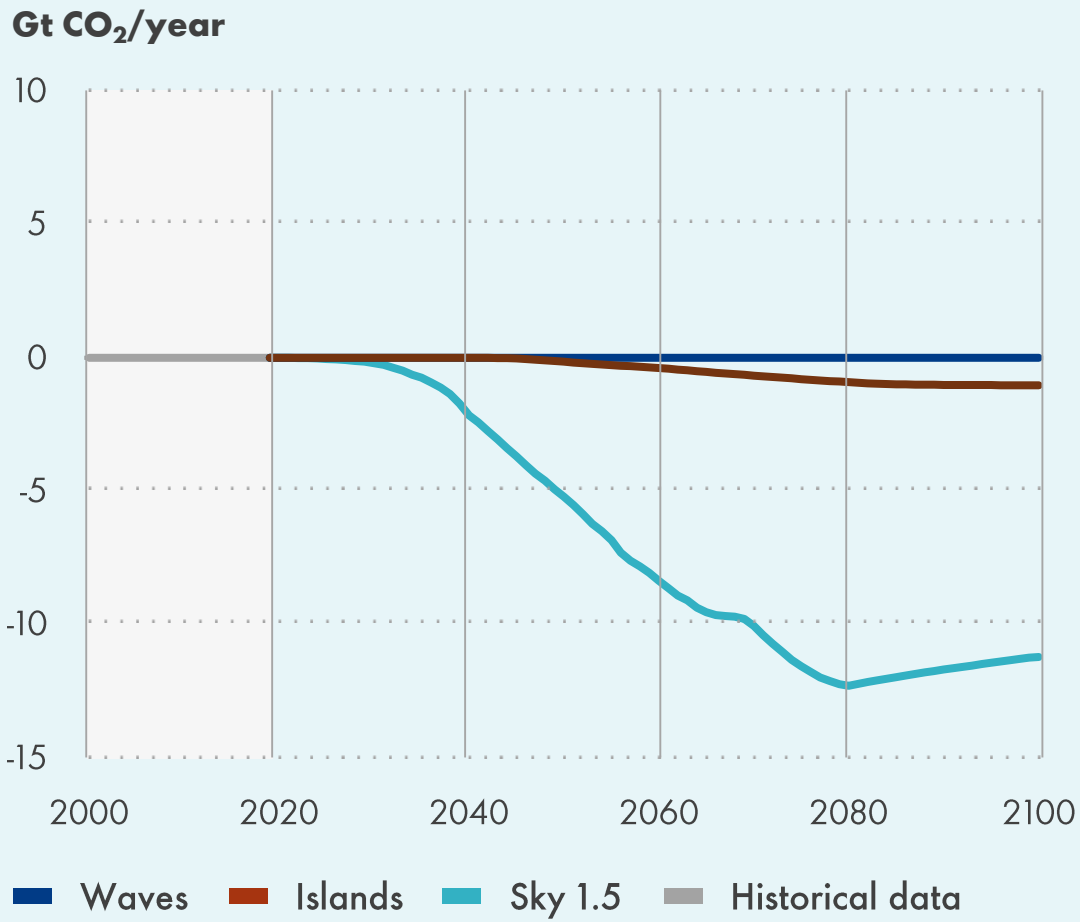
Achieving net-zero CO_2 emissions between the 2050s and into the next century



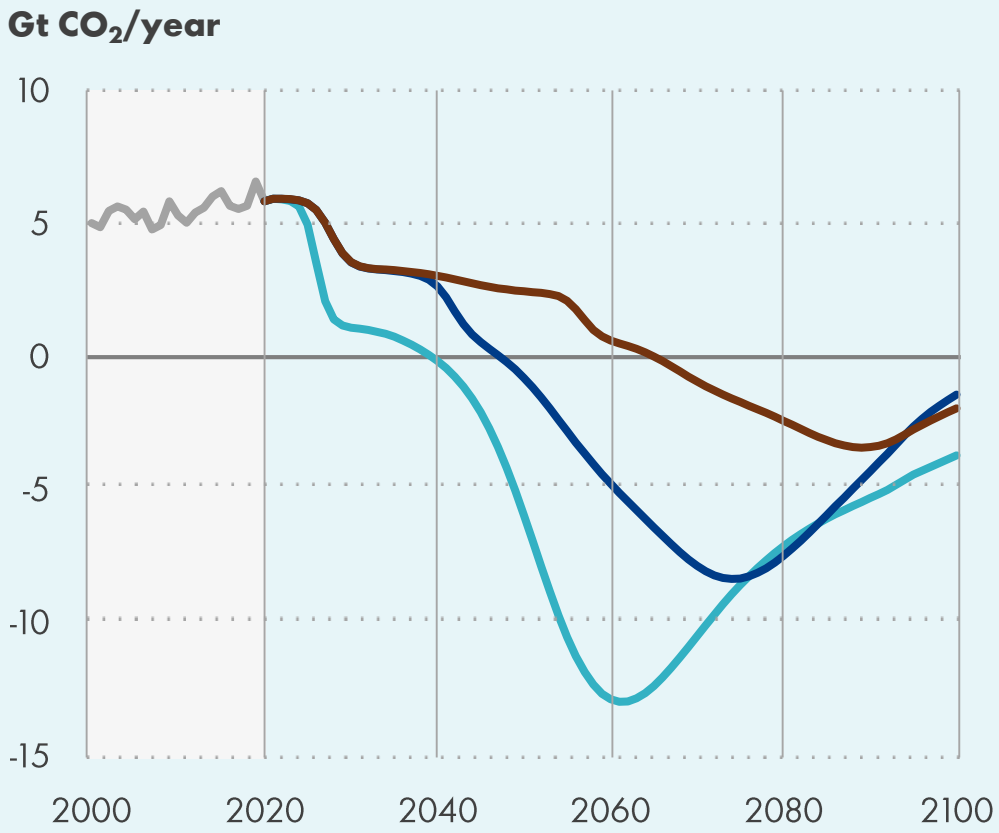
Source: Shell analysis based on data from Global Carbon Project (2020) and the IEA (2020) World Energy Balances (Link), all rights reserved

Both technological and natural sinks will be critical to achieving 1.5 °C

Energy-related emissions captured by CCS

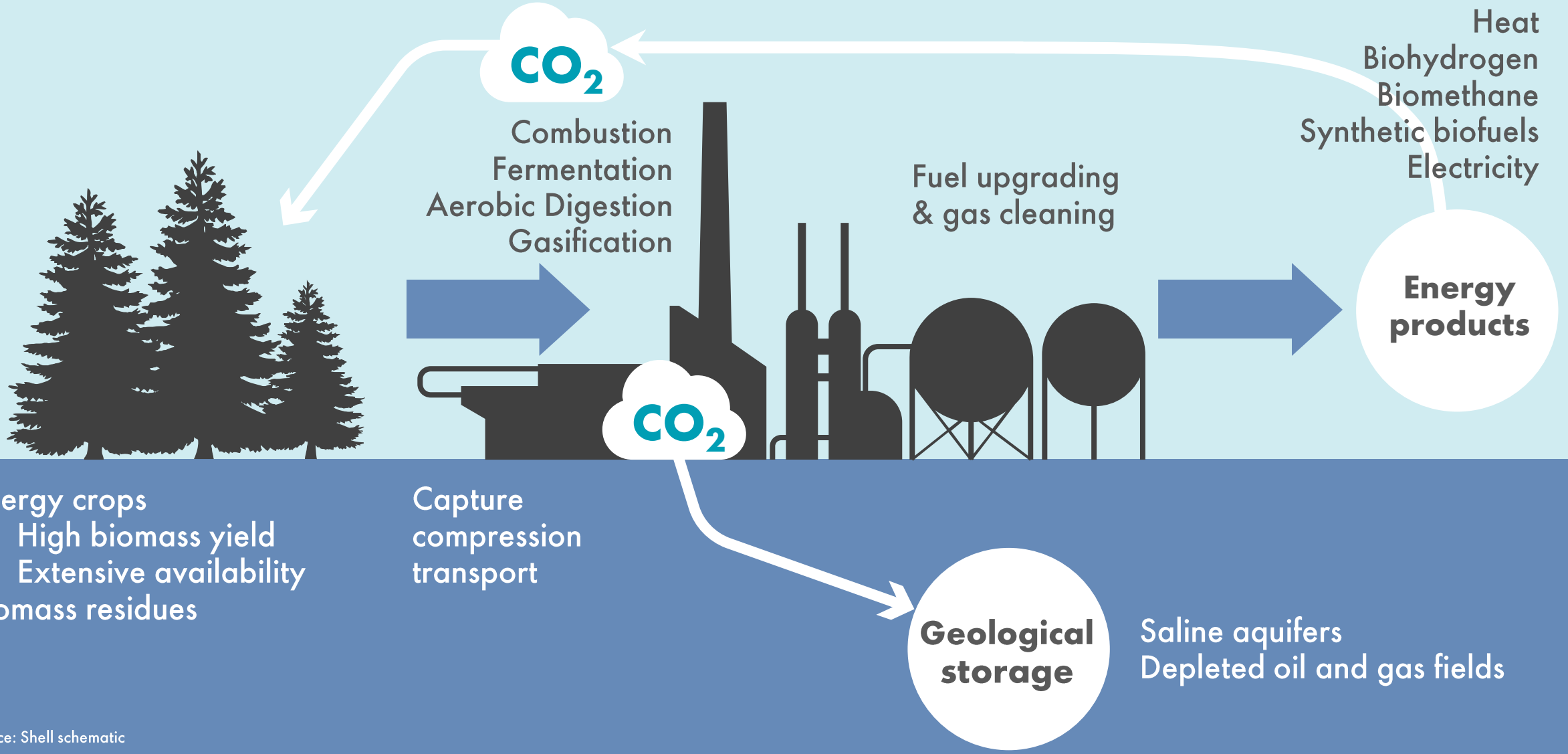


CO_2 removal using nature



Source: Shell analysis, Global Carbon Project (2020)

Bioenergy with CCS has an important role to play



Source: Shell schematic

Sources and sinks of anthropogenic carbon (as CO_2)

Net emissions of ~41 Gt CO_2 per year

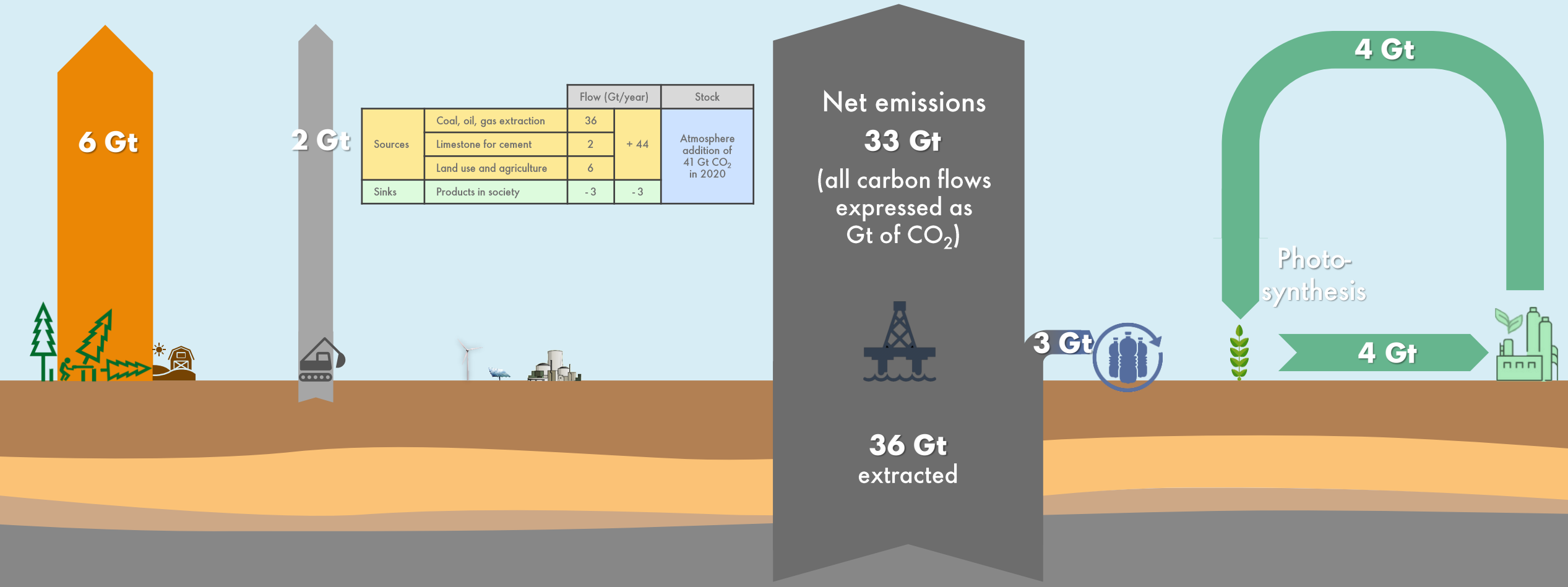
2020

Land use change & agriculture

Process CO_2 (e.g. cement)

Coal, oil & gas extraction and use

Bioenergy production and use



		Flow (Gt/year)		Stock
Sources	Coal, oil, gas extraction	36	+ 44	Atmosphere addition of 41 Gt CO_2 in 2020
	Limestone for cement	2		
	Land use and agriculture	6		
Sinks	Products in society	- 3	- 3	

Source: Shell analysis, Sky 1.5 scenario

Sources and sinks of anthropogenic carbon (as CO_2)

Net negative emissions of ~4 Gt CO_2 per year

2060

Land use change & agriculture

Process CO_2 (e.g. cement)

Coal, oil & gas extraction and use

Bioenergy production and use

4 Gt (drawdown)

7 Gt

5 Gt

14 Gt

13 Gt

2 Gt

12 Gt Net emissions

19 Gt Photo-synthesis

		Flow (Gt/year)		Stock
Sources	Coal, oil, gas extraction	22	+ 24	Atmosphere drawdown of 4 Gt CO_2 In 2060
	Limestone for cement	2		
Sinks	Land use and agriculture	- 13	- 28	
	CCS	- 5		
	Bioenergy + CCS (BECCS)	- 4		
	Products in society	- 6		

1 Gt

5 Gt

18 Gt

0.2 Gt

5 Gt

22 Gt extracted

4 Gt

CCS

CCS

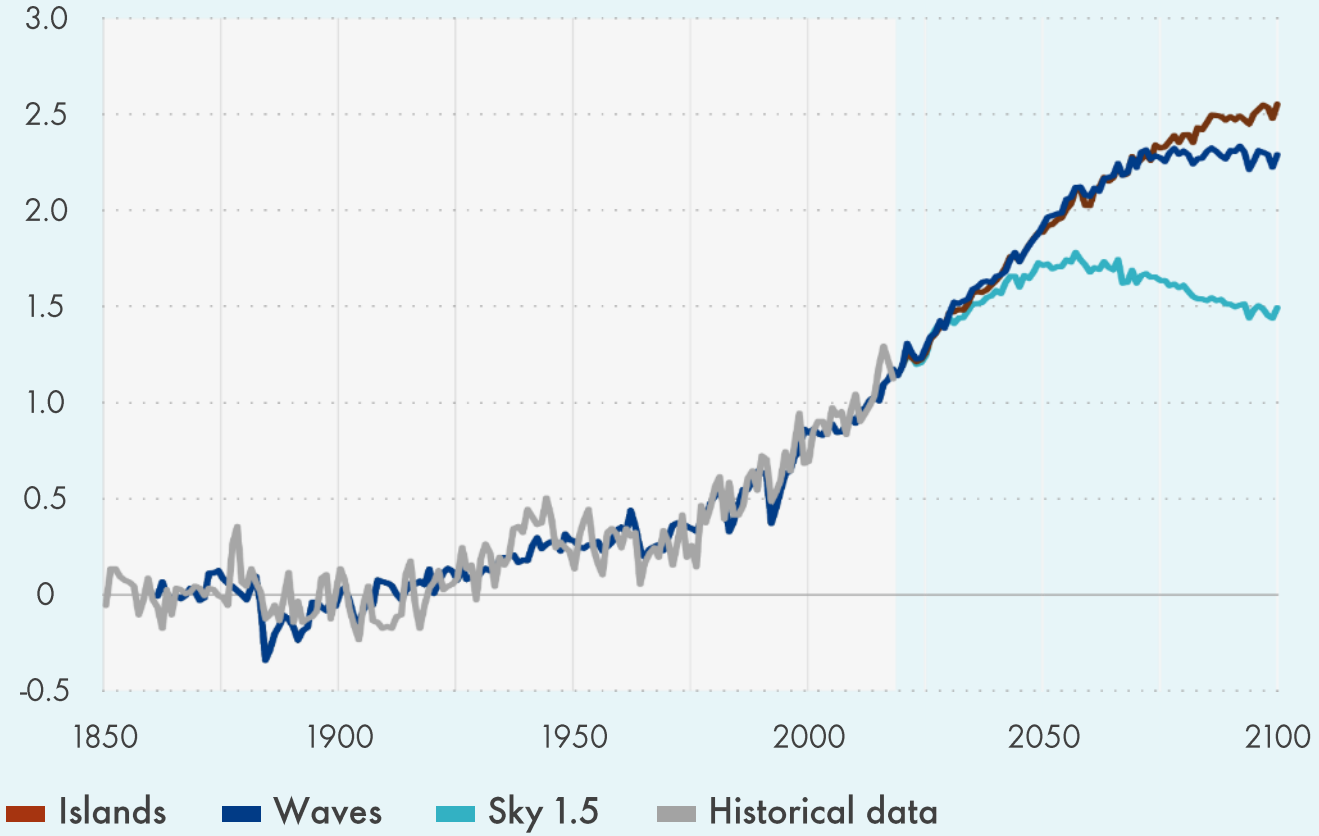
BECCS

Source: Shell analysis, Sky 1.5 scenario

Temperature increases can be halted in the 2060s, but could equally continue to rise until the end of the century and beyond

World average surface temperature

°C above 1850-1900



Source: Shell analysis, Met Office Hadley Centre (2020) (temperature history, HadCRUT5), MIT joint program on Global Change (scenarios)

Accelerating the energy transformation

Creating a virtuous cycle of change

Government

Business

Consumer

Elements of an effective policy framework

DRIVE ECONOMY-WIDE CHANGE

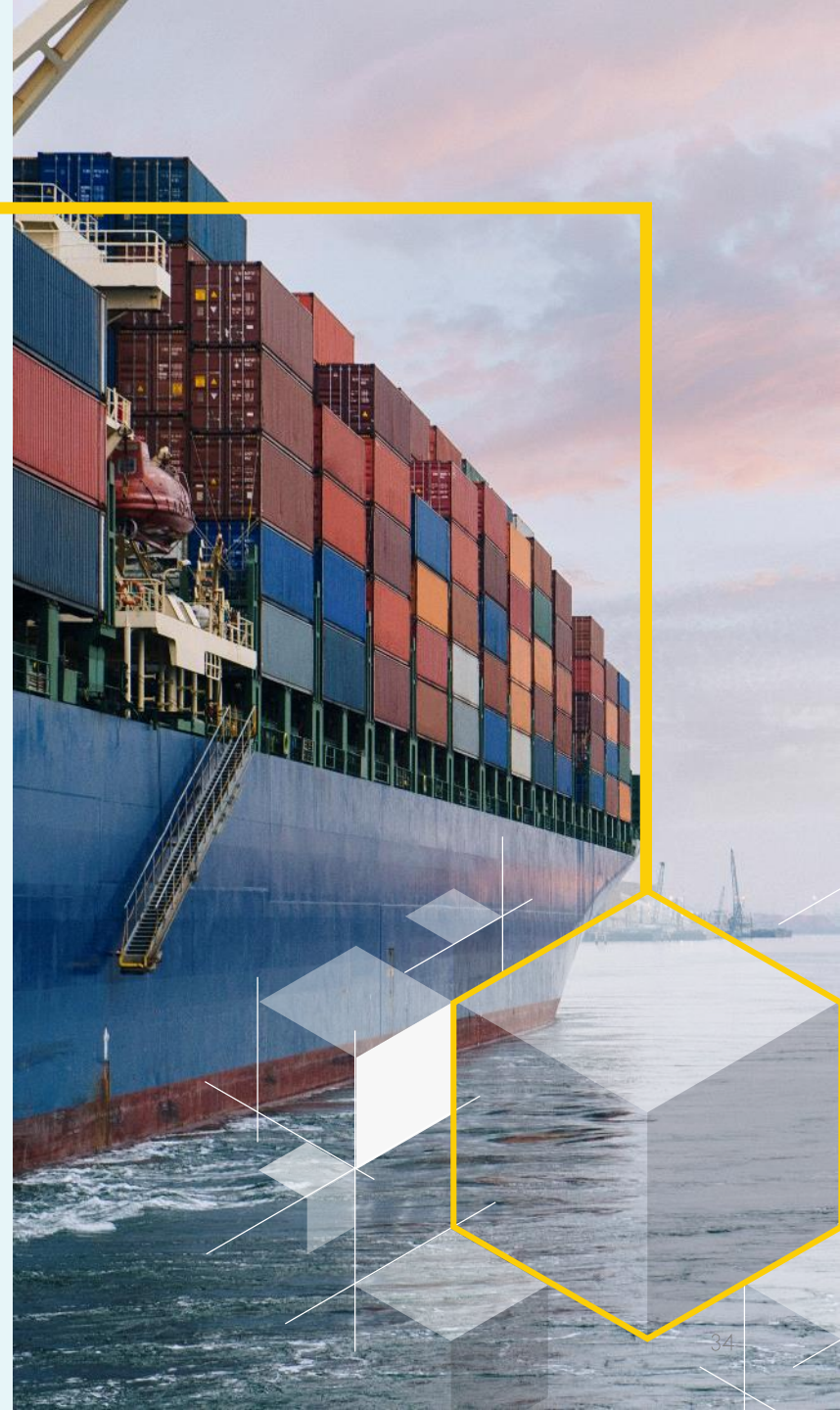
- Set binding decarbonisation targets and a clear trajectory for achieving them
- Ramp up carbon pricing over time
- Rewire the economy with low-carbon electricity

ACCELERATE SECTORAL TRANSFORMATIONS

- Encourage better coordination within sectoral value chains
- Provide time-limited fiscal and financial incentives
- Create markets/demand for these low-carbon fuels
- Support infrastructure planning and investment
- Establish governance for carbon removals

CREATE SOCIETAL SUPPORT

- Keep costs down with clear and predictable policies
- Manage transition frictions and dislocations through fair and equitable policies
- Engage society proactively in driving change with transparent and inclusive policies



The Energy Transformation Scenarios

FOUR CONCLUSIONS

The energy system will be transformed – the issue is speed

Action accelerators are necessary to meet climate aspirations

Energy needs will grow

Transformation will have costs and benefits

Find out more

www.shell.com/transformationscenarios

50 YEARS
#ShellScenarios

Keep in touch, more new Scenario content to follow through 2021