# Achieving Net Zero by decarbonising fossil fuels

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# Key findings from the IPCC Special Report on 1.5°C


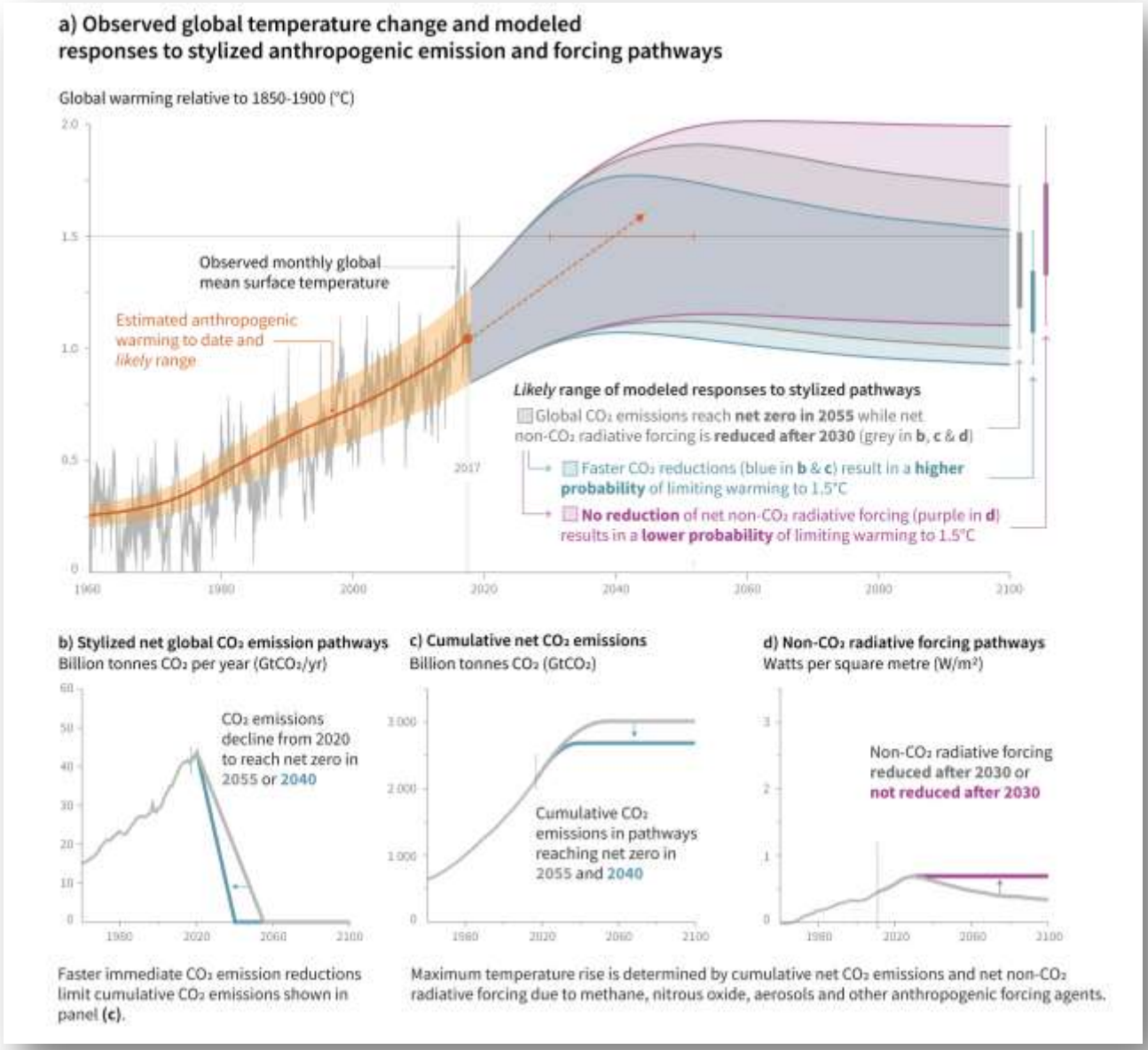


Figure SPM.1 of SR1.5

- 15-20 years to 1.5°C at the current rate of warming.
- 30-40 years to reduce emissions to zero to limit warming to 1.5°C, starting *now*.
- Every year's delay means two years less time to get emissions to zero once we start.

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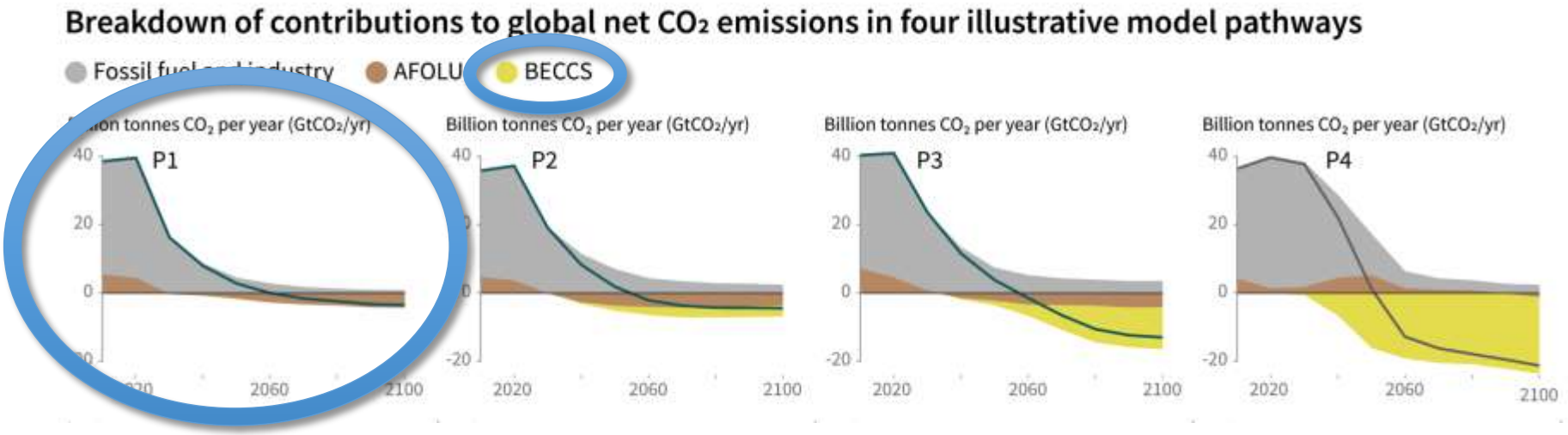
# **Do we need to decarbonise fossil fuels?** Four illustrative emission pathways from the IPCC Special Report on 1.5°C




## $CO_2$ emission reductions are mainly achieved by …

P1: … social, business and technological innovations result in lower energy demand up to 2050 …

P2: … a broad focus on sustainability … with limited societal acceptability for BECCS.

P3: … changing the way in which energy and products are produced, and [some] reductions in demand.

P4: … technological means, making strong use of CDR through the deployment of BECCS.

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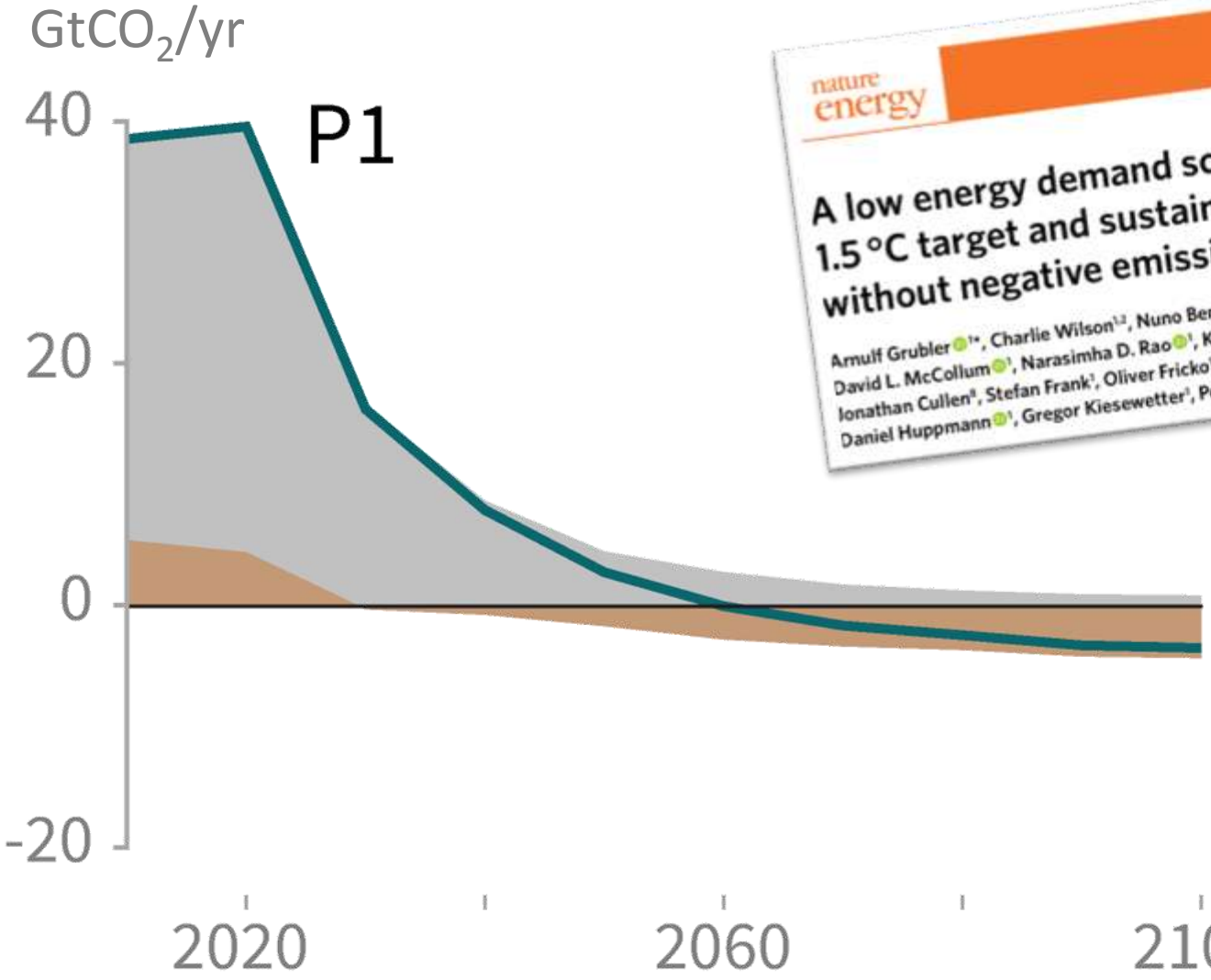
# Does the SR1.5 “P1” scenario mean we can achieve the goals of the Paris Agreement without CCS & industrial CDR?





nature energy

ANALYSIS

A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies

Arnulf Grubler, Charlie Wilson, Nuno Bento, Benigna Boza-Kiss, Volker Krey, David L. McCollum, Narasimha D. Rao, Keywan Riahi, Joeri Rogelj, Simon De Stercke, Jonathan Cullen, Stefan Frank, Oliver Fricko, Fei Guo, Matt Gidden, Petr Havlík, Daniel Huppmann, Gregor Kiesewetter, Peter Rafaj, Wolfgang Schoepp and Hugo Valin

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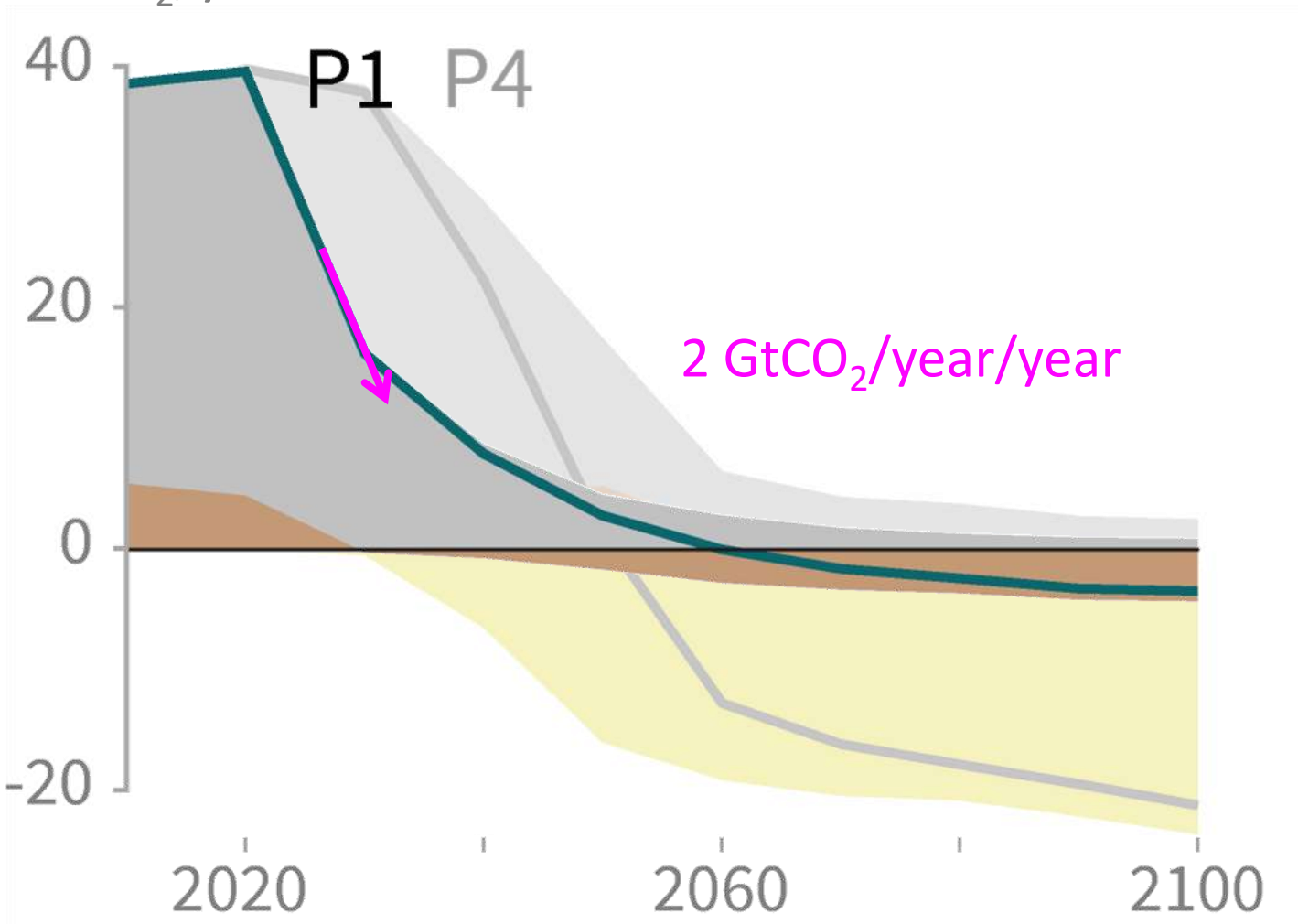
# Scenarios agree that we can't reduce faster than 2 $GtCO_2$/yr per year. At this rate we are committed to 1.5°C even if we start reductions now.

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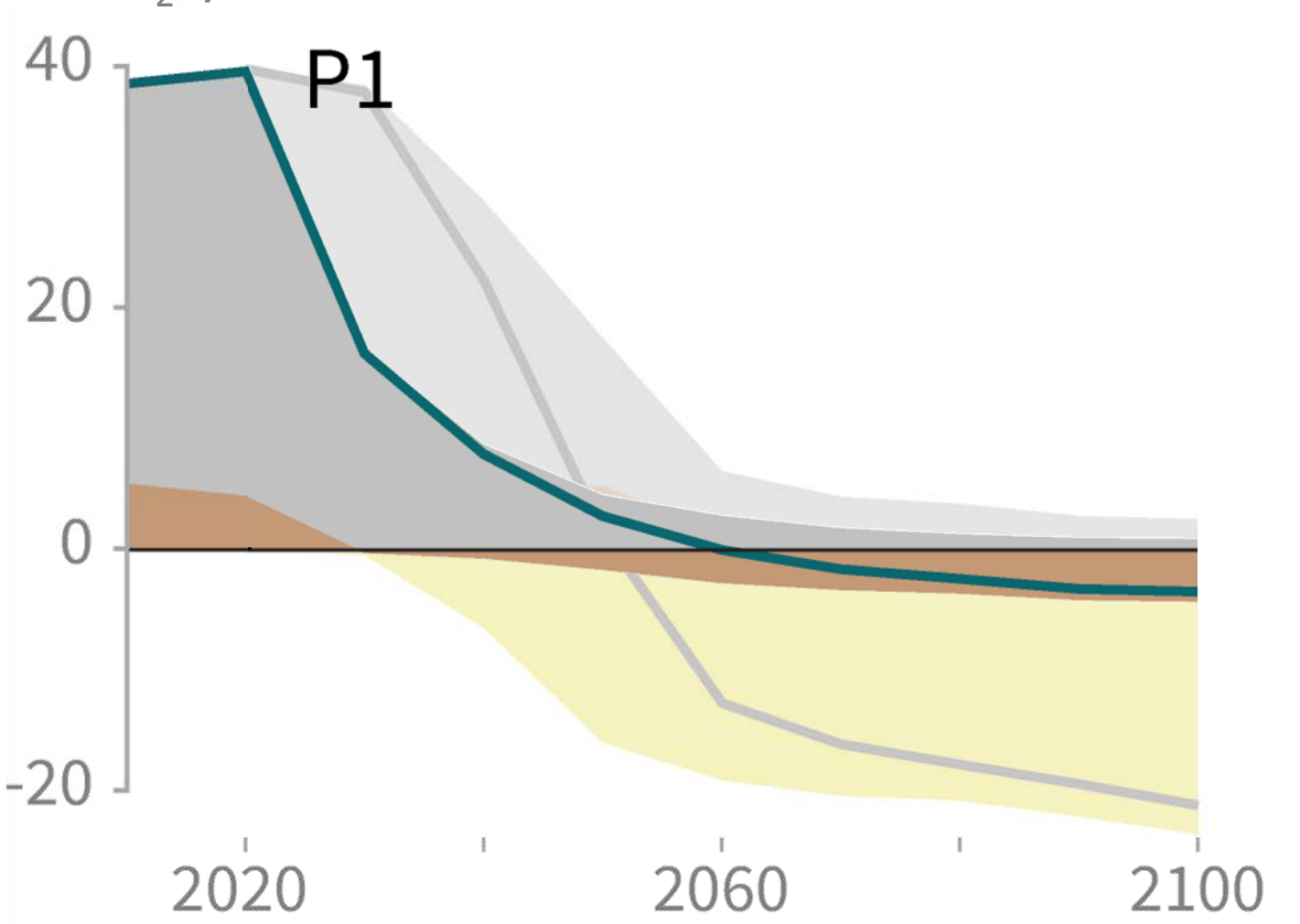
# So if we are to limit warming in 2100 to 1.5°C, every tonne of $CO_2$ dumped in the atmosphere before reductions begin has to be scrubbed out again before 2100

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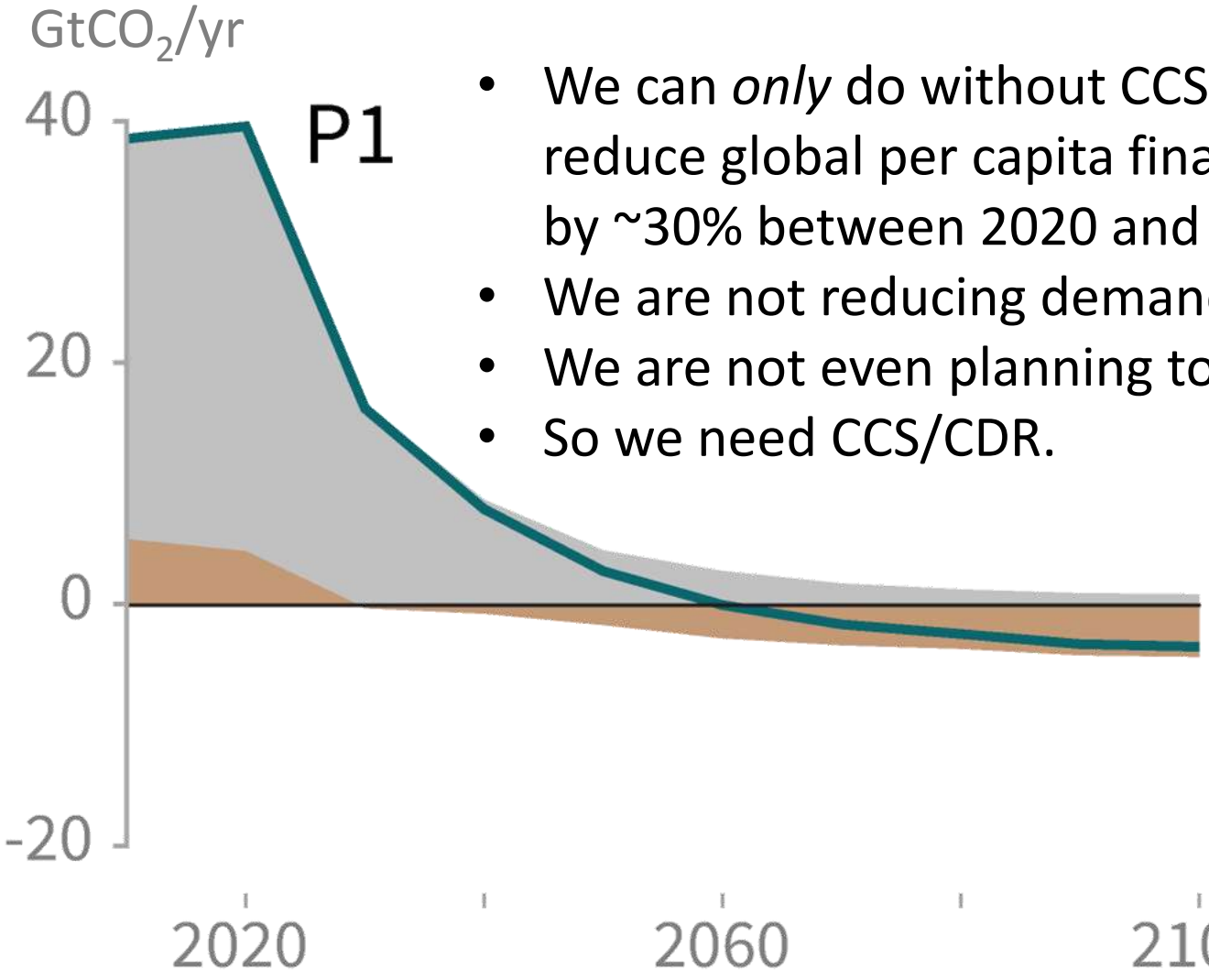
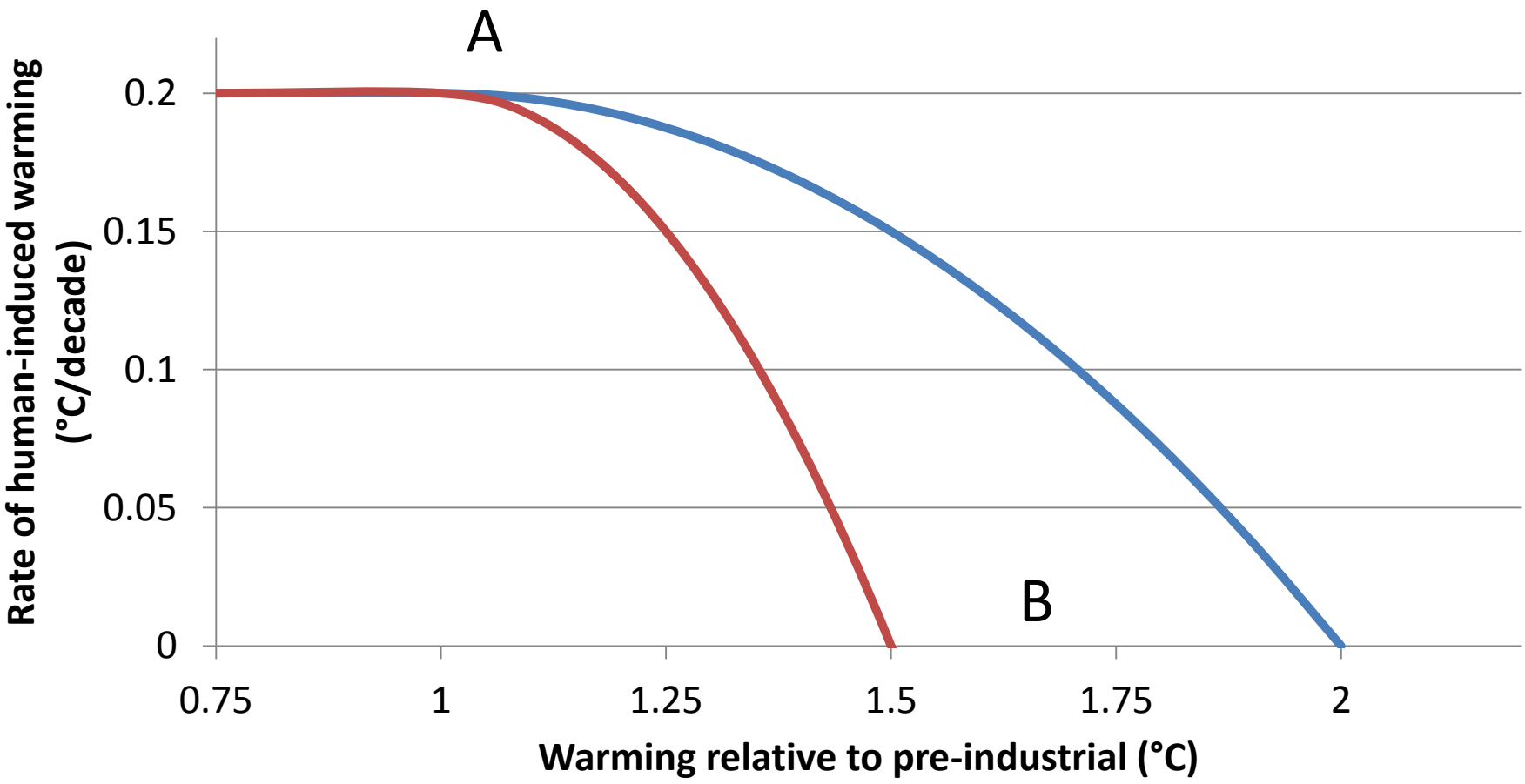
# Interpreting the SR1.5 “P1” scenario:




- We can *only* do without CCS/CDR if we reduce global per capita final energy demand by ~30% between 2020 and 2030.
- We are not reducing demand.
- We are not even planning to reduce demand.
- So we need CCS/CDR.

# Simplifying climate scenarios: getting from A to B



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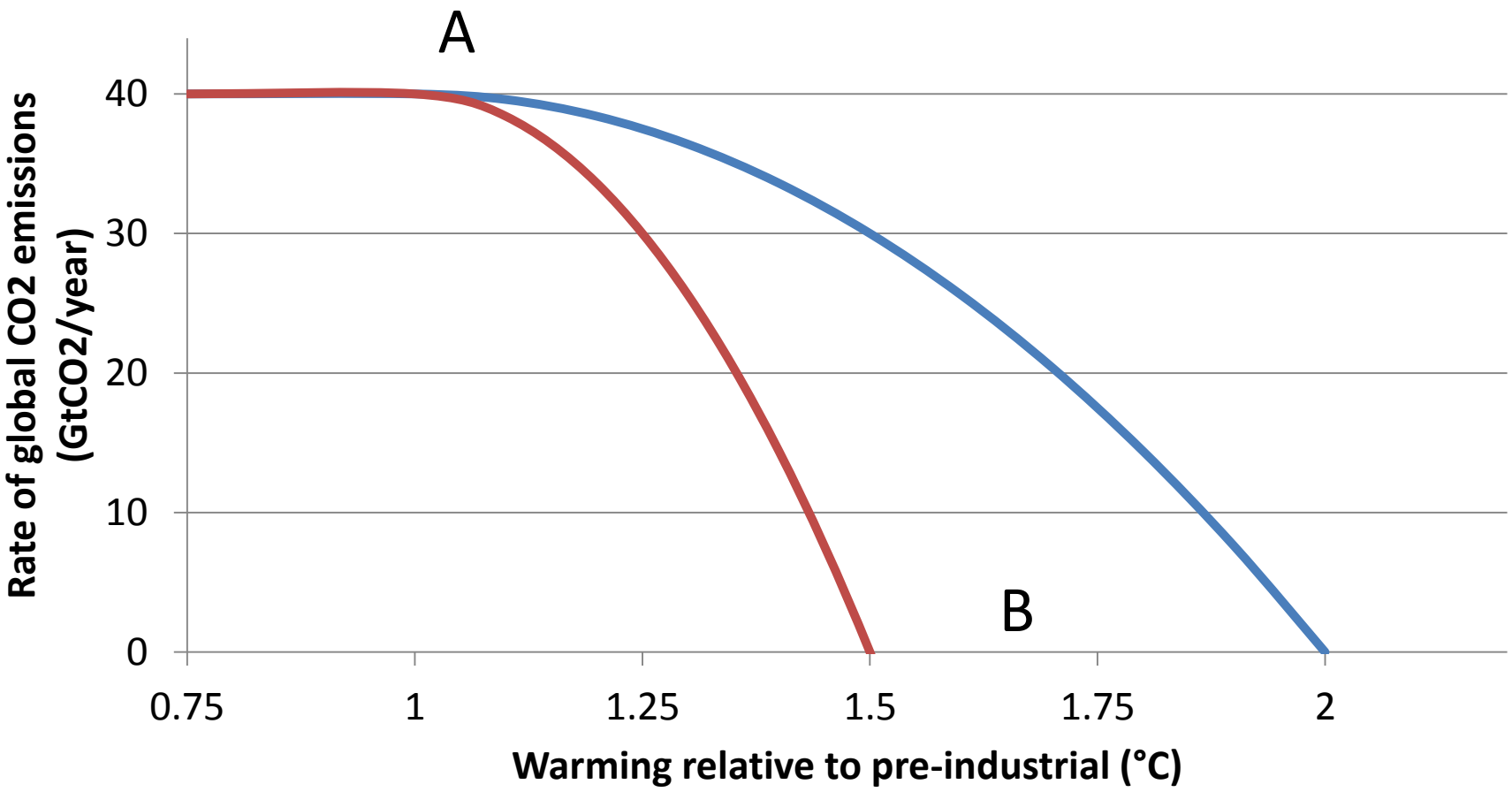

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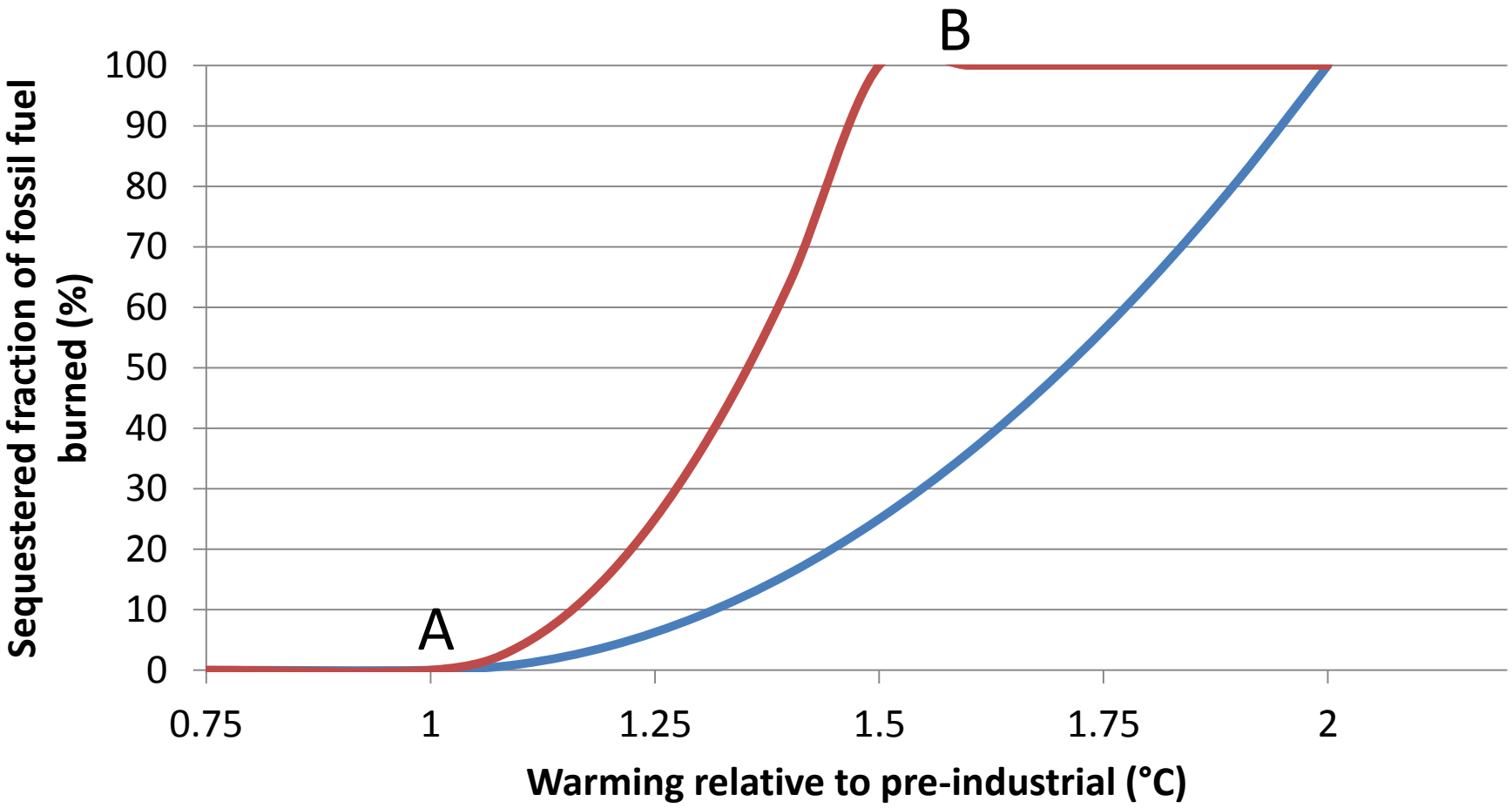
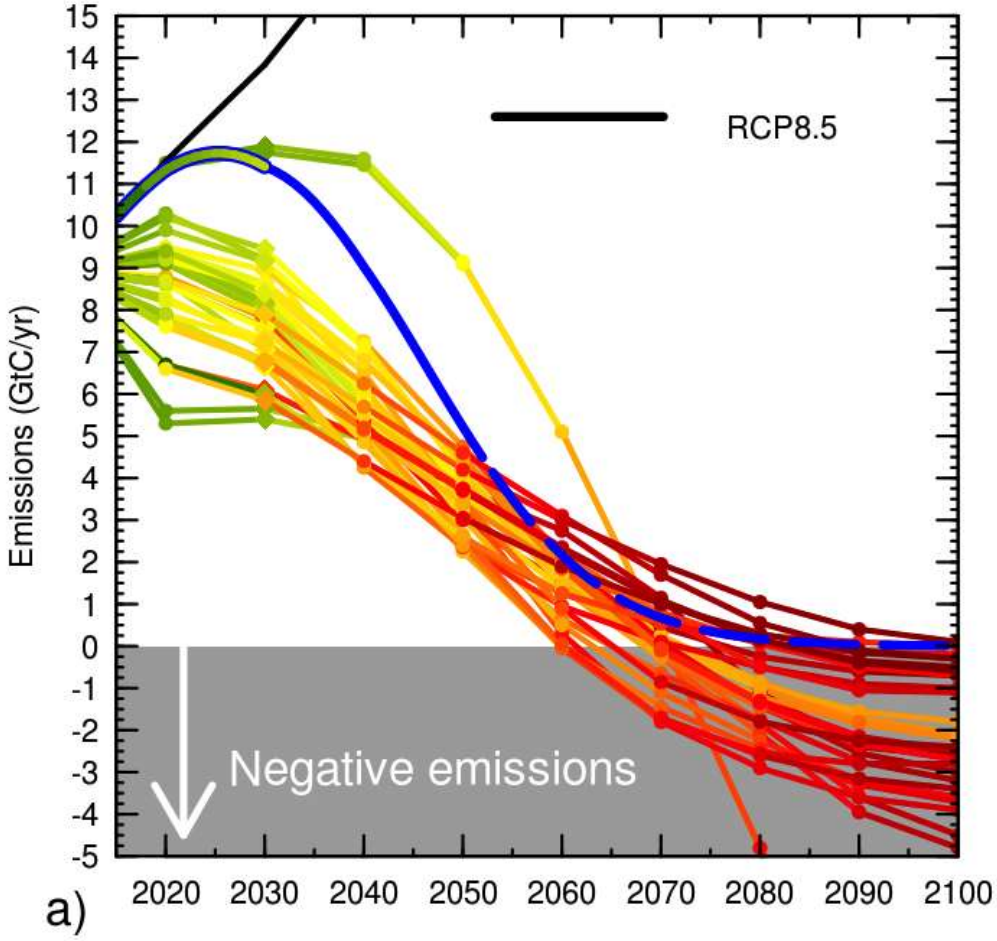


# How does this relate to some "real" (cost-effective, well-below-2° C) scenarios?

Total emissions in scenarios in IPCC WGIII "430-480ppm" (lowest) scenario category

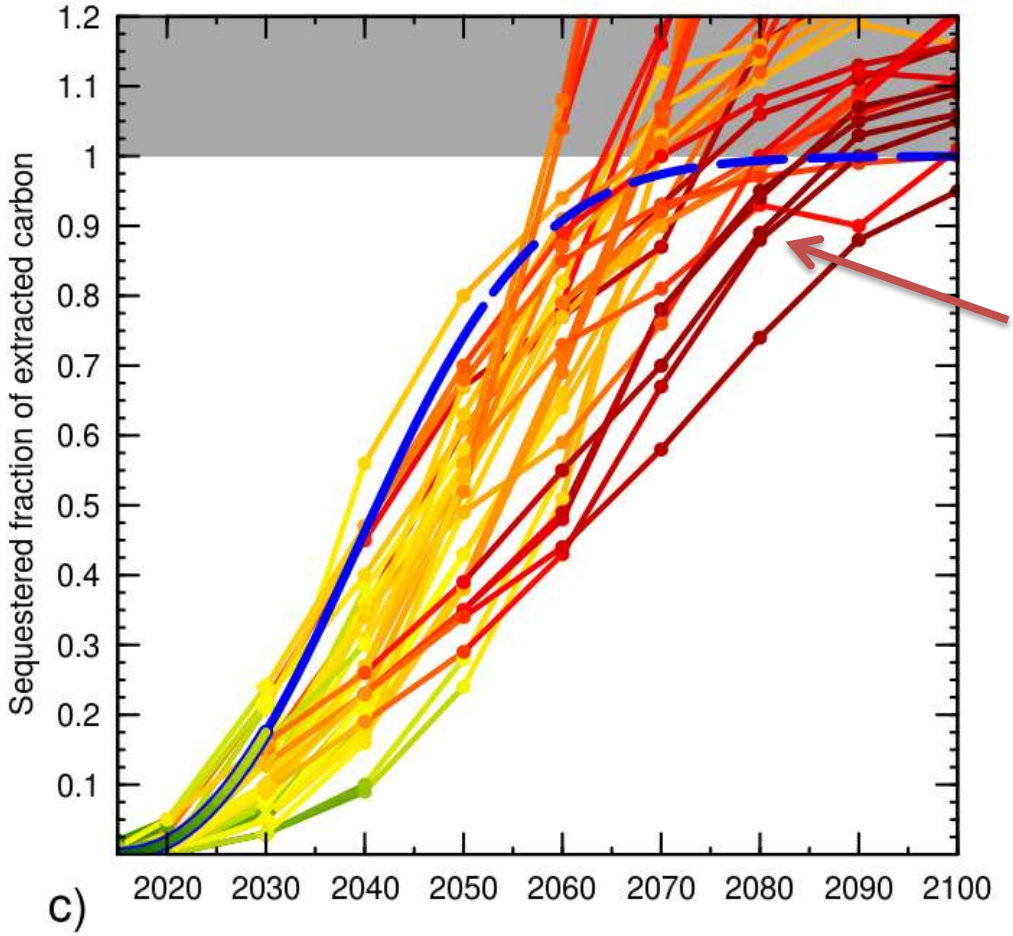



Colours show total policy cost in US$$_{2005}$$

Figures courtesy of Richard Millar based on IIASA database

# Another way of plotting well-below-2° C scenarios

Net fraction of extracted carbon that is re-injected through CCS, Bioenergy with CCS (BECCS) or Direct Air Capture (DAC)



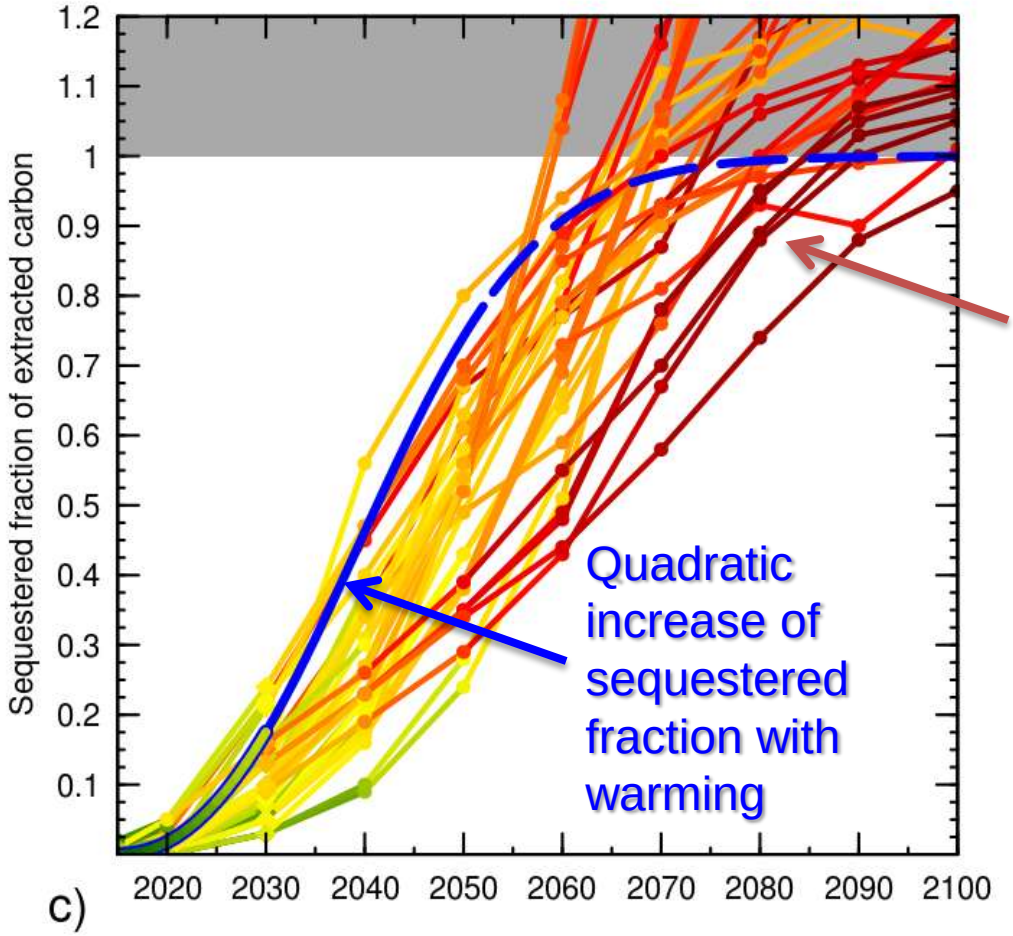

Delayed deployment of $CO_2$ disposal is associated with mitigation costs >\$60 $T\$_{2005}$/year

# Waiting for the carbon price or emission trading scheme to incentivize large-scale CCS...

IWG Theatre Guild

# Another way of plotting well-below-2° C scenarios

Net fraction of extracted carbon that is re-injected through CCS, Bioenergy with CCS (BECCS) or Direct Air Capture (DAC)



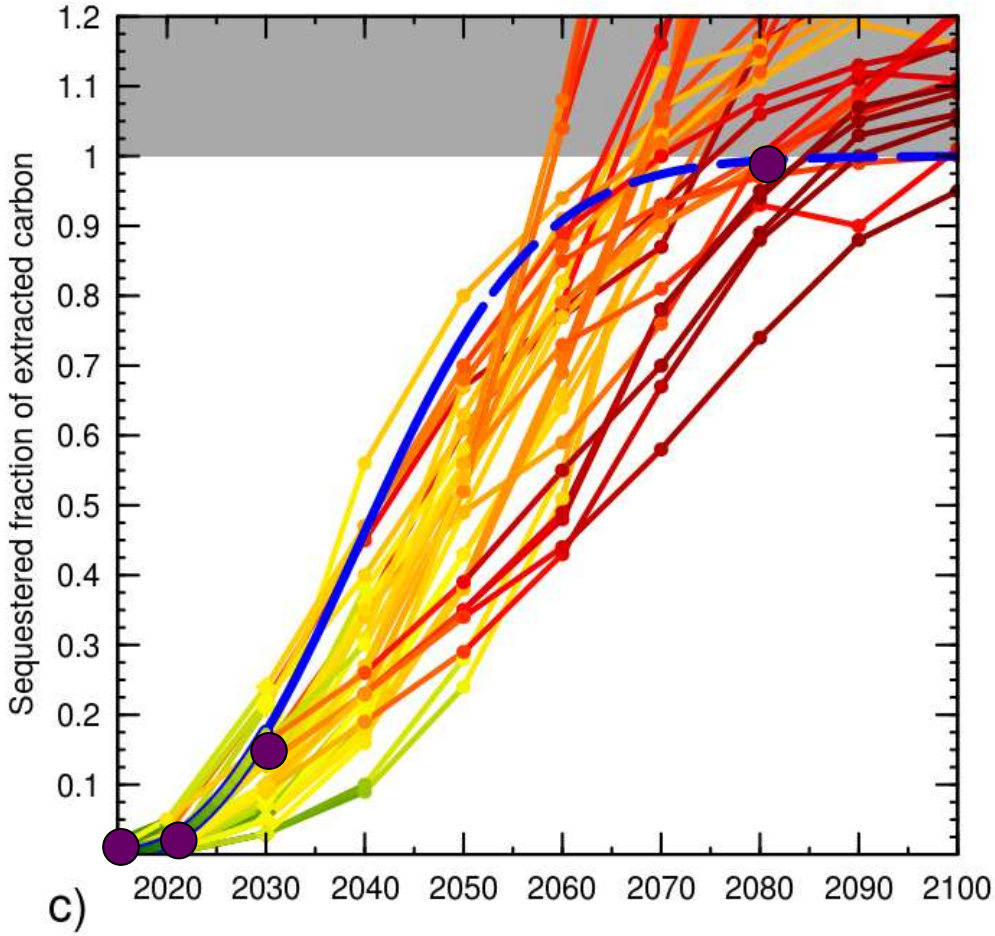
# A scenario for progressive CCS deployment

Net fraction of carbon extracted that is re-injected through CCS:

1% by 2020

15% by 2030

100% by the time temperatures reach 2°C



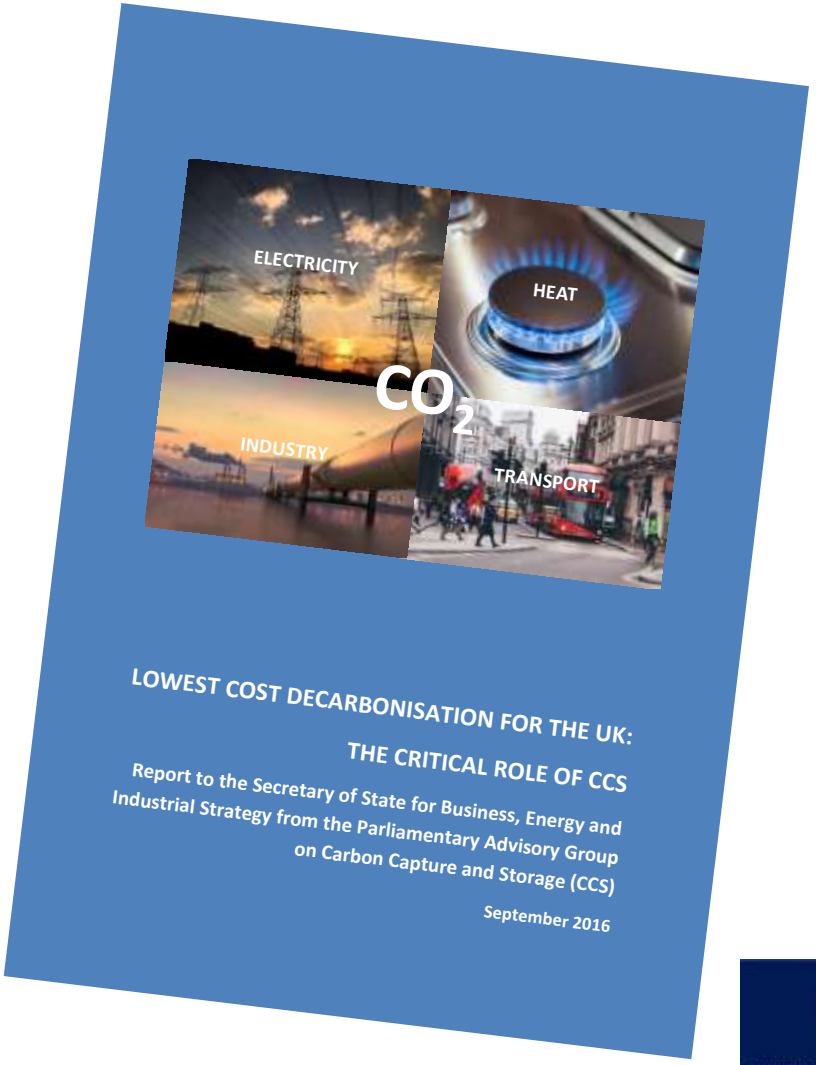

Colours show total policy cost in US$$_{2005}$$

# A practical proposal for making this happen

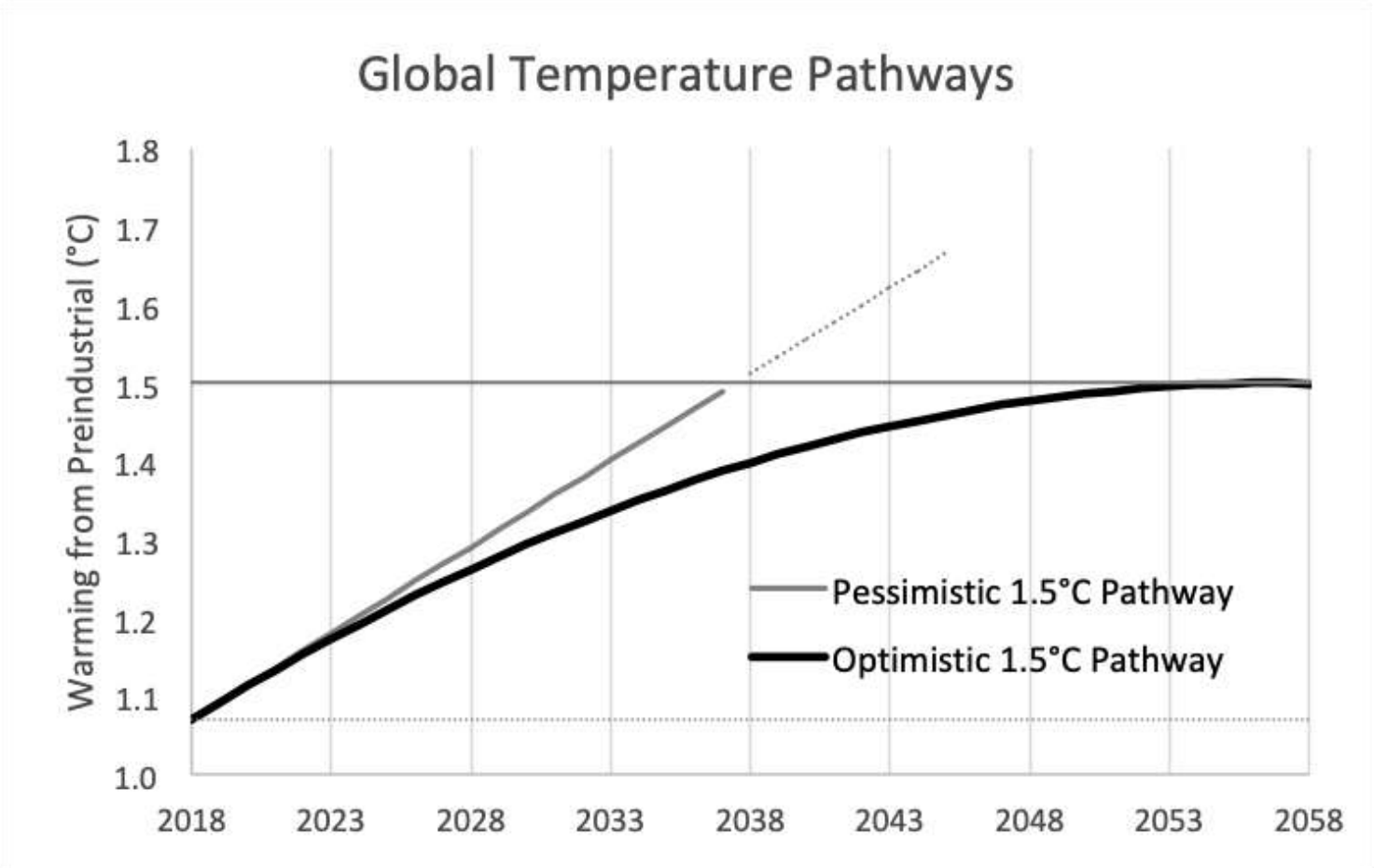
*6. Establish a CCS Obligation System (paras 343-359)*

Government will also implement a CCS Obligation from the late 2020s as a means of giving a long-term trajectory to the fossil fuel and CCS industries. This will put an obligation on fossil fuel suppliers to the UK to sequester a growing percentage of the CO2 associated with that supply.

Oxburgh et al, 2016: Report of the UK Parliamentary Committee on CCS

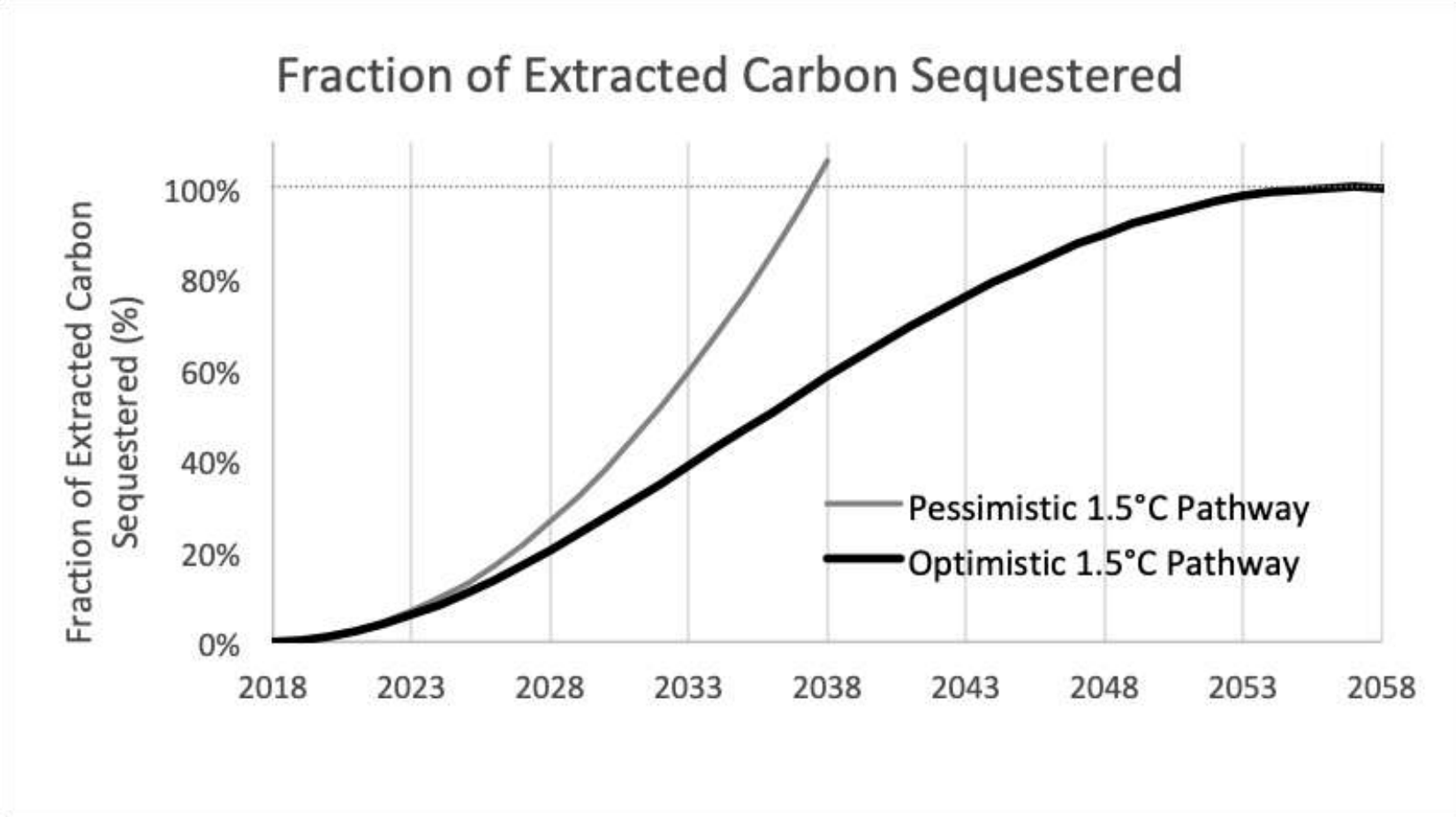


# Application to Scope 3 emissions: “Green Oil & Gas” under two global temperature pathways

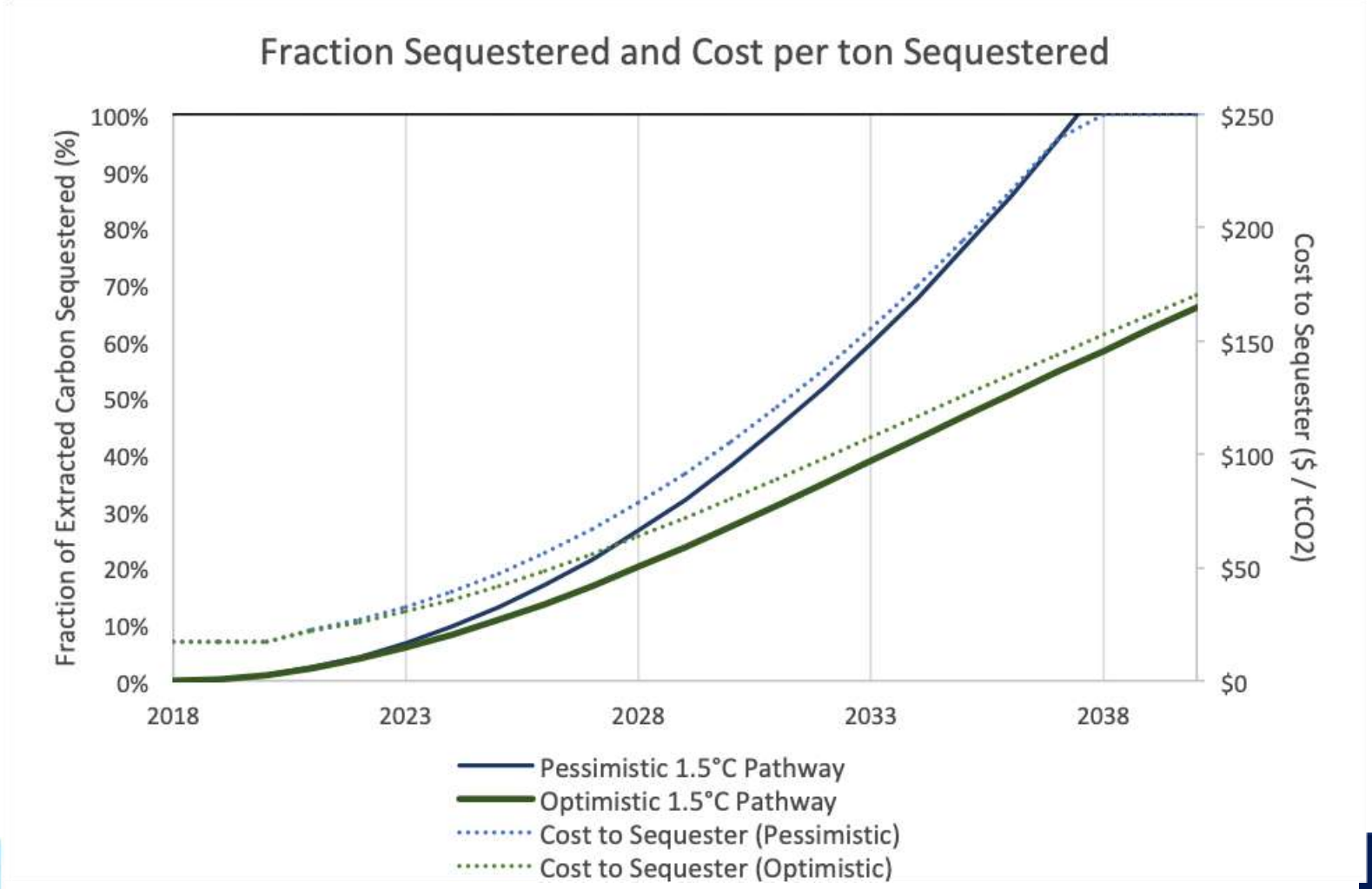



Figures courtesy of Eli Mitchell-Larson

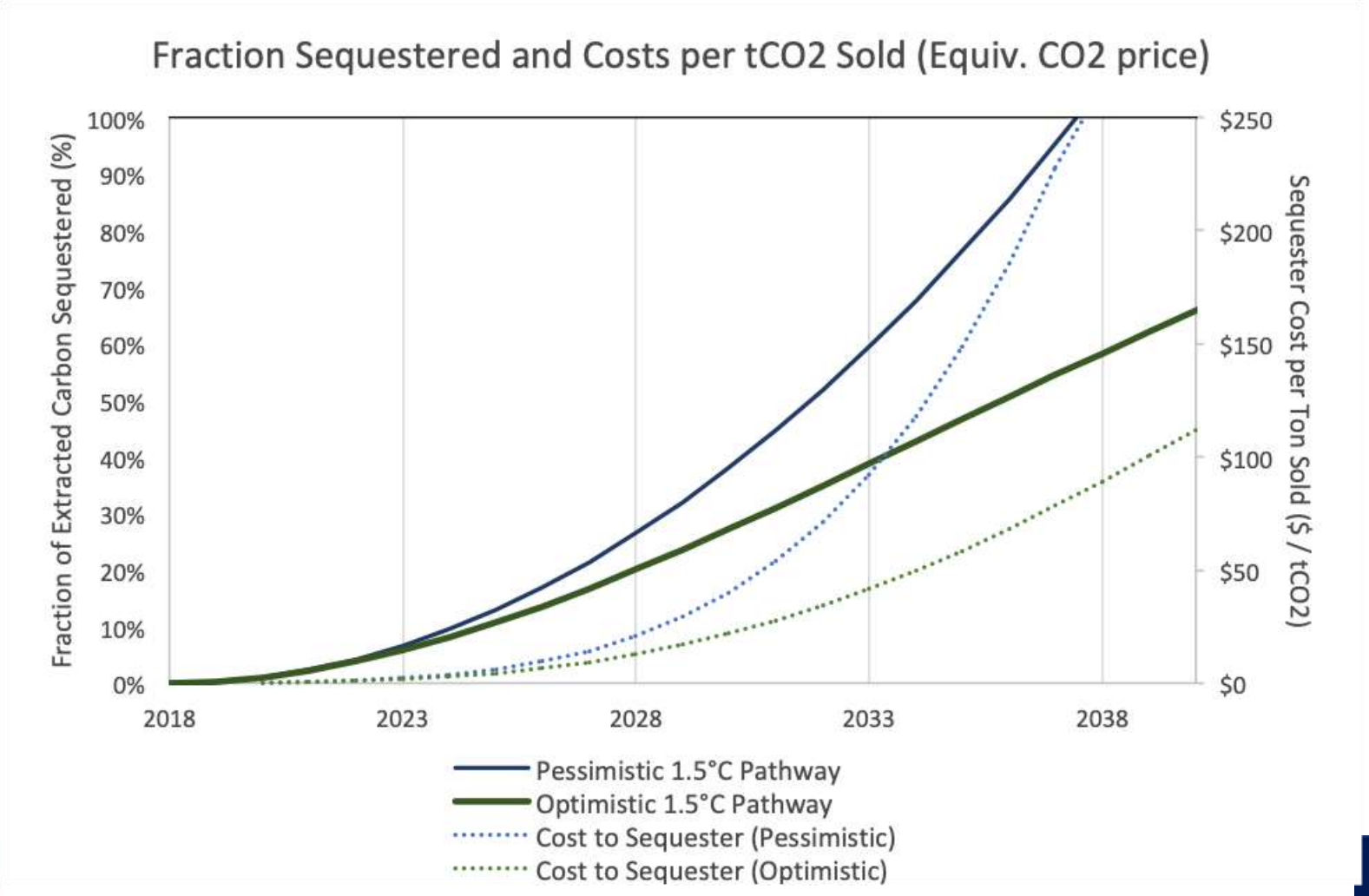
# Fraction of carbon that must be sequestered to achieve net zero by 1.5° C



# Implied cost per $tCO_2$ sequestered



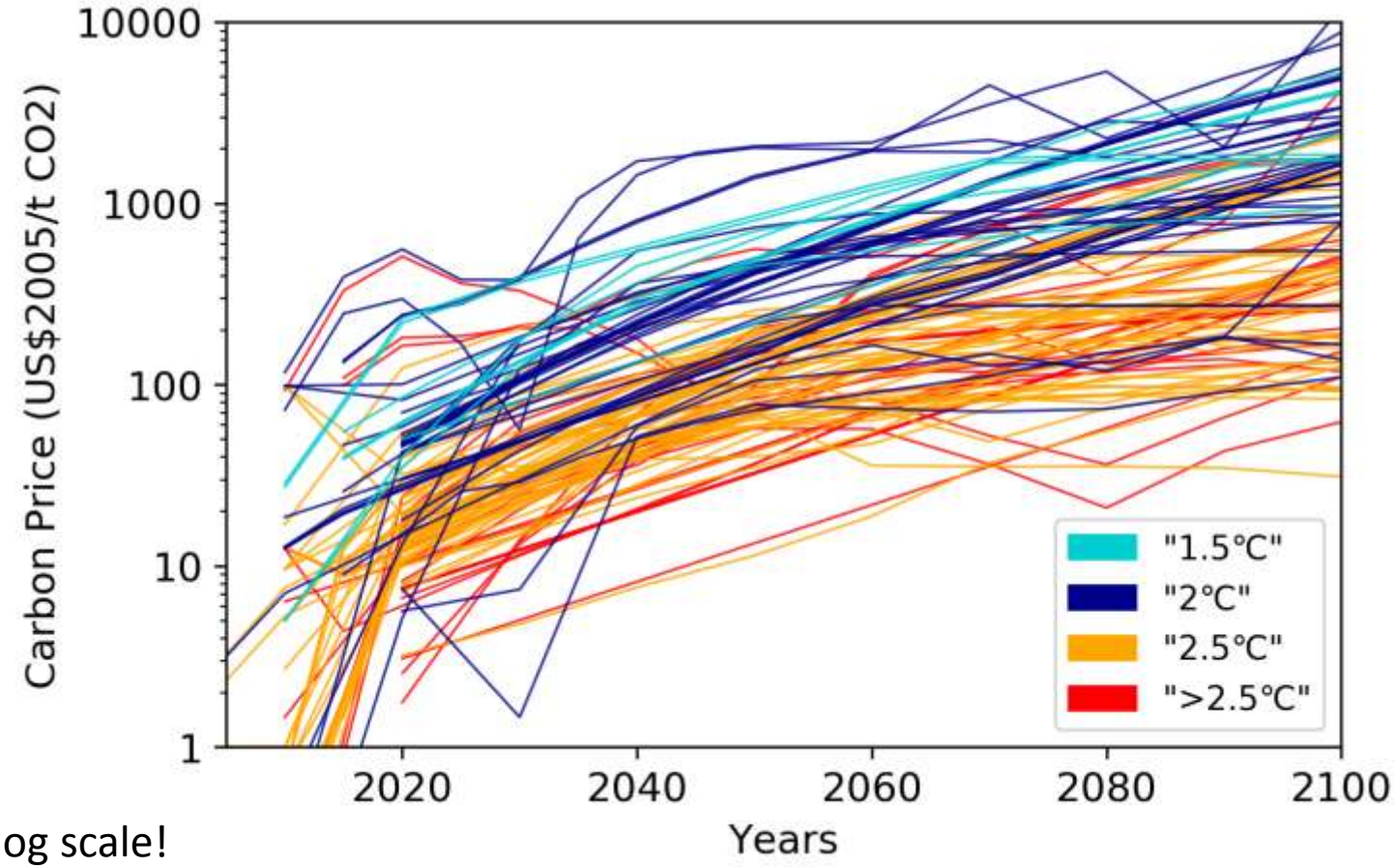
# Implied cost per $tCO_2$ embedded in carbon sold (comparable to ETS $CO_2$ price)



# The remarkable economics of mandatory sequestration

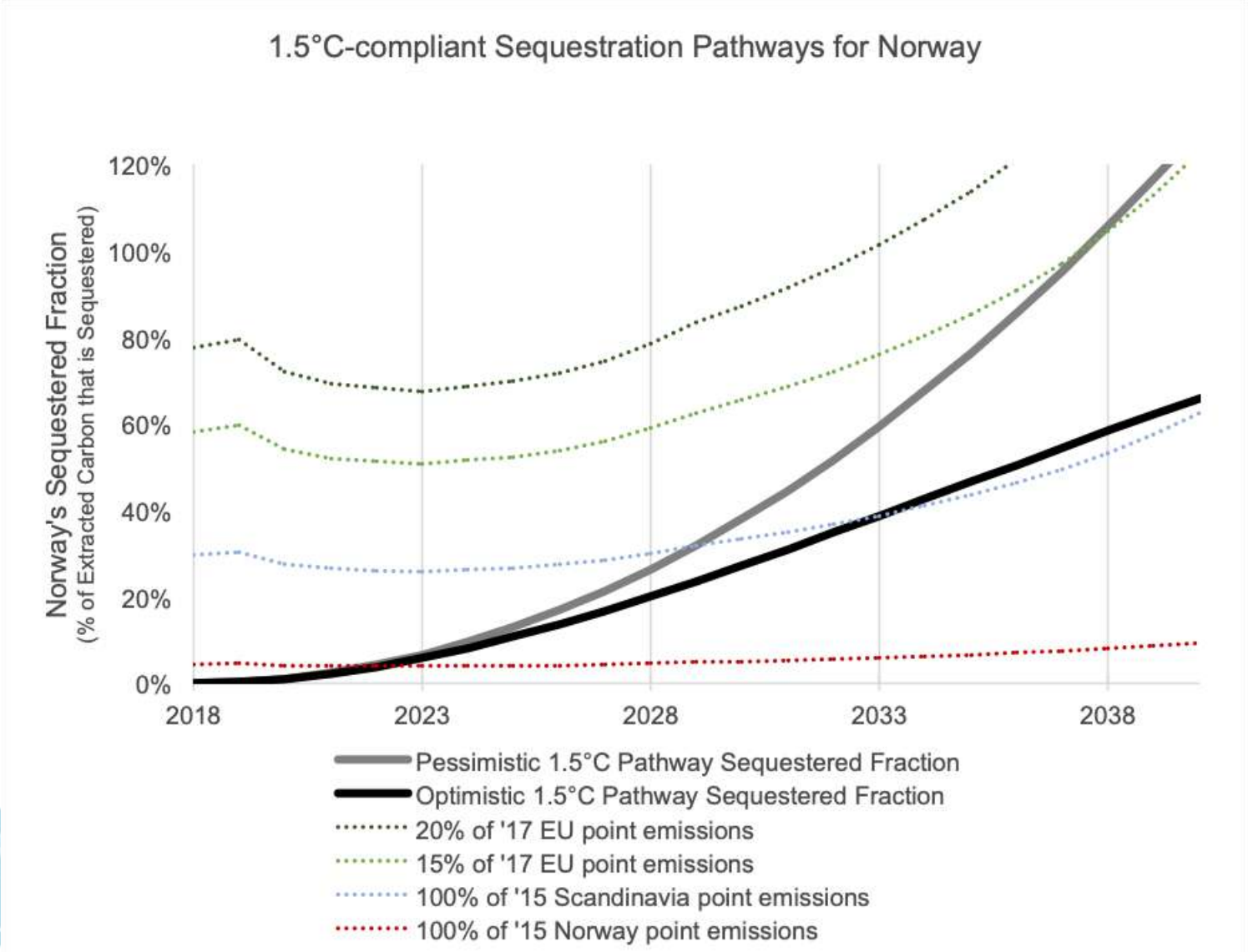
- Suppose $CO_2$ disposal initially costs \$17/t$CO_2$ *sequestered* (Sleipner costs, assuming pure $CO_2$ sources), rising to \$250/t$CO_2$ at net zero (combined CCS, BECCS & DAC).
- Cost per t$CO_2$ fossil carbon *sold*: $S(17+233S)$ where $S$ is sequestered fraction.
- This is equivalent to a carbon price of:
  - \$ 0.18 /t$CO_2$ at $S$=1% (mid-2020s)
  - \$10.00 /t$CO_2$ at $S$=16% (mid-2030s)
  - \$250 /t$CO_2$ at $S$=100% (before 2100)

# Compare these costs to carbon prices in IAM mitigation scenarios




Note log scale!

# Volume required to declare Norwegian O&G "Green" (1.5° C-compliant, incl. scope-3 emissions)



## Simple facts in an uncertain world

- To reach net zero by 1.5° C, the fraction of carbon extracted that is permanently sequestered must increase, on average, by 20% per 0.1° C warming from now on.
- Quadratic increase implies 16% sequestration by 2030.
- 16% sequestration would cost $10-15 per $tCO_2$ even if the entire cost were passed on to the consumer.

# How can oil and gas producing countries and companies best help deliver the goals of the Paris Climate Agreement?

- Not just by reducing their in-house (Scope 1 & 2) emissions.
- By decarbonizing their products – meaning genuine permanent geological offsets for Scope 3 emissions, not accounting tricks like “avoided deforestation”.
- A progressive, verifiable & trusted sequestration programme would protect the value of fossil fuel assets.
- Questions? myles.allen@ouce.ox.ac.uk
eli.mitchell-larson@gtc.ox.ac.uk

# Assumptions about Norwegian O&G production