



Carbon removal for a net zero world

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MOSTYN BROWN, JACK LONSDALE, AND STEPHEN WOODHOUSE

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STEPHEN WOODHOUSE



Director
stephen.woodhouse@afry.com
+44 7970 572 444

MOSTYN BROWN



Senior Consultant
mostyn.brown@afry.com
+44 7854 518 785

JACK LONSDALE



Principal
jack.lonsdale@afry.com
+44 7587 034 176

MAKING FUTURE

Providing leading solutions for generations to come



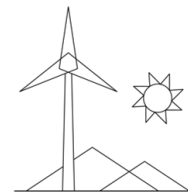
SMART CITIES AND
INFRASTRUCTURE



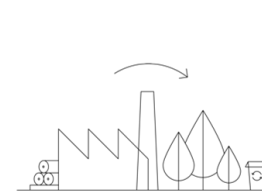
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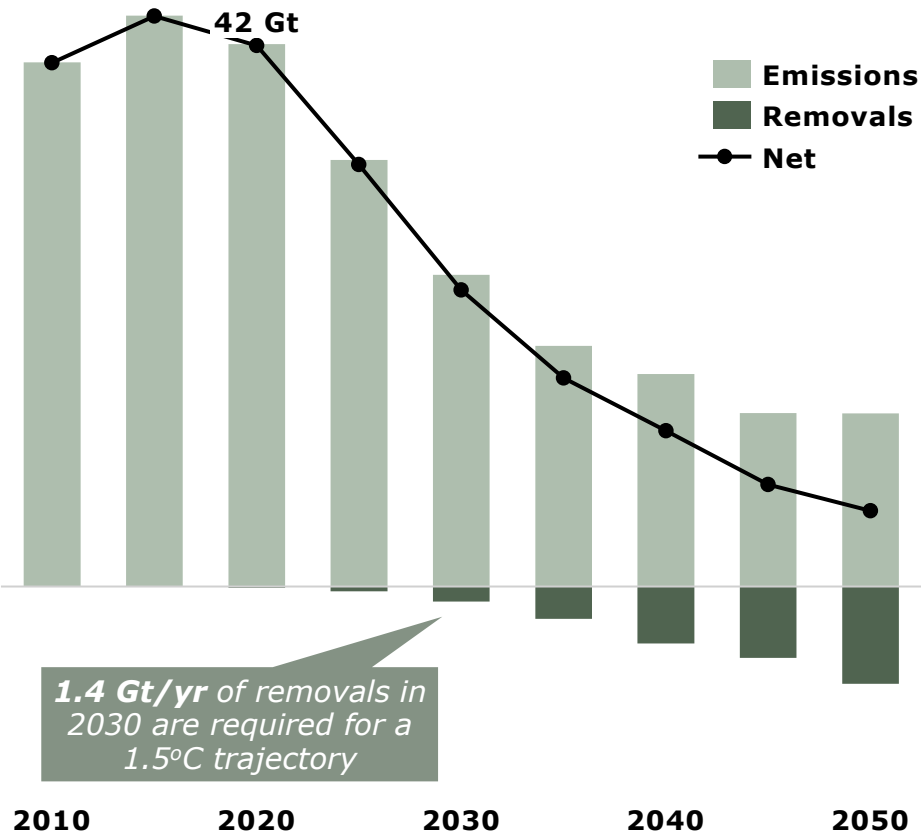
CHANGING ENERGY
MARKETS



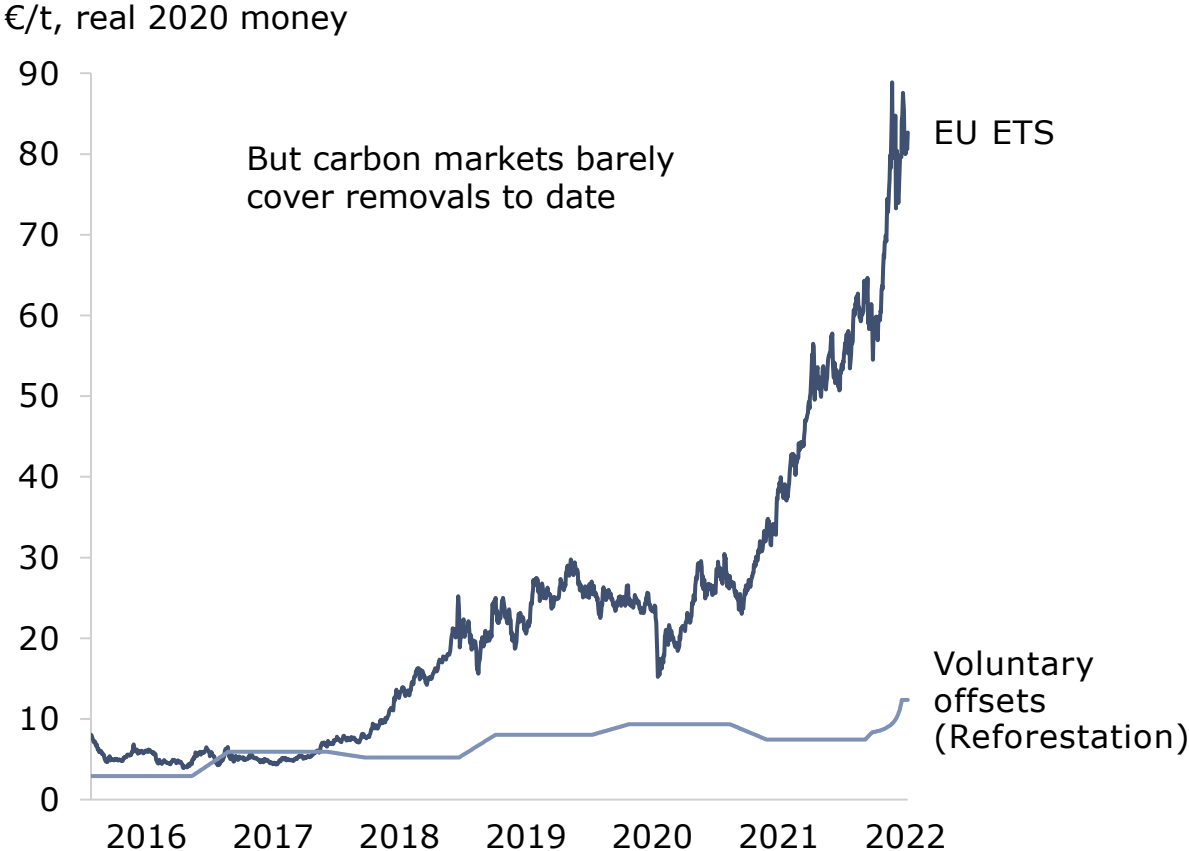
TRANSITION TO
BIOECONOMY

Carbon removals are required to reach net-zero

IPCC 1.5°C PATHWAY TO NET-ZERO (GTCO₂/YR)



CARBON MARKETS ARE GROWING IN IMPORTANCE



Left: Adapted from IPCC (2018) Special report: global warming of 1.5°C (Table 2.4 – 1.5°C with no or limited overshoot pathway) – removals here is represented by BECCS + AFOLU.

Agenda

- 1 Potential supply is large 7
- 2 Government demand is growing 11
- 3 Demand from corporations will accelerate even faster once issues can be resolved 16
- 4 AFRY can help with your decarbonisation journey + Q&A 23



Agenda

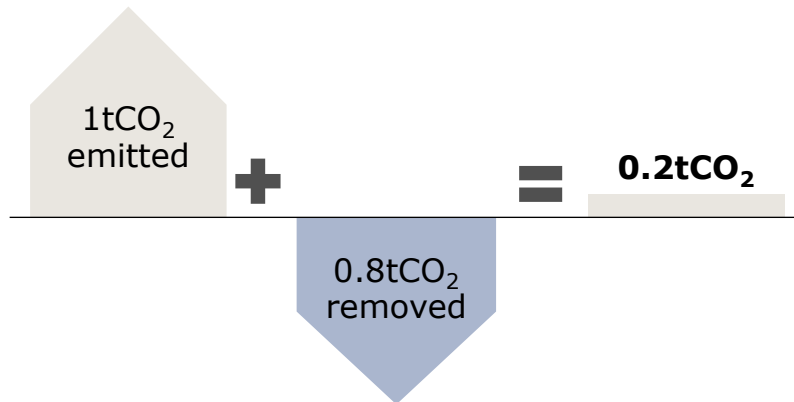
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|-----|--|----|
| 1 | Potential supply is large | 7 |
| 1.1 | Carbon removal technologies must fulfil three criteria | |
| 1.2 | Storage duration varies considerably by technology | |
| 1.3 | Need expensive tech-based removals to meet targets | |
| 2 | Government demand is growing | 11 |
| 3 | Demand from corporations will accelerate even faster once issues can be resolved | 16 |
| 4 | AFRY can help with your decarbonisation journey + Q&A | 23 |



Carbon removal must i) capture carbon from the atmosphere, ii) store it (indefinitely), and iii) be net-negative

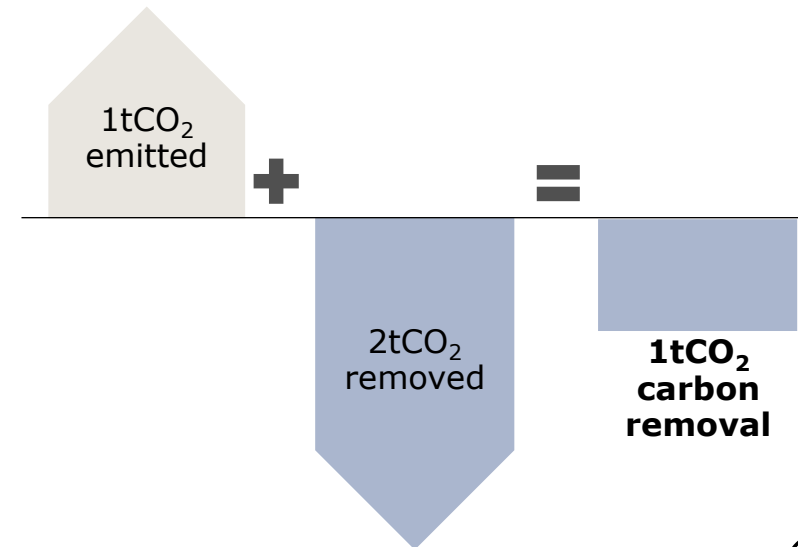
CARBON CAPTURE AND STORAGE (CCS)

- CO₂ captured from fossil fuel combustion
- CO₂ stored
- Emissions reduced, but still net-positive

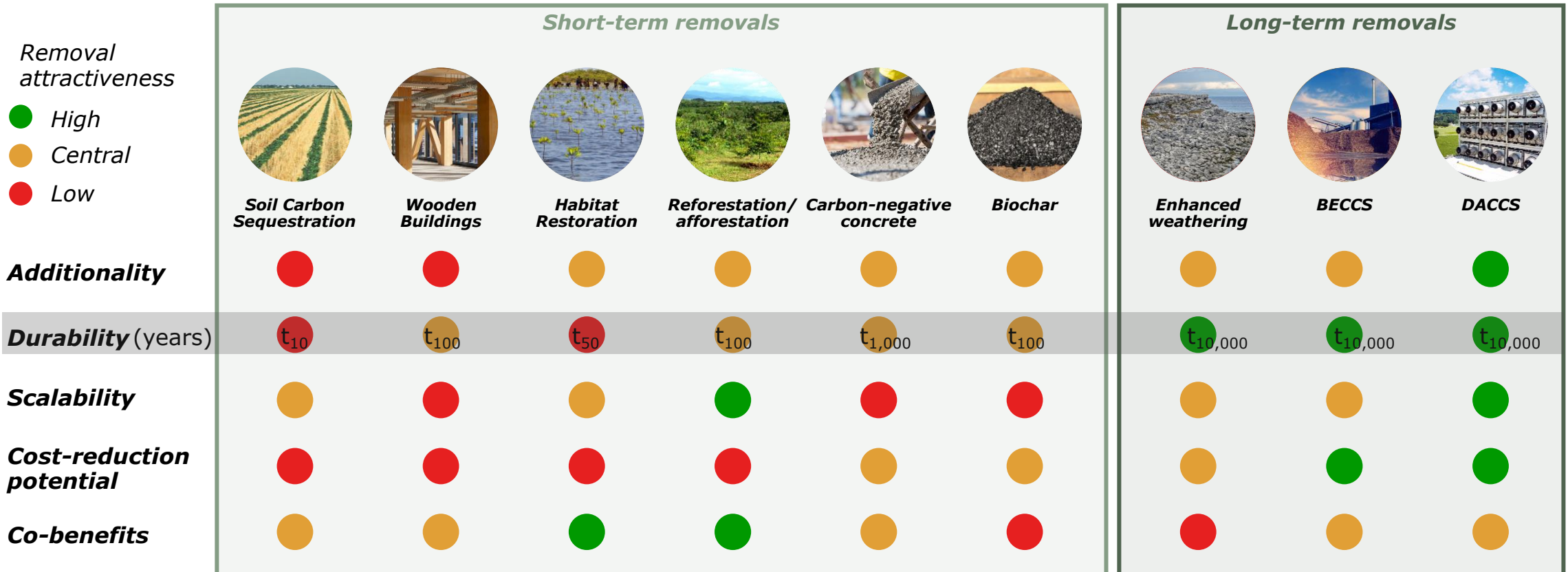


CARBON REMOVAL

- CO₂ captured from **atmosphere**
 - CO₂ stored
 - **Net-negative**
- e.g. reforestation, BECCS, DACCS*



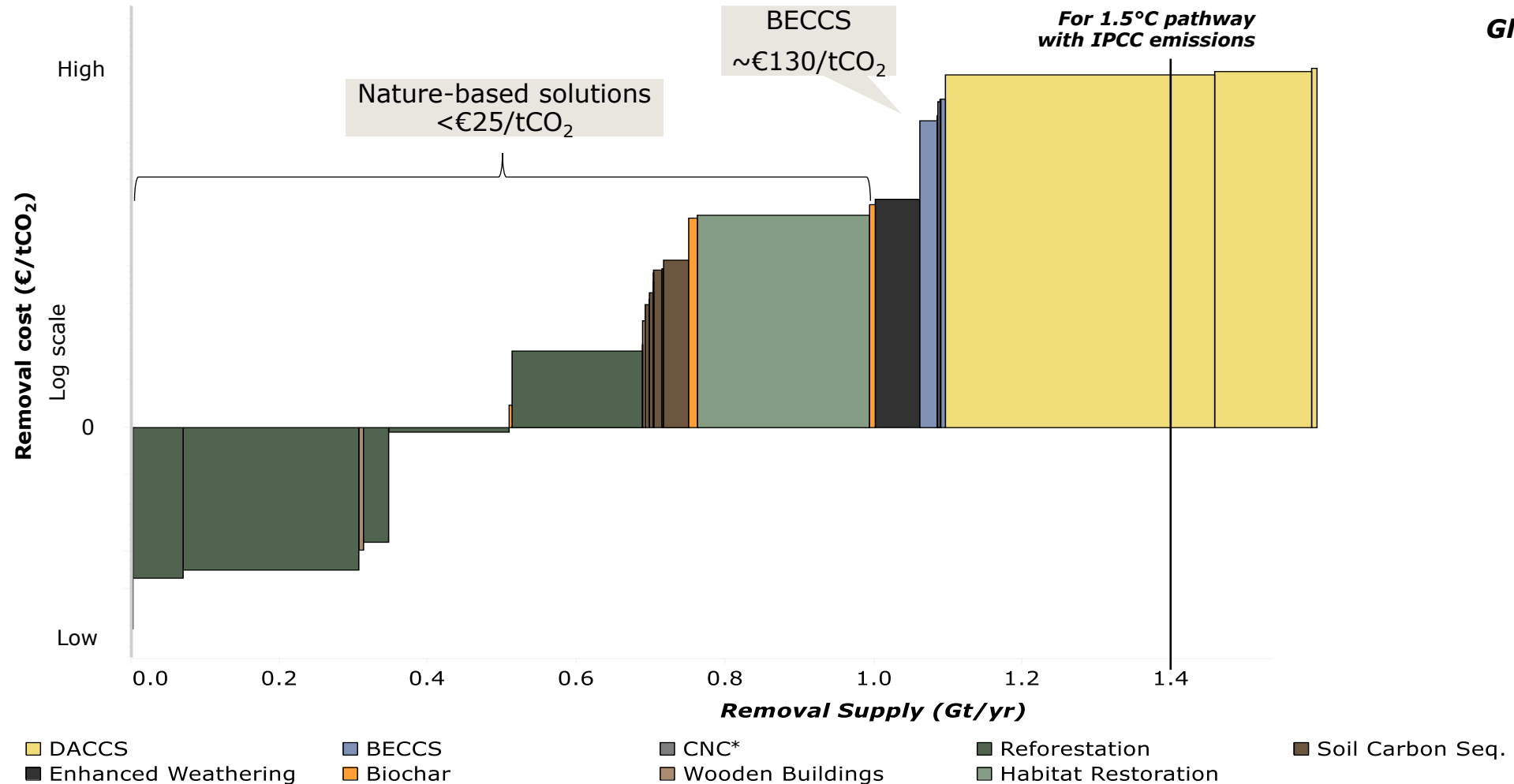
Removal technologies have diverse characteristics, with durability of storage being a key issue for some technologies



POTENTIAL SUPPLY

There is enough potential supply to 2030, but relies on use of expensive tech-based removals

**2030
Global supply**



* Carbon negative concrete

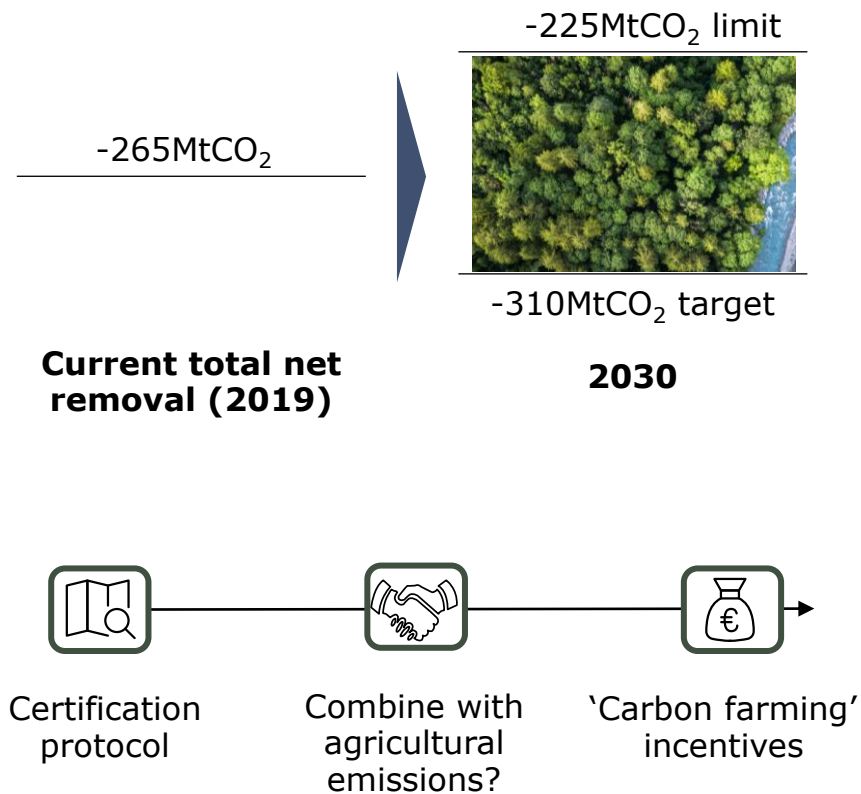
Agenda

- 1 Potential supply is large 7
- 2 Government demand is growing 11
 - 2.1 EU is focused on nature-based removals
 - 2.2 Caution: mixing removals with emission reductions
 - 2.3 Without removals EU ETS prices could be extreme
- 3 Demand from corporations will accelerate even faster once issues can be resolved 16
- 4 AFRY can help with your decarbonisation journey + Q&A 23

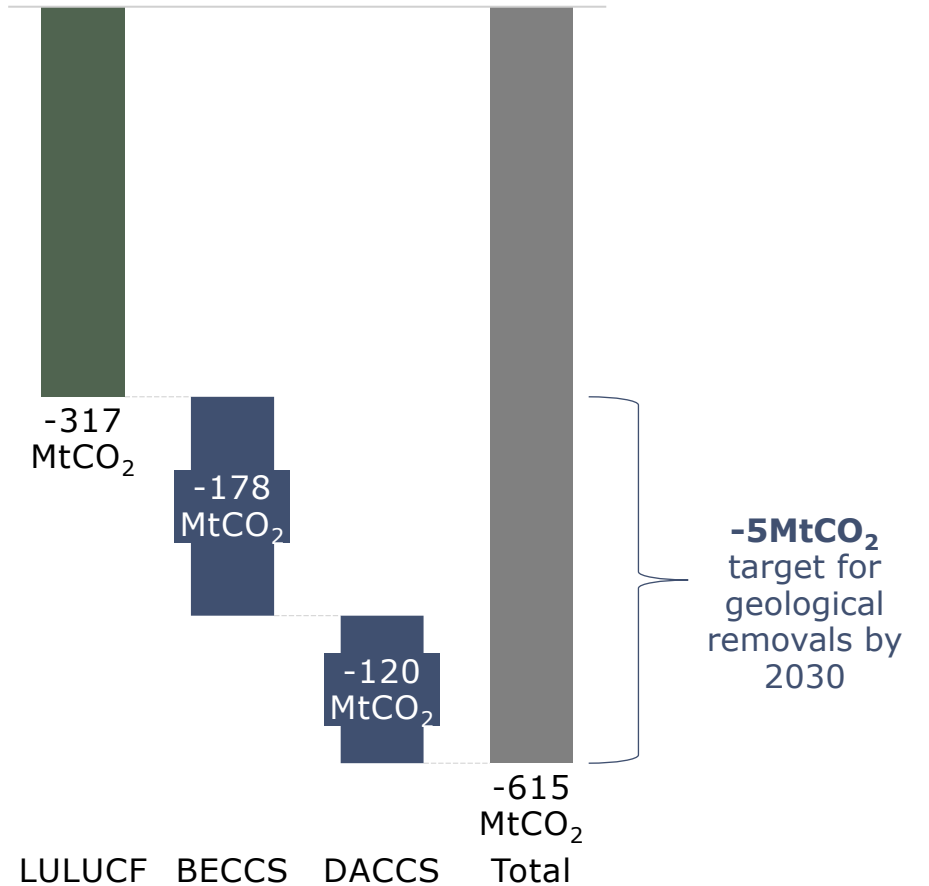


EU carbon removal policies are focused on nature-based solutions

CURRENT FOCUS IS ON THE LULUCF¹ SECTOR



2050 REMOVAL REQUIREMENTS IN NET-ZERO MODELLING



¹ Human activities impact terrestrial sinks, through **land use, land-use change and forestry (LULUCF)** activities. Right: A Clean Planet for all (1.5TECH scenario). European Commission, 2018.

Technological step-change in our ability to measure carbon stored in forests combined with carbon market mechanisms are reducing risk in NBS

TECHNIQUES TO REDUCE RISK OF NATURE-BASED SOLUTIONS

Monitoring, Reporting, Verification

New remote sensing carbon monitoring systems provide:

- Transparency of changes to forest
- Complete coverage across multiple geographical scales
- Reduced cost of verification
- Reduced uncertainty versus pure modelling approaches

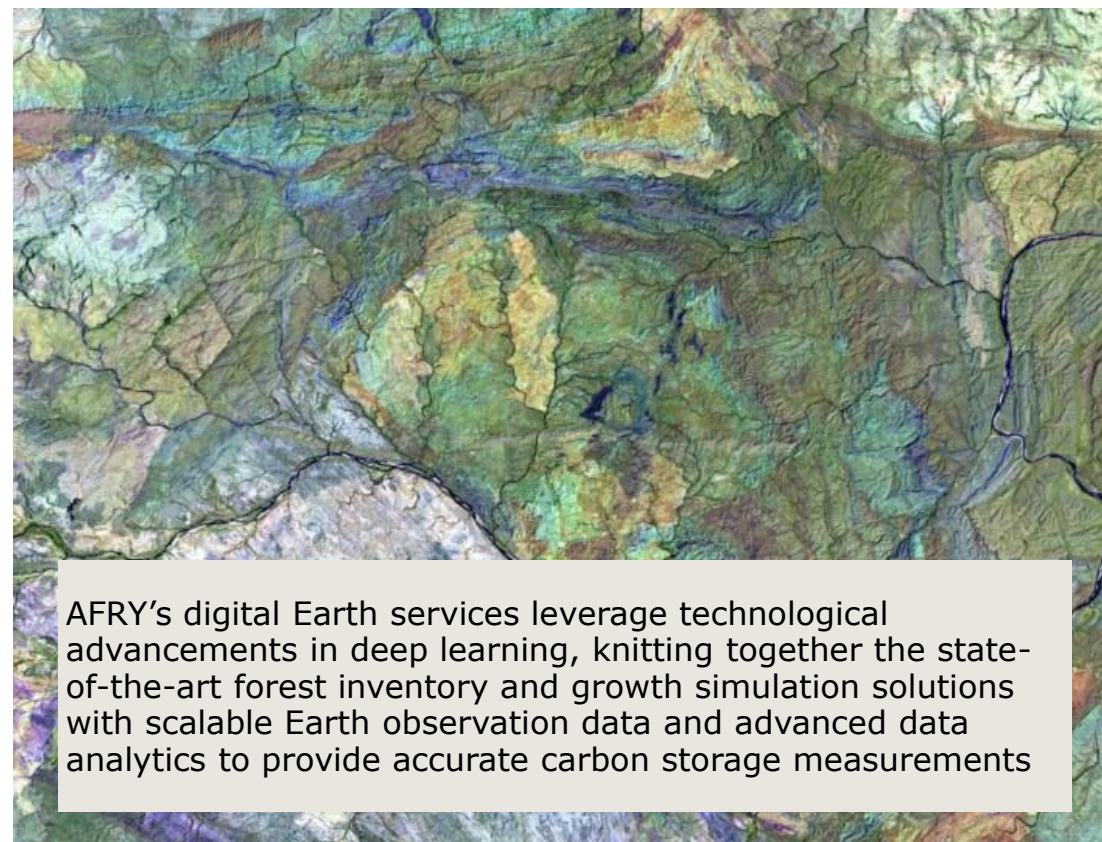
Loss Mitigation Mechanism

Risk of Carbon Credit Buffer Pools:

- Shared 'insurance' for unanticipated loss

Favouring ex-ante credits/results based payment:

- Credits where the storage has already been achieved



AFRY's digital Earth services leverage technological advancements in deep learning, knitting together the state-of-the-art forest inventory and growth simulation solutions with scalable Earth observation data and advanced data analytics to provide accurate carbon storage measurements

GOVERNMENT DEMAND

Mixing removals with emission reductions must be done with care

“We need to think about the integration of carbon removals into our climate policies towards 2050”
European Commission, August 2021

Impact on ETS installations

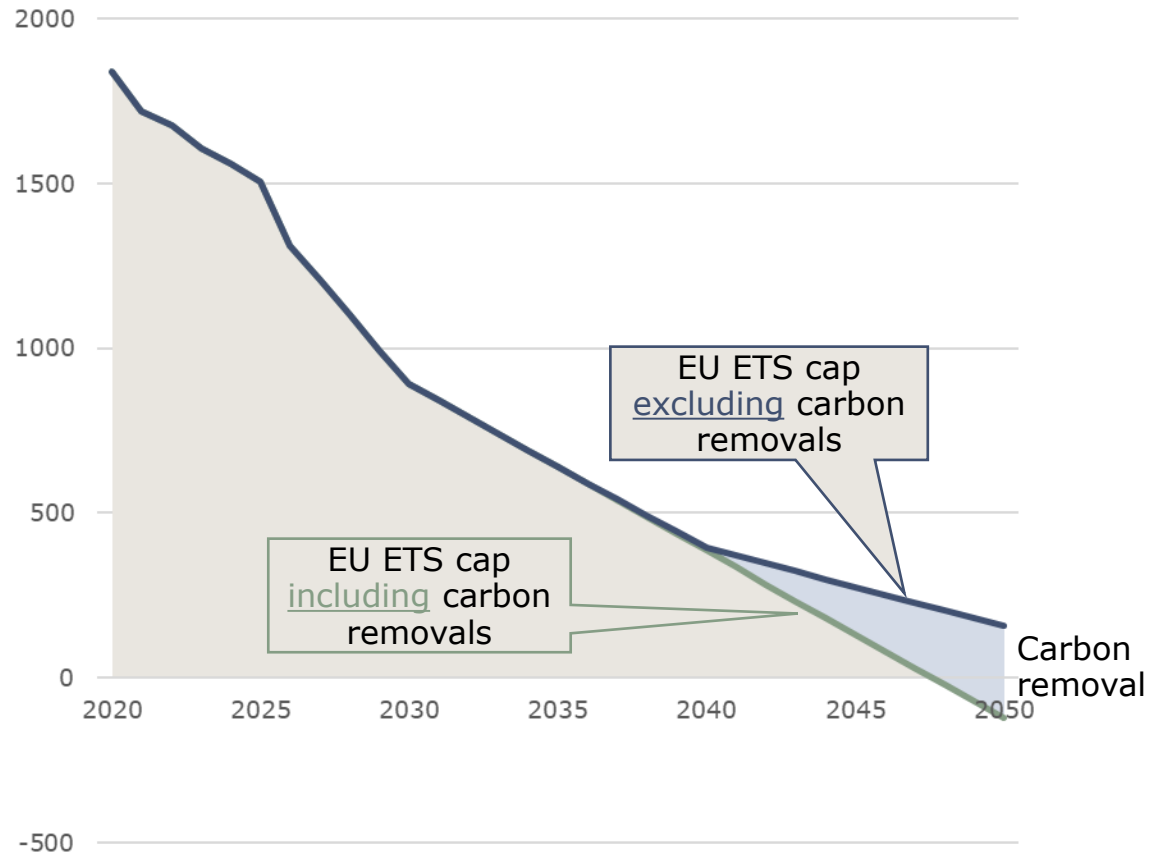
Scope:
Technologies

Market design:
Degree of integration with the EU ETS

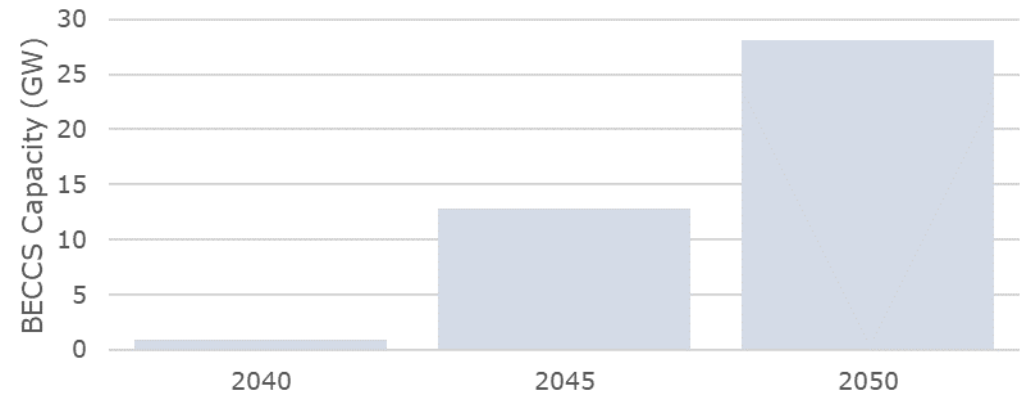


Without removals EU ETS participants could face extreme carbon prices

EMISSIONS CAP UNDER THE EU ETS (MT CO₂)



BECCS CAPACITY REQUIRED TO ACHIEVE A NET-NEGATIVE ETS



CARBON REMOVAL ACTS AS A LONG-TERM PRICE CEILING



Indicative 2050 values,
real 2020 money

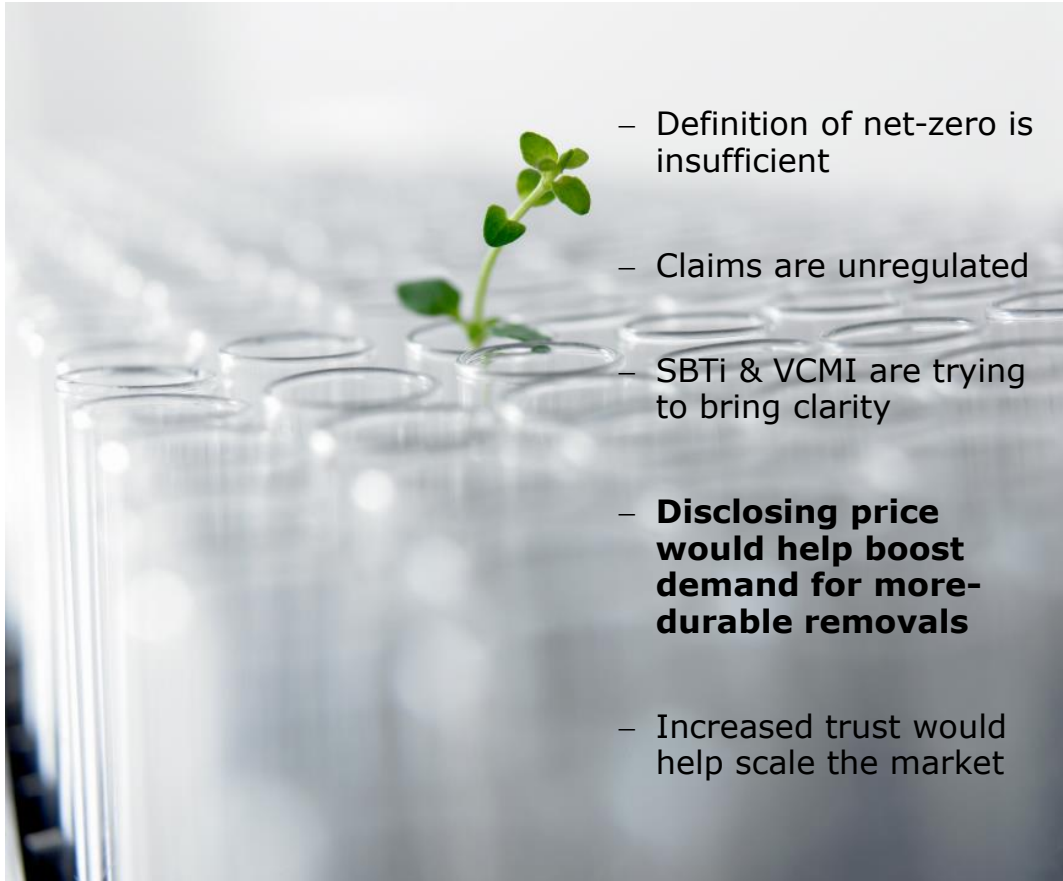
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- 1 Potential supply is large 7
- 2 Government demand is growing 11
- 3 Demand from corporations will accelerate even faster once issues can be resolved 16
 - 3.1 Two major issues persist
 - 3.2 Claims are unregulated: disclose price
 - 3.3 Durability must be included in accounting framework: use tonne-year accounting or de-rating factors
- 4 AFRY can help with your decarbonisation journey + Q&A 23



Corporate demand for removals is increasing but two issues persist

THERE IS INSUFFICIENT TRUST



- Definition of net-zero is insufficient
- Claims are unregulated
- SBTi & VCMi are trying to bring clarity
- **Disclosing price would help boost demand for more-durable removals**
- Increased trust would help scale the market

DURABILITY MUST BE INCLUDED IN ACCOUNTING FRAMEWORK



- Emissions cause near-permanent damage
- But few removals can offer near-permanent storage
- For a valid net-zero claim, these time horizons must be harmonised
- **Solutions include:**
 - **tonne-year accounting; or**
 - **de-rating factors**

In offsetting the claim is the product – to build trust, claims must be regulated

Offset market is like the market for prescription drugs:

- regulating the production of the drug/offset is not enough
- how the drug/offset is used must also be regulated

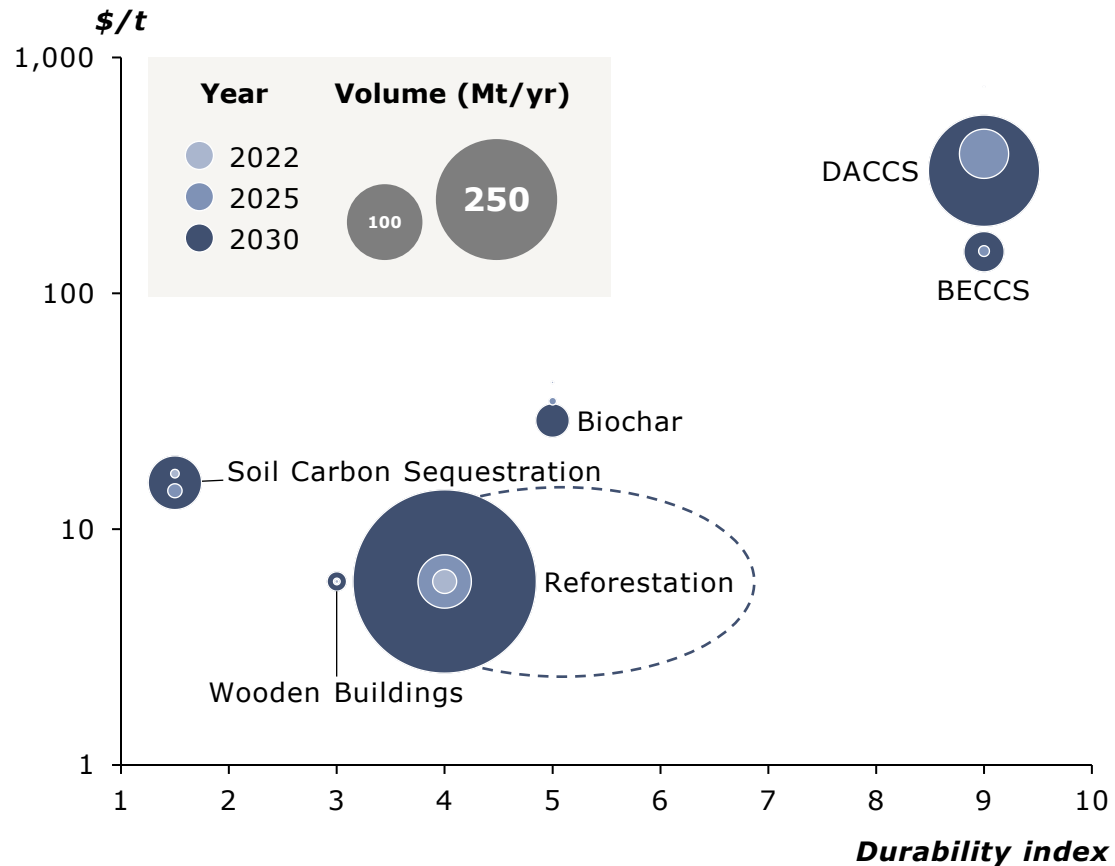
Net-zero¹ claims must be in line with the science. To be net-zero:

- anthropogenic emissions of greenhouse gases to the atmosphere
- are balanced by anthropogenic removals
- over a specified period

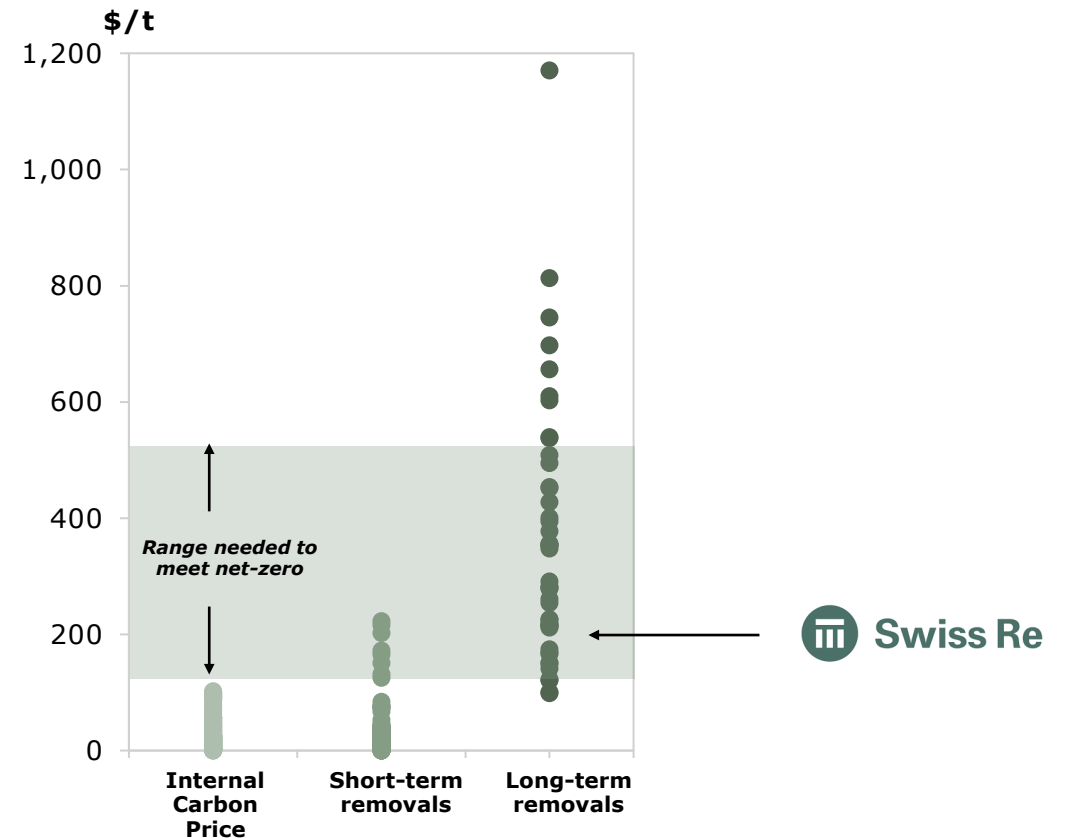
¹ IPCC (2018) Special report: global warming of 1.5°C

Corporates could disclose the price of their offsets when making claims to increase transparency

REMOVAL PRICE IS A GOOD PROXY FOR DURATION OF STORAGE

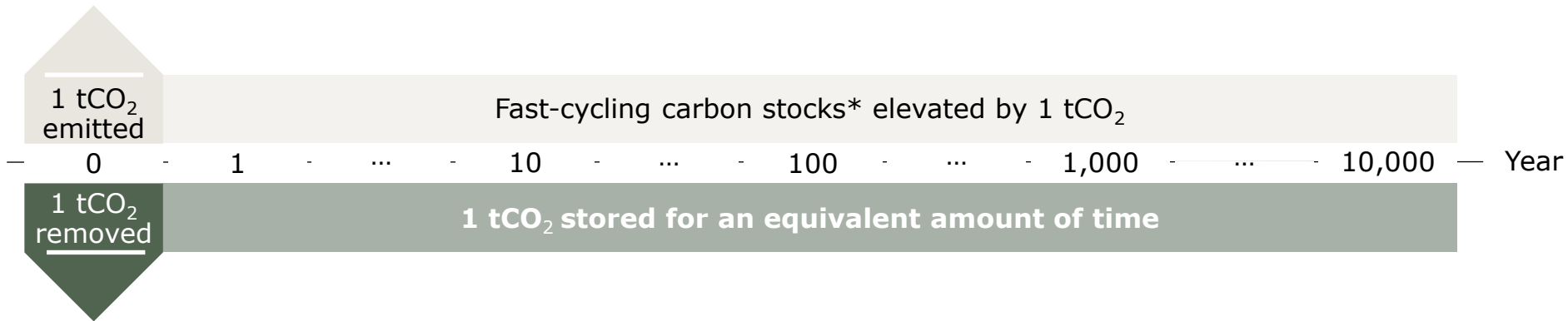


ALIGN WITH CORPORATES' INTERNAL CARBON PRICES

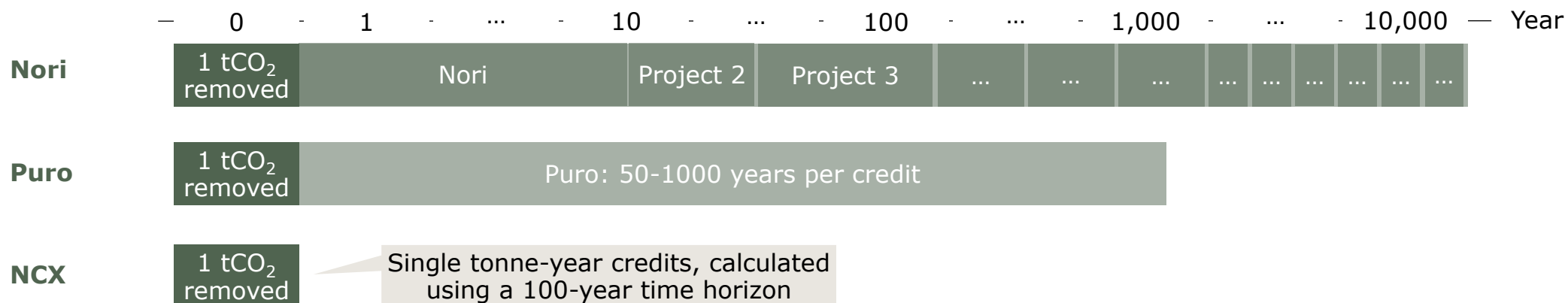


Tonne-year accounting could be used to ensure removals match emissions... if a common time horizon could be agreed upon

NET-ZERO ACCOUNTING: REMOVALS MUST NEUTRALISE EMISSIONS



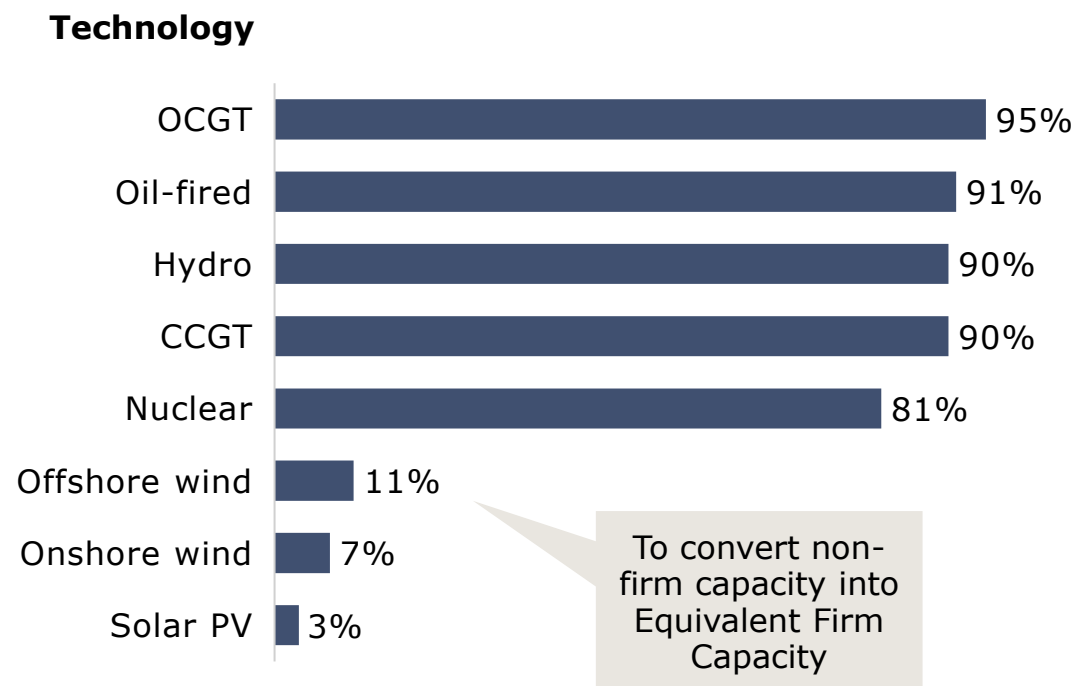
DIFFERENT CREDIT PROVIDERS ARE USING DIFFERENT METHODOLOGIES



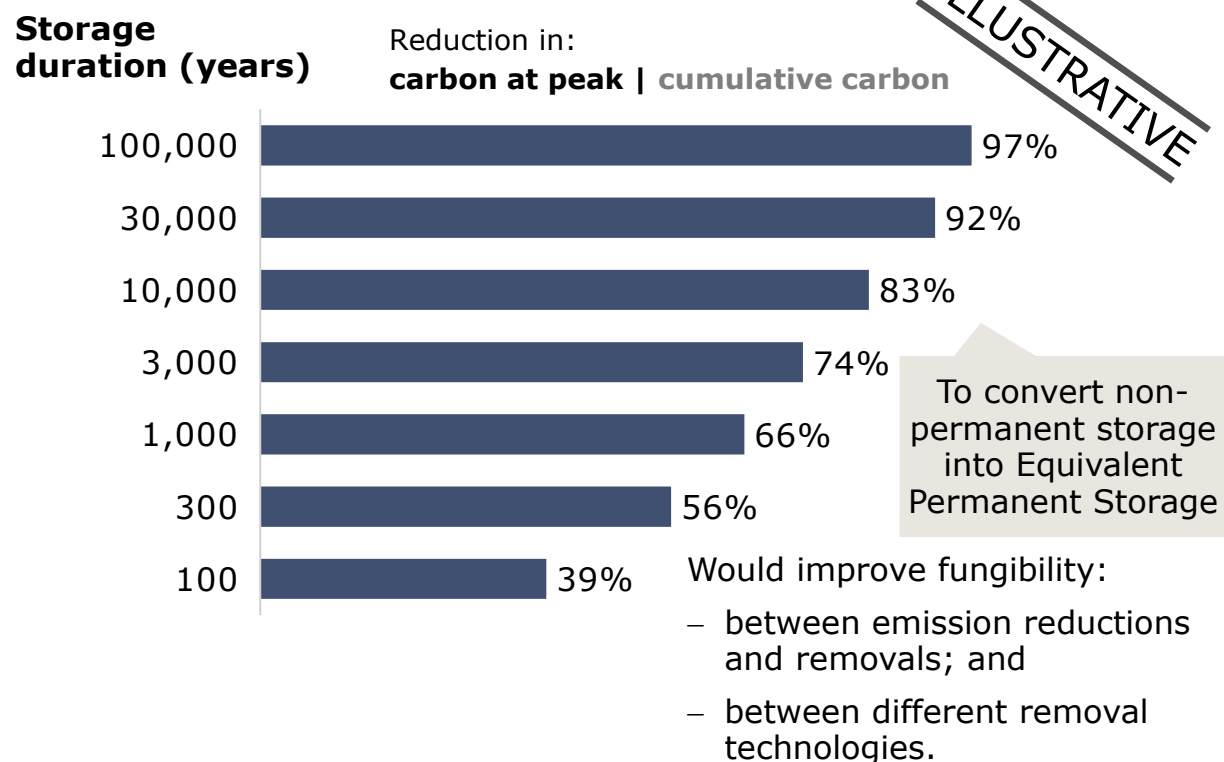
* Atmosphere, biosphere, and shallow ocean

De-rating factors for non-permanent storage could be applied to provide a level playing field, similar to their use in capacity markets

DERATING FACTORS FOR CAPACITY MARKETS



ILLUSTRATIVE DERATING FACTORS FOR CARBON STORAGE

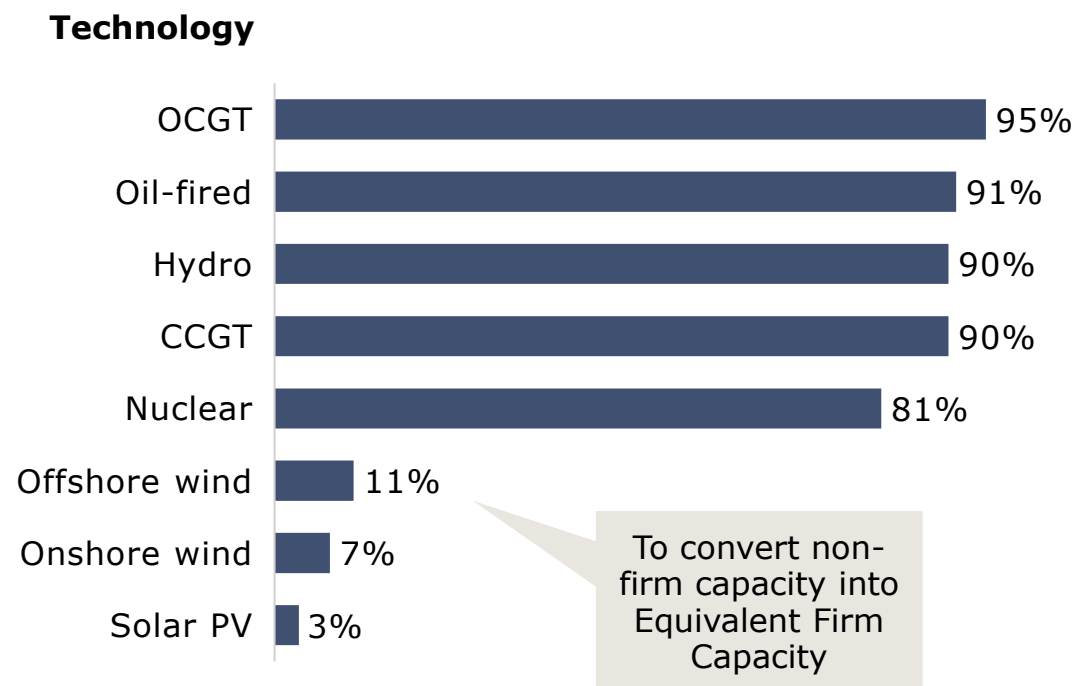


Left: Capacity Market Auction Guidelines. National Grid, 2020.

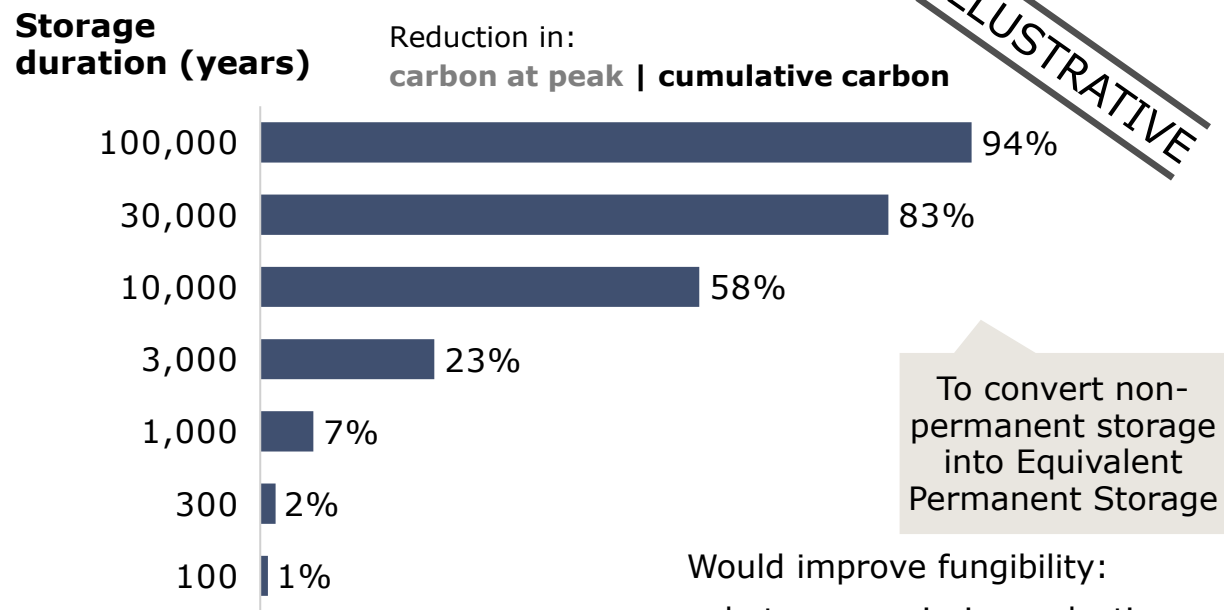
Right: illustrative figures, loosely based on Monitoring, Reporting and Verification of Greenhouse Gas Removals, Task and Finish Group Report; BEIS, 2021 and Lyngfelt, A., Johansson, D. J. A., Lindeberg, E., (2019), Negative CO2 emissions – an analysis of the retention times required with respect to possible carbon leakage, Int J GHG Con., 87, 27 – 33, shown for two different methods for assessing climate impact: reduction in i) carbon at peak or ii) cumulative carbon.

De-rating factors for non-permanent storage could be applied to provide a level playing field, similar to their use in capacity markets

DERATING FACTORS FOR CAPACITY MARKETS



ILLUSTRATIVE DERATING FACTORS FOR CARBON STORAGE



Would improve fungibility:

- between emission reductions and removals; and
- between different removal technologies.

Left: Capacity Market Auction Guidelines. National Grid, 2020.

Right: illustrative figures, loosely based on Monitoring, Reporting and Verification of Greenhouse Gas Removals, Task and Finish Group Report; BEIS, 2021 and Lyngfelt, A., Johansson, D. J. A., Lindeberg, E., (2019), Negative CO2 emissions – an analysis of the retention times required with respect to possible carbon leakage, Int J GHG Con., 87, 27 – 33, shown for two different methods for assessing climate impact: reduction in i) carbon at peak or ii) cumulative carbon.

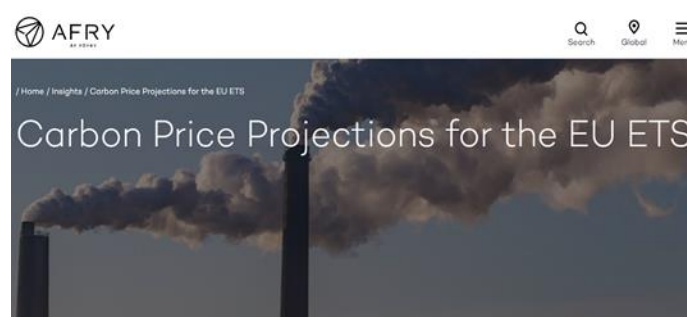
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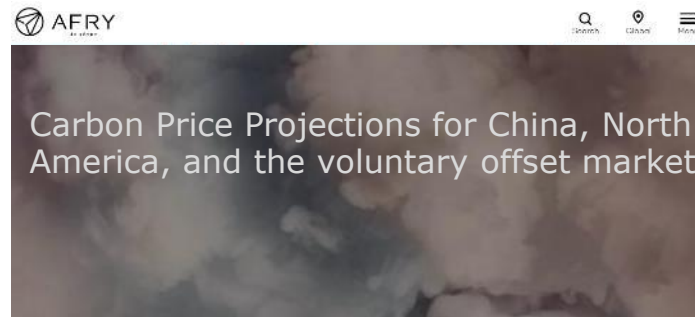
AFRY provide carbon market reports and services

EU ETS CARBON MARKET REPORT



- AFRY's **EU ETS carbon market report** covers:
 - Market background
 - Key price risks
 - Drivers of EU ETS carbon prices
 - Carbon price projections
- This report can be delivered on its own or combined with our insights from our power market modelling:
<https://afry.com/en/insight/carbon-price-projections-eu-ets>

OTHER CARBON MARKET REPORTS



- AFRY covers the evolution of several **mature and emerging compliance markets** around the world, providing insights and price projections for:
 - China
 - North America (WCI, RGGI)
 - the outlook for emerging markets such as Australia; and
 - The voluntary offset market:
<https://afry.com/en/competence/carbon-markets>

BESPOKE WORKSHOPS & WEBINARS



- We provide **bespoke carbon workshops** covering questions you need answers to
- AFRY also organise **client-exclusive Pan-European Price Projections webinars** covering the main carbon changes and other developments:
<https://afry.com/en/webinars/carbon-prices>
<https://afry.com/en/webinars/carbon-offsets-net-zero>

AFRY provide a whole suite of climate and sustainability services

Determination of your impact on climate change

- Mapping of present sustainability performance
- Calculation of GHG emissions
- Calculation of carbon footprint of products using Life Cycle Assessment
- Reporting according to
 - international frameworks, e.g. TCFD, SBT, CDBS, CDP
 - Global Reporting Initiative (GRI)

Managing natural carbon sinks and carbon stocks

- Carbon sink calculation and carbon stock modelling

Advisory support in strategic development

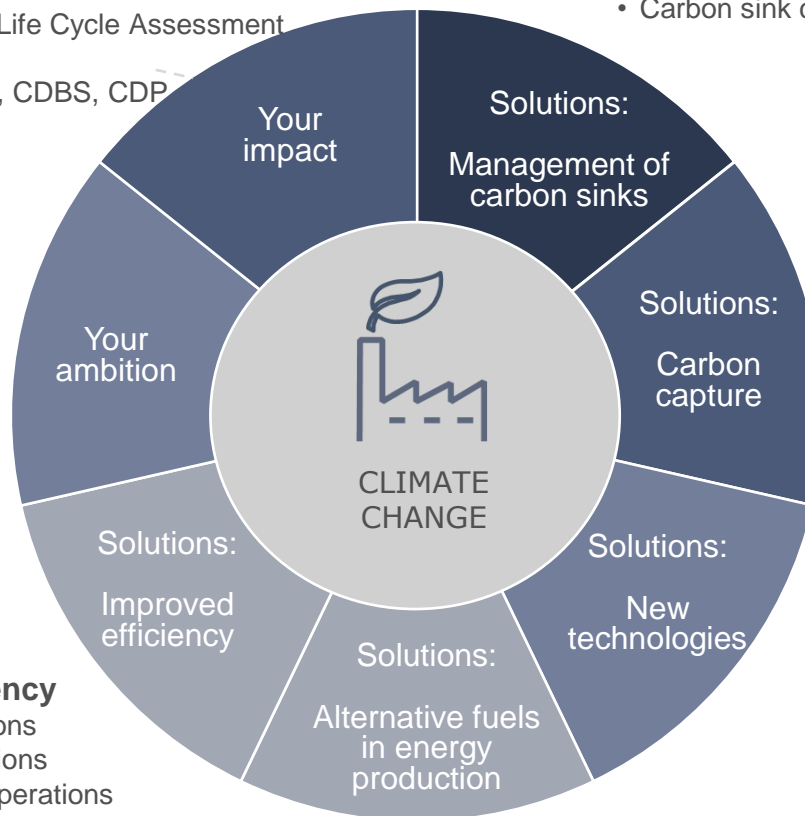
- Development of decarbonisation strategies
- Regulatory and technological development and trends
- Decarbonisation roadmaps – stepwise approach
- Emission trading system consequences
- Climate impact risk analysis

Improving your operation efficiency

- Energy efficiency analysis and solutions
- Material efficiency analysis and solutions
- Automatisation and digitalisation of operations

Considering alternative fuels for your energy production

- Impact and feasibility assessment of alternative fuels
- Low-carbon fuels, biobased fuels, non-fossil fuels



Actions to remove and capture CO₂ in emissions

- Carbon capture and storage

Developing new technologies and solutions for:

Energy production

- Wind and solar power
- Heat pump technology

Energy transition, storage and management

- Smart grids and optimization solutions
- Pumping storages
- Battery storage development
- Hydrogen based technologies

ADDITIONAL SERVICES & Q&A

Discussion & contact us

– **Reach out** to us for more information:

mostyn.brown@afry.com

jack.lonsdale@afry.com

stephen.woodhouse@afry.com

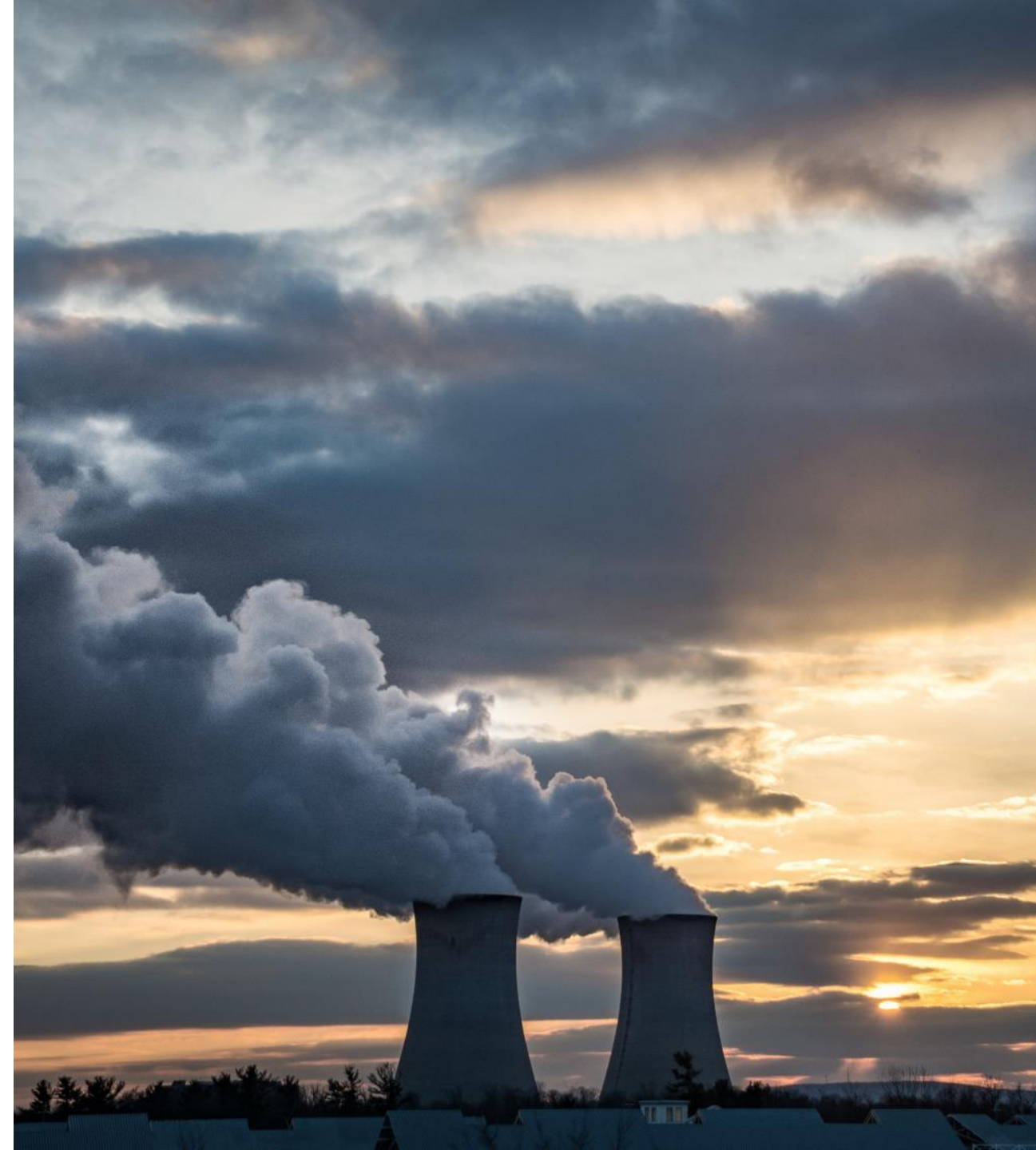
– Fuelling the transition **podcast:**

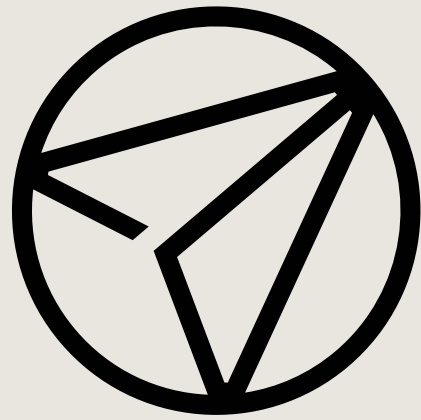
– Episode 2 | How will hydrogen impact heat and safety in the home? with Angela Needle, Director of Strategy at Cadent



– **Listen and subscribe:**

tinyurl.com/fuelling-the-transition





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