

# NET Carbon sources for storage in Scotland; Bio and Techno?

**Industry**



**Nature**



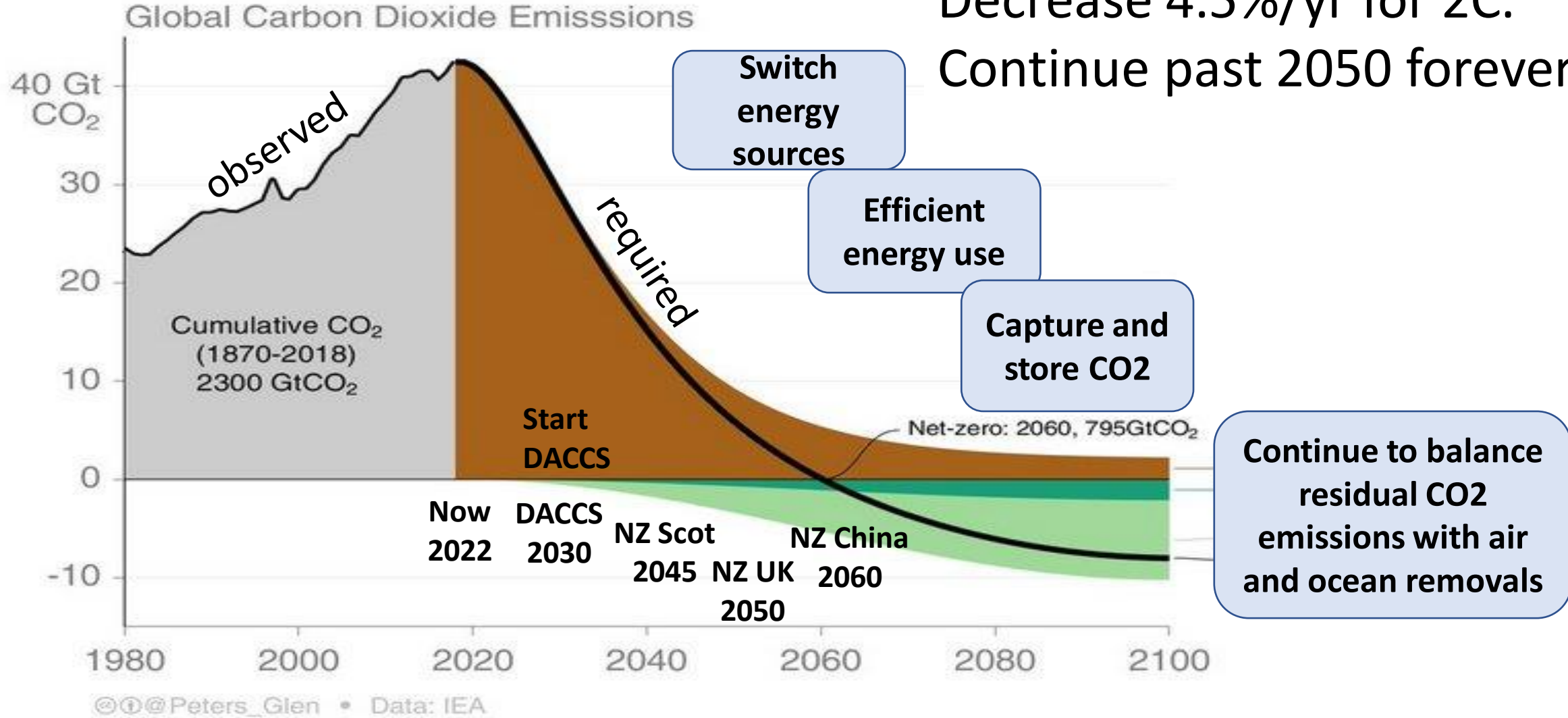
Stuart Haszeldine  
Professor of Carbon Capture and Storage  
University of Edinburgh



Influencing  
the world  
since 1583

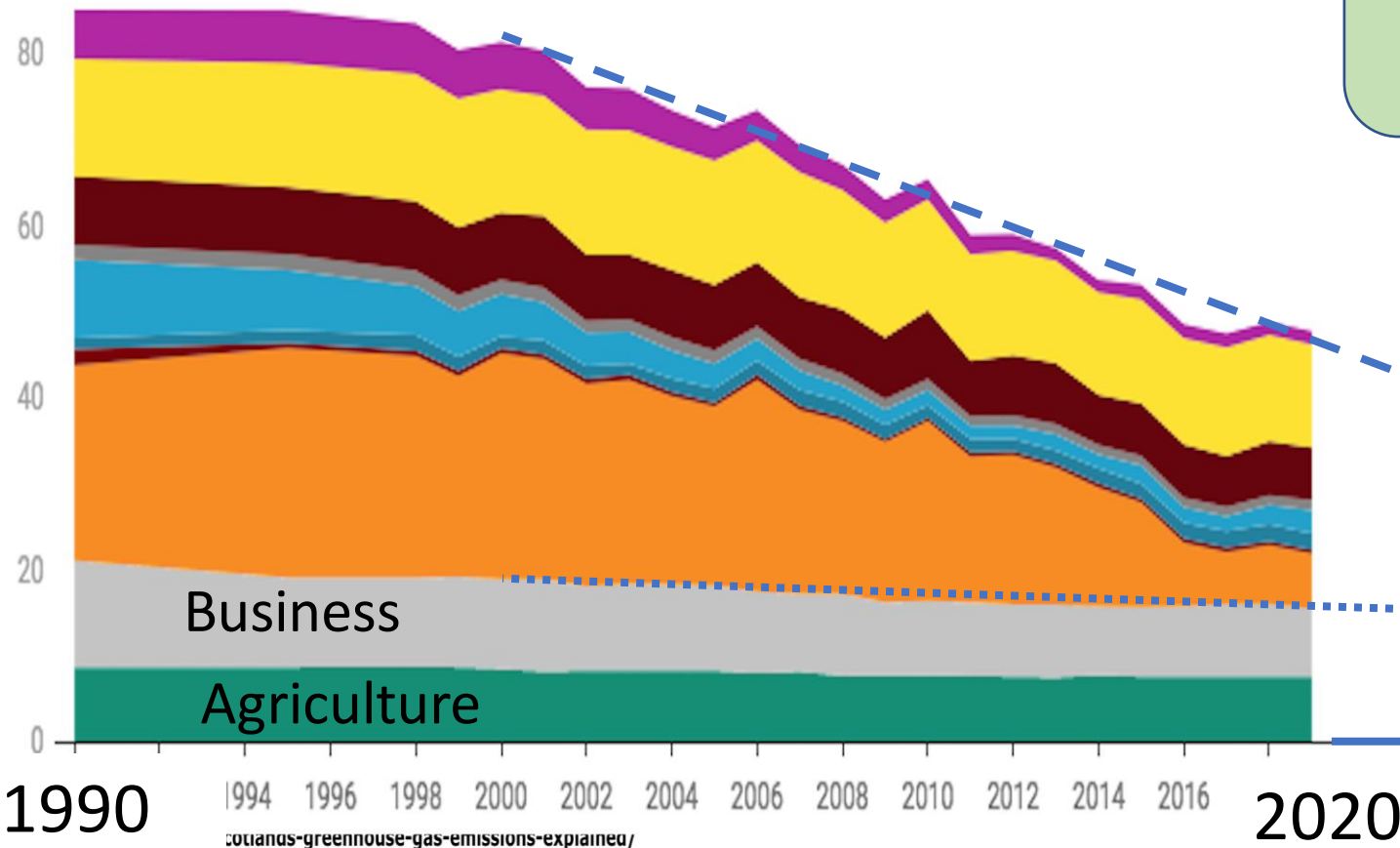
# Path to Net Zero

Increase 2.5% /yr (3ppm)  
Decrease 10% /yr for 1.5C  
Decrease 4.5%/yr for 2C.  
Continue past 2050 forever



# Scotland CO2 pathway

■ Agriculture ■ Business ■ Energy Supply ■ Industrial processes ■ International Aviation and Shipping  
■ Land use and forestry ■ Public ■ Residential ■ Transport ■ Waste Management



**Climate action projections show a policy gap of 10-20% original hard to abate . This requires NET Negative Emissions Technologies to fill**

For Net Zero  
Hard to change is  
balanced by NET  
10-20Mt CO2/yr

Optimistic

Hard to change

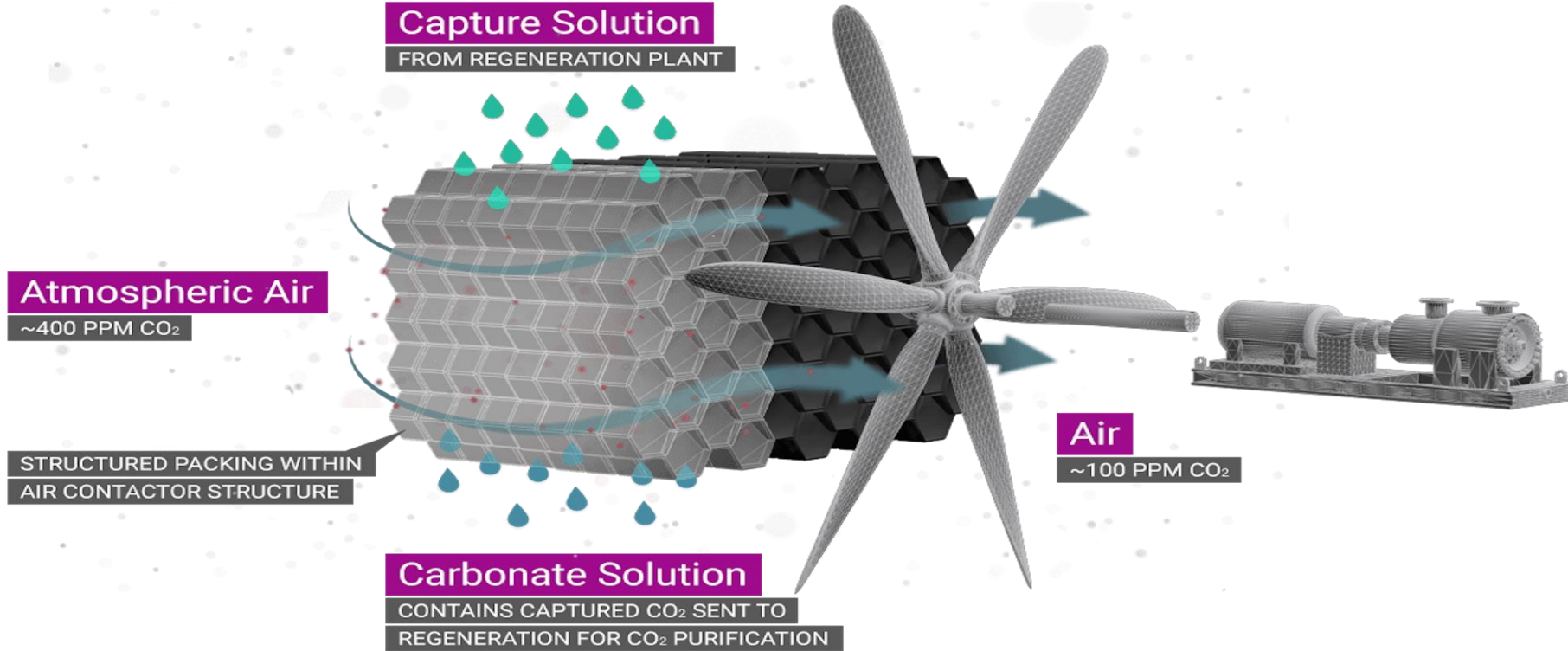
NET

2045

Scottish Greenhouse Gas statistics: 1990 - 2019. Figures are measured in MtCO2e.



# Direct Capture – early development



DAC 2022 is **huge**  
**energy use** 1500 kWhr  
= 1t CO<sub>2</sub> = 1.5 houses

**10MtCO<sub>2</sub>/yr**  
= 15 TWhr  
le annual real output  
of 4 GW offshore  
wind, **about 1/3**  
**Scottish generation**

DAC will be vital for  
planet – 10,000  
plants globally



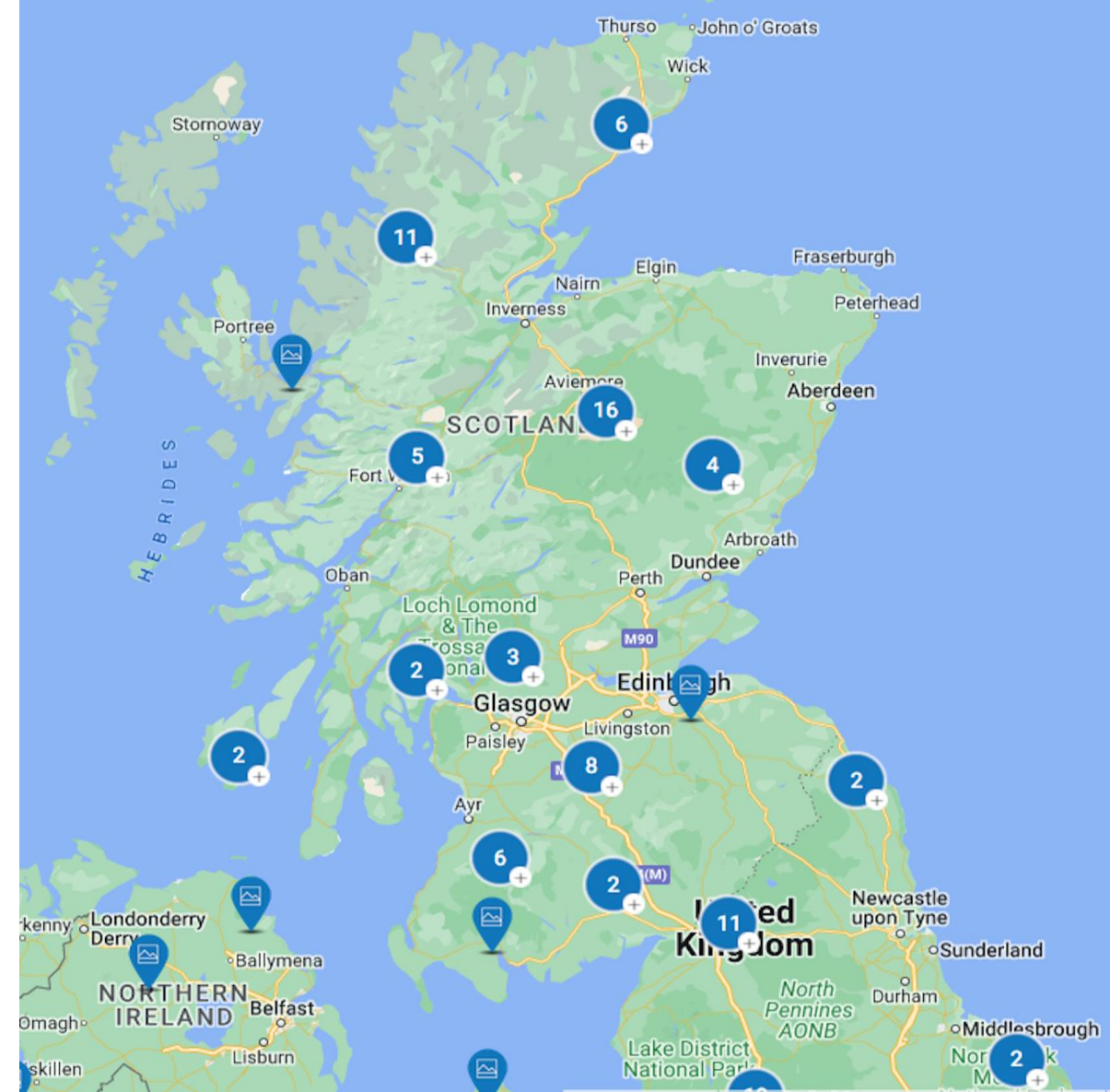
# Peat

**UK Peatland code registers just 68 projects covering 10,300 ha, only 11 are validated storing extra 304,239 tonnes CO2e**  
[www.iucn-uk-peatlandprogramme.org](http://www.iucn-uk-peatlandprogramme.org)

Target of 20,000 ha/yr only around **6,000 ha of peatland have been restored annually from 2018 - 2020.**



Scottish Government (2021) Update to the Climate Change Plan 2018-2032

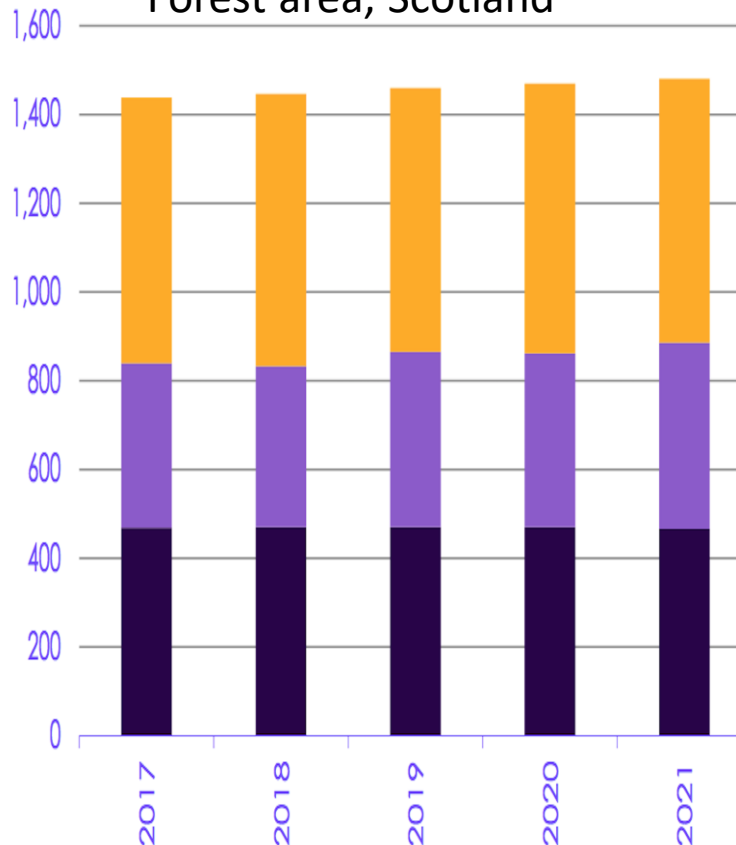


National Peatland Plan identifies 600,000 hectares of restorable peatland by 2030, ie 10x too slow



# Forest and agriculture

Forest area, Scotland



Forest Research (2021) Certified woodland areas

■ FLS certified ■ Private sector certified ■ Non-certified woodland

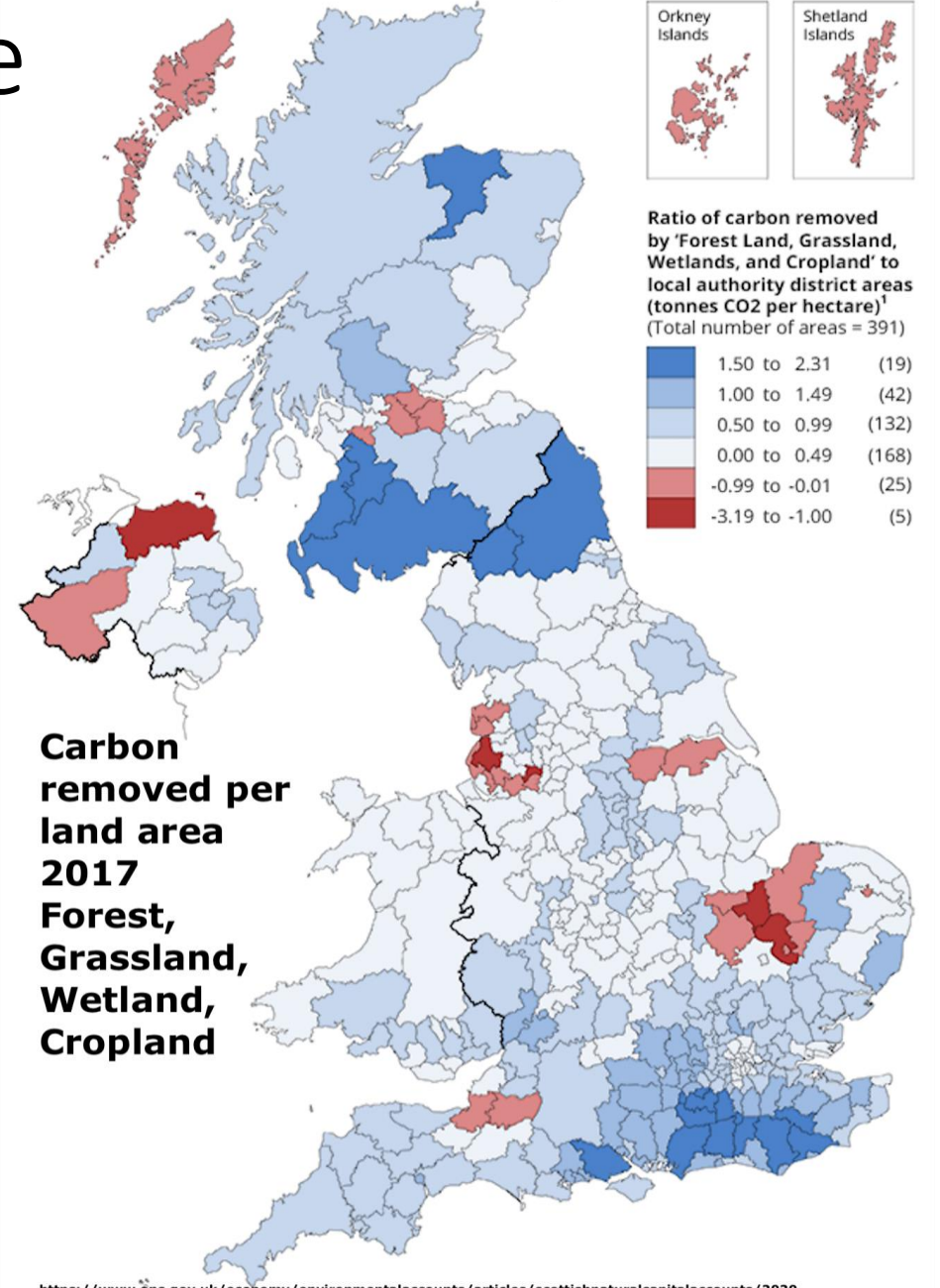
Scotland captures  
11Mt/yrCO<sub>2</sub> forest  
and releases 6  
Mt/yr into crops

Forestry  
Standing trees capture  
carbon. But **do not store**  
carbon longer than 100yr

**Net 5 Mt/yr CO<sub>2</sub>  
captured Scotland  
(ONS 2020)**



**Carbon  
removed per  
land area  
2017  
Forest,  
Grassland,  
Wetland,  
Cropland**



+ ve

- ve

<https://www.ons.gov.uk/economy/environmentalaccounts/articles/scottishnaturalcapitalaccounts/2020>

Source: National Atmospheric Emissions Inventory licensed under the Open Government Licence v3.0. Prepared by the Centre for Ecology and Hydrology for the Department for Business, Energy and Industrial Strategy.

# Top 20 emitters; biogenic component

	Ton CO <sub>2</sub> /yr
SSE gas power station, Peterhead	1.6m
Petroineos oil refinery, Grangemouth	1.3m
ExxonMobil ethylene plant, Mossmorran	680,000
Ineos power plant, Grangemouth	641,000
Tarmac cement works, Dunbar	559,000
Ineos chemical plant, Grangemouth	522,000
RWE biomass plant, Glenrothes	487,000
Ineos infrastructure plant, Grangemouth	429,000
E.ON wood power station, Lockerbie	371,000
Ineos oil and gas pipeline, Grangemouth	345,000
Shell St Fergus gas plant, Peterhead	303,000

UPM-Kymmene paper mill, Irvine	284,000
Viridor energy recovery plant, Dunbar	274,000
Shell gas plant, Mossmorran	250,000
Norbord paper mill, Stirling	210,000
Total gas plant, Shetland	208,000
Engie combustion plant, Shetland	181,000
William Grant whisky distillers, Girvan	165,000
O-I glass plant, Alloa	149,000
FCC Millerhill energy recovery plant, Dalkeith	132,000
<b>TOTAL 1.9 Mt CO<sub>2</sub>/yr</b>	

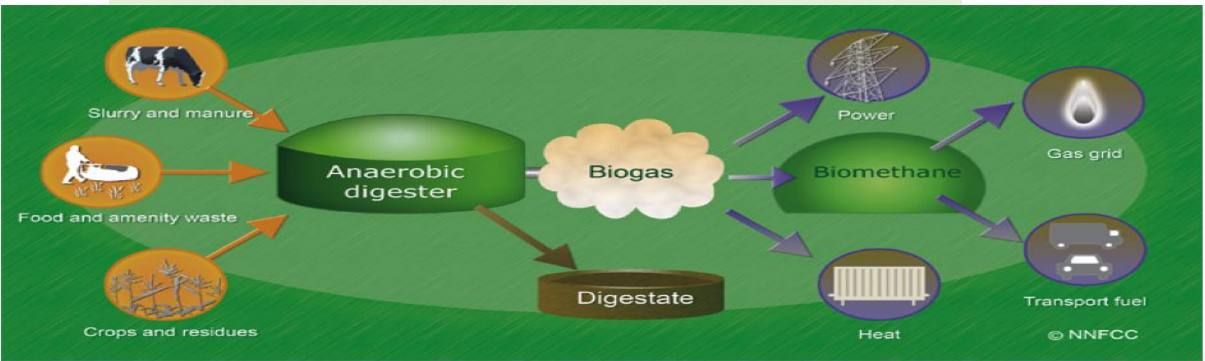
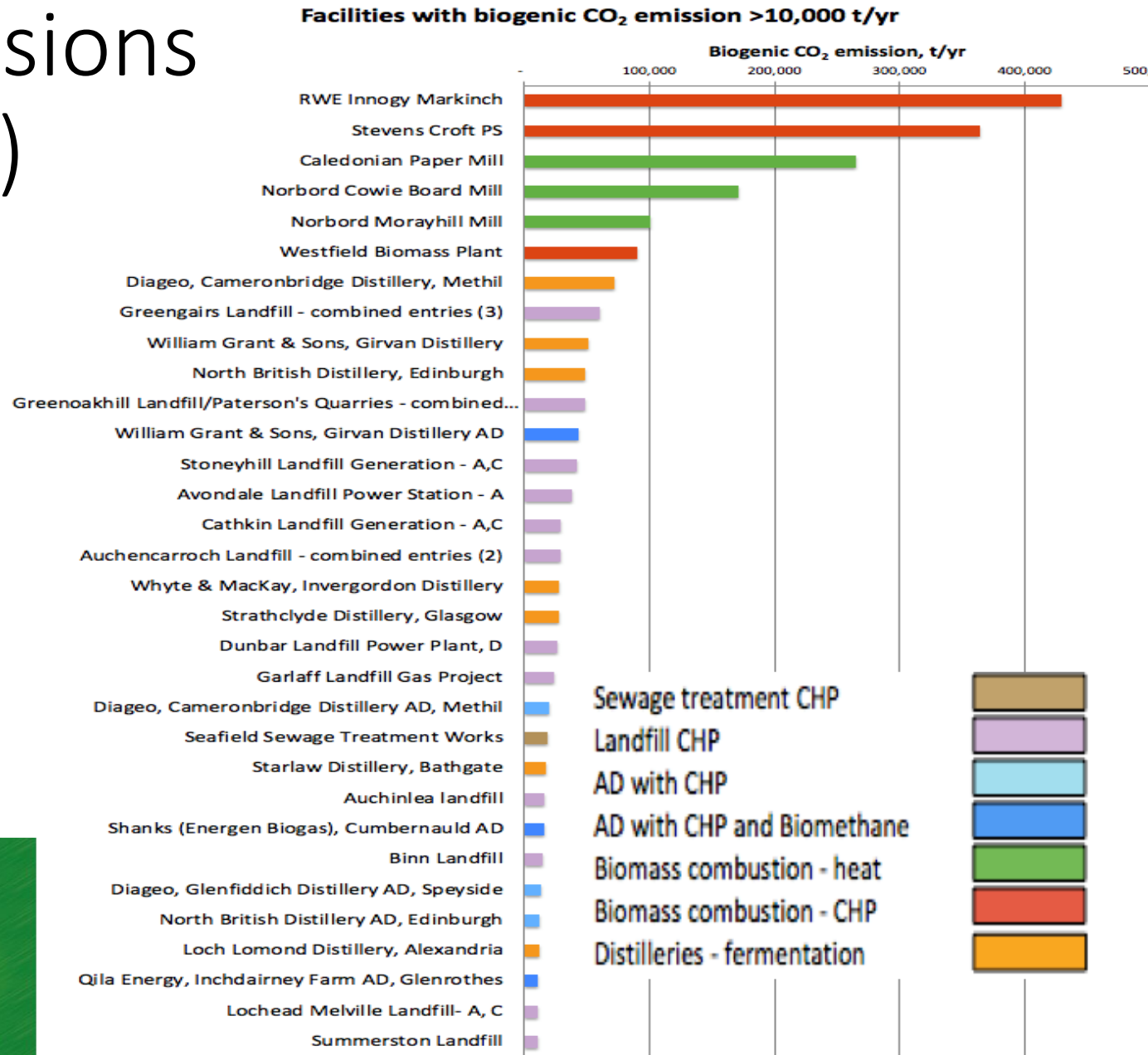
Source: Scottish Environment Protection Agency

# Biogenic emissions (not captured)

## Biogenic emissions

- Biomass combustion
- Fermentation
- Landfill
- Energy from Waste
- Anaerobic Digestion (biogas)
- Water and sewage

20 - 430 kton CO<sub>2</sub>e /yr  
TOTAL 2.0 Mt CO<sub>2</sub>e /yr



Brownsort [https://www.sccs.org.uk/images/expertise/reports/working-papers/WP\\_SCCS\\_2018\\_08\\_Negative\\_Emission\\_Technology\\_in\\_Scotland.pdf](https://www.sccs.org.uk/images/expertise/reports/working-papers/WP_SCCS_2018_08_Negative_Emission_Technology_in_Scotland.pdf)



# Energy from Waste (not captured)

- 6 municipal Energy from Waste plant operational, combined emissions of **414,080 tCO<sub>2</sub>/yr** (2019 data), at least 4 in planning (1 large plant in 2015 data). How many connected to CHP and/ or CCS
- Probable that Energy from Waste will be 1 Mt/yr CO<sub>2</sub> – biomass for NET

- UK Committee on Climate Change advice to Government is that *“new [waste-to-energy] plants should only be constructed in areas confirmed to soon have CO<sub>2</sub> infrastructure available, and should be built ‘CCS ready’ or with CCS”*

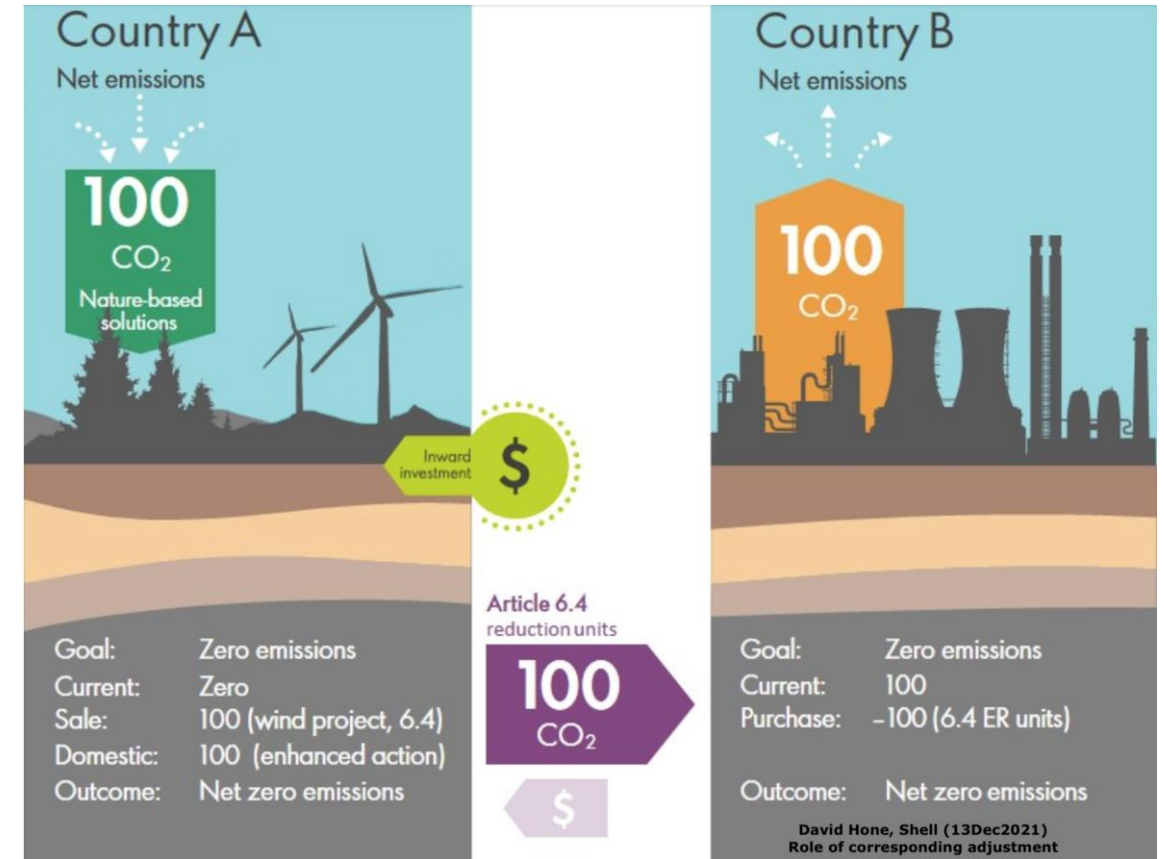


# Paris agreement Future accounting; Article 6 Corresponding adjustments

To be considered as Bankable Removals.  
CO2 storage needs to be demonstrable  
and verifiable and permanent.

And also a **removal has to be underwritten by Government as a Corresponding Adjustment**, to avoid double counting, and ensure UK-ETS Certificate can be cancelled

- Land/forest owner can self-certify to voluntary market, but has no Government support or business cover





# Summary

- Scotland to NetZero has unclear pathway. DACCS elegant but expensive
- Nature Based Solutions small and developing
- Biogenic emission tonnages are comparable to forestry – possibly a lower cost option to capture and store pure fermentation CO<sub>2</sub>, or combustion?
- Biogenic considered carbon-neutral, so reporting not always required. Data difficult to obtain, not a requirement currently to record and report
- Fermentation emissions not reported in SPRI (SEPA emissions inventory) but are increasing with gin. Same with Anaerobic Digestion. EfW is big.
- Offsetting and Removals – permanent reliable storage required. NOT Avoided emissions, which are hard to verify counterfactuals



Whittakers Gin – micro fermentation



Millerhill EfW, Dalkeith