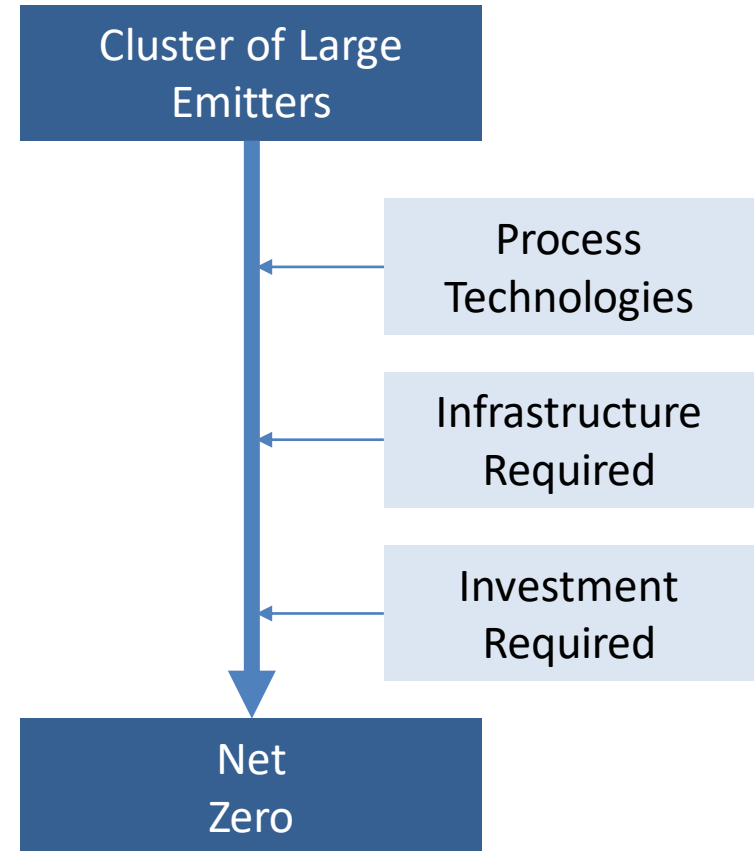


## A Net Zero Roadmap for Scottish Industry

# PROJECT OBJECTIVES

- Identify a pathway for a selected cluster of large emitters to achieve net zero by 2045
  - Taking advantage of economies of scale and collective action
- Develop strategies and infrastructure that other companies can use
- Provide a route-map for emitters, infrastructure owners and government to jointly deliver a net-zero cluster



# Project Partners

- Led by NECCUS with the following partners:



- With significant funding provided by Innovate UK

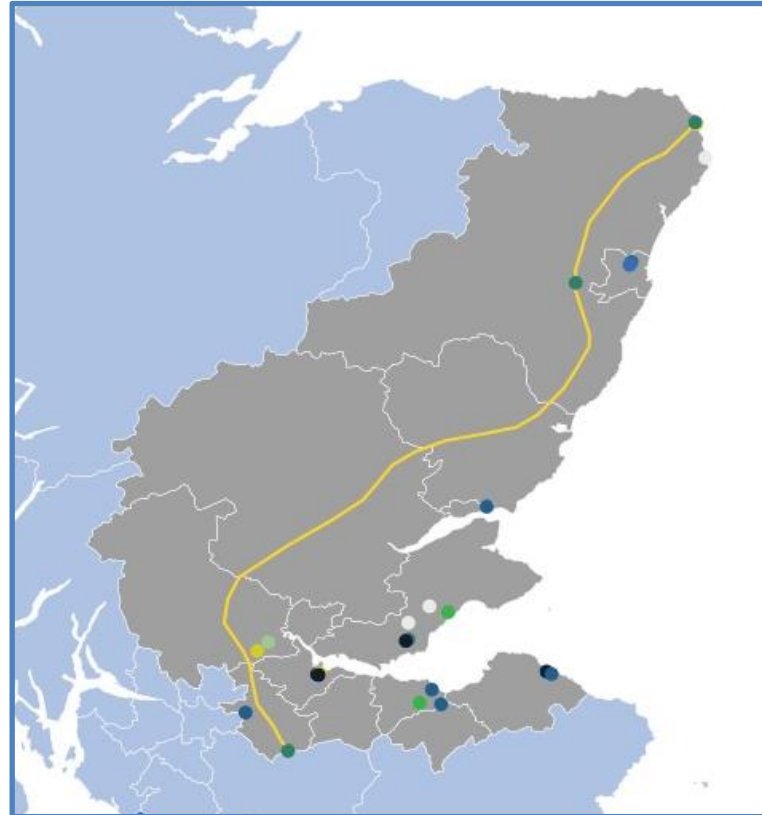


- Industry funding and support from the following partners:



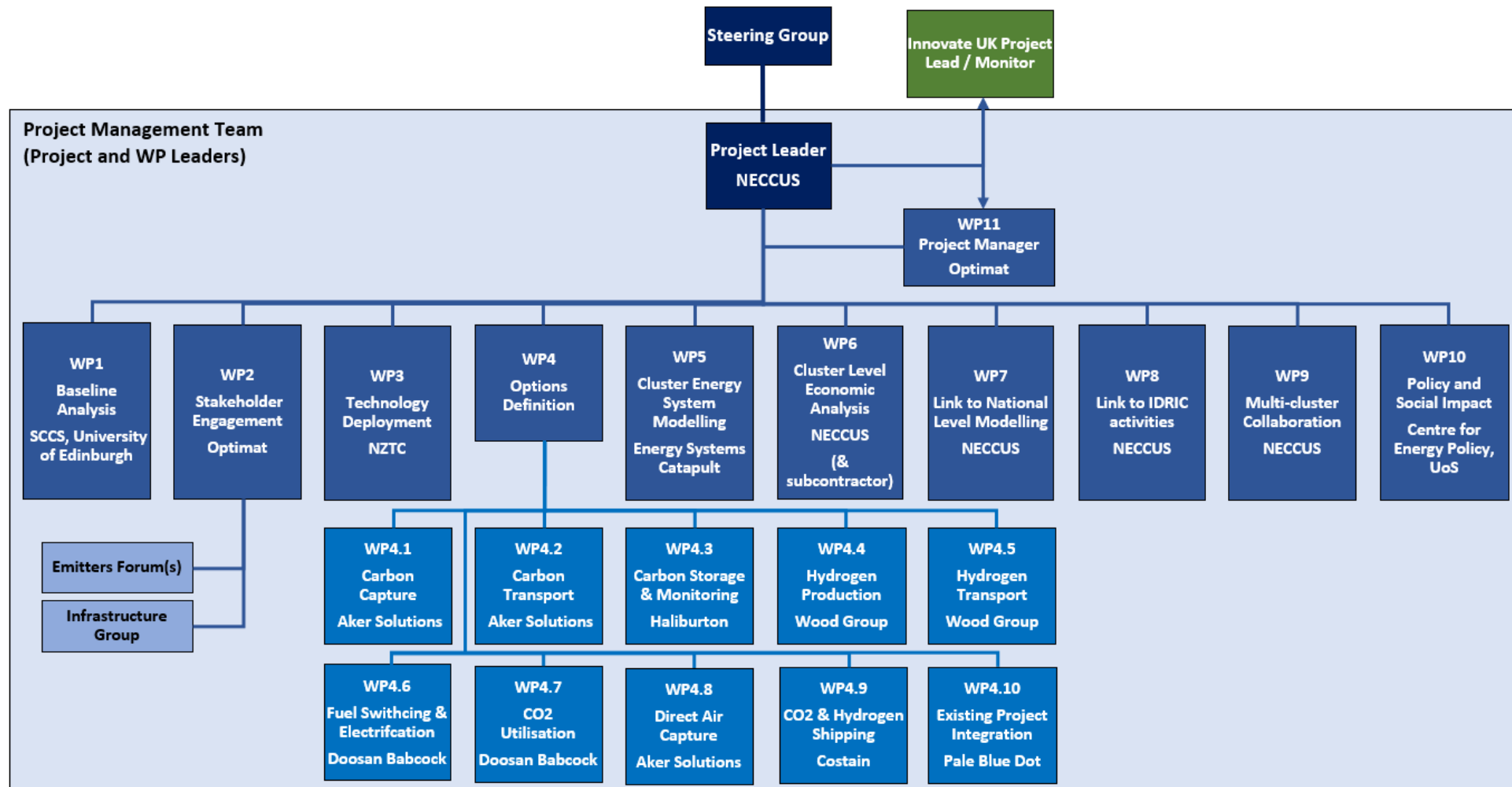
# Cluster scope & profile (2019)

- Large geographical area
- High percentage of CO<sub>2</sub> emissions
- Multiple sectors
- Aligned with existing and/or near-term gas transport and infrastructure options
- 28 sites
- 11 industrial sectors
- 14 local authority areas
- 8.6Mt (76%) of Scotland's industrial CO<sub>2</sub> emissions (2019)



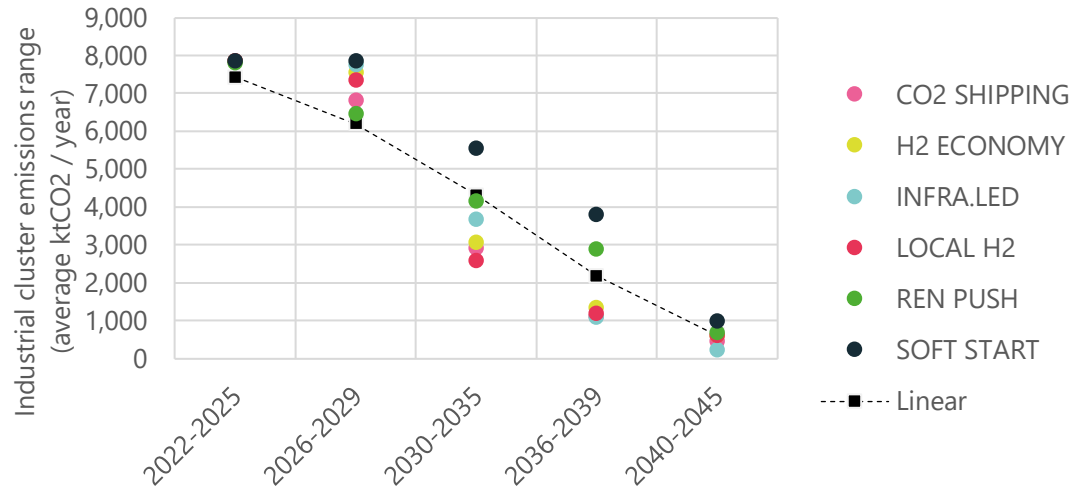
	Company / Industrial Site	2019 Emissions (kt)
1	SSE Generation Limited	1,579
2	Petroineos Manufacturing Scotland Limited	1,343
3	ExxonMobil Chemical Ltd	680
4	Grangemouth CHP Ltd	641
5	Tarmac Cement & Lime Limited	559
6	INEOS Chemicals	522
7	RWE Markinch Limited	487
8	Ineos Infrastructure (Grangemouth) Limited	429
9	Ineos FPS Limited (Kinneil Terminal)	345
10	Shell UK Limited (St Fergus)	303
11	Viridor Waste Management Ltd. Dunbar ERF Dunbar	274
12	Shell UK Limited. Fife NGL Plant Cowdenbeath	250
13	Norbord Europe Limited	210
14	O - I Manufacturing UK Ltd	149
15	FCC Waste Services (UK) Limited.	132
16	MVV Environmental (Dundee Energy Recycling)	102
17	SAGE Gas Terminal (Wood Group UK Limited)	94
18	EPR Scotland Limited	86
19	Diageo Distilling Limited	68
20	Versalis UK Limited	58
21	Arjo Wiggins Fine Papers Ltd	58
22	PX Limited (St Fergus Gas Terminal)	52
23	National Grid Gas Plc - Bathgate	41
24	The North British Distillery Company Limited	35
25	Energen Biogas Limited. Energen Biogas Ltd	29
26	Veolia Water Outsourcing Limited	27
27	National Grid Gas Plc - Aberdeen	27
28	National Grid Gas plc - Gas Terminal	26

# Project Partners and Work Packages

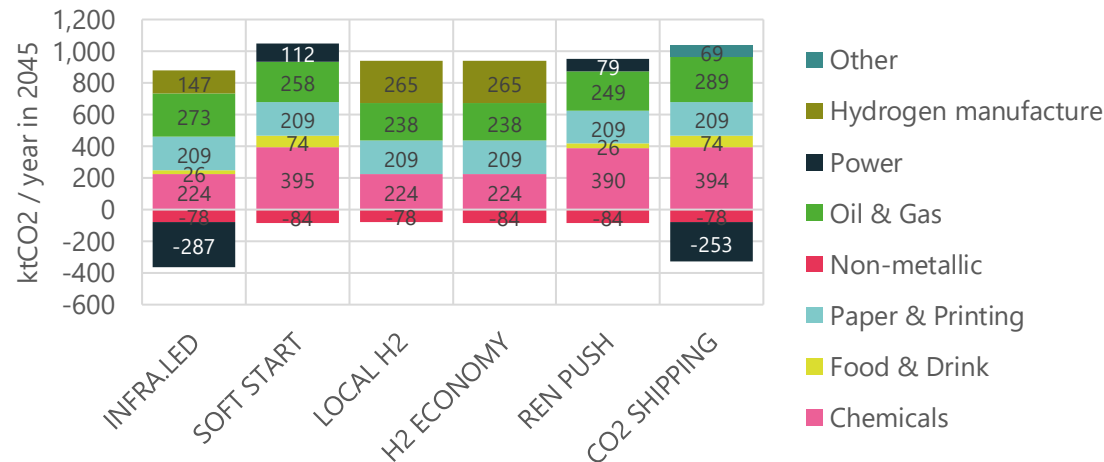


# Key scenario outcomes

Emissions reduction profile for Scotland's industrial cluster across scenarios



Residual emissions across scenarios



- **In all scenarios:** cluster emissions reduced by at least 92% compared with baseline. DACC required to eliminate last few 100-500 ktCO<sub>2</sub>
- **Philosophy of scenario** – and implied infrastructure requirements – informs speed of transition and alignment with economy-wide greenhouse gas targets. E.g. RENEWABLES PUSH scenario delivers early carbon savings via electrification; exclusion of hydrogen as fuel switch in some sectors increases residual emissions
- **Oil / gas and chemicals** sectors contribute much residual emission (typically CCS residuals), with bioenergy injection into power and non-metallic (cement / glass) sectors providing offset

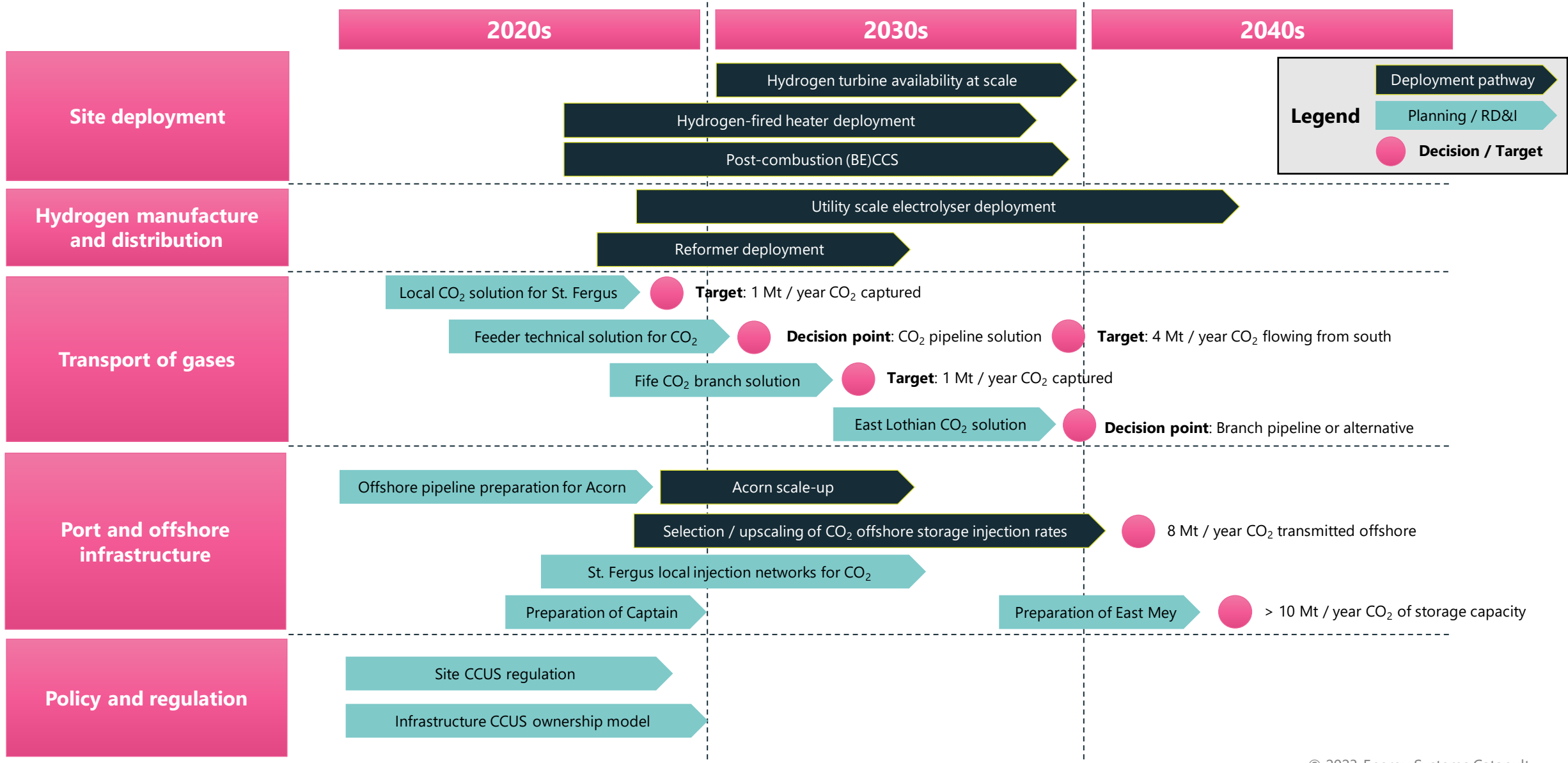


# Critical insights from scenario analysis

- **There are multiple possible routes to Net Zero for industry in Scotland**
  - CCS is mandatory for some sectors, but a viable choice of electrification, hydrogen or CCS is present at many sites
  - Removals via DACC are highly likely to be required
- **Early decarbonisation is particularly challenging**
  - Ahead of major infrastructure availability (H<sub>2</sub> / CO<sub>2</sub> pipelines) options such as electrification are limited
  - Shipping of CO<sub>2</sub> could be impactful in terms of acceleration of capture
- **Activity in the late 2020 / early 2030s is vital**
  - CO<sub>2</sub> / H<sub>2</sub> pipeline development (or vehicular rollout) allows emissions removal first in Grangemouth and then in Fife. Extensive site and infrastructure projects
- **Strong synergies with out-of-cluster decarbonisation in hydrogen-focused scenarios**
  - Industrial demand for hydrogen can help underpin the economic case for hydrogen usage in other demand sectors nearby
- **Opportunity for multi-billions of capital investment in all scenarios**

Metric	Value
Emissions in 2045 (without DACC)	90 – 500 ktCO <sub>2</sub> / year
Cumulative 2022-2045 emissions	83 – 120 MtCO <sub>2</sub>
Capital investment	£5-9bn
Approximate cost of decarbonisation	£130-170 / tCO <sub>2</sub>
Hydrogen consumed	0 – 25 TWh / year
Carbon captured	4 – 9 MtCO <sub>2</sub> / year
Emissions offset through NETs	0 – 1 MtCO <sub>2</sub> / year
Criterion	Promising scenario(s)
Low decarbonisation costs	INFRA LED / LOCAL H2
Successful delivery of Net Zero	INFRA LED
Low cumulative emissions	CO2 SHIPPING
Early progress	RENEWABLES PUSH
Site retained optionality	INFRA LED / LOCAL H2 / H2 ECONOMY
Synergy with non-industrial transition	LOCAL H2 / H2 ECONOMY / INFRA LED

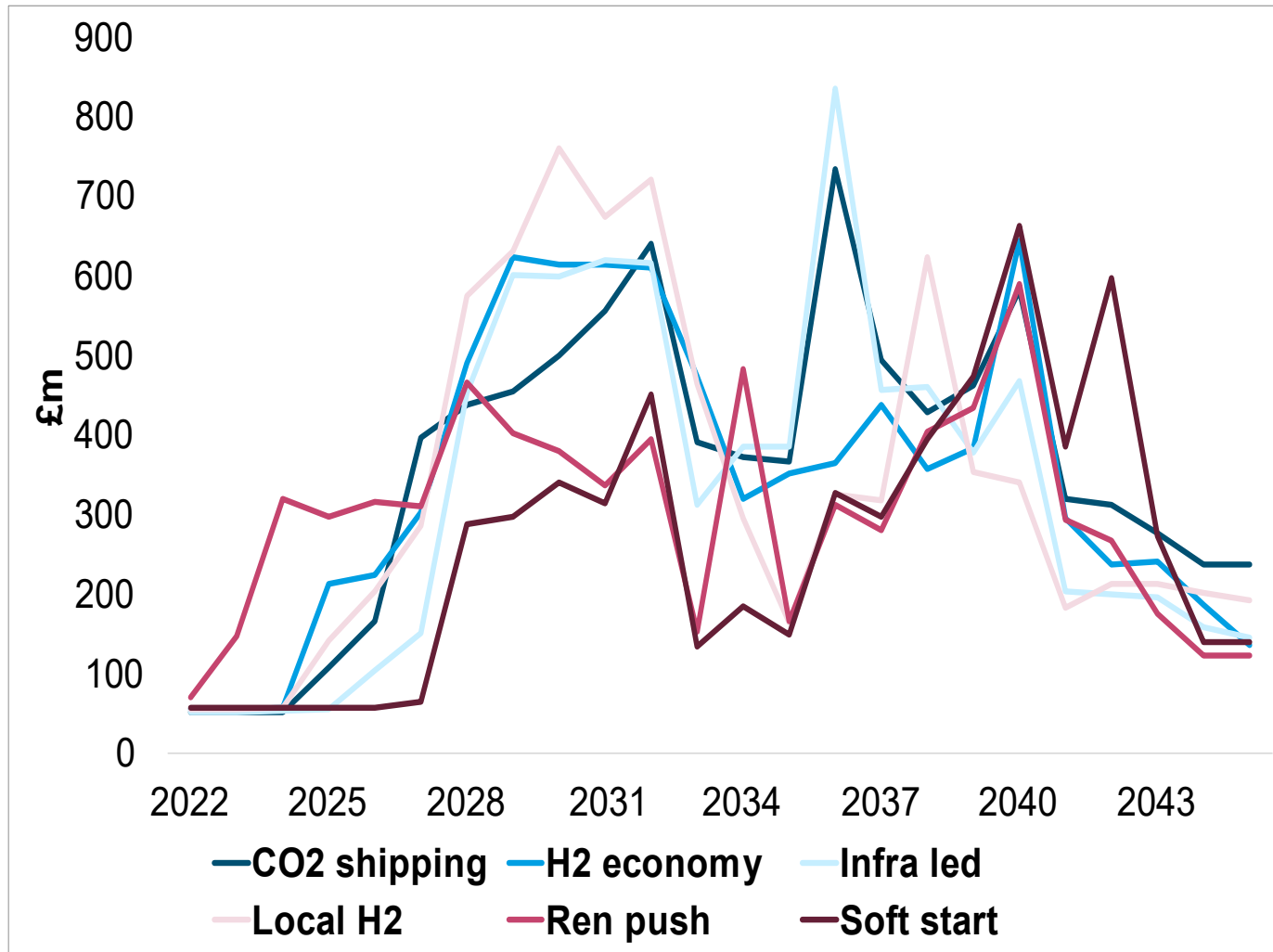
# From scenarios to an industrial roadmap





# ECONOMIC IMPACTS

## The impact on gross value added (GVA)

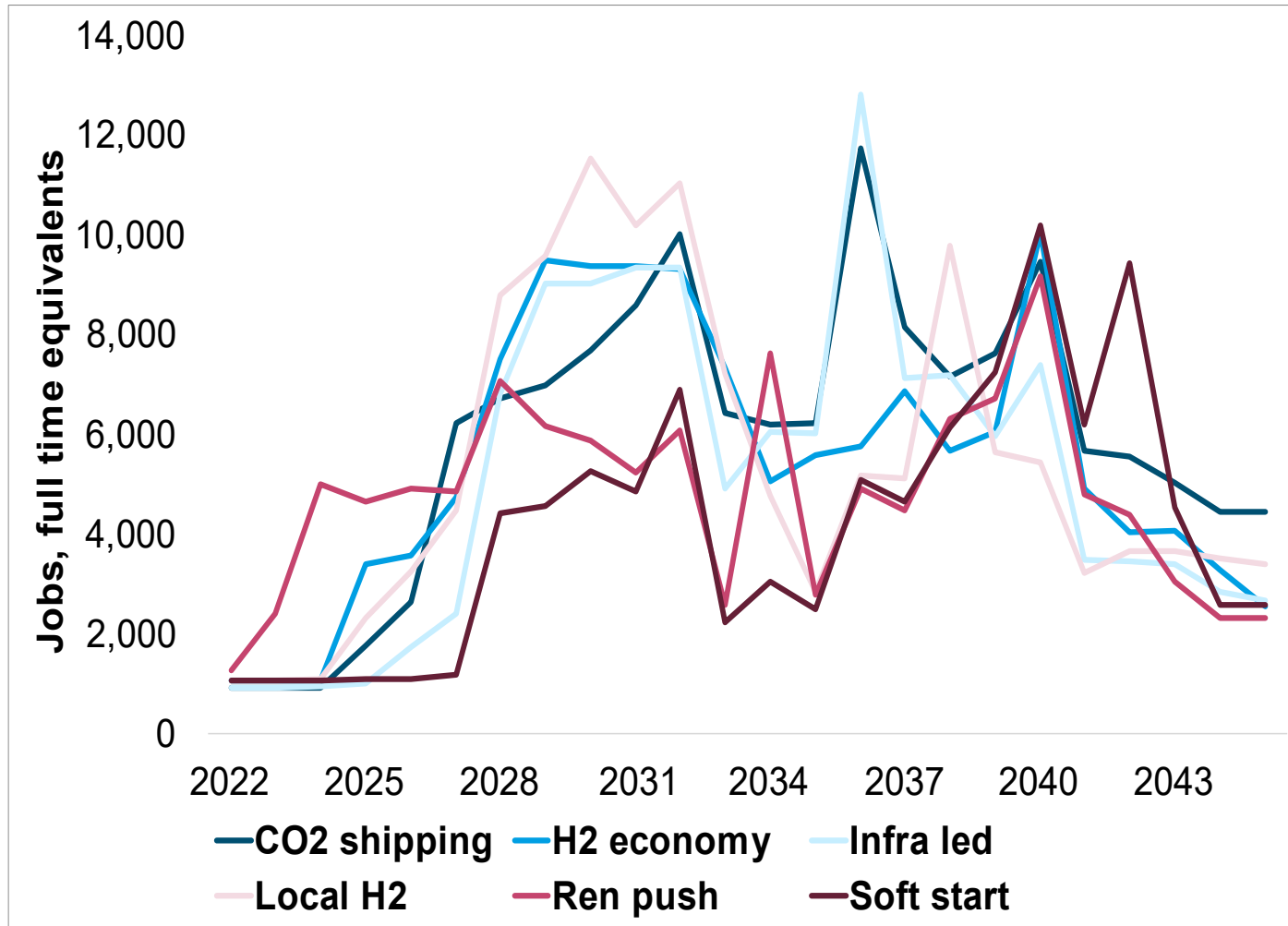


The time profile of capital expenditures plays a large role in determining economic outcomes

- **Infrastructure led** impacts peak in 2036, due to the large-scale infrastructure roll out in this year
- delayed investment in more mature technologies has the impact of both limiting capital and operating expenditures and limiting the scale of gross output generated, as seen in the **soft start** scenario.

# ECONOMIC IMPACTS

## The impact on employment



- As many as **12,800** jobs could be created at the peak in the **infrastructure led** scenario, if policy can support the development of very strong domestic supply chains
  - a more modest assumption around domestic content implies a peak of 5,500 jobs
- Direct jobs are around 50% of the total – i.e. flowing directly from the capital and operating expenditures (e.g. construction, manufacturing)

# KEY ACTIONS

- Establish ownership and leadership of roadmap implementation
- Set-up a co-ordination mechanism
- Support ACORN projects as an initial focal point for the roadmap
- Invest in CO<sub>2</sub> pipeline infrastructure
- Investment in hydrogen manufacturing, transport and supply
- Investment in direct air capture capacity



SNZR

Scottish Net Zero Roadmap

# Thank You

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and Innovation