



Developing Carbon Capture and Utilisation in Scotland

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Purpose of the CCU Action Plan

Developed in the context of the Scottish Government's Net Zero emissions commitment for 2045, with the vision of ***positioning Scotland as an innovation driven cluster and international leader in innovation and adoption of carbon capture and utilisation (CCU).***

Scottish Enterprise and Falkirk Council, as partners in the EU-funded Interreg project, Northern Connections, have identified specific opportunities for Scotland's industries to work with European partners to realise these opportunities.



Project Objectives

- Apply the innovation systems approach to develop a plan to accelerate development and adoption of CCU technologies in Scotland

Innovation focused national level action plan for growth

- Catalyse specific CCU value chain development projects

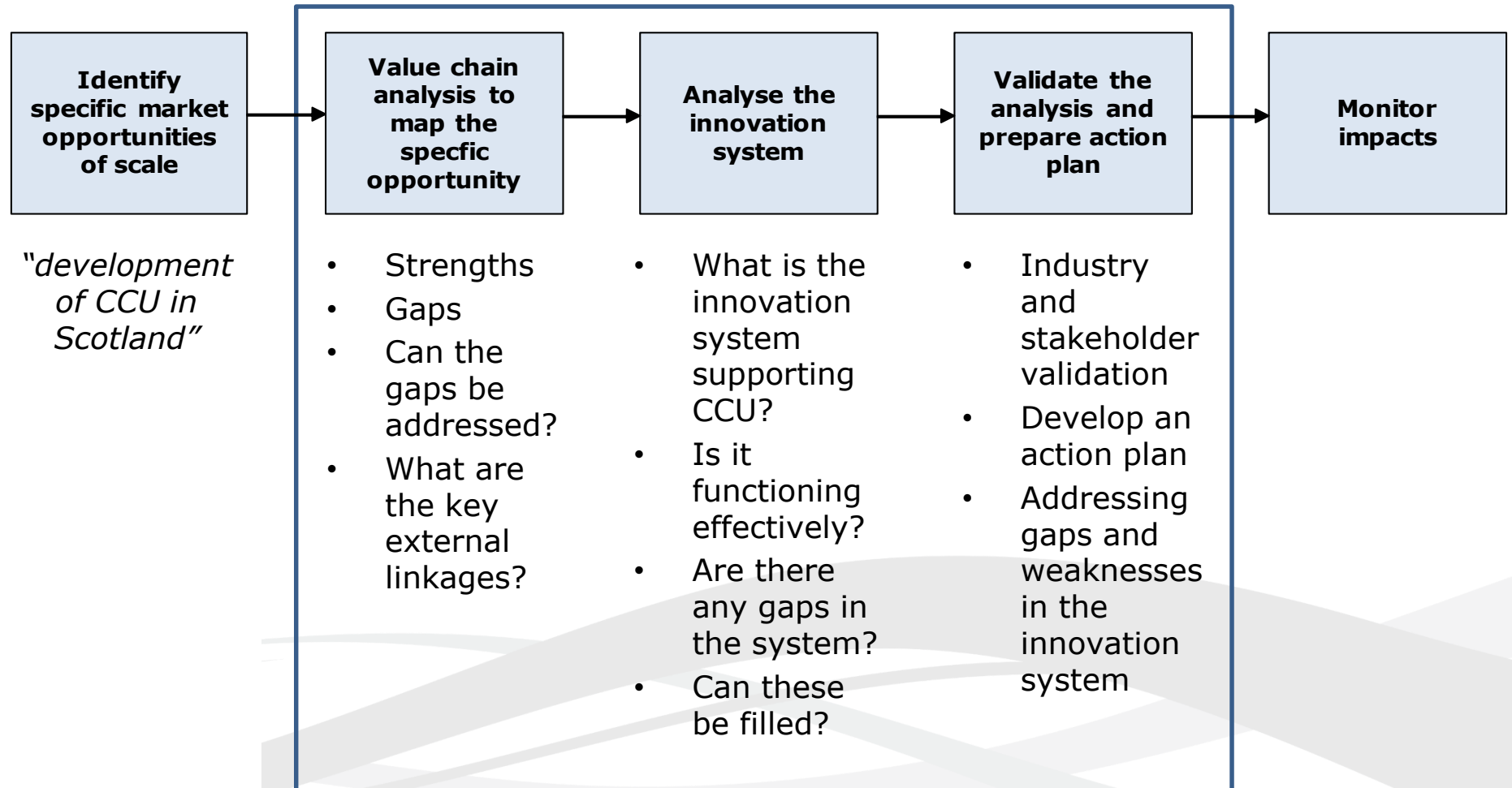
Company driven innovation project development

Addressing Interreg project requirements



Innovation Systems Approach

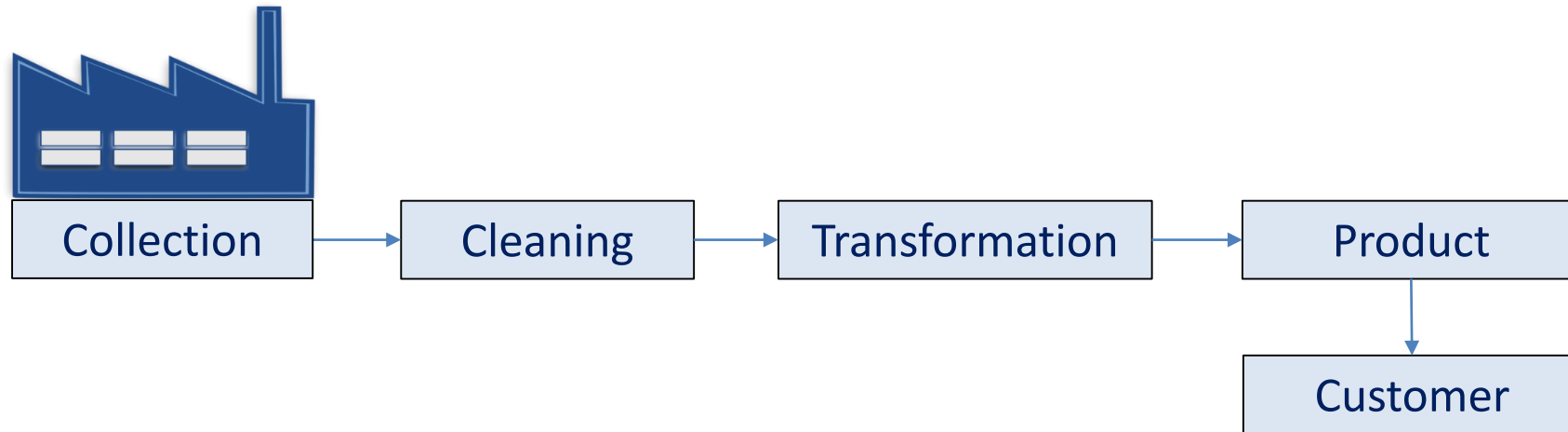
5 key steps





Project Scope

- Development of the CCU value chain from source to market



- Highlights the importance of the CO₂ emitter
 - Focal point to address Interreg requirements
- The structure/scope of the value chain will vary, depending on the product

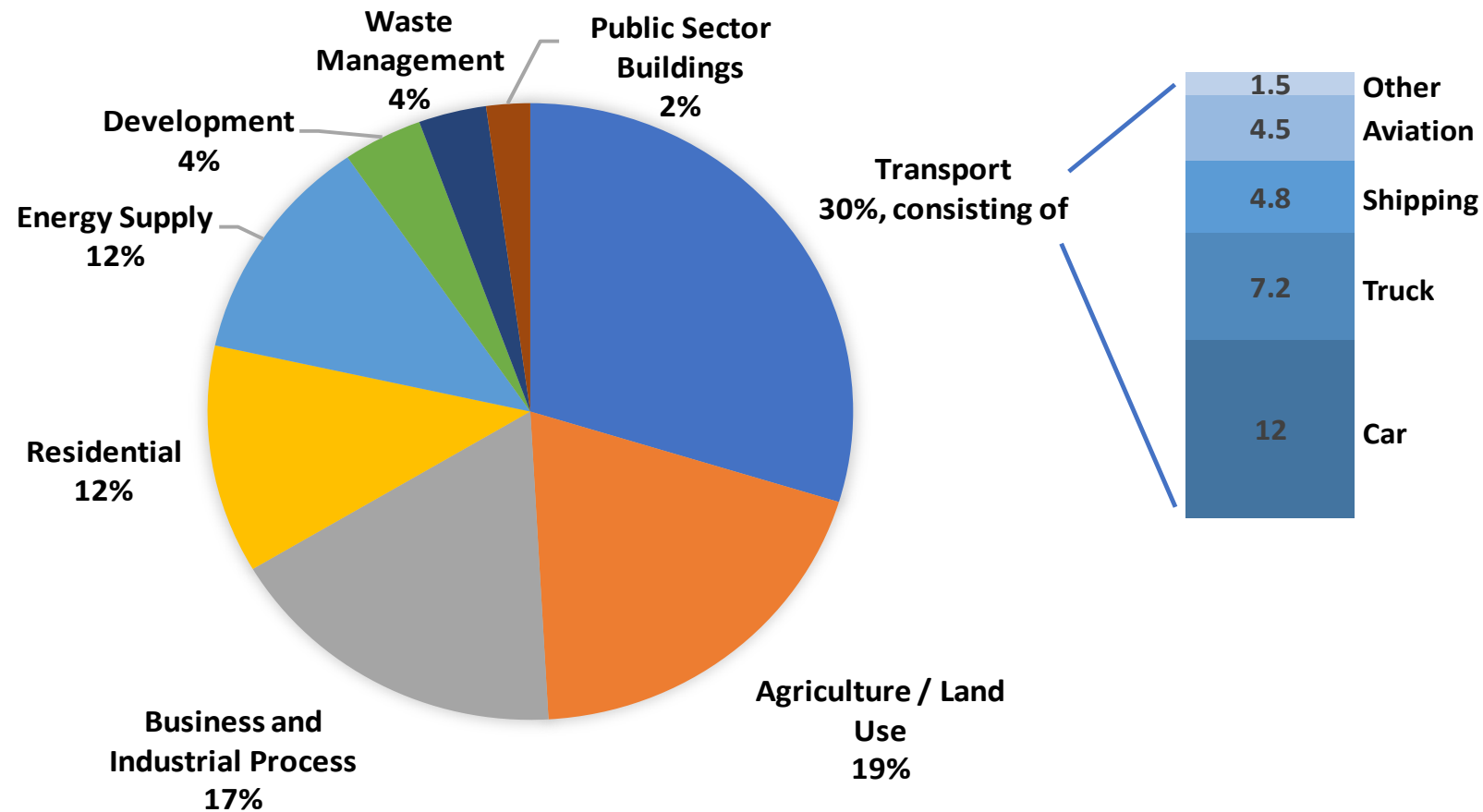


Large Potential Markets – Chemicals and Fuels

Product	Demand	Production Levels	Market Value
Methanol	Global – fuel and feedstock	110Mt	\$55B
Butanol	Global – feedstock, solvent and also fuel	>1.5Mt (1997)	\$9.9B (2020)
Butadiene	Global – synthetic rubber (tyres), feedstock	~16Mt	\$33.5B (2024)
Dimethyl ether	Global – fuel and propellant	~5Mt (2014)	\$9.7B (2020)
PHA	Global – packaging and replacement of other fossil-fuel derived plastics	Limited ~100Kt (but growing)	\$93.5M (2021)
Terpenes	Global – feedstocks, fuels	Large for natural terpenes	\$688.54M (2022)
Olefins	Global – feedstocks	~4.3Bt (2016)	\$12.58B (2025)
Polyols	Global – feedstock, e.g. for polyurethanes	1.74Mt (2021)	\$4.71B (2021)



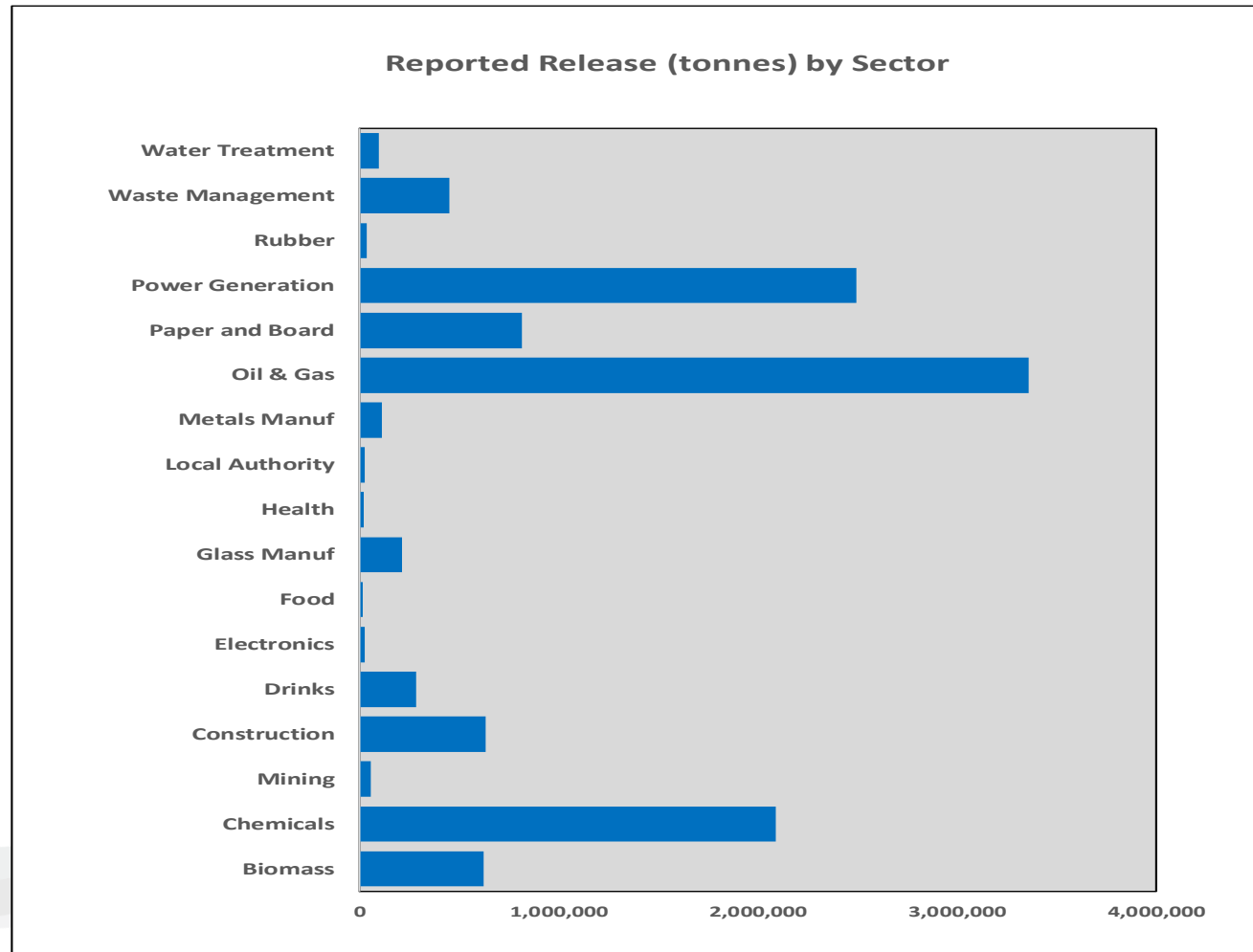
Greenhouse Gas Emissions in Scotland



- 50 million tonnes CO₂ equivalent
- 17% from business & industry
- >11.3 million tonnes CO₂ (reported)
- >3.6 million tonnes CO₂ within Falkirk Local Authority



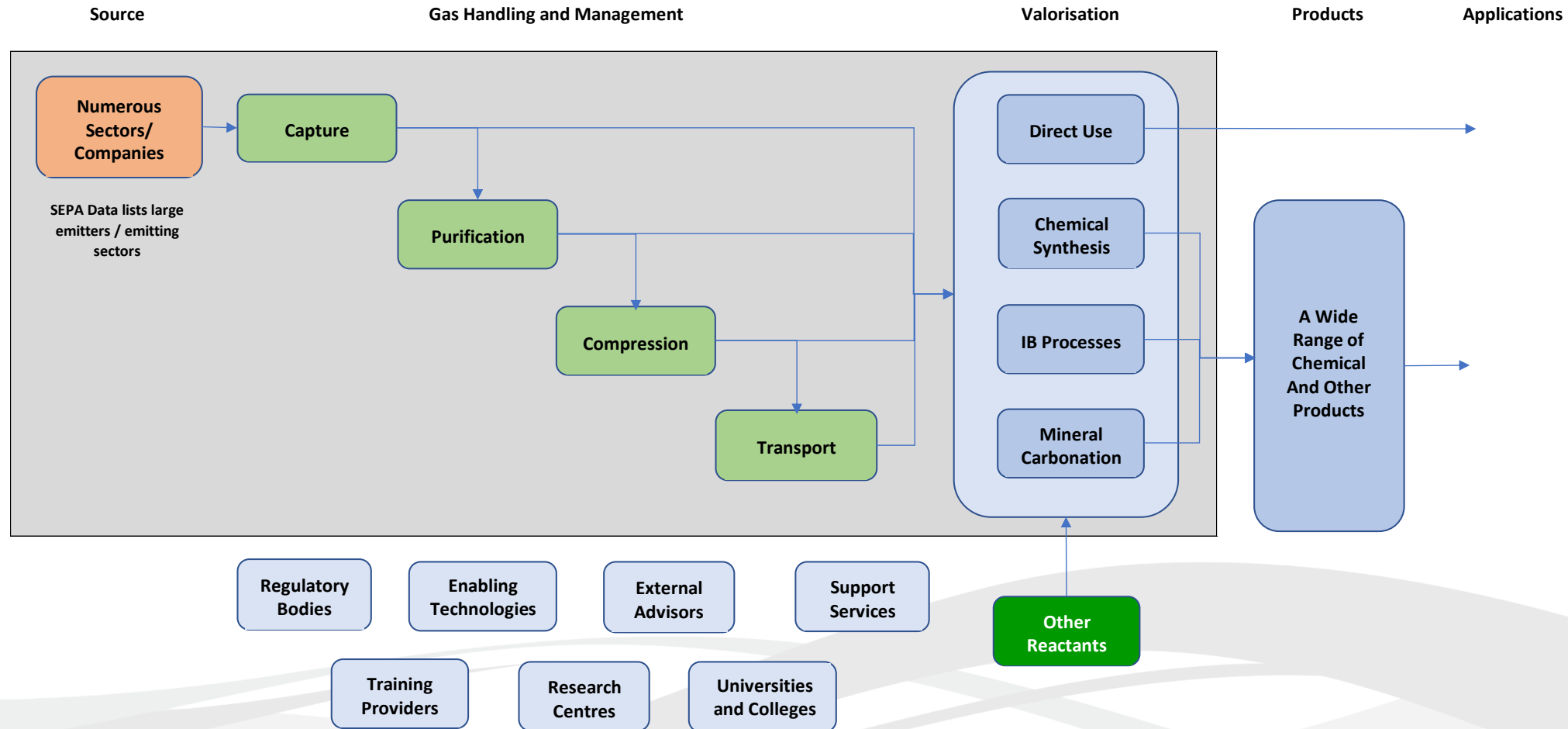
Industrial CO₂ Emissions



The oil and gas sector is the largest emitter in Scotland, followed by power generation then chemicals.



Value Chain Structure





Limited CCU Value Chain in Scotland

- CO₂ Capture: Doosan Babcock
- CO₂ Transport: BOC /Air Liquide (linking to North British Distillery)
- Valorisation: Carbon Capture Machine, a university spin-out, based in Aberdeen, developing mineral carbonation processes
- Enabling technology: Xanthella – developers of photobioreactors
Ingenza – development of IB process technology
NiTech – development of continuous process technologies
- Industrial research Drochaid - chemical research company

But strong academic capability, particularly within the universities of Heriot Watt, Edinburgh and Aberdeen and presence of support organisations, such as IBioiC, Chemical Sciences Scotland and the Scotch Whisky Research Institute.

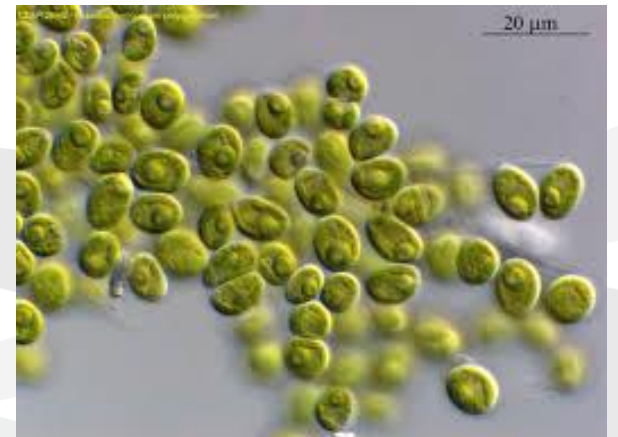


Market Opportunities for Scotland

- Large-scale manufacture of commodity chemicals and biofuels
- Smaller, niche market opportunities that align with Scottish circular economy activities

For example:

- Production of biofuels that can be blended in Grangemouth to meet sustainability targets, e.g. for aviation fuels that Petroineos supplies to Scottish airports
- Microalgal growth to produce feed that can supply the significant aquaculture industry in Scotland, displacing imported soyameal





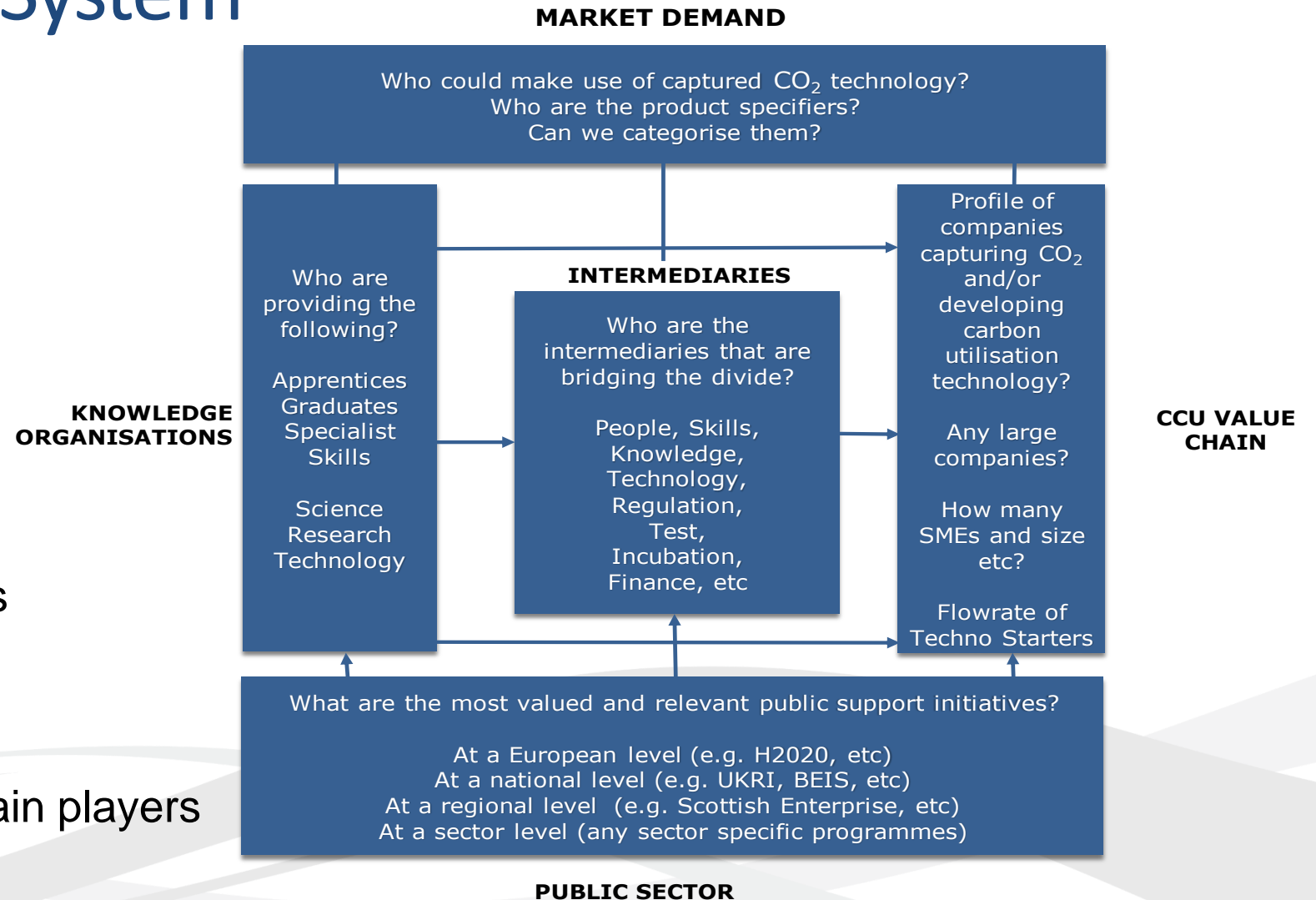
Sector Innovation System

The network of stakeholders, infrastructure and funding programmes that support innovation

Strong in terms of:

- Public sector support
- Key knowledge organisations
- Relevant intermediaries

But weak in terms of value chain players





Role of Innovation

- Existing innovation system relatively strong
- Developing new technologies is not a priority
- Strong interest in adaptation, demonstration and adoption of existing technology
 - Could be number of aspects: capture, purification, transport, as well as utilisation/valorisation
- Efficiency improvements will be important in longer-term
- Key is how this is supported



Challenges

- The lack of existing value chain activity and, thus, best practice examples
- There are no regulatory or legislative drivers
- The apparent/perceived investment risk
- A lack of evidence of the business / financial case for CCU
- CCU is not core business for emitters
- A lack of ownership of CCU development



Development Options

- **Living lab** – delivered through Interreg Northern Connections project, identifying alternative/new technologies, services or processes (*today*)
- **Feasibility studies** – to assess potential technologies and prepare initial techno-economic analyses
- **Demonstration scale facility** – to evaluate technologies in a pseudo-industrial emission environment (*part of a potential UK/Scottish Government funding for Falkirk*)
- **Innovation competition** – for the research and business communities to demonstrate solutions to one or more issues based on well-defined outcomes
- **Sector Innovation Network** – to catalyse and drive further development (*NECCUS*)



Wider Intervention Needs

- Clarity and leadership
 - A clear agenda and strategy for mitigating carbon emissions
- Development of market pull
 - Market incentives such as public procurement of products utilising captured carbon or tax relief on these
- Investment in necessary linked infrastructure
 - Access to cost effective hydrogen and energy will also be required

Must be company/market focused



Way forward

		Potential Interventions							Other Interventions		
		Living Lab	Feasibility studies	Demo-scale facility	Competition	Falkirk Growth Deal	Knowledge network	Technoeconomic analysis	Carbon R&D tax credits	Market incentives	Regulations
Issue	Demonstration at scale		●	●	●	●		●			
	No economic case	●	●	●			●	●		●	
	No regulatory requirements									●	
	No funding mechanisms		●	●	●	●			●		
	Technology push, not pull	●	●	●			●	●	●	●	
	CSR	●	●				●	●	●		



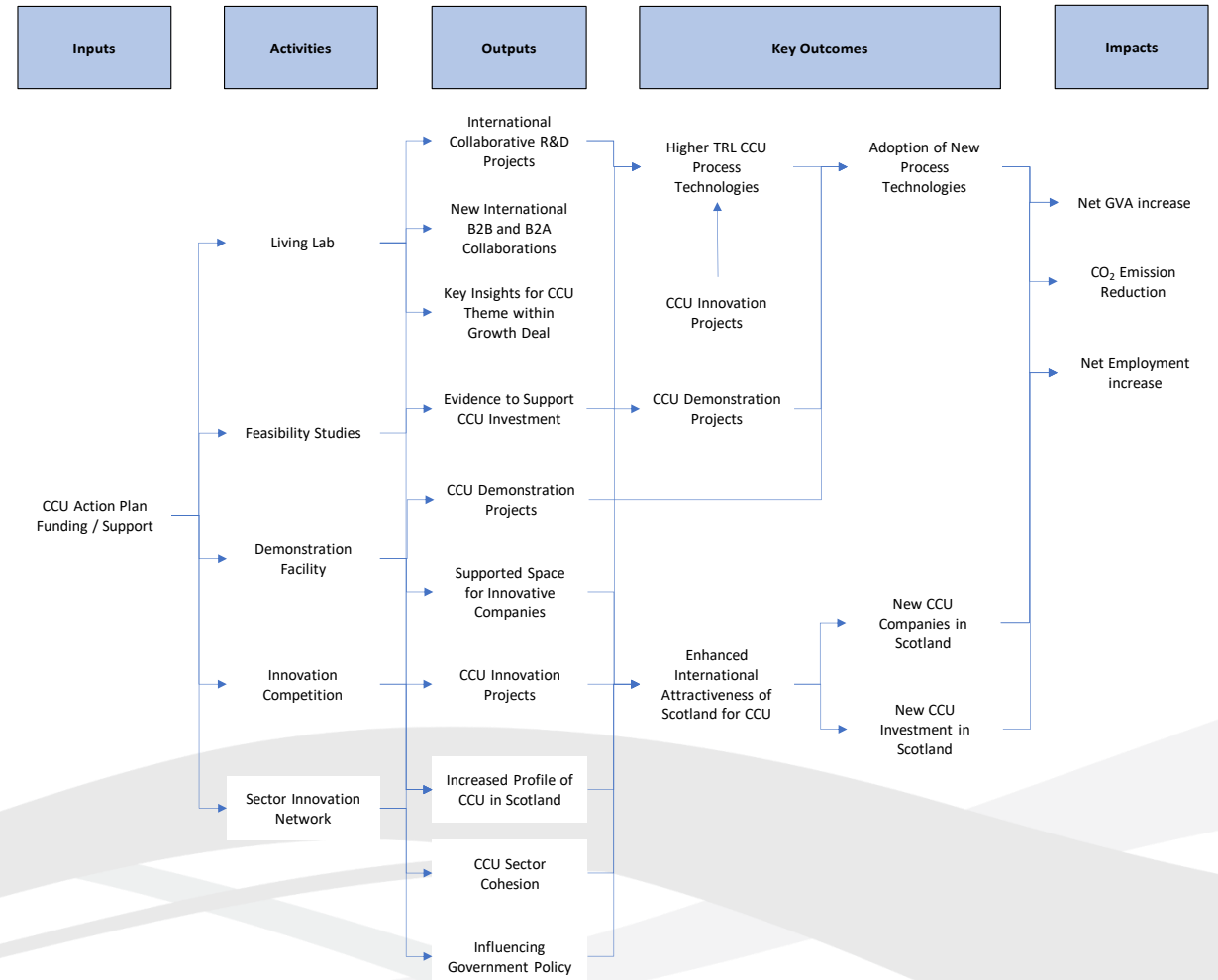
Expected Outcomes & Impacts

Expected outputs and outcomes are:

- Twenty CCU feasibility projects within 5 years
- Over ten CCU innovation and demonstration projects within 5 years
- Adoption of CCU by more than five companies within 5 years
- A proactive and effective CCU cluster organisation
- Over five new CCU companies in Scotland within 5 years

As a result, the main impacts arising are:

- Recognition of Scotland as an innovation driven leader in CCU
- An increase in international collaboration opportunities for Scottish businesses and research organisations
- Increase in the size of the CCU sector in Scotland (businesses and skilled, high value jobs)
- Increase in the GVA of the CCU sector in Scotland





Priorities for Action Plan

- Support feasibility studies
 - Optimise technology for specific emissions
 - Based on full value chain development
 - Assess economic case
- Establish demonstrator programme
 - Combine lab-based and industrial demonstrators
 - Assess / optimise technologies on real emissions
 - Opportunity for Living Lab project(s)
- Establish CCU network
 - Continue engagement
 - Support other activities
 - Make case for fiscal / market interventions



Thanks to all the Contributors to this Study:

Company	Stakeholder
CalaChem	BEIS
Carbon Capture Machine	Chemical Sciences Scotland
Diageo	University of Birmingham
Doosan Babcock	Heriot Watt University
Drochaid Research Services	IBioIC
DSM	Interface
Ineos	James Hutton Institute
Ingenza	Pale Blue Dot Energy
NiTech Solutions	Scottish Carbon Capture and Storage
North British Distillery	Scottish Hydrogen Fuel Cell Association
Petroineos	TUV-NEL
Xanthella	University of Strathclyde
	Zero Waste Scotland



Falkirk Council



THANK YOU

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