Industrial Decarbonisation. From linear to circular: a life cycle lesson

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LCA-RSIN LCA Regulatory Science and Innovation Network

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The Role of Higher Education Institutes and Life Cycle Assessment in Achieving Sustainable Futures, Imperial College, London. March 2025

IDRIC

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What will I talk about today….?

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IDRIC

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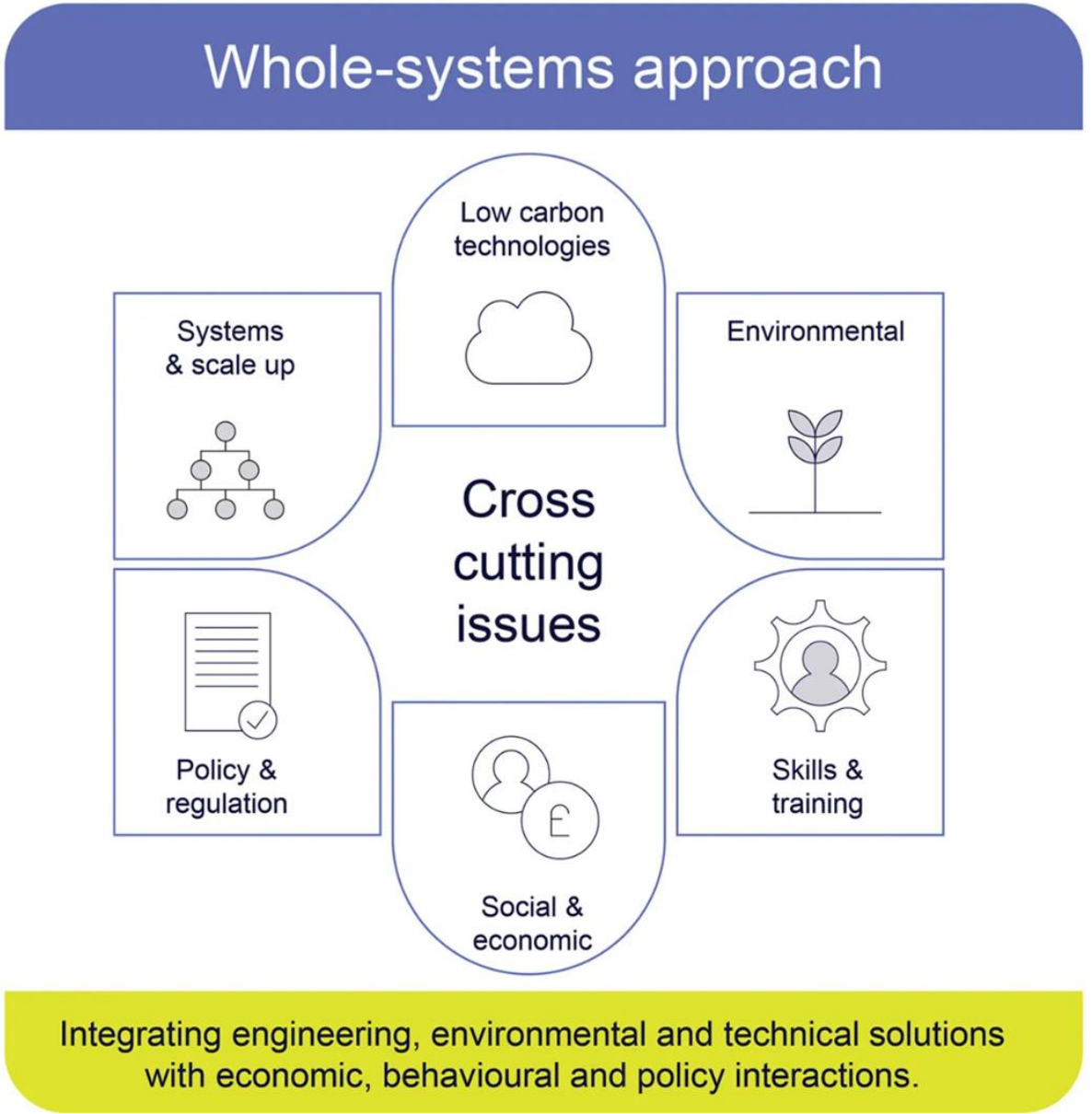
- IDRIC is backed by over £20m and is part of the IDC
- We started in 2020
- Cluster focused
- Over 60 individual projects – all linked with industry



Grangemouth oil refinery to close by end of June, putting 500 jobs at risk

Owners confirm site will become fuel import terminal and distribution hub, in blow to Scotland's industrial base

Business live – latest updates

There had been hopes jobs could be saved after Keir Starmer descri
priority'. Photograph: Murdo Macleod/The Guardian

The owners of the Grangemouth oil refinery have confi
the end of June next year, in a blow to Scotland's indus
site's 500 employees.

Over 2,000 workers apply for Tata Steel redundancy

art of its restructure

voluntary redundancy at Tata Steel's

where the company plans to close its
e.

Labour's net zero quest will cost jobs, unions fear

Ed Miliband and Sir Keir Starmer visited the Scunthorpe steel plant last year

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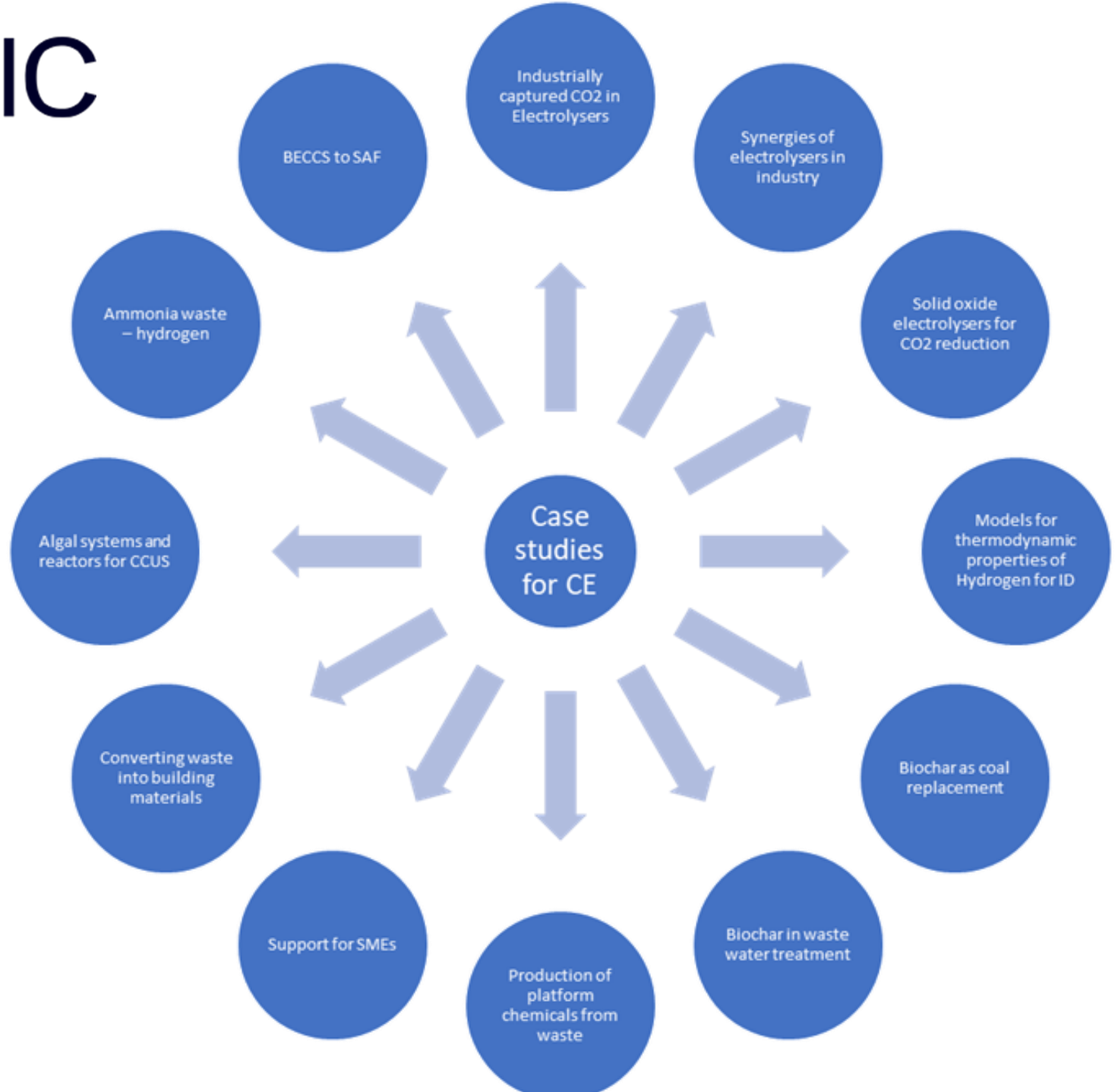


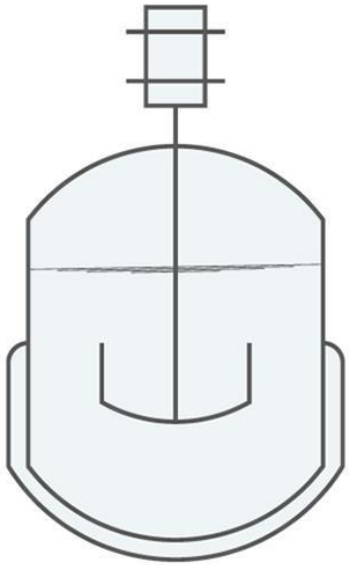
PRODUCTION OF VOLATILE FATTY ACIDS BY ANAEROBIC DIGESTION OF BIOWASTES: TECHNO-ECONOMIC AND LIFE CYCLE ASSESSMENTS

Organic Wastes

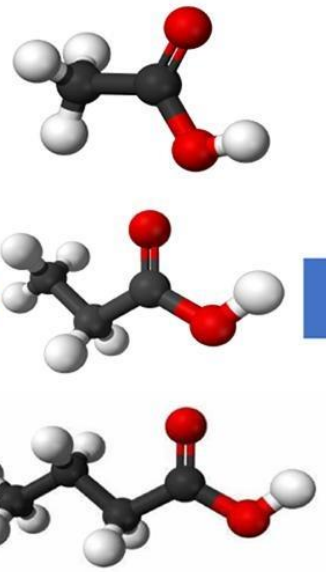
~ 10 million tonne/year

(United Kingdom)

Anaerobic Digestor



Volatile Fatty Acids Production



Techno-economic Analysis

Economic feasibility was achieved.

VFA's price could vary from 1,491.23 to 1,864.04 GBP/ton. of total organic acids.

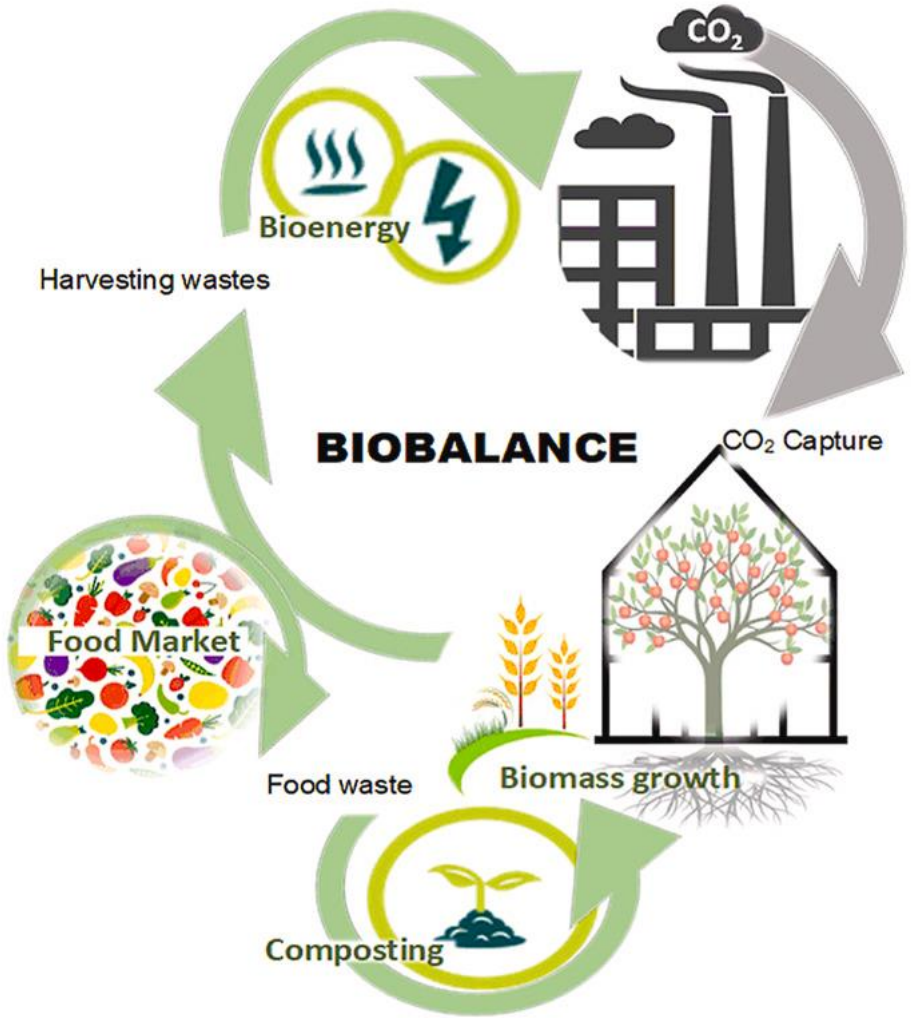
Life Cycle Assessment

The higher the VFA yield, the lower the GWP, varying from -0.21 to 0.01 CO_2 eq./kg of product.

Foreground uncertainty with mass balance preservation was performed.

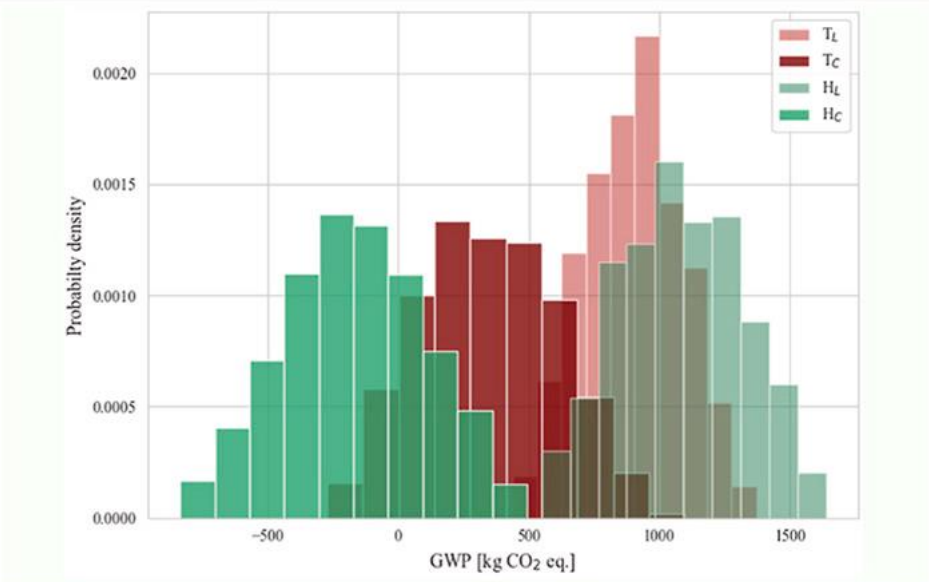
Pinto, McDonald, Jones, Massanet-Nicolau, Guwy, McManus, 2023, https://doi.org/10.1016/j.biortech.2023.129726.

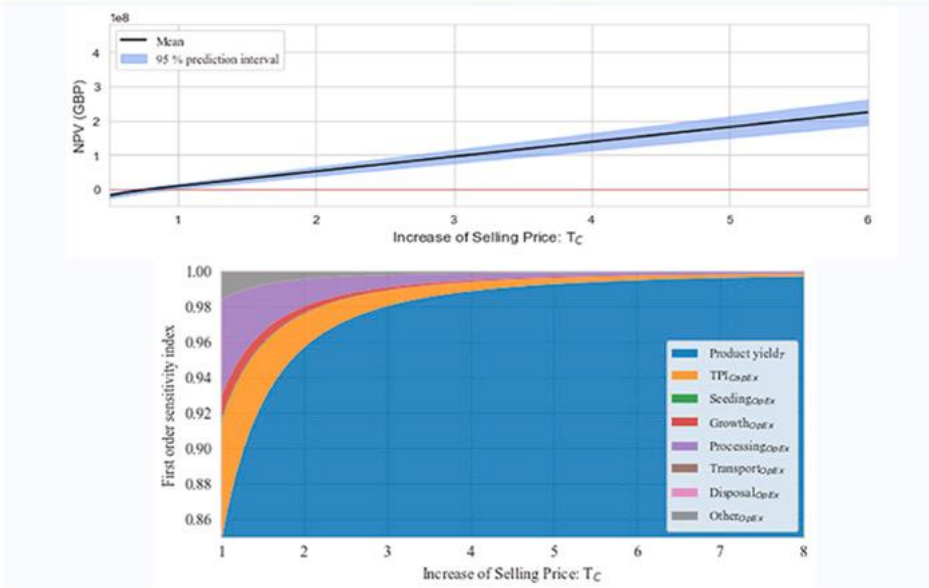
Bio-based carbon capture as a negative emission strategy for industrial decarbonisation



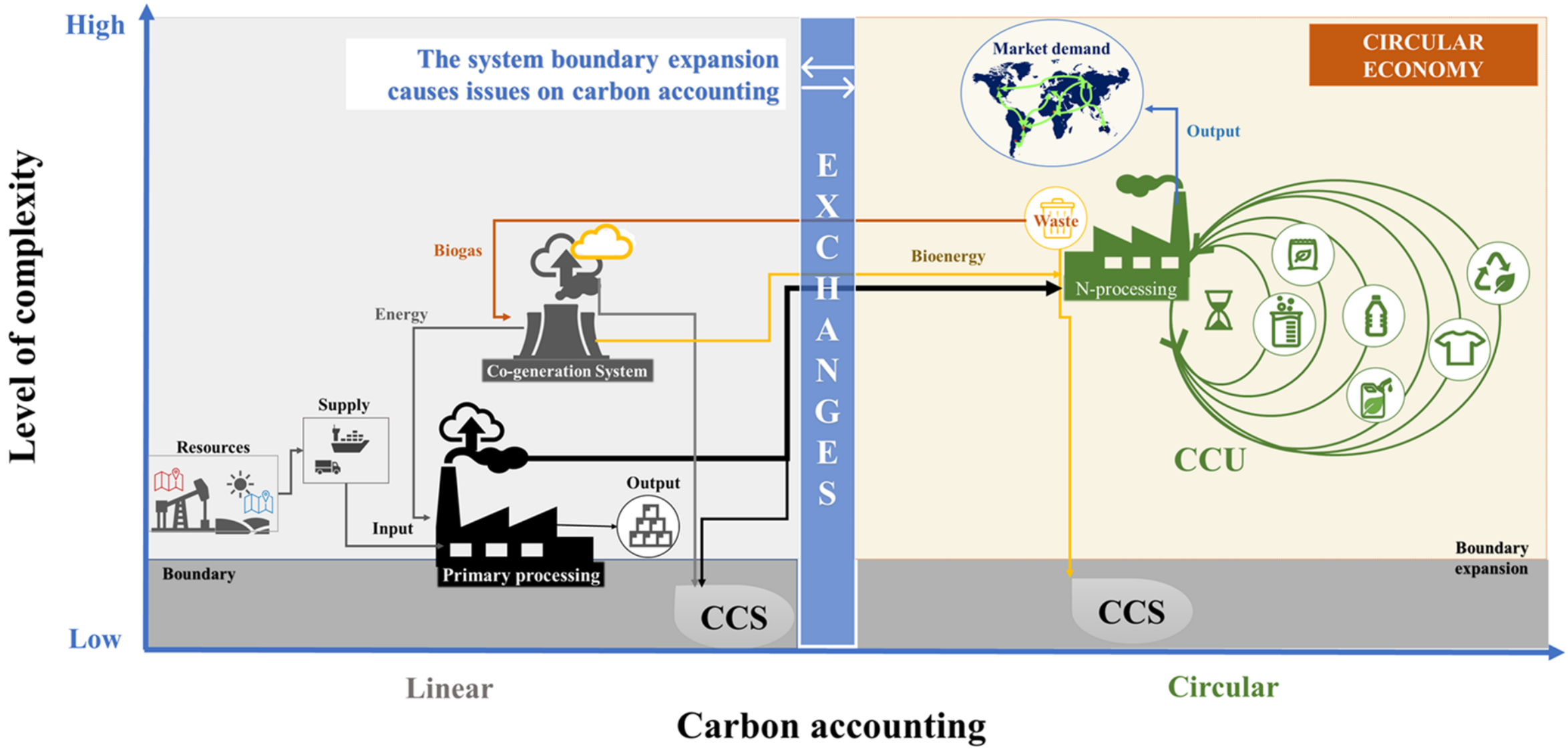
LCA

TEA



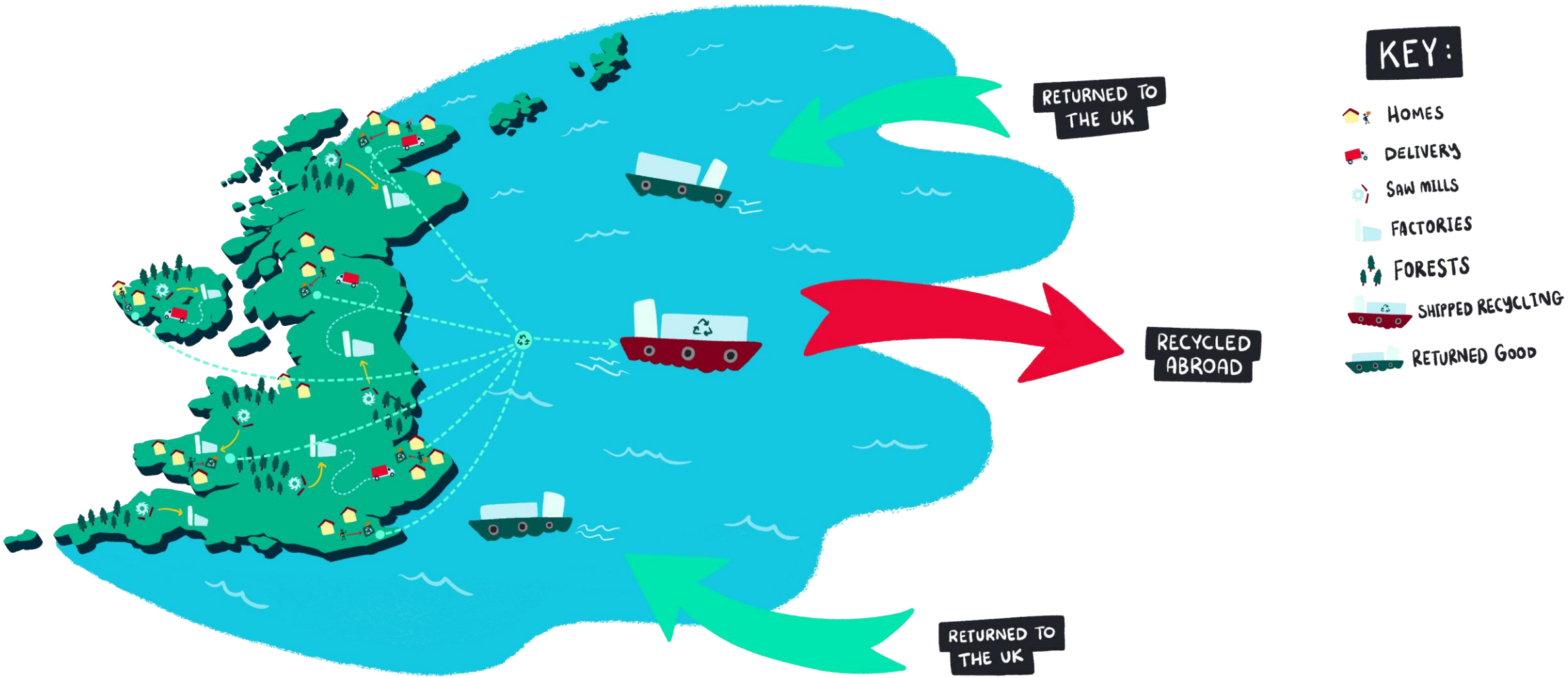


McDonald, Pinto, Arshad, Rowe, Donnison, McManus, 2023, https://doi.org/10.1016/j.jclepro.2023.139650.



Improving life cycle assessment for carbon capture and circular product systems, Pinto, McDonald, Galvan & McManus, 2024

https://doi.org/10.1007/s11367-023-02272-9



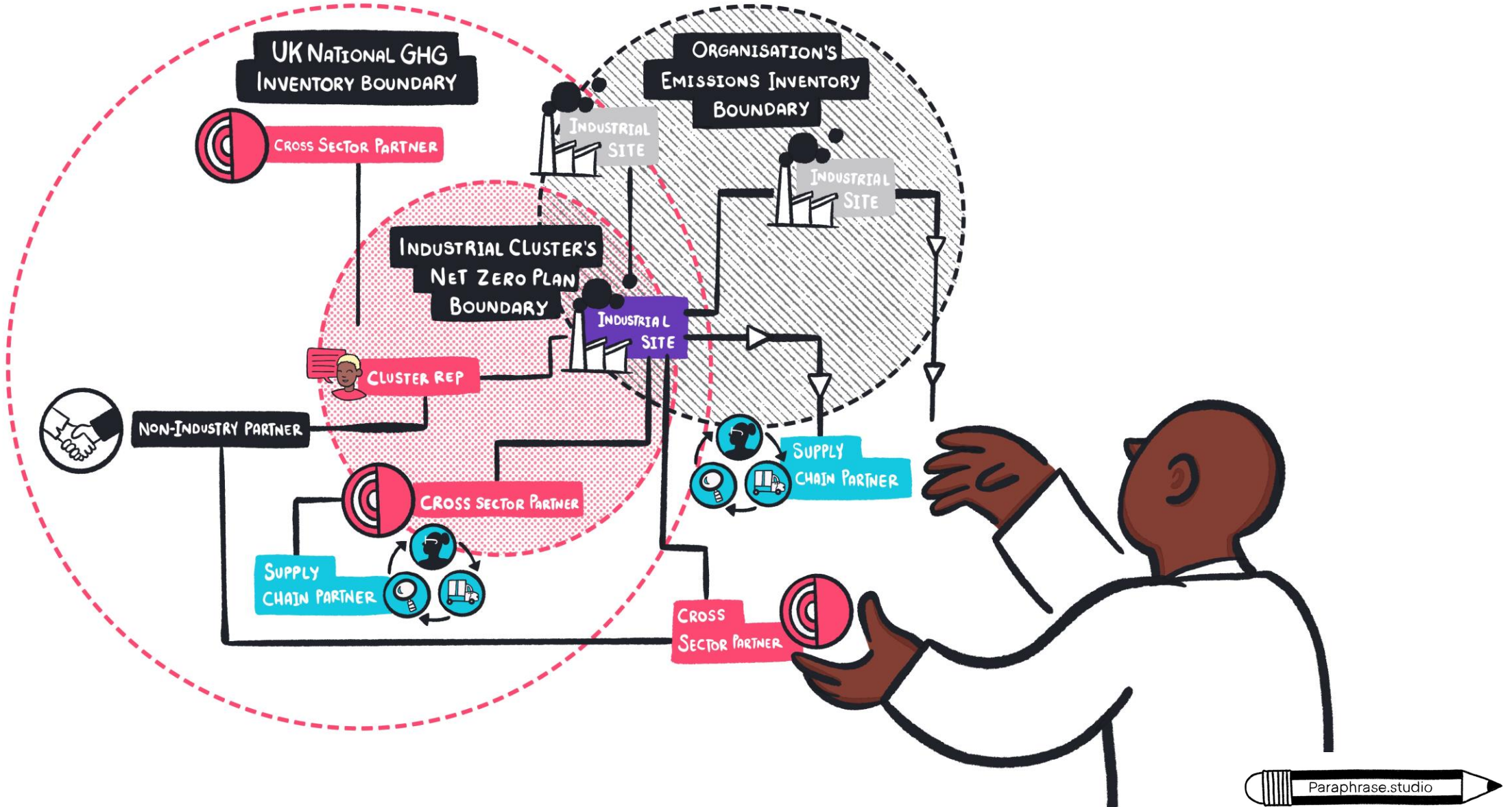


Table 1. Methodological approach adopted in current regulations, standards and framework.

	territorial based	production based	consumption based	income based	EEMRIO	ETS	CBAM
GHG protocol	✓	✓	—	—	—	—	—
ISO 14067	—	✓	✓	—	✓	—	—
PAS 2050	✓	✓	✓	—	—	—	—
compliance market-based mechanism—ETS	✓	—	✓	—	—	✓	✓
SECR	—	✓	✓	—	—	—	—
CDP	—	✓	—	—	—	—	—
SBTi	—	—	—	—	—	—	—
ESOS	✓	—	✓	—	—	—	—
CCA	✓	—	—	—	—	—	—
ISSB	—	—	—	—	—	—	—
TCFD	—	—	—	—	—	—	—
CDSB	—	—	—	—	—	—	—
value reporting foundation's integrated reporting framework	—	—	—	—	—	—	—
World Economic Forum's stakeholder capitalism metrics	—	—	—	—	—	—	—
SASB	—	✓	—	—	—	—	—

Summary of LCA modelling guidelines

Source		ISO 14040 & 14044	Techno-Economic Assessment & Life Cycle Assessment Guidelines for CCU	Life Cycle Assessment of Circular Systems	Responsible Steel International Standard	Whole life carbon assessment for the built environment	PEFCR
Primary Considerations	ALCA		■				
	CLCA						
	Economic Allocation		■	■			
	Mass Allocation				■	■	
	Energy Allocation						
	Sub-division of System		■	■		■	
	System Expansion		■	■			
	Circular LCA			■			■
	CCUS		■	■		■	
Temporal	Dynamic Inventory						
	Dynamic Characterisation Factors						
	Delayed Emissions		■	■			
Regionalisation	Regionalised LCA						■
Data Quality Analysis	Uncertainty Analysis		■				
	Sensitivity Analysis		■				
Comments		[1]	[1,2,3,4,5]	[6]	[6]	[6]	[1]
References		(ISO 14040, 2006; ISO 14044, 2006)	(Langhorst, 2022)	(ICCA, 2022a, 2022b)	(ResponsibleSteel, 2022)	(RICS, 2017)	(EC, 2017)

Legend:

- ■ *Mention & describe*
- ■ *Mention only*
- *Do not mention*

[1] Generic, applicable to many processes/products

[2] "Shall, should, and may" guidelines are used.

[3] The socio-economic aspects are mentioned and described, but the regionalisation modelling of the LCA characterization impacts is just mentioned.

[4] Dynamic characterisation factors are fully described for the TEA combined with LCA guidelines.

[5] The circularity is regarding new strategies for mitigating environmental impacts.

[6] Sector specific guidelines

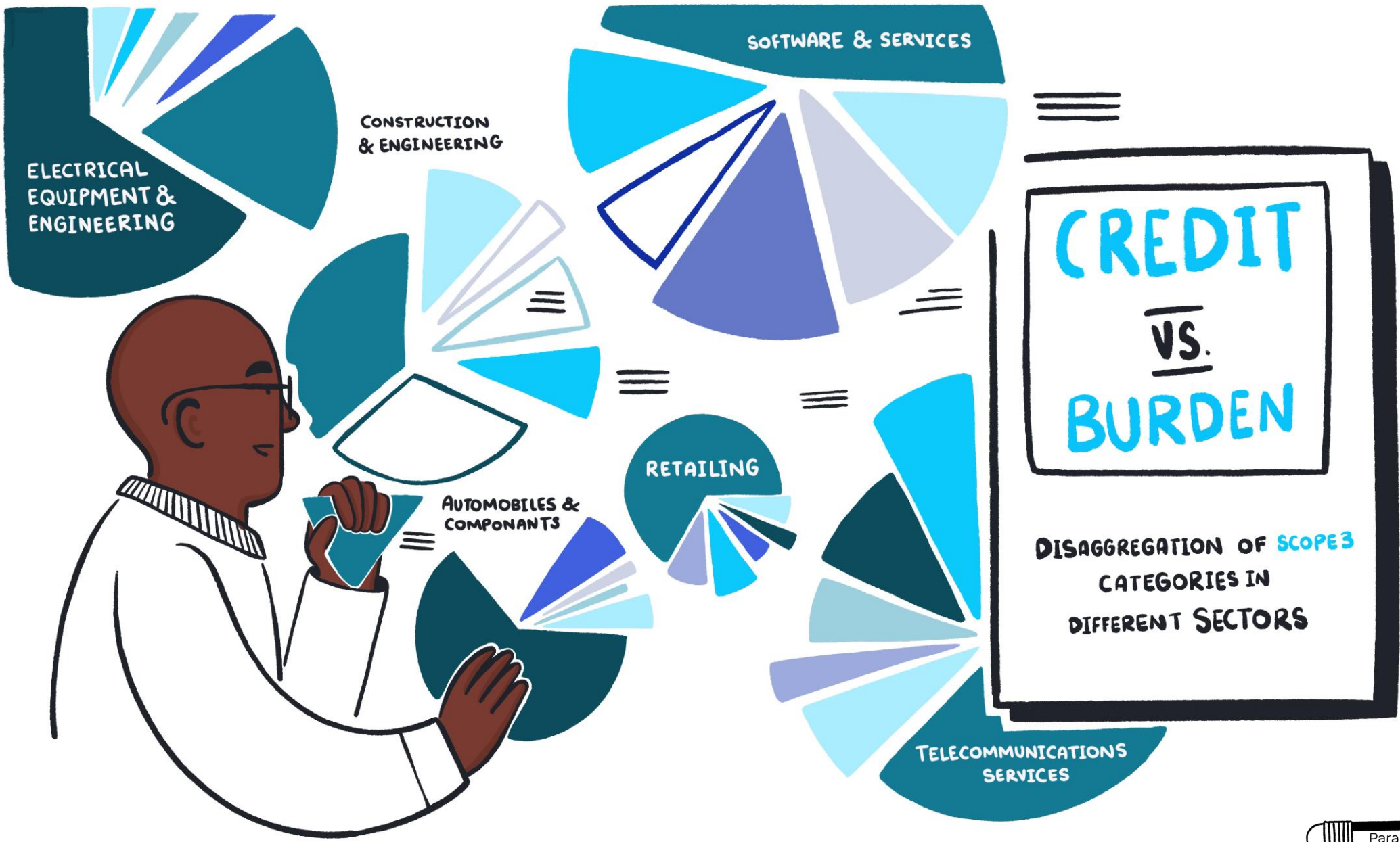
Improving life cycle assessment for carbon capture and circular product systems, Pinto, McDonald, Galvan & McManus

When companies in the SAME SUPPLY CHAIN use DIFFERENT METHODS it's hard to produce TRANSPARENT & MEANINGFUL RESULTS

As we move towards a CIRCULAR ECONOMY, understanding this impact on a GLOBAL ENVIRONMENT as well as local business & industry level is CRITICAL...

...It is critical for the SURVIVAL OF INDUSTRY & critical for the SURVIVAL OF BUSINESS


Equitable distribution of credits and burdens
Evolving and adapting to meet needs
Incorporate global trade emissions
Accurate, verifiable and transparent
Accessible and useable to non-experts
Handles emissions and storage over time
Consistent data requirements



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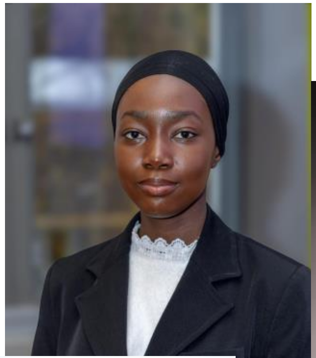







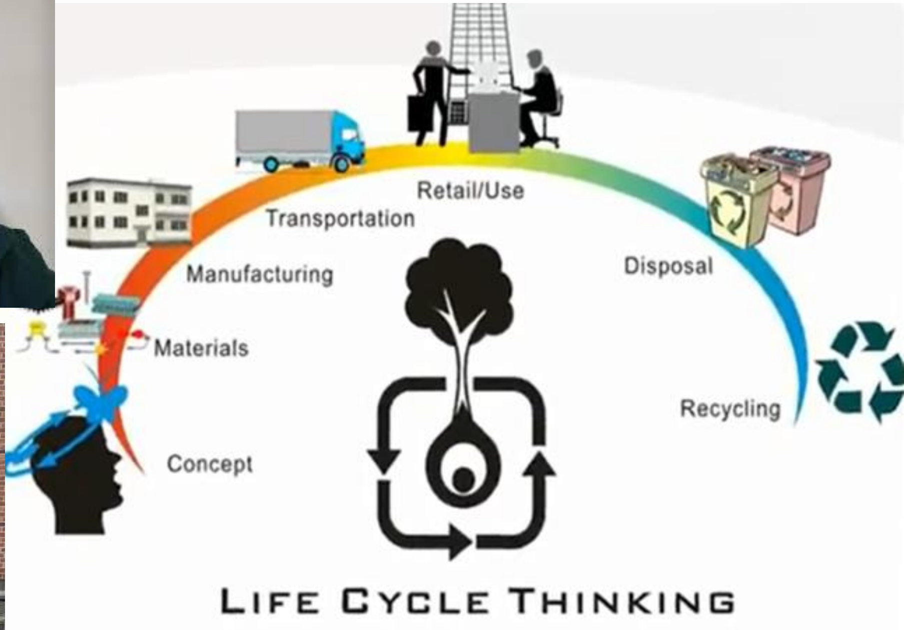


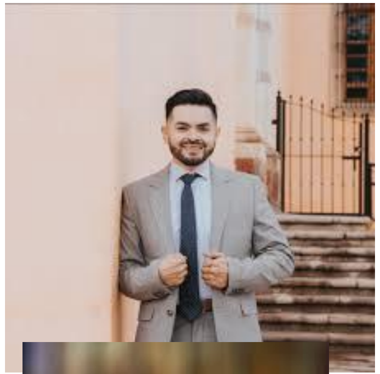



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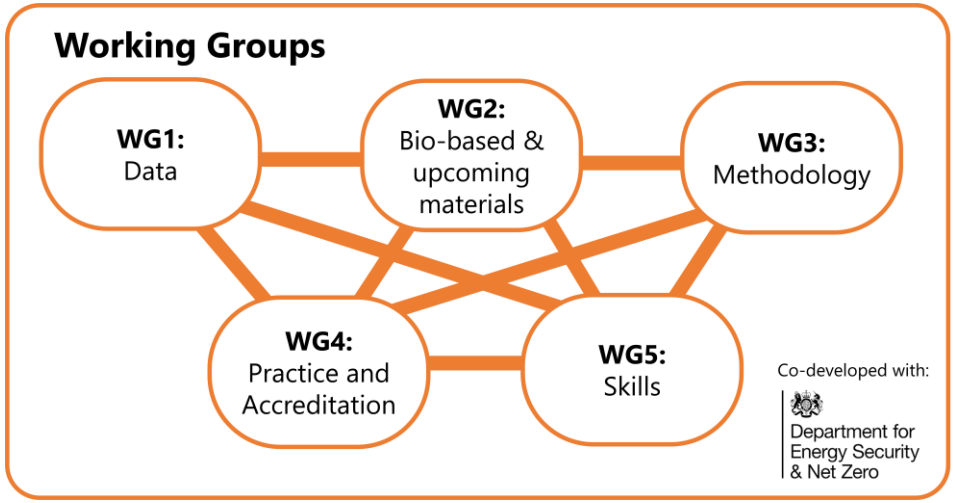
Life Cycle Assessment Regulatory Science and Innovation Network

- Innovate UK funded network est. 2024
- Over 250 members and growing
- Tackling major challenges in LCA

Aims:

- Research-based evidence and insights to support policy towards Net Zero.
- Hub of knowledge exchange between policymakers, industry and academia.
- Generating a network-of-networks



Join our annual meeting:

- 19-20th June 2025
- Details: www.lca-rsin.org (coming soon)

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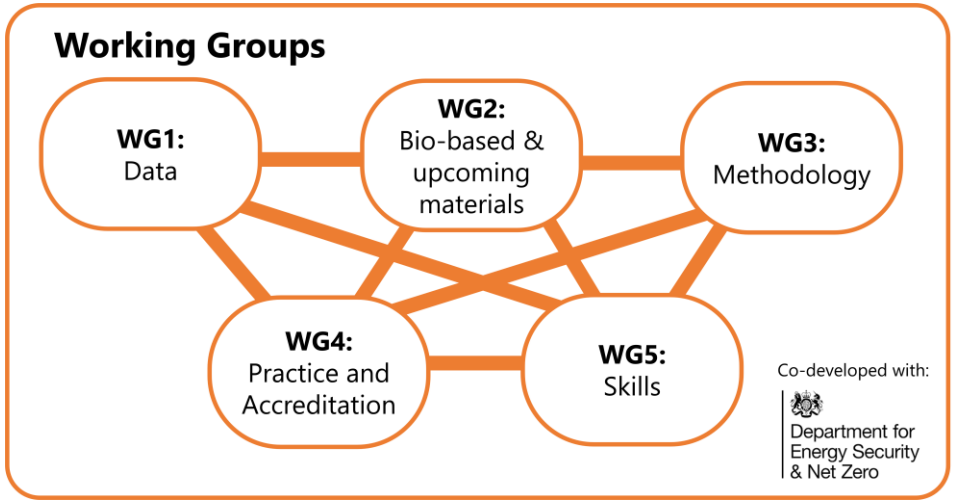
Life Cycle Assessment Regulatory Science and Innovation Network

Working Groups:

- Focus areas co-developed with DESNZ
- Led by academic and industry experts
- 8-10 members with in-depth subject experience
- Researcher time allocated to each group
- Each group addressing a key focus area



Special Interest Groups:

- Open groups to facilitate knowledge exchange
- Focus on areas of interest and future focus
- Forums for development and best practice

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Life Cycle Assessment Regulatory Science and Innovation Network

Events:

- SIGs hold regular online meetings and talks
- WGs will produce presentations and papers

Network annual meeting:

- 19th – 20th June 2025
- University of Sheffield

Join the network:

Visit www.lca-rsin.org to join, sign up for our newsletter and join us on Linkedin!

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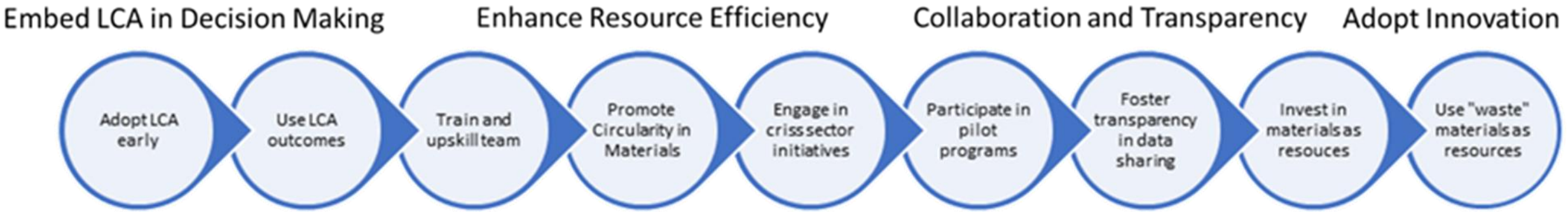
From Linear to Circular:

will this make industry more sustainable and can LCA help?

- LCA and carbon accounting needs to work for the planet, but also the industry involved
- Spatial and Temporal aspects are important for the success of life cycle-based carbon modelling
- Current tools aren't sufficient
- LCA can help – but the correct lens needs to be applied



Questions?

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