Transforming industrial waste gases (CO/CO2) to chemicals

a joint webinar delivered by the Bioeconomy Cluster Builder (BCB) and IUK KTN's Circular Economy Innovation Network (CE IN)

Thursday 2nd March 2023

Dana Heldt (Innovate UK KTN, BCB)
Kim Cameron (Industrial Biotechnology Innovation Centre, BCB)
Michael Burnett (Innovate UK KTN, Circular Economy Innovation Network)

Time	Agenda Item
10:00 – 10:10	Welcome & Intro Bioeconomy Cluster Builder (Michael Burnett, Dana Heldt, Innovate UK KTN)
10:10 – 10:20	Innovate UK Circular Economy Innovation Network Overview (Elle Runton, Innovate UK KTN)
10:20 – 10:40	Transforming Industrial Waste Gases (CO/CO2) to Chemicals Challenge and Action Plan (Michael Burnett, IUK KTN)
10:40 – 10:55	Flue2Chem Project (Sean Rouse, Croda)
10:55 – 11:00	From CO2 to Fatty Alcohols (Qiang Li, CPI)
11:00 – 11:15	Industrial Waste CO2 feeds for conversion to value-added chemcicals, Ingenza (Roxann Cortis, Ingenza)
11:15 – 11:25	Decarbonisation via CO2 upcycling, Phase Biolabs (David Ortega, Phase Biolabs)
11:25 – 11:40	Funding and collaboration opportunities (Catherine Mort, Innovate UK KTN)
11:40 – 12:00	Panel Q&A
12:00 – 12:15	Next Steps & Wrap-up (Kim Cameron, BCB; Michael Burnett, Innovate UK KTN)

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Housekeeping

- All participants are muted throughout the webinar
- Please use the Q&A function to submit questions
- Please use the chat box for any technical issues with sound/visuals etc.
- The webinar will be recorded and published online
- Slide decks will be shared after the webinar

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Meeting Mojo

- Virtual event platform through which you can direct message other delegates and hold one-to-one meetings

- Platform will be available to schedule meetings from 13:30 to 16:30 today. Direct Messaging will remain available for longer.

- Register your profile (link in email)

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Innovate UK
KTN

Scottish Enterprise

Introduction to the Bioeconomy Cluster Builder

- Three-year ERDF funded project
- Collaboration between Industrial Biotechnology Innovation Centre, Innovate UK KTN and Scottish Enterprise

Contact:
Kim Cameron, Industrial Biotechnology Innovation Centre, kim.cameron@ibioic.com
Dana Heldt, Innovate UK KTN, Dana.Heldt@iuk.ktn-uk.org

www.bioeconomybuilder.com

European Union
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Investing in a Smart, Sustainable and Inclusive Future

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- Raise awareness of the benefits and applications of industrial biotechnology
- Connect people and resources to develop new and improve existing value chains
- Encourage utilisation of Scotland's bioresources

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BCB
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- Run targeted workshops and awareness raising activities
- Provide innovation support
- Signpost to funding opportunities
- www.bioeconomybuilder.com

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Action Plan to transform industrial waste gases to chemicals

Innovate UK KTN
Circular Economy Innovation Network

Michael Burnett (michael.burnett@iuk.ktn-uk.org)
2nd March 2023

Innovate UK
KTN

About Us

Innovate UK KTN exists to connect innovators with new partners and new opportunities beyond their existing thinking – accelerating ambitious ideas into real-world solutions.

Innovate UK
KTN

Circular Economy Innovation Network

Gartner predicts that by 2029, supply chains will not be allowed to produce waste, and during 2030s it is realistic to expect that a circular economy will be the only economy

Elle Bennett Runton
Knowledge Transfer Manager Net Zero

www.ktn-uk.org

UKRI Innovate UK KTN

About Us

Innovate UK KTN exists to **connect innovators** with **new partners** and **new opportunities** challenging existing thinking transforming ambitious ideas into real-world solutions

UKRI Innovate UK KTN

Our Net Zero Strategy

Decarbonisation

Reducing carbon emissions and the use of fossil fuels across energy, heat, transport, agriculture and industrial networks

Circular Economy

Reducing the use of virgin fossil carbon through reuse, recycle, remanufacture and the manufacture of non-fossil-based products

Place

Connecting national innovators to regional and local opportunities

Enabling Action

Connecting enabling technologies to Net Zero innovators and established industry

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Circular Economy Innovation Network

The Circular Economy Innovation Network aims to **enable** stronger**, more collaborative, and resilient industries working together to achieve net zero through circular innovation.**

By catalysing new sector communities, focused on **circular design, circular business models, and circular recovery** we seek to empower industry members to work together to co-create shared pathways to accelerate transition for a lower carbon future

Communities : Aluminium - Wool - Carbon Capture Utilisation

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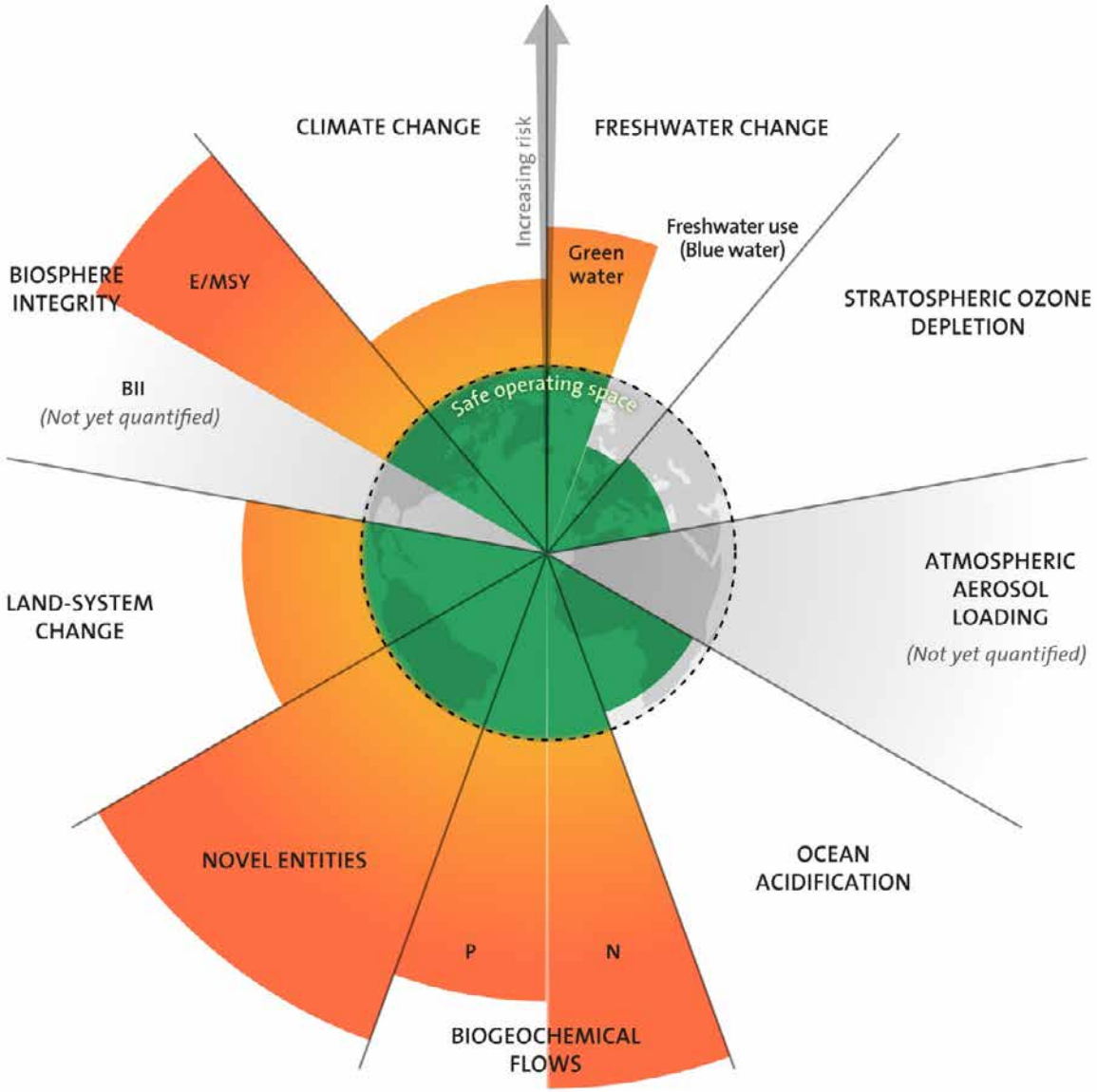
The Human Race will need 3 planets by 2050 if we continue as we are



Licenced under CC BY-NC-ND 3.0 Credit: "Azote for Stockholm Resilience Centre, based on analysis in Persson et al 2022 and Steffen et al 2015".

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Value of nature to global GDP estimated up to 125 trillion dollars

In 2020, UK natural capital asset services estimated to be worth £1.8 trillion per annum*

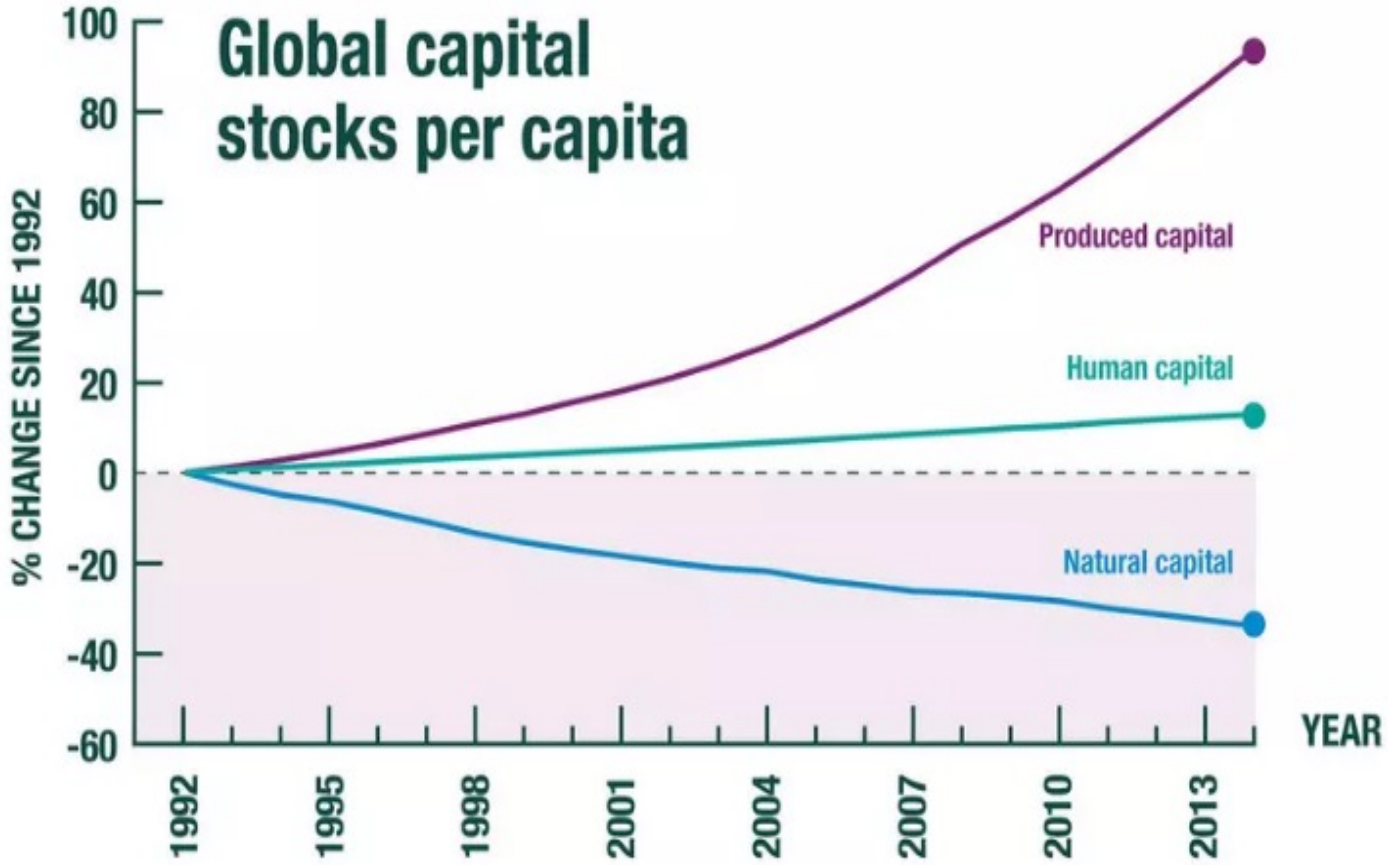

Image: The Dasgupta Review/HM Treasury

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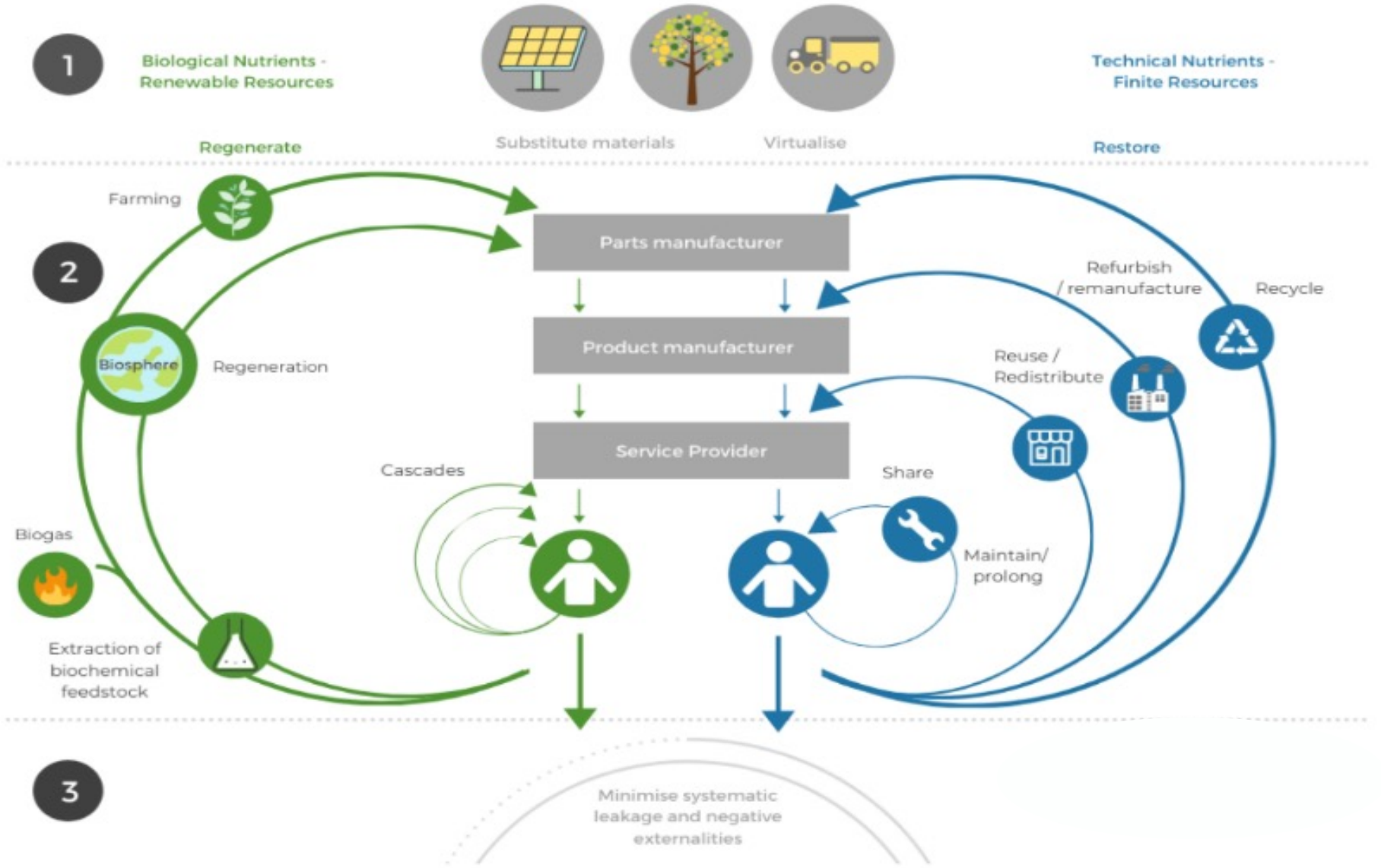
*UK natural capital accounts - Office for National Statistics (ons.gov.uk)

CIRCULAR ECONOMY FRAMEWORK

Reverse biodiversity loss

Create climate positive outcomes

Circular Economy Framework Butterfly



n - Image reproduced from the original diagram - Source: "Growth within" (2015) - Ellen MacArthur Foundation and McKinsey Center for E

DESIGN

Eliminating waste and pollution

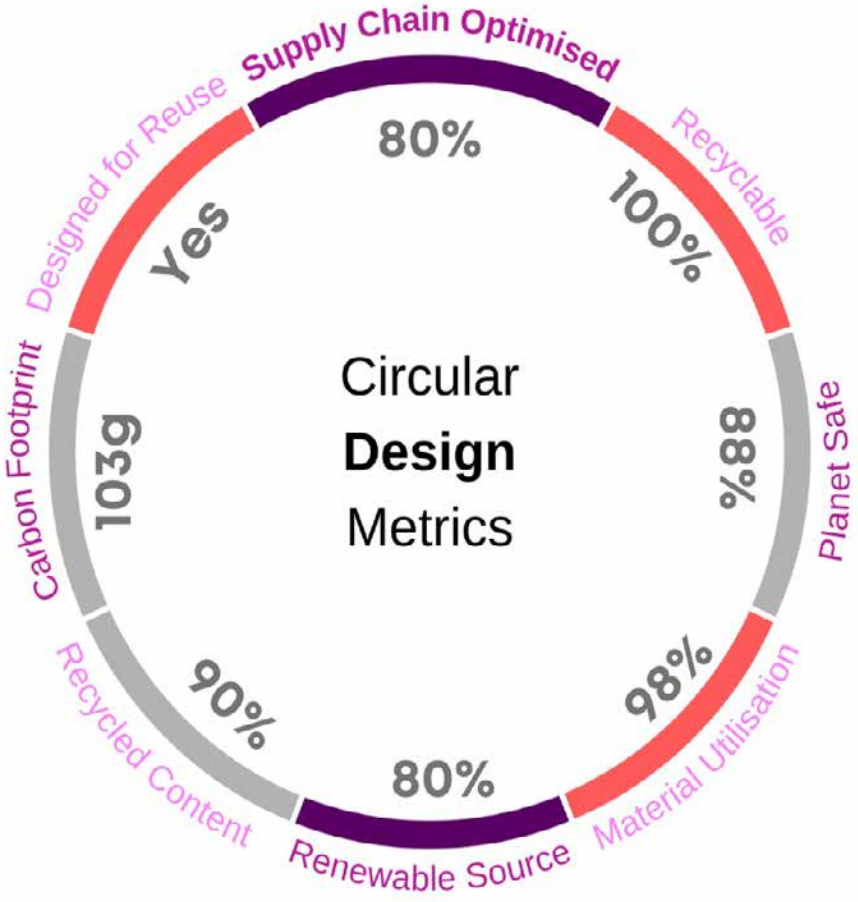


Image based on DS Smith example

70% - 80% of a product's environmental footprint is set during its design phase

Influences recovery of assets and end of life solutions

Shapes the revenue growth models for business operations and the enabling systems

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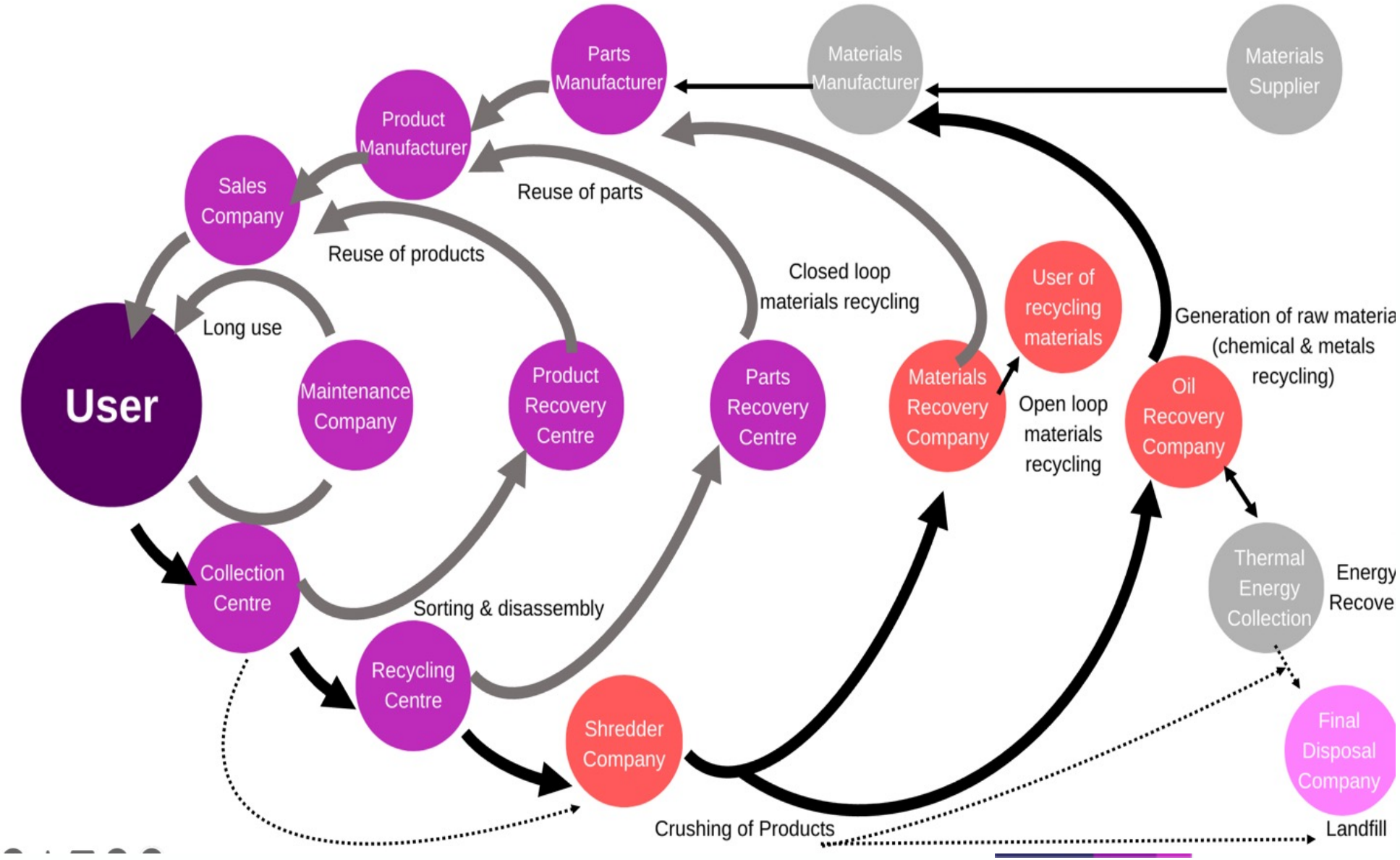
BUSINESS MODELS

Slowing down the flow rate - narrowing the flow volume of materials and assets



RECOVERY

To reduce the amount of new feedstocks needed

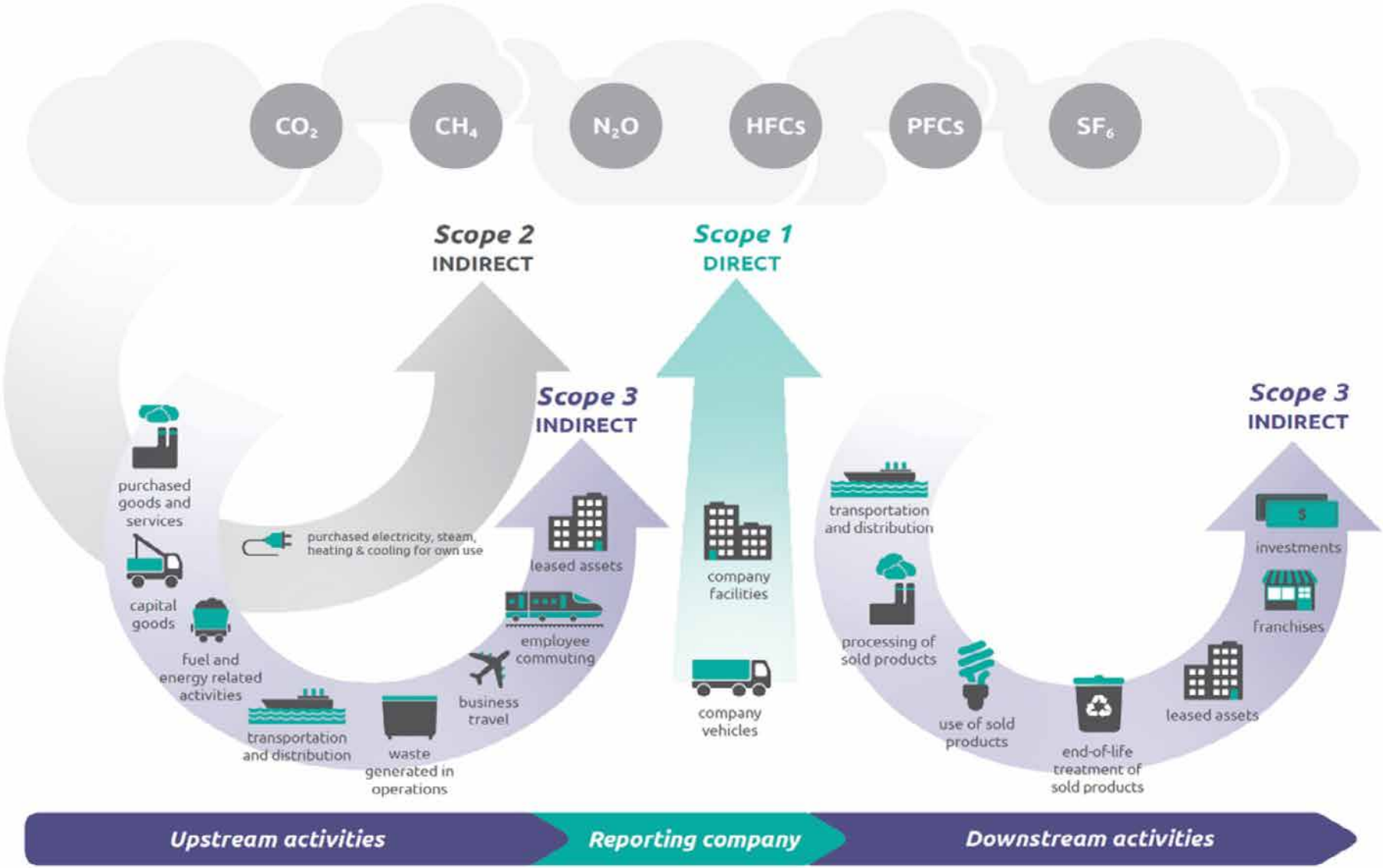


Figure. Overview of GHG Protocol scopes and emissions across the value chain (Source: WRI/WBCSD Corporate Value Chain (Scope 3) Accounting and Reporting Standard)

The Circular Economy Innovation Network

ENABLES

CONNECTING THE CHALLENGE WITH THE SOLUTION

- Diverse Communities | **UK Innovation Networks**
- Research academia and business | **Knowledge Transfer Partnerships**
- Insight to impact Action Plans | **Insight reports**
- Innovators, funders & collaborators | **Innovation Exchange**
- Innovators, funders & collaborators | **Collaboration Exchange**

https://iuk.ktn-uk.org/programme/circular-economy-innovation-network/

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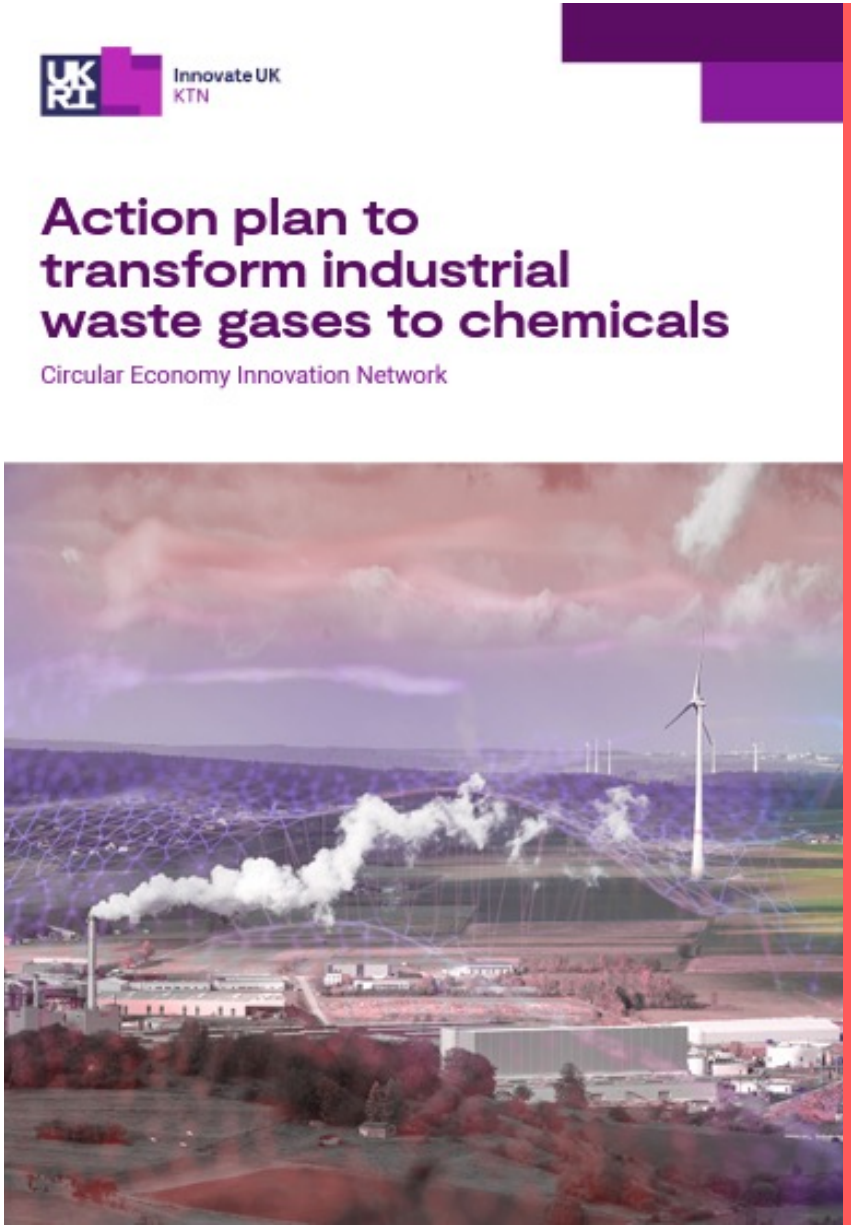


Innovate UK KTN
Circular Economy Innovation Network (CEIN)

Transforming industrial waste gases (CO/CO2) to chemicals challenge

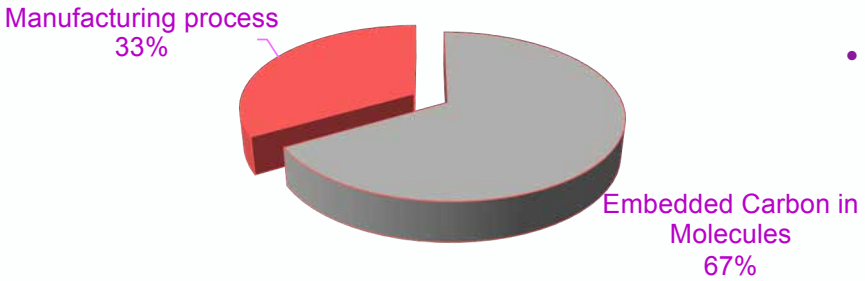
Michael Burnett
Innovate UK KTN
Knowledge Transfer Manager - Process Manufacturing

Innovate UK
KTN

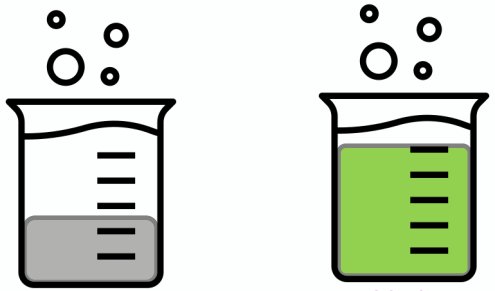
Circular Economy Opportunities: Why Transform Industrial Waste Gases (CO/CO2) to Chemicals?

How much carbon is used in chemical manufacture?

From the Renewable Carbon Initiative / nova-Institute reports:



Source: Renewable Carbon Initiative (RCI), April 2022



Source: Renewable Carbon Initiative (RCI), Feb. 2022

- About a third of the carbon footprint of most chemical and chemical intermediates is from the manufacturing process while the other two-thirds is from the embedded carbon in the molecules.(1)

- In 2020 the global demand for carbon embedded in organic chemicals and their derived materials was estimated to be 450 Mt/year. (2)

- Predictions are that the global demand for embedded carbon in chemicals will increase to 1000 Mt/yr by 2050.(2)

(1) Kähler, F. and Carus, M. et al. 2022: CO2 Reduction Potential of the Chemical Industry Through CCU. Editor: Renewable Carbon Initiative (RCI), April 2022. Available at:www.renewable-carbon-initiative.com

(2) vom Berg, C. and Carus, M. et al. 2022: Renewable Carbon as a Guiding Principle for Sustainable Carbon Cycles. Editor: Renewable Carbon Initiative (RCI), Febr. 2022. Available at: www.renewable-carbon-initiative.com

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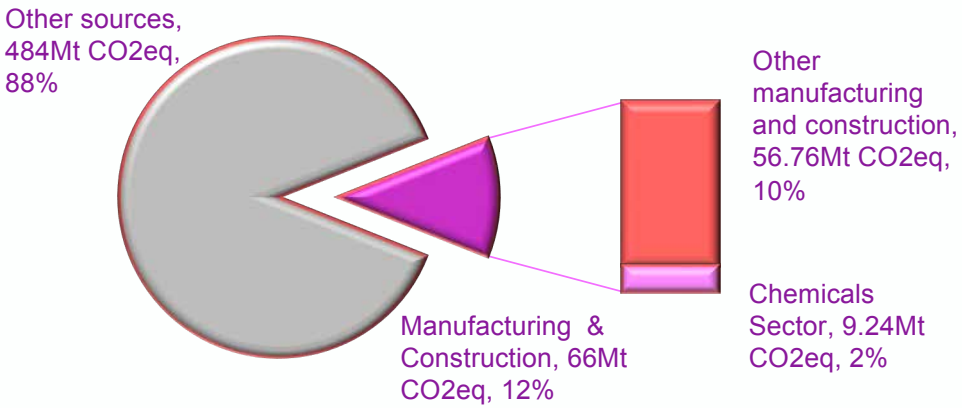
Circular Economy Opportunities: Why Transform Industrial Waste Gases (CO/CO2) to Chemicals?

What is the UK opportunity?

2018 UK emissions Mt CO2eq



Source: Climate Change Committee (Dec, 2020)

- In 2018 it was estimated that 66MtCO2eq (12%) of direct UK greenhouse gas (GHG) emissions were from manufacturing and construction. While direct GHG emissions from the chemical sector were 9.42CO2eq (14%) (3)

£ 11bn GVA

Source: Climate Office of National Statistics (June,2020)

- In 2020 the manufacture of chemicals and chemical products for the UK generated a turnover of approximately £32 bn and a GVA of approximately £11bn.(4)

(3) Climate Change Committee. (2020, Dec). The Sixth Carbon Budget: Manufacturing and construction. Retrieved from Climate Change Committee: https://www.theccc.org.uk/publication/sixth-carbon-budget/

(4) Office for National Statistics. (2022, June 16). Non-financial business economy, UK: Sections A to S. Retrieved Jan 2023, from Office for National Statistics: https://www.ons.gov.uk/ businessindustryandtrade/business/businessservices/datasets/ uknonfinancialbusinesseconomyannualbusinesssurveysectionsas

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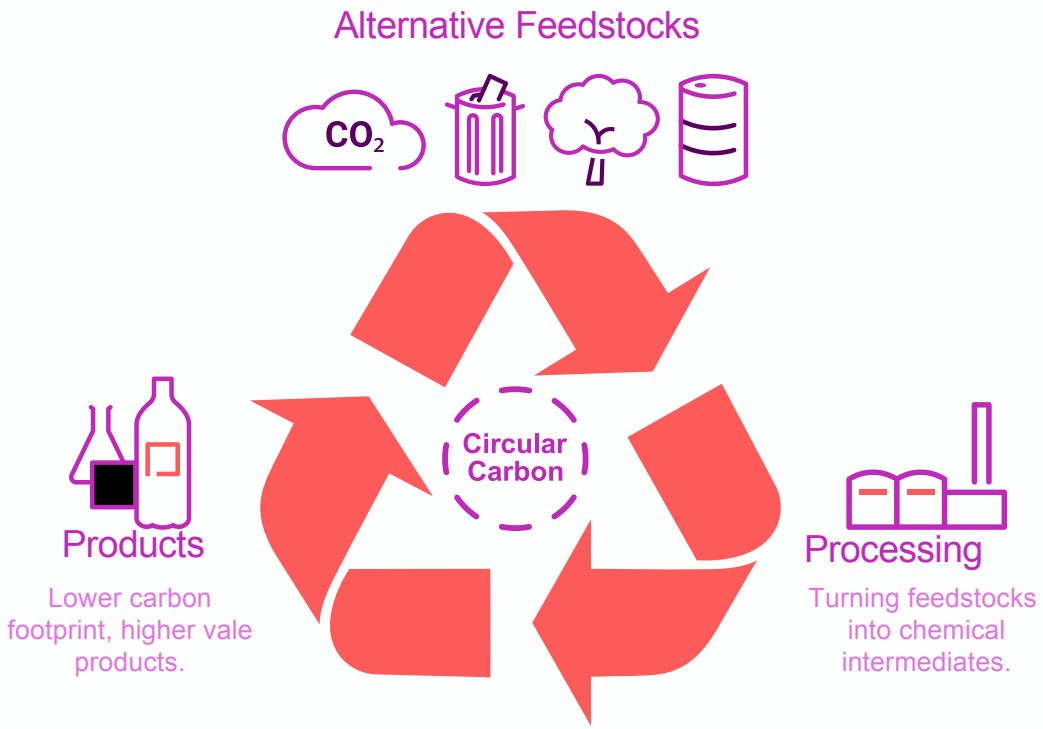
Circular Economy Opportunities: Why Transform Industrial Waste Gases (CO/CO2) to Chemicals?

Moving toward a more circular carbon future



- UK chemical industries have a pivotal role in achieving net zero and a circular economy.
- Using industrial waste gases as an alternative feedstock can help meet our demand for carbon and lower scope 1, 2 and 3 emissions across the supply chain
- Innovate UK Circular Economy Innovation Network established the ‘transforming industrial waste gases to chemicals challenge to:
  - Develop a community action plan (covering from source to final product)
  - Establish challenges using the Innovate UK KTN collaboration exchange pilot programme

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Action Plan: Our Vision and Aim

"We must find ways of establishing UK manufacturing supply chains that produce products, without having a negative impact on our environment yet meet the demands of an increasing and ageing population."

Vision:

Our vision is to capture industrial waste gases (CO/CO2) to be used in the manufacture of higher-value chemicals, leading the UK towards a circular carbon future that reduces our reliance on virgin fossil-based carbon feedstocks.

Aim:

We aim to create a chemical sector and associated supply chains that can thrive in a circular Net Zero world. This will benefit society through the employment of skilled scientists and engineers in high-value jobs, producing low carbon footprint products for local and global markets.

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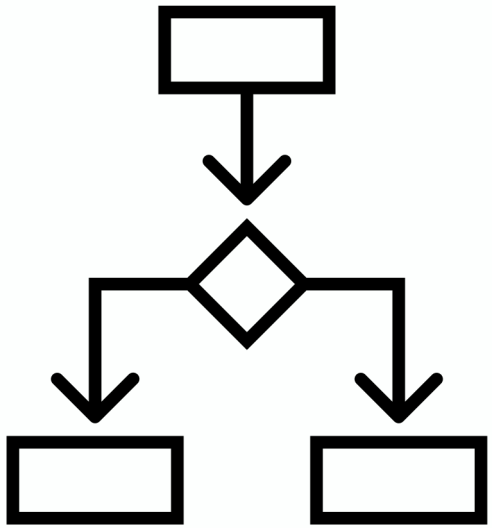
Anticipated Action Plan Outcomes

- Development of a clear, consistent and concise narrative capable of conveying:
  - The value of the chemicals supply chain to the UK and its role in achieving net zero.
  - The rationale and urgent need to diversify away from virgin petrochemicals and create new supply chains for the production of chemicals from alternative feedstocks, including waste gases.
  - Why the UK is the right environmental and economic investment choice for manufacturing chemicals from industrial waste gases
  - The key target opportunities for existing and emerging technologies to benefit the chemicals and associated supply chains in the UK.
- Roadmaps and timelines for the various technologies and supply chains.
- A policy and regulatory environment that recognises the opportunity for using carbon capture and utilisation for the manufacture of chemicals
- Key exemplars of precompetitive collaborative value chain projects using Innovate UK KTN Collaboration Exchange.



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Designing for Circularity

Understanding the products we use, how they're made,
what they're made from, and how the end of life can be facilitated

Action

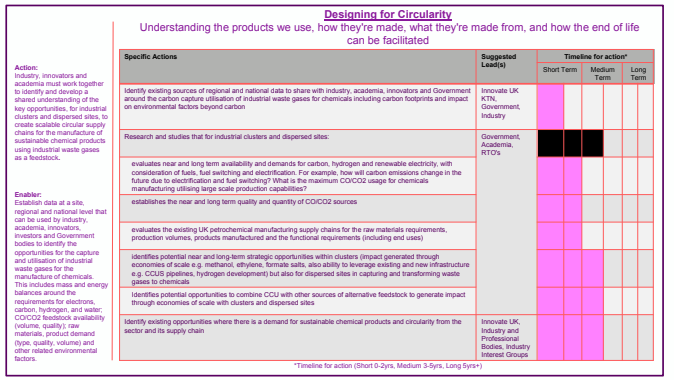
- Identify and develop an understanding of the key opportunities to create scalable circular supply chains.

Enabler

- Establishing data at that can be used to identify the opportunities

Specific Actions

- Identify existing sources of carbon footprint data
- Research and studies for industrial clusters and dispersed sites covering:
  - feedstocks (e.g. Carbon, CO2, H2) and electricity availability
  - the existing UK petrochemical manufacturing supply chains
  - strategic opportunities within clusters and for dispersed sites
  - opportunities to combine CCU with other alternative feedstock
- Identify demand led opportunities for sustainable chemicals



Designing for Circularity

Understanding the products we use, how they're made, what they're made from, and how the end of life can be facilitated

Action: Industry, innovators and academia must work together to identify and develop a shared understanding of the key opportunities, for industrial clusters and dispersed sites, to create scalable circular supply chains for the manufacture of sustainable chemical products using industrial waste gases as a feedstock.

Enabler: Establish data at a site, regional and national level that can be used by industry, academia, innovators, investors and Government bodies to identify the opportunities for the capture and utilisation of industrial waste gases for the manufacture of chemicals. This includes mass and energy balances around the requirements for electrons, carbon, hydrogen, and water; CO/CO2 feedstock availability (volume, quality); raw materials, product demand (type, quality, volume) and other related environmental factors.

Specific Actions	Suggested Lead(s)	Timeline for action*		
		Short Term	Medium Term	Long Term
Identify existing sources of regional and national data to share with industry, academia, innovators and Government around the carbon capture utilisation of industrial waste gases for chemicals including carbon footprints and impact on environmental factors beyond carbon	Innovate UK KTN, Government, Industry			
Research and studies that for industrial clusters and dispersed sites:	Government, Academia, RTO's			
evaluates near and long term availability and demands for carbon, hydrogen and renewable electricity, with consideration of fuels, fuel switching and electrification. For example, how will carbon emissions change in the future due to electrification and fuel switching? What is the maximum CO/CO2 usage for chemicals manufacturing utilising large scale production capabilities?				
establishes the near and long term quality and quantity of CO/CO2 sources				
evaluates the existing UK petrochemical manufacturing supply chains for the raw materials requirements, production volumes, products manufactured and the functional requirements (including end uses)				
identifies potential near and long-term strategic opportunities within clusters (impact generated through economies of scale e.g. methanol, ethylene, formate salts, also ability to leverage existing and new infrastructure e.g. CCUS pipelines, hydrogen development) but also for dispersed sites in capturing and transforming waste gases to chemicals				
identifies potential opportunities to combine CCU with other sources of alternative feedstock to generate impact through economies of scale with clusters and dispersed sites				
Identify existing opportunities where there is a demand for sustainable chemical products and circularity from the sector and its supply chain	Innovate UK, Industry and Professional Bodies, Industry Interest Groups			

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

Innovate UK KTN

Circular Business Models

Defining and creating the business models that can deliver value

Action

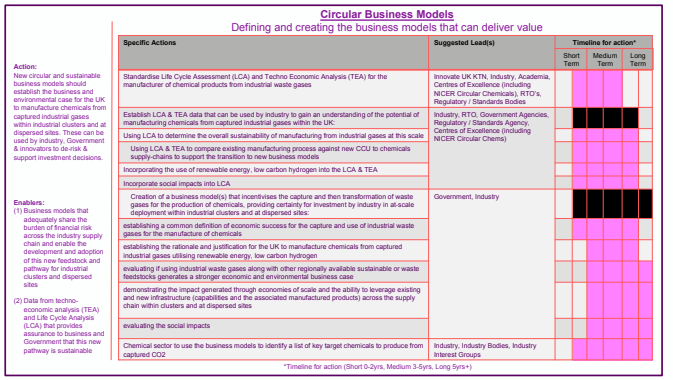
- Generate new circular and sustainable business models that should establish the business and environmental case for manufacturing in the UK

Enablers

- Business models across the supply chain
- Techno-economic analysis (TEA) and Life Cycle Analysis (LCA)

Specific Actions

- Standardise Life Cycle Assessment (LCA) and Techno Economic Analysis (TEA)
- Establish LCA & TEA data that
  - incorporates renewable energy, hydrogen and other related supply chains
  - accounts for other social impacts
- Creation of a new business model(s):
  - establishing a common definition of economic success
  - establish the rationale and justification for manufacturing in the UK
- Use the business models to identify a list of key target chemicals



Circular Business Models

Defining and creating the business models that can deliver value

Action: New circular and sustainable business models should establish the business and environmental case for the UK to manufacture chemicals from captured industrial gases within industrial clusters and at dispersed sites. These can be used by industry, Government & innovators to de-risk & support investment decisions.

Enablers:
(1) Business models that adequately share the burden of financial risk across the industry supply chain and enable the development and adoption of this new feedstock and pathway for industrial clusters and dispersed sites

(2) Data from techno-economic analysis (TEA) and Life Cycle Analysis (LCA) that provides assurance to business and Government that this new pathway is sustainable

Specific Actions	Suggested Lead(s)	Timeline for action*		
		Short Term	Medium Term	Long Term
Standardise Life Cycle Assessment (LCA) and Techno Economic Analysis (TEA) for the manufacturer of chemical products from industrial waste gases	Innovate UK KTN, Industry, Academia, Centres of Excellence (including NICER Circular Chemicals), RTO's, Regulatory / Standards Bodies			
Establish LCA & TEA data that can be used by industry to gain an understanding of the potential of manufacturing chemicals from captured industrial gases within the UK	Industry, RTO, Government Agencies, Regulatory / Standards Agency, Centres of Excellence (including NICER Circular Chems)			
Using LCA to determine the overall sustainability of manufacturing from industrial gases at this scale				
Using LCA & TEA to compare existing manufacturing process against new CCU to chemicals supply-chains to support the transition to new business models				
Incorporating the use of renewable energy, low carbon hydrogen into the LCA & TEA				
Incorporate social impacts into LCA				
Creation of a business model(s) that incentivises the capture and then transformation of waste gases for the production of chemicals, providing certainty for investment by industry in at-scale deployment within industrial clusters and at dispersed sites:	Government, Industry			
establishing a common definition of economic success for the capture and use of industrial waste gases for the manufacture of chemicals				
establishing the rationale and justification for the UK to manufacture chemicals from captured industrial gases utilising renewable energy, low carbon hydrogen				
evaluating if using industrial waste gases along with other regionally available sustainable or waste feedstocks generates a stronger economic and environmental business case				
demonstrating the impact generated through economies of scale and the ability to leverage existing and new infrastructure (capabilities and the associated manufactured products) across the supply chain within clusters and at dispersed sites				
evaluating the social impacts				
Chemical sector to use the business models to identify a list of key target chemicals to produce from captured CO2	Industry, Industry Bodies, Industry Interest Groups			

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

UKRI Innovate UK KTN

Circular Recovery

Retaining and recovering value from materials and products
Capturing industrial waste gas emissions

Action

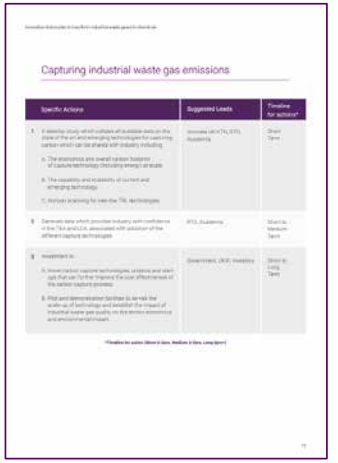
- Industries to determine the economic, technical and environmental capabilities of existing and new carbon capture technologies

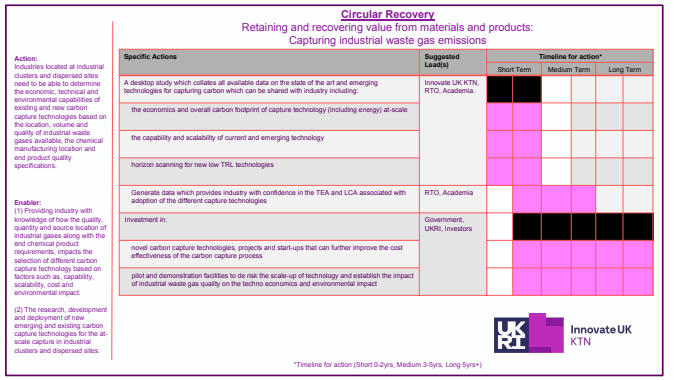
Enablers

- Providing industry with knowledge of the factors that impact the selection of different carbon capture technology
- The research, development and deployment of new emerging and existing carbon capture technologies for at-scale capture

Specific Actions

- Desktop study on the state of the art and emerging technologies
- Generate data to provide confidence in the TEA and LCA
- Investment in:
  - pilot and demonstration facilities to de risk the scale-up of technology
  - novel carbon capture technologies, projects and start-ups





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Circular Recovery

Retaining and recovering value from materials and products

Innovation and investment in chemical manufacture from captured waste gases

- **Action**

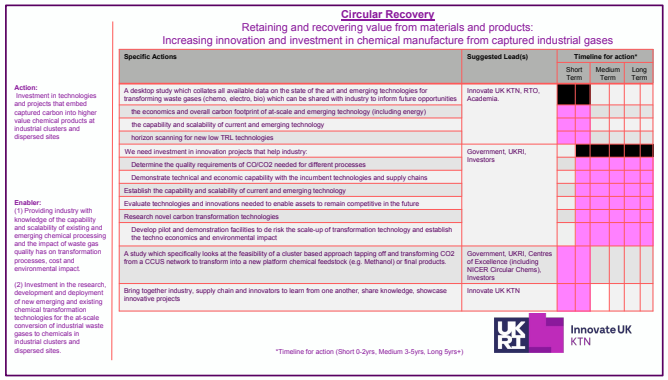
- Investment in technologies and projects that embed captured carbon into higher value chemical products at industrial clusters and dispersed sites

Enablers

- Providing industry with knowledge of the capability and scalability of existing and emerging chemical transformation technology.
- Investment in the research, development and deployment of new emerging and existing chemical transformation technologies for the at-scale.

Specific Actions

- Desktop study on the state of the art and emerging technologies
- Investment in innovation projects that help industry:
  - Establish the capability and scalability of current and emerging technology
  - Research novel carbon transformation technologies
  - Develop pilot and demonstration facilities to de risk scale-up
- A feasibility study into using CO2 from a CCS network
- Ongoing community activities



UKRI Innovate UK KTN

Government Framework for Circularity

Stimulating the transition to a UK circular carbon economy

Action

To create a policy, regulatory and standards environment that drives behavioural change and long term invest attractive.

Enablers

- Policy and regulatory mechanisms that encourage the move towards a circular economy and the utilisation of ‘waste’ carbon feedstocks
- Developing new standards for LCA, TEA, waste carbon and the chemicals products manufactured.

Specific Actions

- Produce a summary of the current policy and regulation landscape
- Build a case for policy and regulation changes
- Define and develop standards for
  - carbon emissions and carbon accounting throughout the value chain
  - for chemical products made from waste gases
  - TEA & LCA
- Develop the strategic case for the Government investment in CAPEX projects
- Establish a virtual circular economy policy centre

Government Framework for circularity:
Stimulating the transition to a UK circular carbon economy

Action: Industry needs a policy, regulatory and standards environment that drives behavioural change and makes the utilisation of industrial waste gases to chemicals an attractive long-term investment

Enabler: (1) Policy and regulatory mechanisms that encourage the move towards a circular economy and the opportunity to utilise ‘waste’ carbon feedstocks to displace virgin petrochemicals

(2) Developing new standards for LCA, TEA, waste carbon and the chemicals products manufactured

Specific Actions	Suggested Lead(s)	Timeline for action*		
		Short Term	Medium Term	Long Term
A summary of the current policy and regulation landscape and the challenges / opportunities	Innovate UK KTN, UKRI Centre of Excellence (NICER)			
Build a case for policy and regulation changes in key areas that are required to enable the chemical sector and its supply chain to invest	Industry and Professional Bodies, Trade Associations			
Define and develop standards for	Regulatory / Standards Bodies			
carbon emissions and carbon accounting throughout the value chain including a framework for measurement and traceability				
Development of a standards for chemical products made from waste gases				
TEA & LCA				
Develop the strategic case for the Government investment in CAPEX intensive projects	Industry Bodies, Industry, RTO’s			
Establish a virtual circular economy policy centre that can provide fast responses to government requests for policy input and evidence.	Industry Bodies, Centres of Excellence (including NICER Circular Chems)			

Innovate UK KTN

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

UKRI Innovate UK KTN

Looking Ahead

Transforming Industrial Waste Gases to Chemicals Action Plan: Next Steps 2023/24

- We will continue to champion the move towards a circular carbon future and will engage with the community and facilitate the delivery of the action plan by
    - acting upon the actions KTN can lead on or support
    - generating active support/leadership for other actions
- Strategically we want to develop of deployment projects within clusters and support the development of new technology for dispersed sites
- Establishing more challenges using the Innovate UK KTN collaboration exchange pilot programme
- If you can contribute this challenge and the action plan then please get in touch

Join the Innovate UK KTN Circular Economy Innovation Network

https://info.ktn-uk.org/p/2VFU-COI/circular-economy-innovation-network

UKRI Innovate UK KTN

We connect **innovators, funders and collaborators** to transform ideas into solutions

Our **Collaboration Exchange (cX)** pilot programme builds multi-partner collaborations between industry, SMEs and/or academics addressing a specific industrial challenge.

We are looking to work with companies who want to develop solutions and require new partners!

Our unique cross-sector approach connects businesses with opportunities beyond their existing thinking.

Collaboration exchange builds upon KTN's successful **Innovation Exchange (iX)** platform which connects companies with specific technical challenges to innovators who are already working on the solutions.

Do you have a chemicals or industrial biotechnology challenge that we can help you with?

UKRI Innovate UK KTN

Thank you for your time, input and support

Contact us if you would like to discuss further

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Dana Heldt Dana.Heldt@iuk.ktn-uk.org

Sign up to our newsletter in www.ktn-uk.org

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Additional Action Plan Information

www.ktn-uk.org

Designing for Circularity

Understanding the products we use, how they're made, what they're made from, and how the end of life can be facilitated

Action:
Industry, innovators and academia must work together to identify and develop a shared understanding of the key opportunities, for industrial clusters and dispersed sites, to create scalable circular supply chains for the manufacture of sustainable chemical products using industrial waste gases as a feedstock.

Enabler:
Establish data at a site, regional and national level that can be used by industry, academia, innovators, investors and Government bodies to identify the opportunities for the capture and utilisation of industrial waste gases for the manufacture of chemicals. This includes mass and energy balances around the requirements for electrons, carbon, hydrogen, and water; CO/CO2 feedstock availability (volume, quality); raw materials, product demand (type, quality, volume) and other related environmental factors.

Specific Actions	Suggested Lead(s)	Timeline for action*					
		Short Term		Medium Term		Long Term	
Identify existing sources of regional and national data to share with industry, academia, innovators and Government around the carbon capture utilisation of industrial waste gases for chemicals including carbon footprints and impact on environmental factors beyond carbon	Innovate UK KTN, Government, Industry						
Research and studies that for industrial clusters and dispersed sites:	Government, Academia, RTO's						
evaluates near and long term availability and demands for carbon, hydrogen and renewable electricity, with consideration of fuels, fuel switching and electrification. For example, how will carbon emissions change in the future due to electrification and fuel switching? What is the maximum CO/CO2 usage for chemicals manufacturing utilising large scale production capabilities?							
establishes the near and long term quality and quantity of CO/CO2 sources							
evaluates the existing UK petrochemical manufacturing supply chains for the raw materials requirements, production volumes, products manufactured and the functional requirements (including end uses)							
identifies potential near and long-term strategic opportunities within clusters (impact generated through economies of scale e.g. methanol, ethylene, formate salts, also ability to leverage existing and new infrastructure e.g. CCUS pipelines, hydrogen development) but also for dispersed sites in capturing and transforming waste gases to chemicals							
Identifies potential opportunities to combine CCU with other sources of alternative feedstock to generate impact through economies of scale with clusters and dispersed sites							
Identify existing opportunities where there is a demand for sustainable chemical products and circularity from the sector and its supply chain	Innovate UK, Industry and Professional Bodies, Industry Interest Groups						

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

Circular Business Models

Defining and creating the business models that can deliver value

Action:
New circular and sustainable business models should establish the business and environmental case for the UK to manufacture chemicals from captured industrial gases within industrial clusters and at dispersed sites. These can be used by industry, Government & innovators to de-risk & support investment decisions.

Enablers:
(1) Business models that adequately share the burden of financial risk across the industry supply chain and enable the development and adoption of this new feedstock and pathway for industrial clusters and dispersed sites

(2) Data from techno-economic analysis (TEA) and Life Cycle Analysis (LCA) that provides assurance to business and Government that this new pathway is sustainable

Specific Actions	Suggested Lead(s)	Timeline for action*
		Short Term / Medium Term / Long Term
Standardise Life Cycle Assessment (LCA) and Techno Economic Analysis (TEA) for the manufacturer of chemical products from industrial waste gases	Innovate UK KTN, Industry, Academia, Centres of Excellence (including NICER Circular Chemicals), RTO's, Regulatory / Standards Bodies	
Establish LCA & TEA data that can be used by industry to gain an understanding of the potential of manufacturing chemicals from captured industrial gases within the UK:	Industry, RTO, Government Agencies, Regulatory / Standards Agency, Centres of Excellence (including NICER Circular Chems)	
Using LCA to determine the overall sustainability of manufacturing from industrial gases at this scale		
Using LCA & TEA to compare existing manufacturing process against new CCU to chemicals supply-chains to support the transition to new business models		
Incorporating the use of renewable energy, low carbon hydrogen into the LCA & TEA		
Incorporate social impacts into LCA		
Creation of a business model(s) that incentivises the capture and then transformation of waste gases for the production of chemicals, providing certainty for investment by industry in at-scale deployment within industrial clusters and at dispersed sites:	Government, Industry	
establishing a common definition of economic success for the capture and use of industrial waste gases for the manufacture of chemicals		
establishing the rationale and justification for the UK to manufacture chemicals from captured industrial gases utilising renewable energy, low carbon hydrogen		
evaluating if using industrial waste gases along with other regionally available sustainable or waste feedstocks generates a stronger economic and environmental business case		
demonstrating the impact generated through economies of scale and the ability to leverage existing and new infrastructure (capabilities and the associated manufactured products) across the supply chain within clusters and at dispersed sites		
evaluating the social impacts		
Chemical sector to use the business models to identify a list of key target chemicals to produce from captured CO_2	Industry, Industry Bodies, Industry Interest Groups	

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

Circular Recovery

Retaining and recovering value from materials and products: Capturing industrial waste gas emissions

Action:
Industries located at industrial clusters and dispersed sites need to be able to determine the economic, technical and environmental capabilities of existing and new carbon capture technologies based on the location, volume and quality of industrial waste gases available, the chemical manufacturing location and end product quality specifications.

Enabler:
(1) Providing industry with knowledge of how the quality, quantity and source location of industrial gases along with the end chemical product requirements, impacts the selection of different carbon capture technology based on factors such as, capability, scalability, cost and environmental impact.

(2) The research, development and deployment of new emerging and existing carbon capture technologies for the at-scale capture in industrial clusters and dispersed sites.

Specific Actions	Suggested Lead(s)	Timeline for action*					
		Short Term		Medium Term		Long Term	
A desktop study which collates all available data on the state of the art and emerging technologies for capturing carbon which can be shared with industry including:	Innovate UK KTN, RTO, Academia.						
the economics and overall carbon footprint of capture technology (including energy) at-scale							
the capability and scalability of current and emerging technology							
horizon scanning for new low TRL technologies							
Generate data which provides industry with confidence in the TEA and LCA associated with adoption of the different capture technologies	RTO, Academia						
Investment in:	Government, UKRI, Investors						
novel carbon capture technologies, projects and start-ups that can further improve the cost effectiveness of the carbon capture process							
pilot and demonstration facilities to de risk the scale-up of technology and establish the impact of industrial waste gas quality on the techno economics and environmental impact							

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*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

Circular Recovery

Retaining and recovering value from materials and products:
Increasing innovation and investment in chemical manufacture from captured industrial gases

Action:
Investment in technologies and projects that embed captured carbon into higher value chemical products at industrial clusters and dispersed sites

Enabler:
(1) Providing industry with knowledge of the capability and scalability of existing and emerging chemical processing and the impact of waste gas quality has on transformation processes, cost and environmental impact.

(2) Investment in the research, development and deployment of new emerging and existing chemical transformation technologies for the at-scale conversion of industrial waste gases to chemicals in industrial clusters and dispersed sites.

Specific Actions	Suggested Lead(s)	Timeline for action*
		Short Term / Medium Term / Long Term
A desktop study which collates all available data on the state of the art and emerging technologies for transforming waste gases (chemo, electro, bio) which can be shared with industry to inform future opportunities	Innovate UK KTN, RTO, Academia.	Short Term
the economics and overall carbon footprint of at-scale and emerging technology (including energy)		Short Term
the capability and scalability of current and emerging technology		Short Term
horizon scanning for new low TRL technologies		Short Term
We need investment in innovation projects that help industry:	Government, UKRI, Investors	Medium Term / Long Term
Determine the quality requirements of CO/CO2 needed for different processes		Short Term / Medium Term / Long Term
Demonstrate technical and economic capability with the incumbent technologies and supply chains		Short Term / Medium Term / Long Term
Establish the capability and scalability of current and emerging technology		Short Term / Medium Term / Long Term
Evaluate technologies and innovations needed to enable assets to remain competitive in the future		Short Term / Medium Term / Long Term
Research novel carbon transformation technologies		Short Term / Medium Term / Long Term
Develop pilot and demonstration facilities to de risk the scale-up of transformation technology and establish the techno economics and environmental impact		Short Term / Medium Term / Long Term
A study which specifically looks at the feasibility of a cluster based approach tapping off and transforming CO2 from a CCUS network to transform into a new platform chemical feedstock (e.g. Methanol) or final products.	Government, UKRI, Centres of Excellence (including NICER Circular Chems), Investors	Short Term / Medium Term
Bring together industry, supply chain and innovators to learn from one another, share knowledge, showcase innovative projects	Innovate UK KTN	Short Term

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

UKRI Innovate UK KTN

Government Framework for circularity:
Stimulating the transition to a UK circular carbon economy

Action:
Industry needs a policy, regulatory and standards environment that drives behavioural change and makes the utilisation of industrial waste gases to chemicals an attractive long-term investment

Enabler:
(1) Policy and regulatory mechanisms that encourage the move towards a circular economy and the opportunity to utilise 'waste' carbon feedstocks to displace virgin petrochemicals

(2) Developing new standards for LCA, TEA, waste carbon and the chemicals products manufactured

Specific Actions	Suggested Lead(s)	Timeline for action*					
		Short Term		Medium Term		Long Term	
A summary of the current policy and regulation landscape and the challenges / opportunities	Innovate UK KTN, UKRI Centre of Excellence (NICER)						
Build a case for policy and regulation changes in key areas that are required to enable the chemical sector and its supply chain to invest	Industry and Professional Bodies, Trade Associations						
Define and develop standards for	Regulatory / Standards Bodies						
carbon emissions and carbon accounting throughout the value chain including a framework for measurement and traceability							
Development of a standards for chemical products made from waste gases							
TEA & LCA							
Develop the strategic case for the Government investment in CAPEX intensive projects	Industry Bodies, Industry, RTO's						
Establish a virtual circular economy policy centre that can provide fast responses to government requests for policy input and evidence.	Industry Bodies, Centres of Excellence (including NICER Circular Chems)						

UKRI Innovate UK KTN

*Timeline for action (Short 0-2yrs, Medium 3-5yrs, Long 5yrs+)

Flue2CHEM

Redesigning and ***validating*** a UK value chain to ***convert industrial waste gases*** (both fossil and non-fossil) into ***sustainable materials*** for ***consumer products***.

Speaker: Add name

00 Add month 2023

AGENDA

1. Why Flue2Chem is needed?

- Setting the scene: UK Transformation

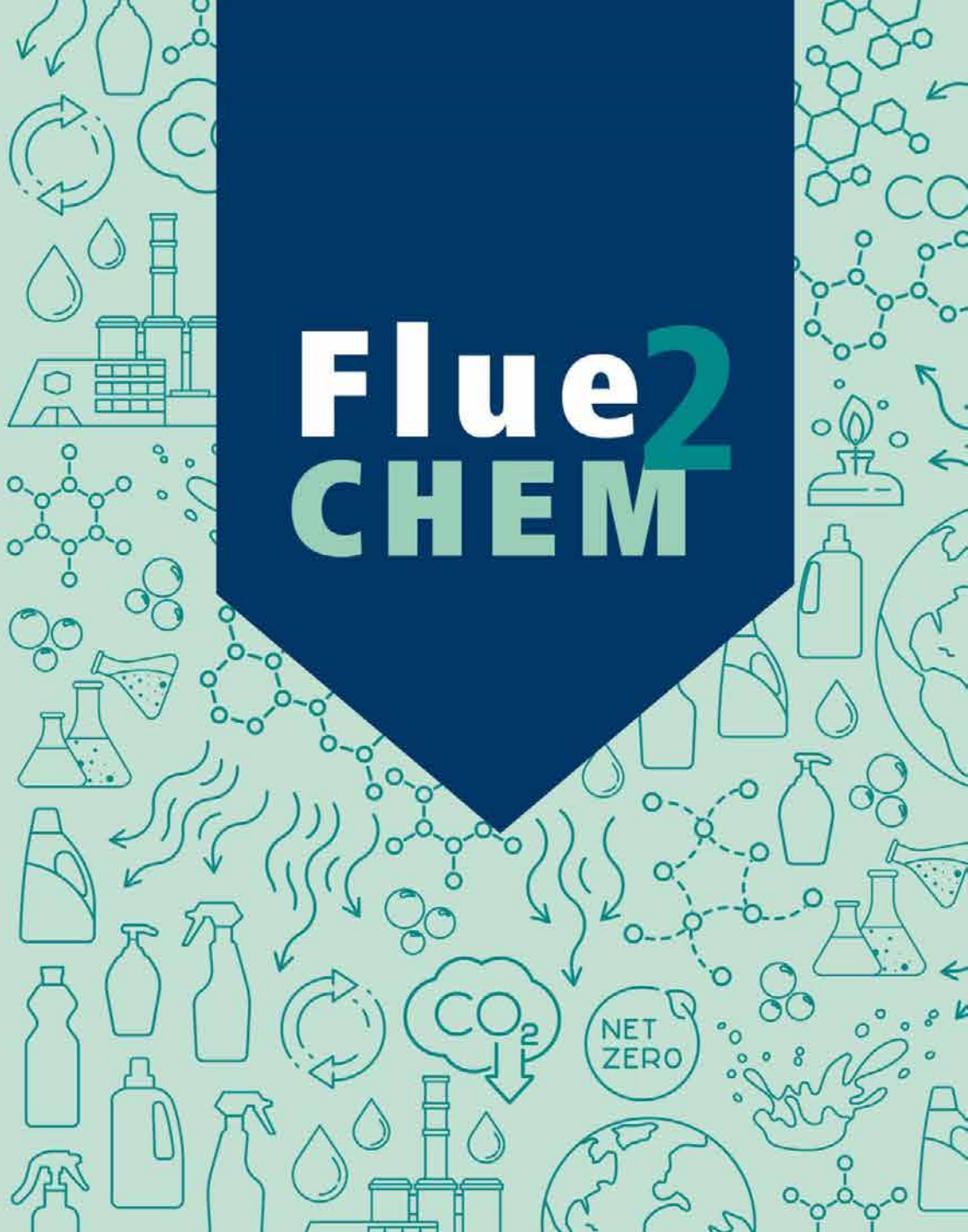
2. What Flue2Chem will do?

- Overall picture/Why alkoxylated surfactants?
- The team and their roles
- Where the money will be spent

3. Carbon flows and how to change them

4. The next steps

1 Why Flue2Chem is needed?



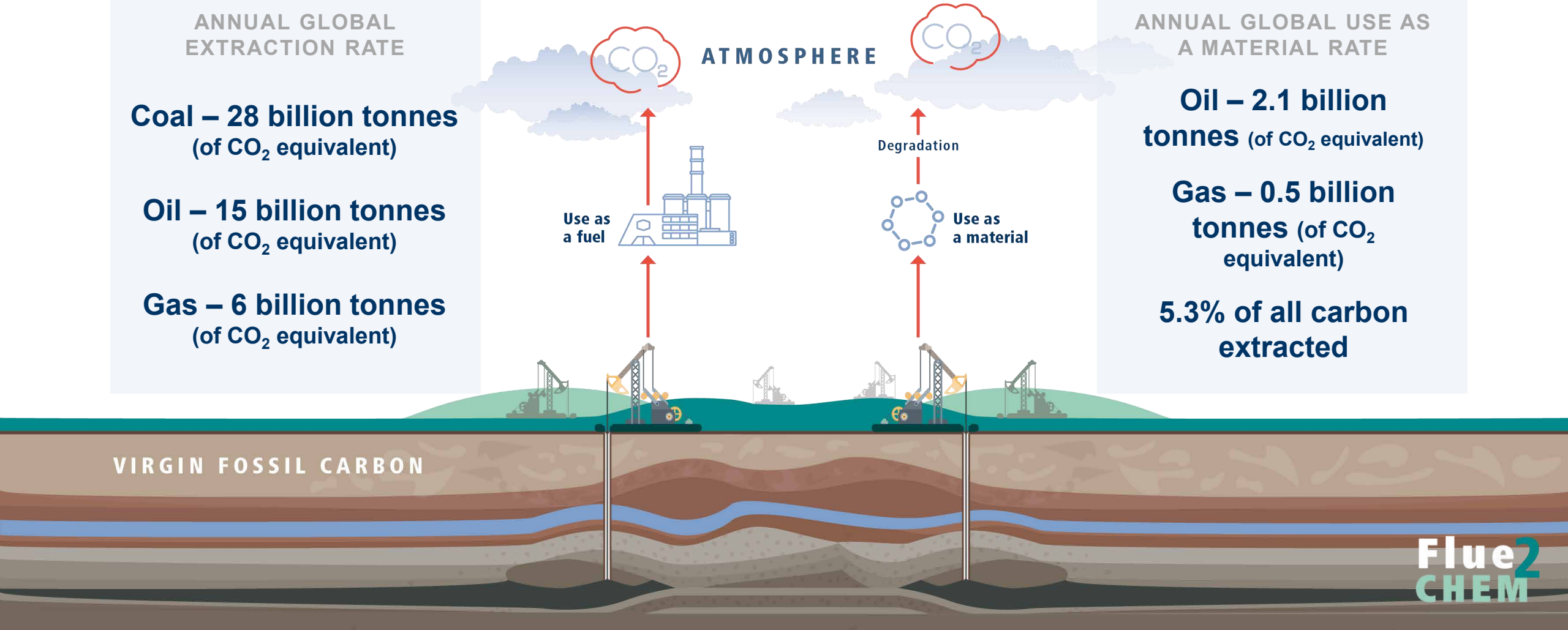
Why Flue2Chem is needed

ANNUAL GLOBAL EXTRACTION RATE

Coal – 28 billion tonnes (of CO_2 equivalent)

Oil – 15 billion tonnes (of CO_2 equivalent)

Gas – 6 billion tonnes (of CO_2 equivalent)



ANNUAL GLOBAL USE AS A MATERIAL RATE

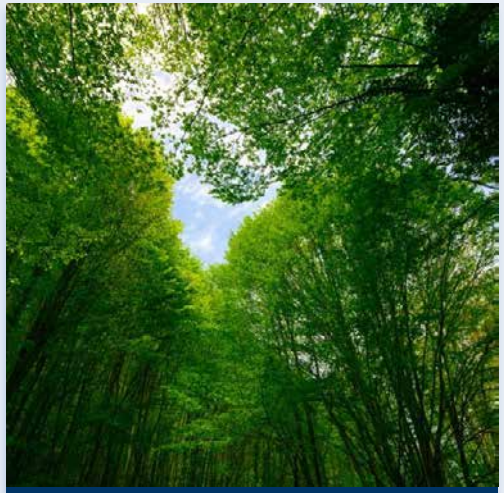
Oil – 2.1 billion tonnes (of CO_2 equivalent)

Gas – 0.5 billion tonnes (of CO_2 equivalent)

5.3% of all carbon extracted

Flue2 CHEM

1 Why Flue2Chem is needed



We will *not reach Net Zero* unless we find another source for carbon as a material

The science is well known, but the question is whether it can be made to work *at scale* and the *right cost*

The consumer market has the most *immediate driver for change*

Other uses of carbon as a feedstock (plastics, paints, adhesives, insulation, fabrics, textiles and so on) would be able to use similar supply chains to *move away from fossil carbon* in time

Flue2 CHEM

UK transformation agenda: Clean growth

INDUSTRIAL STRATEGY CHALLENGE FUND

The Industrial Strategy Challenge Fund addresses the big societal challenges being faced by UK businesses today.

It's made up of 23 challenges, covering the four themes of the government's industrial strategy:

Clean growth | Ageing society | Ffuture of mobility

Artificial intelligence | Data economy

FUNDING

£2.6 billion
public money

£3 billion
matched private sector

TRANSFORMING FOUNDATION INDUSTRIES

The foundation industries are vital to the UK manufacturing and construction sectors.

This challenge aims to transform the UK's foundation industries by:

- **Making them internationally competitive**
- **Securing more jobs throughout the UK**
- **Growing the sector by 2024 in an environmentally sustainable way**

BUDGET

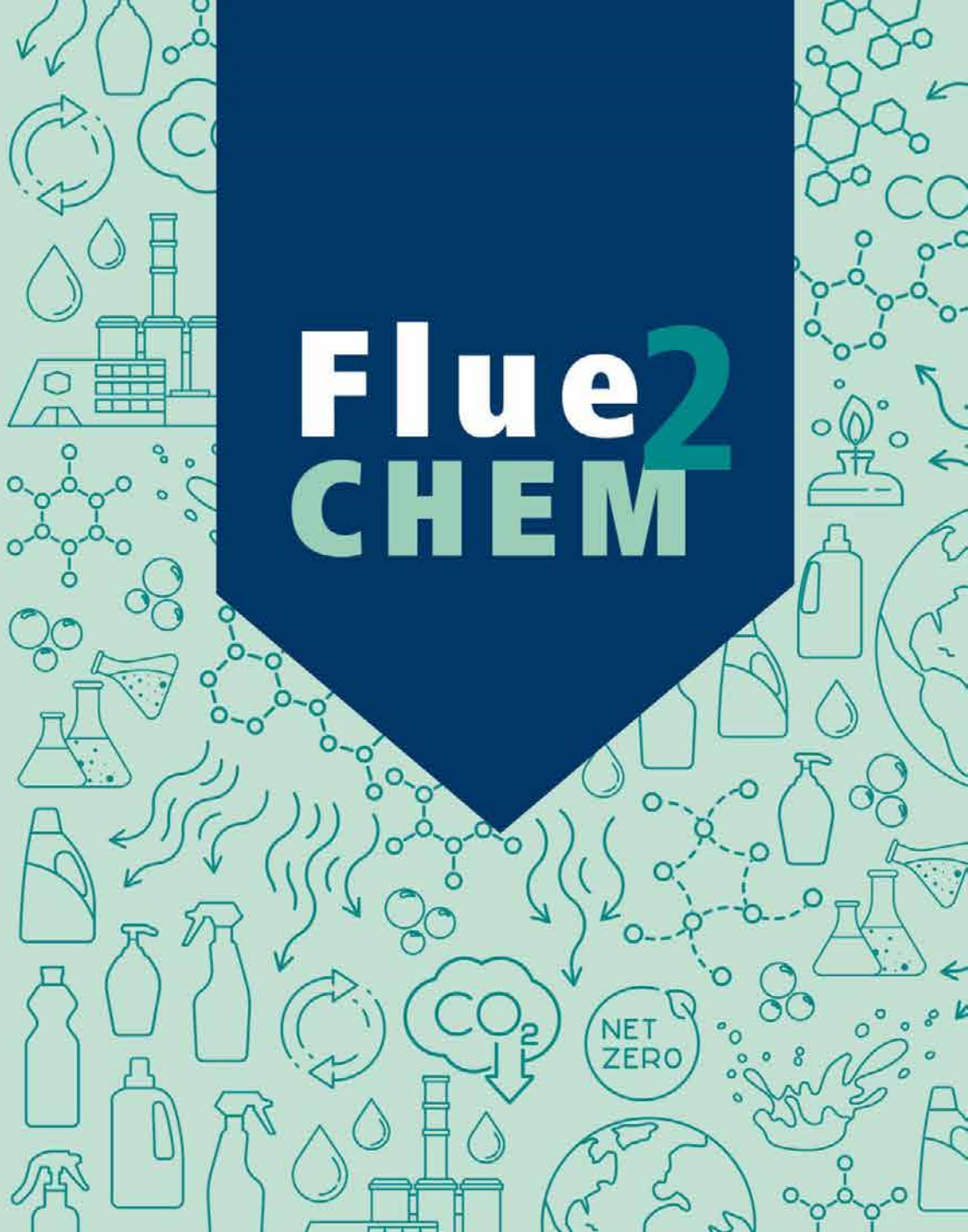
£66 billion

Duration

2020 to 2024

Flue2 CHEM

2 What Flue2Chem will do?



2 Flue2Chem: Transforming the Foundation Industries Challenge

Make sustainable materials for consumer products (Alkoxylated Surfactants) from UK emissions

Entire value chain is in scope

- Source of emissions (second use black & biogenic),
- Capture and purification of emissions,
- Conversion of CO / CO_2 to hydrocarbons and ethylene oxide,
- Manufacture and use of alkoxylated surfactants.

Consortium of 15 partners

- Evaluate the full end-to-end business & environmental impacts,
- Build the case to create a chemicals infrastructure to utilise CCU in the UK.

Start 1st December 2022: 2-year project

- Unilever lead partner
- £5.4m project, £2.7m grant

Why Alkoxylated Surfactants?

Global production > 6million T /yr and £10 billion | Wide range of consumer applications
ex Fossil Carbon – GHG increase | ex PKO – Deforestation / GHG increase
Generally imported to the UK

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2 Face to face kick-off

(SCI Office, London, 14 October)

- Team building
- Creating shared vision
- Develop project plan
- Networking
- ***Collaboration agreement!***

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SCIENCE BASED INDUSTRIES JOIN FORCES FOR FIRST TIME TO ADDRESS UK NET ZERO TARGET

METHOD

Development of a new business model and capability to utilise industrial waste gases to produce affordable feedstocks and chemicals for use in the production of consumer products in the UK.

FUNDING

£2.68 million from Innovate UK

UKRI Innovate UK

PURPOSE

The Flue2Chem project will ***convert*** **industrial waste gases** to create more ***sustainable*** **consumer products.**

GOAL

Cut **around 15-20 MILLION TONNES of carbon dioxide emissions a year and** ***help*** **the UK reach its net zero target.**

PARTNERS

Unilever, JM, SCI where science meets business, P&G, cpi, BASF We create chemistry, UPM BIOFORE BEYOND FOSSILS, TATA STEEL, carbon clean, CRODA, University of Sheffield, reckitt, UNIVERSITY OF SURREY, cpi confederation of paper industries, HOLMEN

Industry giants from ***£73 billion*** *UK sector embark on first ever cross sector collaboration to tackle decarbonisation.*

LENGTH TWO-YEAR PROGRAMME

Flue2 CHEM

Flue2 CHEM

SUPPLY CHAIN

The Confederation of Paper Industries is looking for ***wider application*** in its **sector**.

The University of Surrey is ***leading*** the **techno-economic evaluation**.

SCI® is responsible for ***dissemination*** of the **progress and outcomes**.

1. It starts with a ***source*** of **carbon dioxide**, which is currently a waste stream,

   Holmen, UPM & Tata Steel

2. **gases** are ***captured***,

   Carbon Clean & Sheffield University

3. **carbon dioxide** is ***converted*** into the **components** of an **alkoxyl surfactant**,

   BASF, Johnson Matthey, CPI & Sheffield University

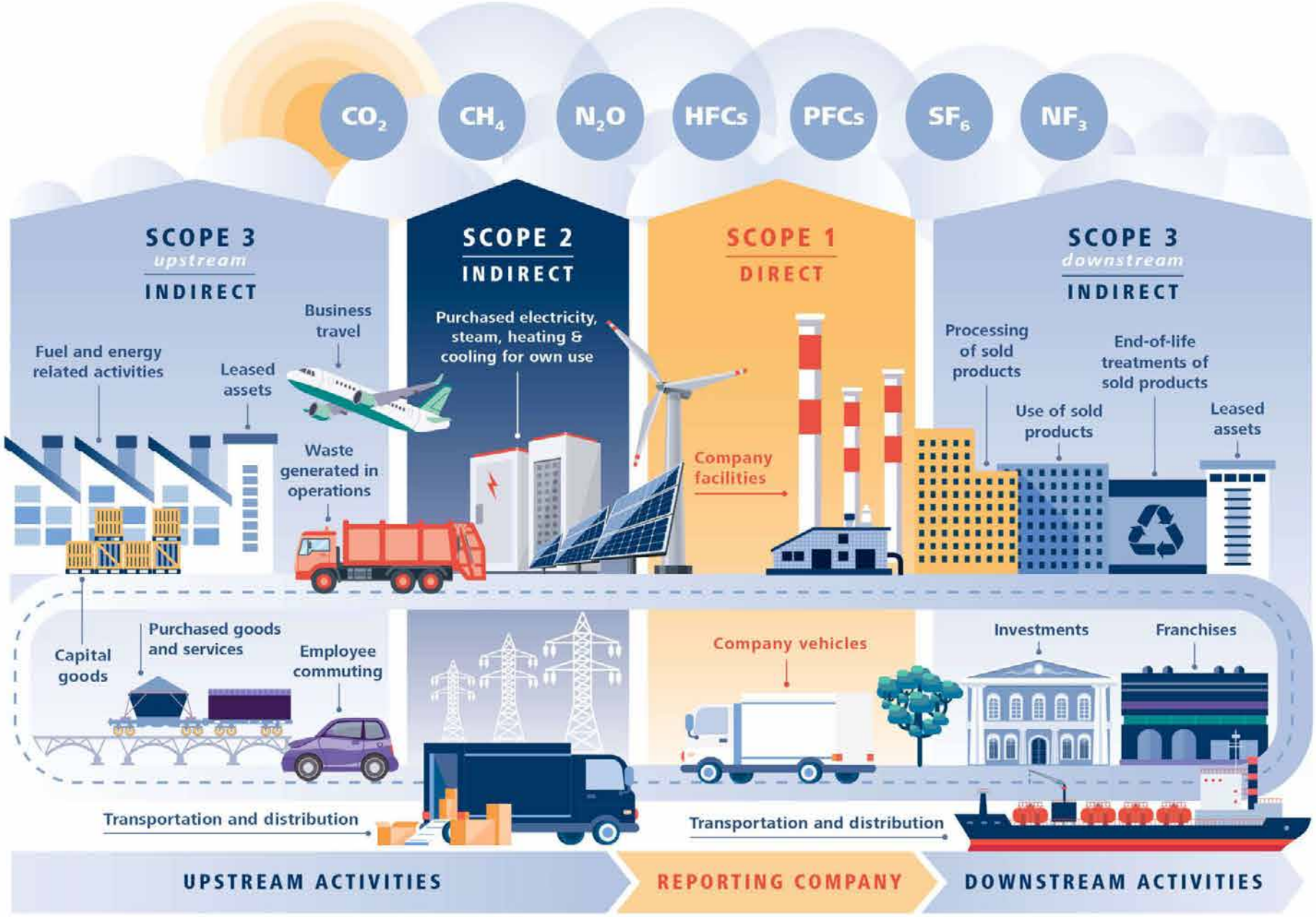
3b. the components are ***made*** into an **alkoxyl surfactant**,

   Croda

4. which is ***manufactured*** into **formulated cleaning products** and **coatings**.

   Unilever, Reckitt, P&G & Tata Steel

SCOPES OF CARBON DIOXIDE EMISSIONS



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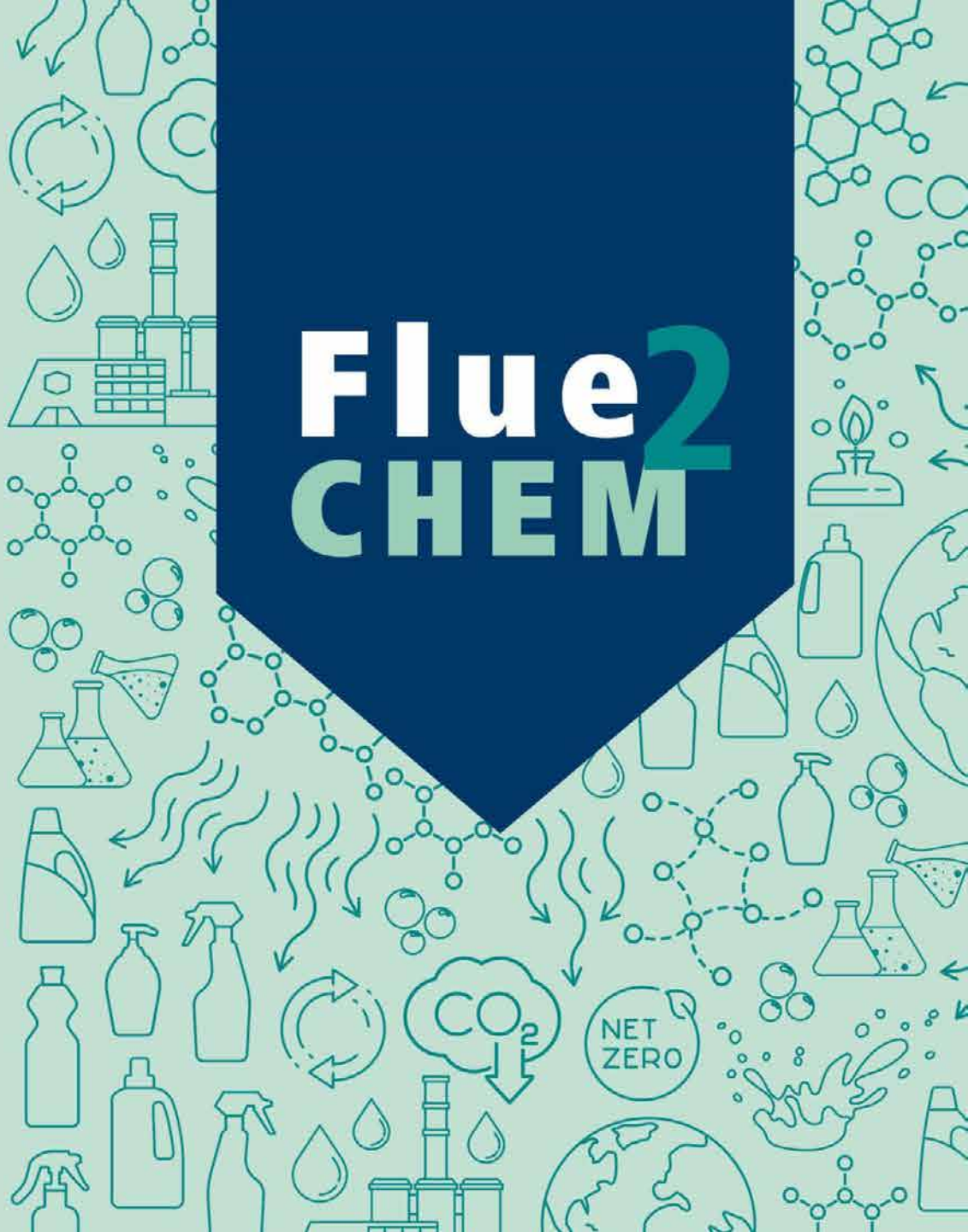
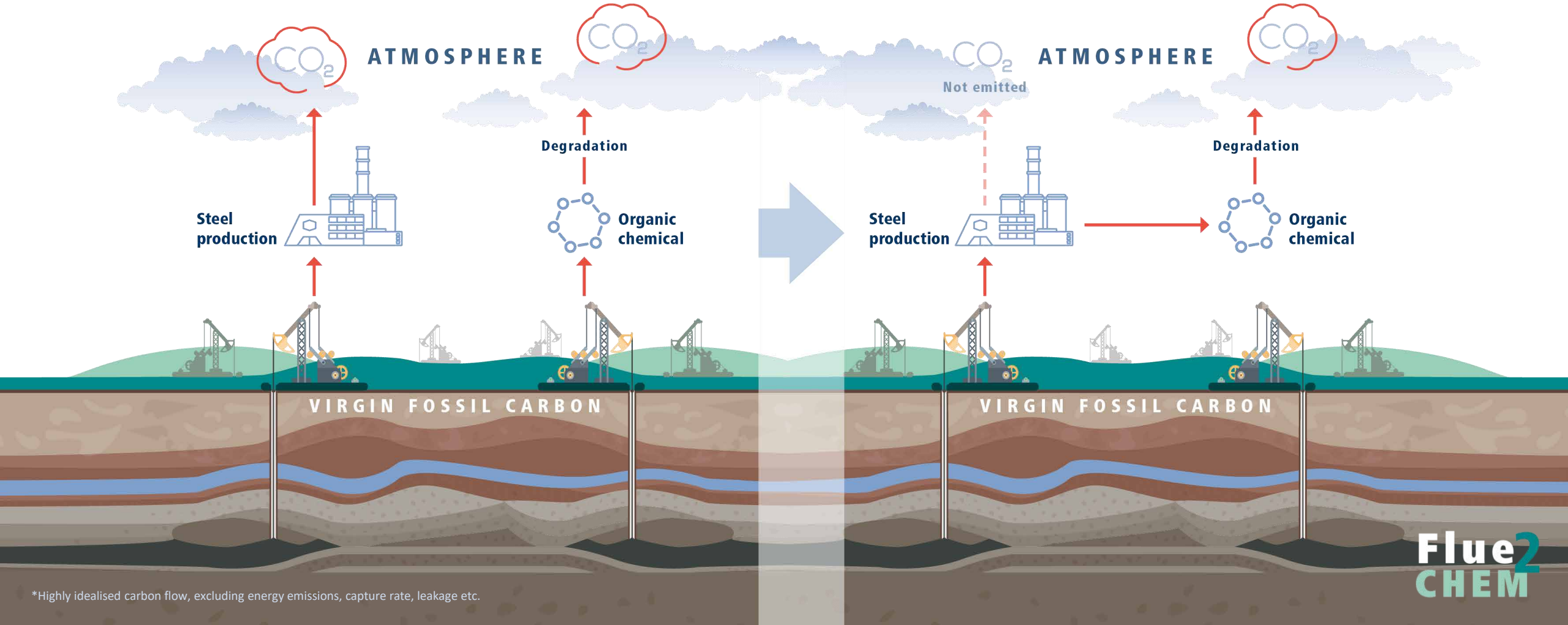
3 Carbon flows and how to change them



3 Embedded Carbon Recycling & Carbon Avoidance: Organics

Reusing point source **fossil** CO_2 emissions can lead to **emissions reduction (<50%)** of the system



*Highly idealised carbon flow, excluding energy emissions, capture rate, leakage etc.

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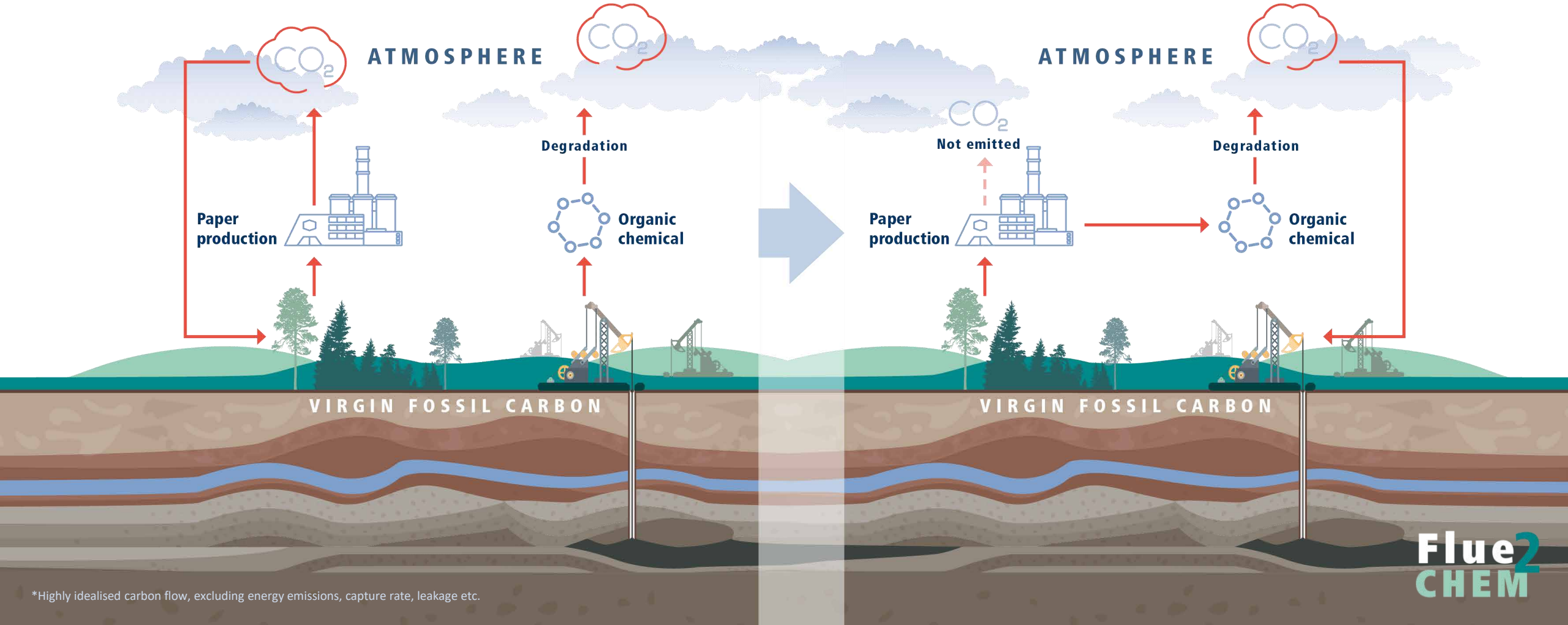
3 Embedded Carbon Recycling & Carbon Avoidance: Organics

Re-using point source **biogenic** CO_2 emissions can lead to **zero emissions** of the system



*Highly idealised carbon flow, excluding energy emissions, capture rate, leakage etc.

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3

Total GHG Impact

.....it's not just about where the carbon comes from !

TOTAL GHG =

Net Carbon Emissions on degradation + Value Chain Emissions

WHERE carbon comes from

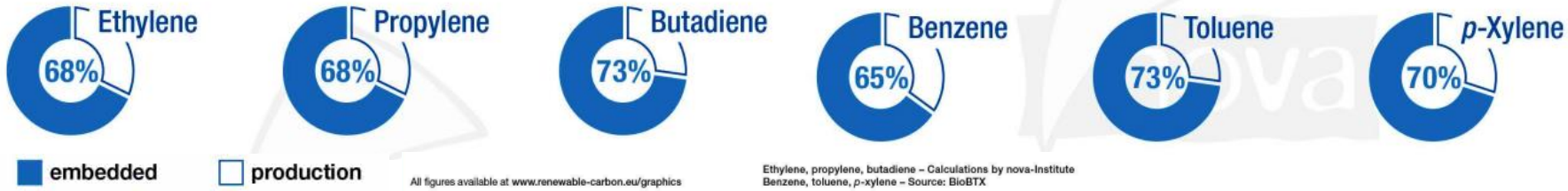
CARBON RAINBOW

HOW carbon is incorporated

SUSTAINABLE SOURCING

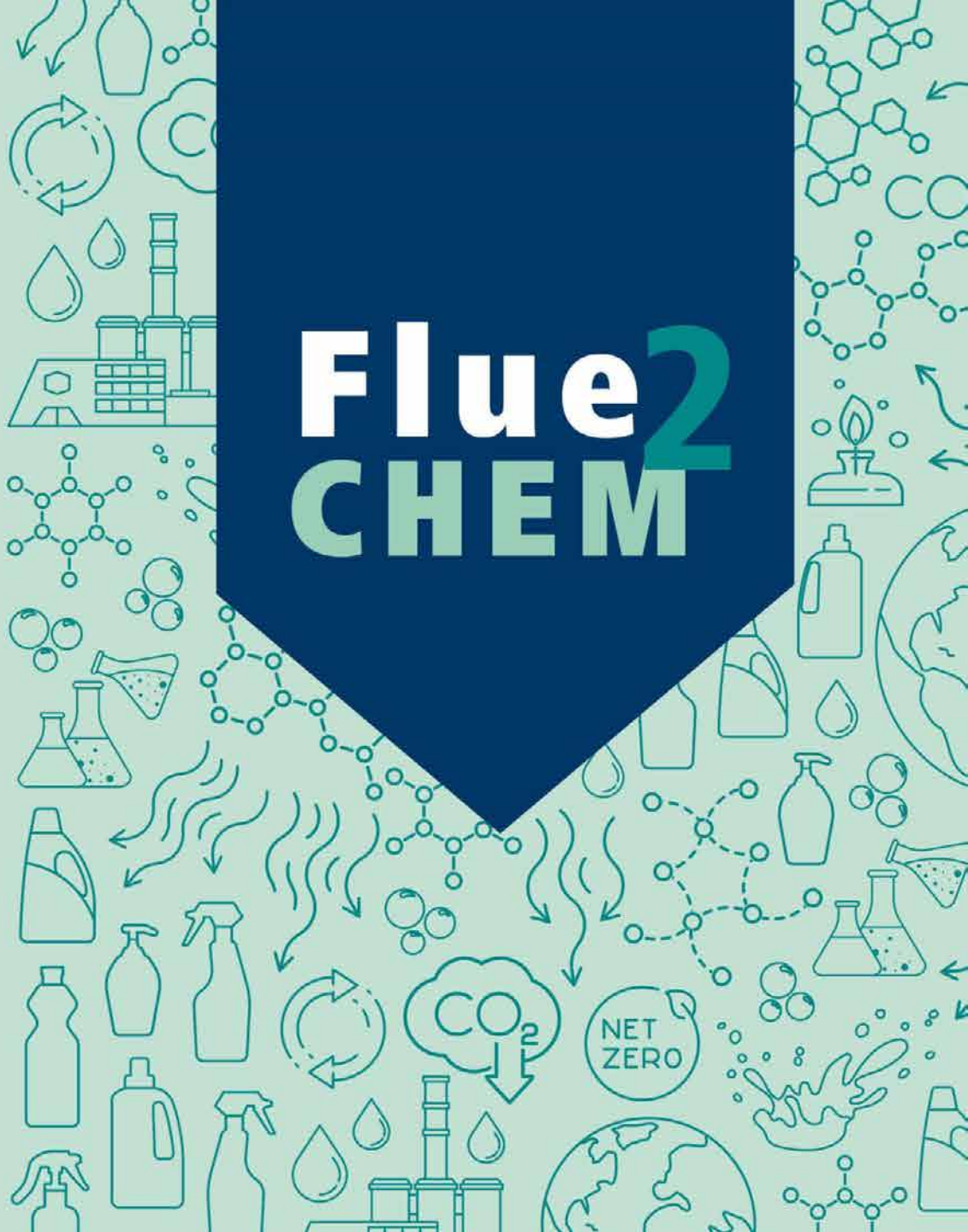
> *We must not stop using carbon but start using the right carbon that avoids adding more carbon into the atmosphere.*
>
> Michael Carus, *Nova Institute*

The invisible carbon footprint



Flue2 CHEM

4 The next steps



Flue2Chem – Next steps...

Design and build UK value chain to convert industrial waste gases (both fossil and non-fossil) into sustainable materials for consumer products.

Demonstrate that it is possible to make Alkoxylated Surfactants from waste emissions

Show it is possible to mitigate waste emissions from the Foundation Industries

Displace import of non-sustainable materials from outside of the UK

Frame interventions that will be required to make the business model work

We will use this to create the blueprint for driving change in other countries.

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THANK YOU

SCI where science meets business

Unilever

P&G

BASF We create chemistry

JM

UPM BIOFORE BEYOND FOSSILS

TATA STEEL

CRODA

reckitt

University of Sheffield

cpi

UNIVERSITY OF SURREY

cpi confederation of paper industries

HOLMEN

From CO2 to Fatty Alcohol Ethoxylate

Qiang Li

Principal scientist, Industrial Biotechnology

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Biological CO_2 assimilation pathways

- There are natural existing CO_2-fixation pathways across many kingdoms of life with various energy efficiencies.
- CO_2 can be the sole source of carbon for growth but also typically requires an energy source e.g. hydrogen, electrons or light.
- Synthetic biology plays an increasingly important role, improving the efficiency of those biological pathways.

- Typically operates at ambient temperature and pressure with smaller environmental impact, in comparison to thermo-catalysis route.
- Tolerates gas impurities from flue gases better than chemical processes, hence potentially more economically favourable by reducing the cost of purifying CO_2.
- However the reaction rate is usually slower, this is often offset by large biological reactors.

Bio-based fatty acid manufacture: challenges and solutions

Fatty acid (FA) synthesis is a fundamental part of cell metabolism and well characterised.

Produce mostly aliphatic C16-18 FA, in contrast to C12-14 fatty alcohol ethoxylate needed for surfactant and other chemical entities.

Genetic tools available to increase the titre and control the chain length of the bio-based FA.

The challenge is these genetic modifications often interfere with the native FA synthesis.

CPI will study the effects of targeted genetic mutations on FA synthesis in CO_2 utilising strains, optimise medium chain length FA production, and scale up for material generation and demonstration.

What we target : fatty alcohol ethoxylate

Fatty alcohol ethoxylate is an important commodity chemical found in a wide range of industrial applications e.g. non-ionic surfactants.

The biotechnology route of the Flue2chem project explores the opportunities of **medium chain fatty acid** production via **gas fermentation**, using **genetically modified microorganisms.**

Subsequently converting the fatty acid to **fatty alcohol** using **hydrodeoxygenation**.

Thank you

For more information visit **www.uk-cpi.com**

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Industrial waste CO_2 feeds for conversion to value-added chemicals

2nd March, 2023

Who are we?

Custom host

Custom build

Custom screen

Custom scale-up

- World leader in **Engineering Biology**
- Specialised in the **design, development and biomanufacture** of chemicals, biologics, pharmaceuticals and biofuel products
- **Successfully** delivering for our customers since 2003
- **Multidisciplinary** team
- **Proprietary technologies**
- **Flexible** collaboration and business models

Our Team

Molecular Biology

- Strain engineering via inABLE® assembly
- 20 years optimising recombinant protein expression and metabolic engineering
- Strains tailored to customer requirements free of 3rd party IP

Fermentation

- Expertise in bacterial, yeast and mammalian cell culture
- Cost-effective and scalable bioprocesses
- Comprehensive technology transfer documentation
- Bioprocess scale up and optimisation

Chemistry

- Biocatalyst screen and custom assay development
- Chemical synthesis of intermediates and metabolites
- Analytical method development
- Downstream processing and product isolation

Who are our customers?

Pharma/Consumer Goods/Ag companies outsourcing pathway optimization, enzyme evolution and protein expression for biomanufacturing and/or new product functionality

Chemical companies developing biobased chemical products for superior COGs, IP, sustainable applications

Academic groups advancing early stage research for proof-of-concept, spin-outs, funding/investment

Biobased conversion of waste gases to formate

Project objectives

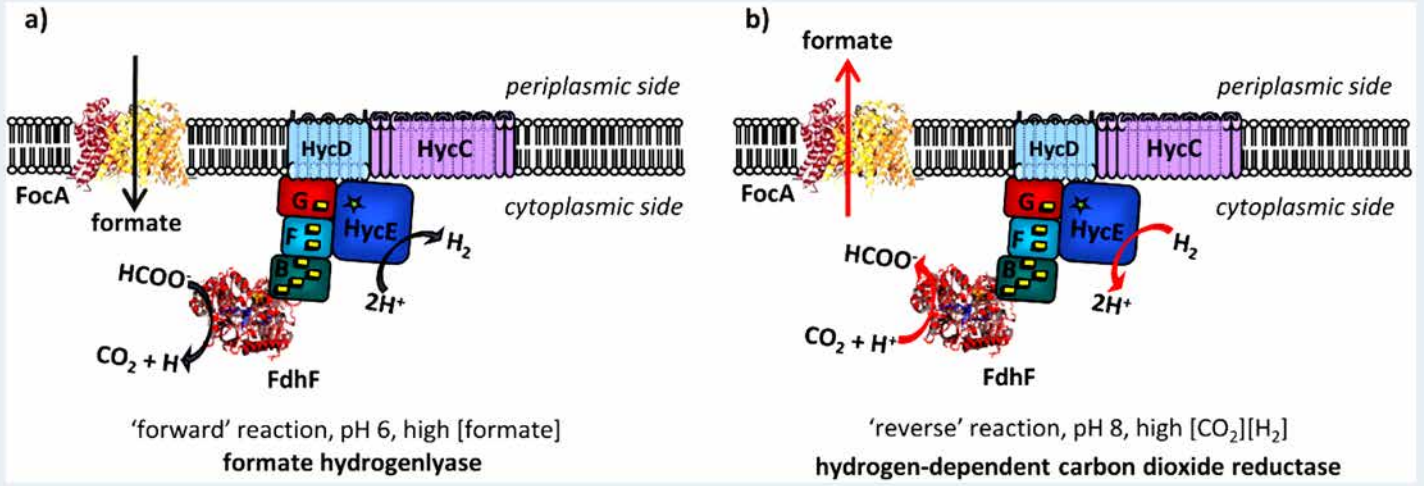
- Funded by BEIS in collaboration with Johnson Matthey

- Demonstrate a novel enzymatic carbon capture solution to efficiently convert CO_2 into formic acid/formate salt
- Build on previous feasibility studies to determine if this technology can be improved for cost-effective removal of industrial waste CO_2 emissions at scale

Biobased conversion of waste gases to formate

Intracellular enzymatic production of formate from H_2 and CO_2

Reversible enzyme – functions in two modes depending on external conditions - reverse mode = fixation of CO_2 *in vivo* ?



Roger, M., Brown, F., Gabrielli, W., and Sargent, F. (2018) Efficient Hydrogen-Dependent Carbon Dioxide Reduction by *Escherichia coli*. *Current Biology* **28**: 140-145.e2.

Process relies on enzymatic conversion

- via **FHL** (formate hydrogen lyase)
- of **CO_2** (waste gas)
- to **formate** (useful feedstock)

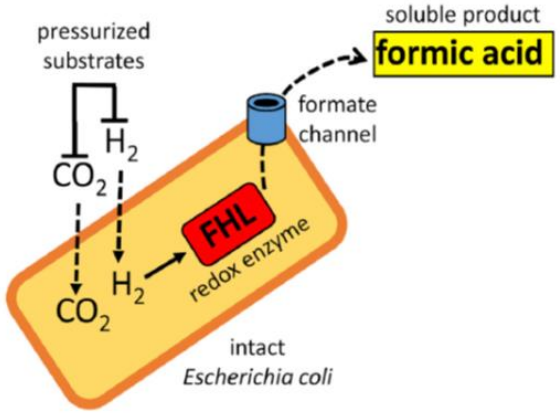
FHL:

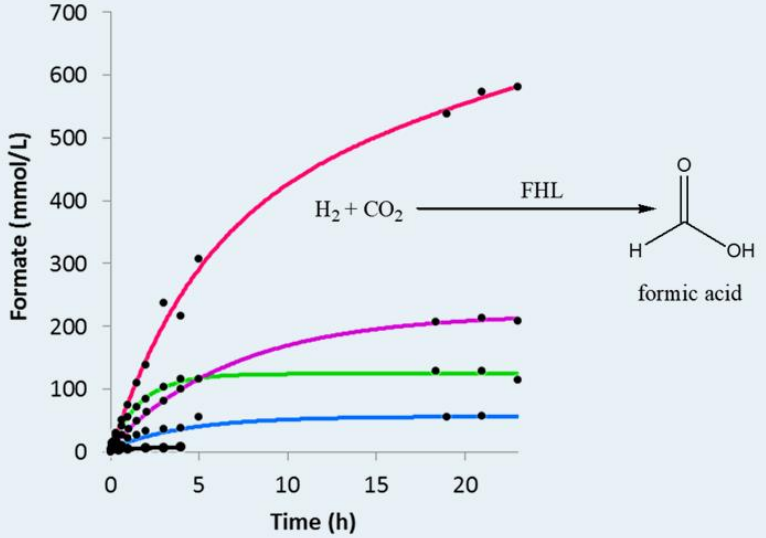
- 2 directions:
  - Fwd = **uses** formate (native)
  - Rev = **produces** formate (non-native)

- Reverse reaction requirements:
  - Anaerobic conditions
  - High levels of **H_2** and **CO_2**
  - Higher pressure (>200 bar)

Biobased conversion of waste gases to formate

Intracellular enzymatic production of formate from H_2 and CO_2





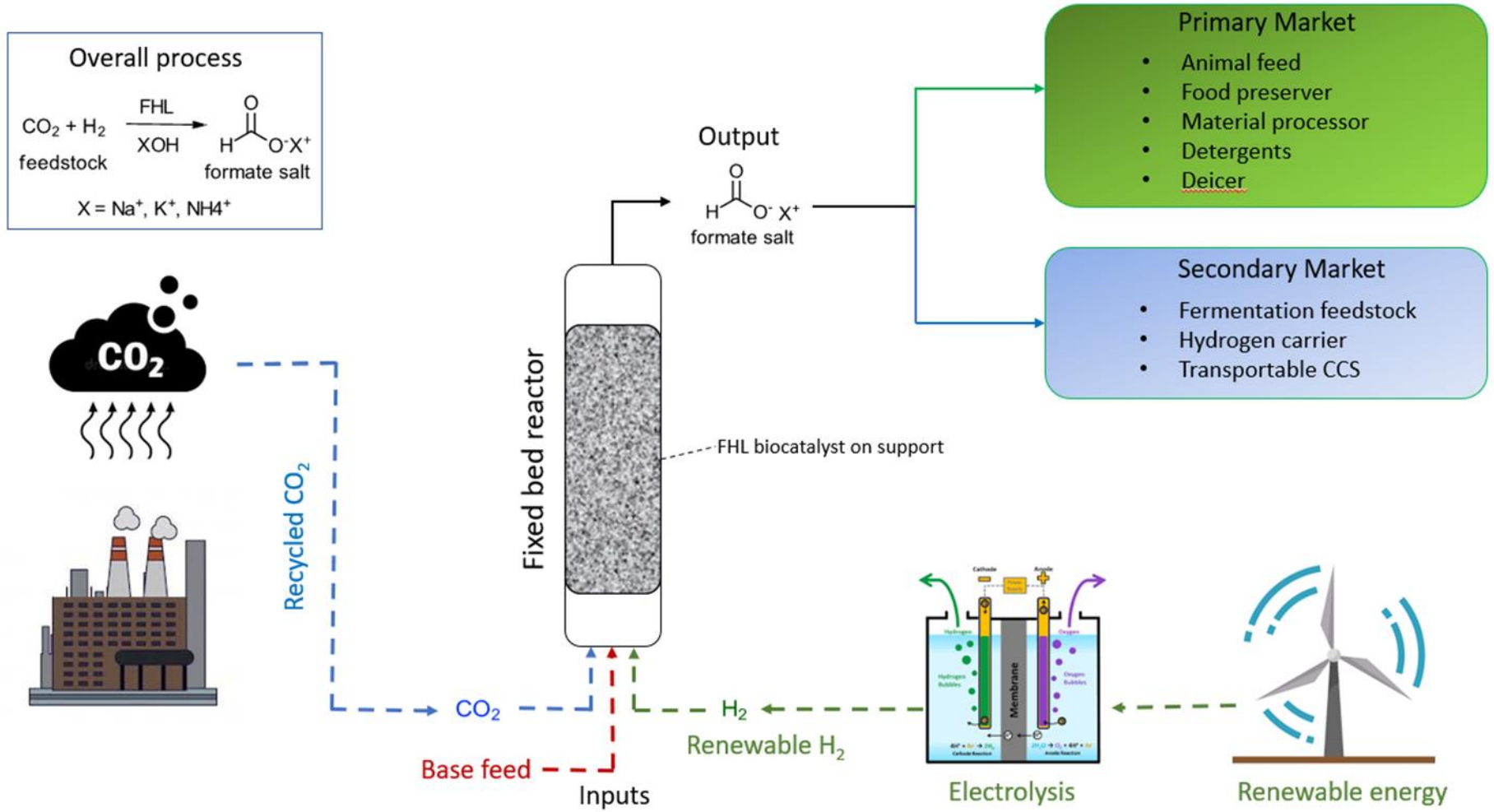
FHL - Reverse Mode

- 100% conversion of gaseous CO_2 to formate
- >500mM extracellular formate measured
- Carbon capture technology
- Building block feedstock for other higher value chemicals

Roger, M., Brown, F., Gabrielli, W., and Sargent, F. (2018) Efficient Hydrogen-Dependent Carbon Dioxide Reduction by *Escherichia coli*. *Current Biology* **28**: 140-145.e2.

Proposed Continuous Process

Fixed bed continuous formate production using FHL, $CO_2 + H_2$

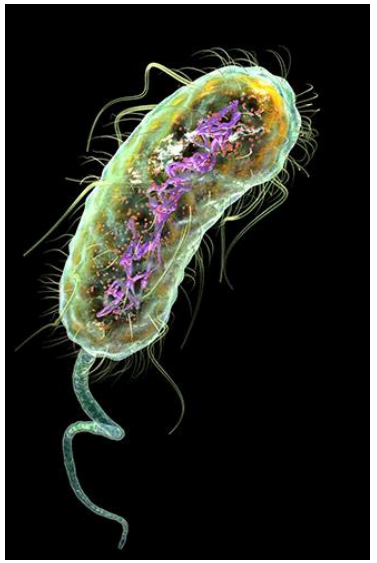


Biobased conversion of waste gases to formate

E. coli as the workhorse for carbon capture and utilisation

- *E. coli* produces a native FHL – does not need to be engineered into the host
  - Evolved as a mechanism to detoxify high intracellular concentrations of formate
- Normal function: under ambient conditions formate is disproportionated to H_2 + CO_2 by FHL

- Under high pressure, the reverse reaction for the reduction of CO_2 to formate is highly efficient
  - increases gas solubility, allowing increased substrate availability for FHL
  - 100 % conversion of waste CO_2 to formate



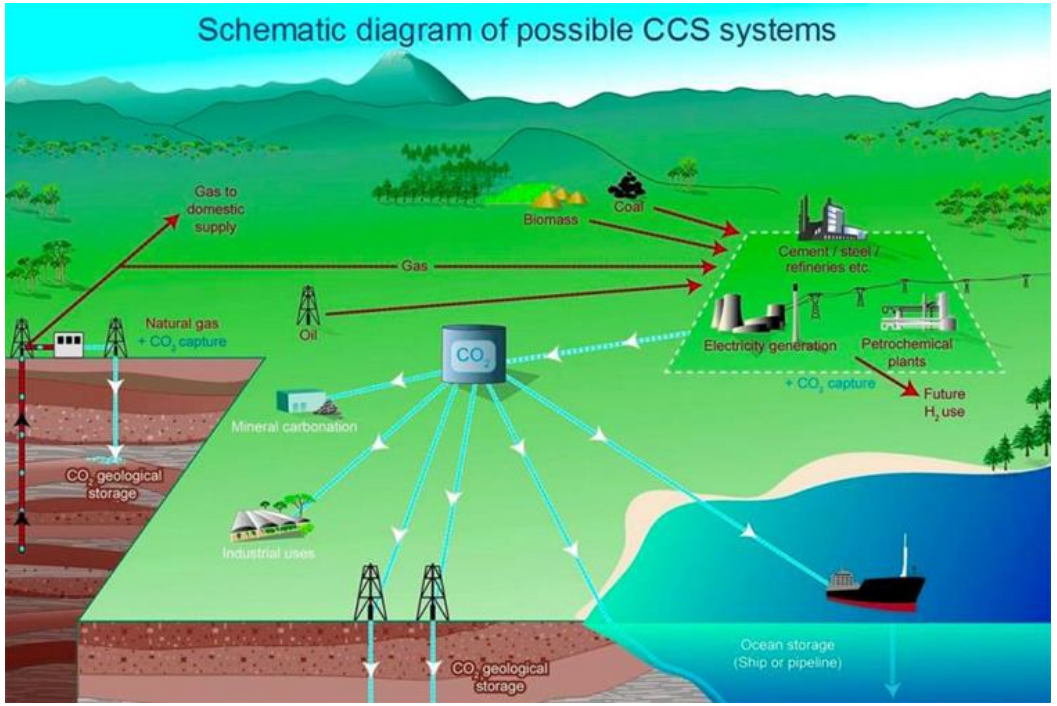
- Immediate secretion of formate via native pH-dep FocA channel
  - allows maintenance of maximum rate of FHL reverse reaction via pH control

- Intact whole cells – allows continuous use of biocatalyst

Biobased conversion of waste gases to formate

Strain engineering considerations for waste CO_2 capture as formate

- Inactivation of formate-utilising pathways via genome modifications
  - Optimisation of CO_2 reduction to formate
- Maximise FHL expression
  - Improve overall productivity
- Engineering of heterologous enzymes to remove gaseous impurities found within waste gases – e.g. NO_x/SO_x/O_2
  - Ease of implementation in a wide range of settings



Biobased conversion of waste gases to formate

Summary

Pros

- Natural property of host – minimal modification
- Carbon capture/CO_2 recycling technology
- Effective & efficient whole-cell biocatalyst
- Suitable for immobilisation – increases biocatalyst longevity, reduces cost
- Accumulates outside the cell – No need for costly DSP to recover product
- Formate is a commodity chemical and feedstock for the synthesis of other high value chemicals

Cons

- A cleaner CO_2 waste stream is most suitable for FHL
  - e.g. biogenic CO_2 from ethanol production

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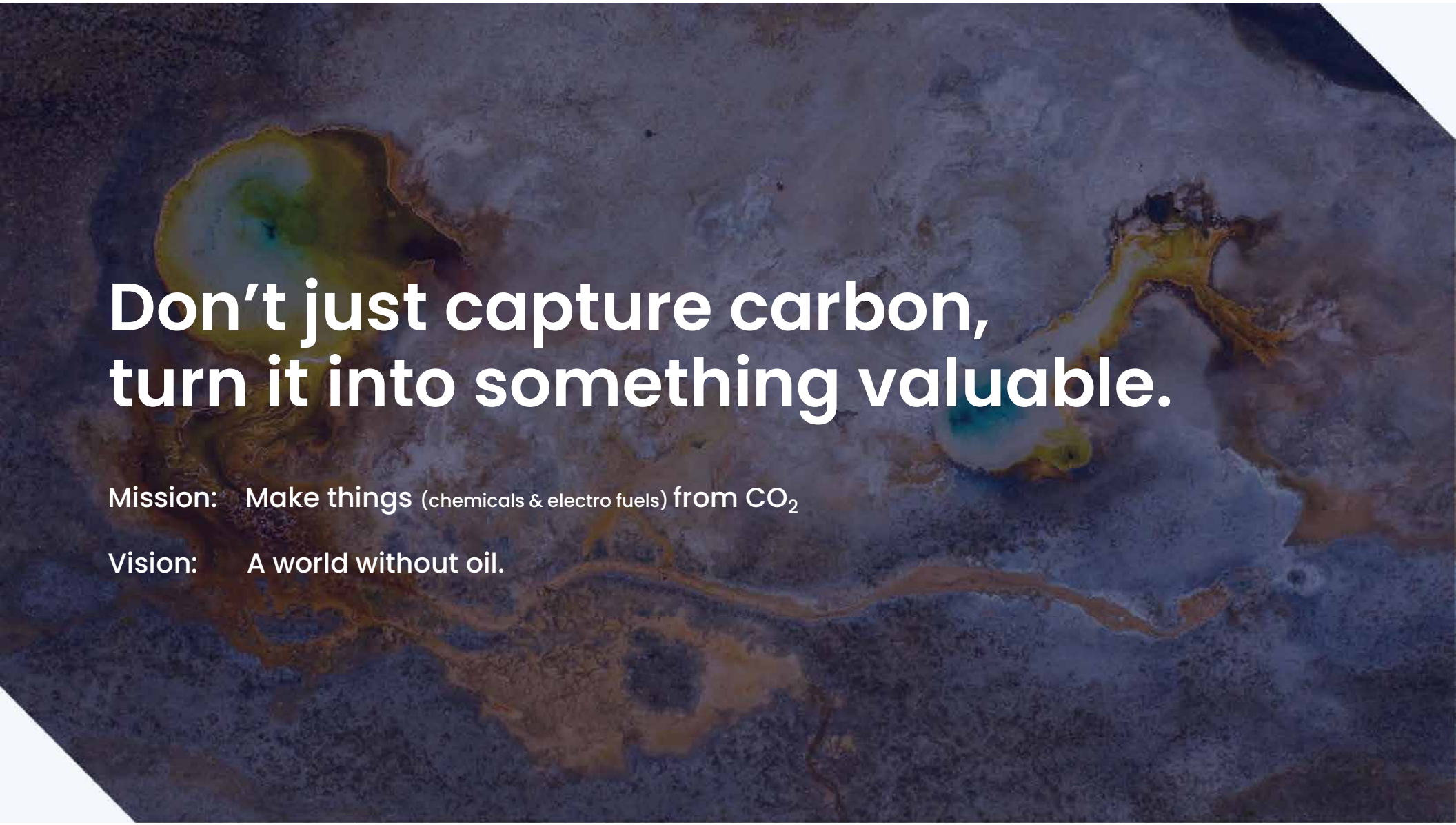
PHASE
BIOLABS
Decarbonisation via CO_2 upcycling
www.phasebiolabs.com



Don’t just capture carbon, turn it into something valuable.

Mission: Make things (chemicals & electro fuels) from CO_2

Vision: A world without oil.

Agenda

1. Some background
   a. approaches
   b. acronyms

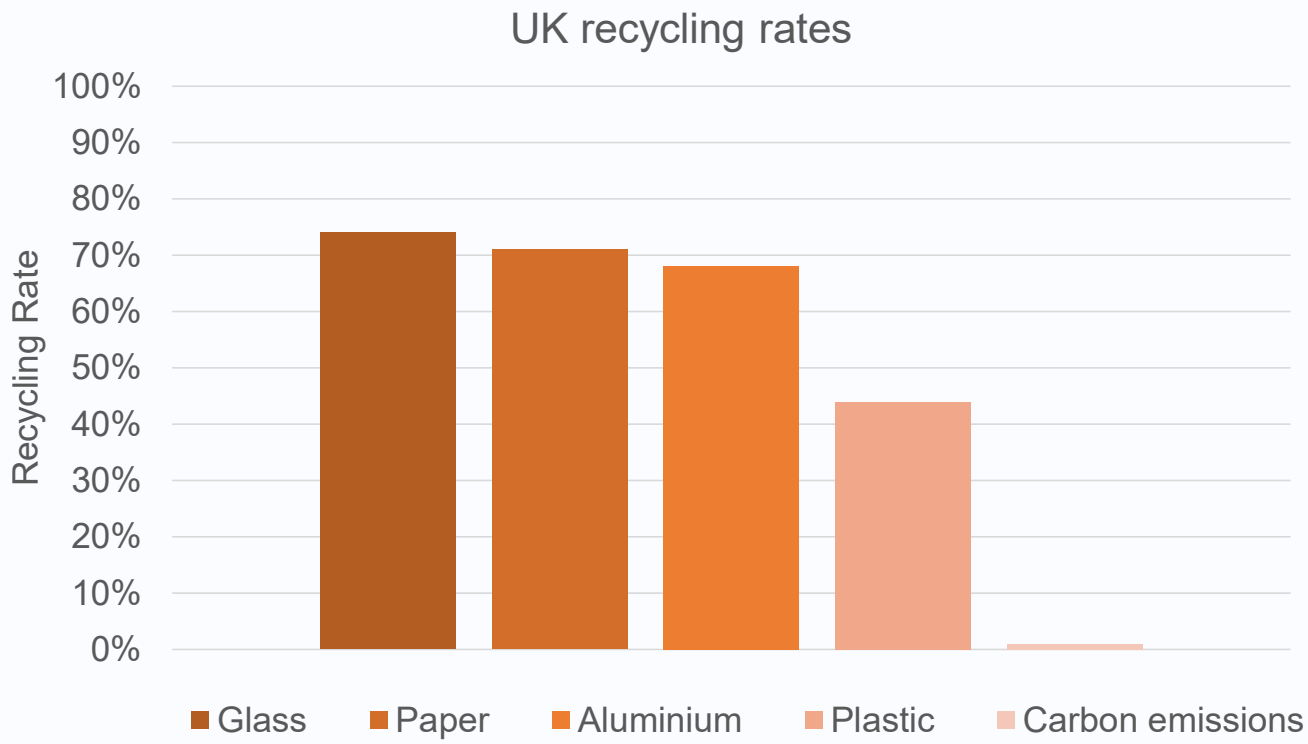
2. What about industrial gasses?
   a. availability
   b. types
   c. Sources

3. Technology types

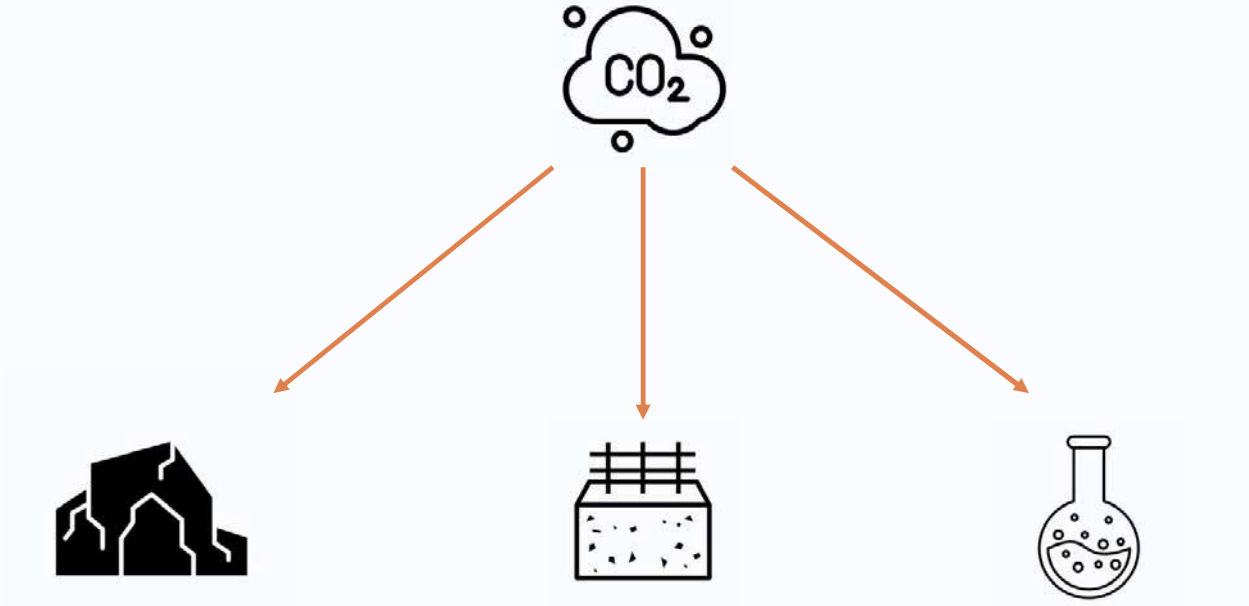
4. Phase Biolabs
   a. our vision
   b. what we hope to produce
   c. our technology
   d. roadmap

5. Importance of hydrogen

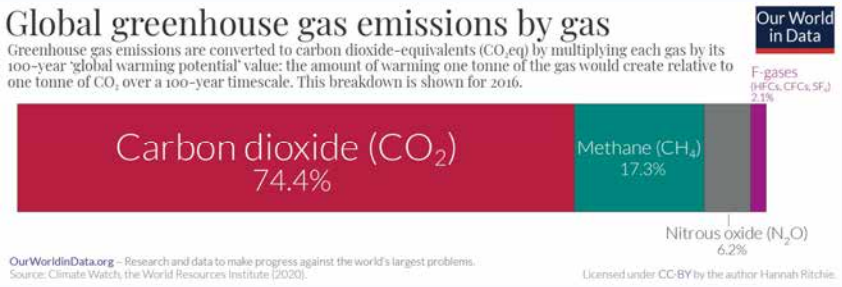
We already recycle

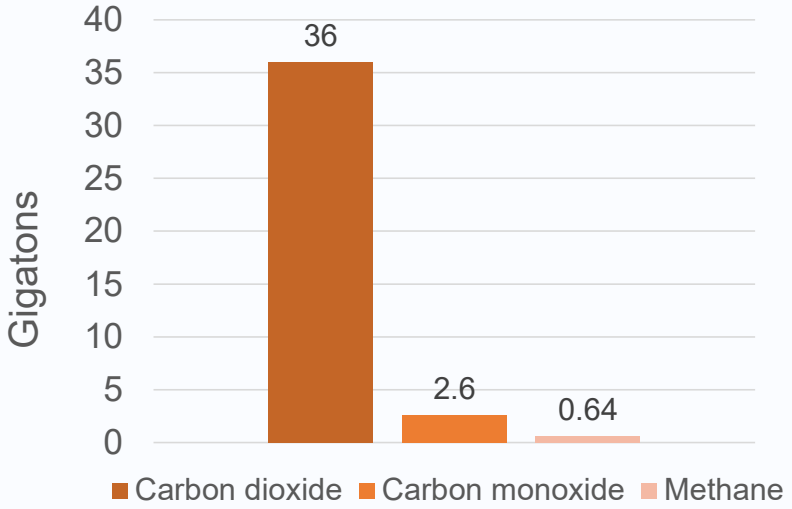


CCS vs CCUS vs CCU

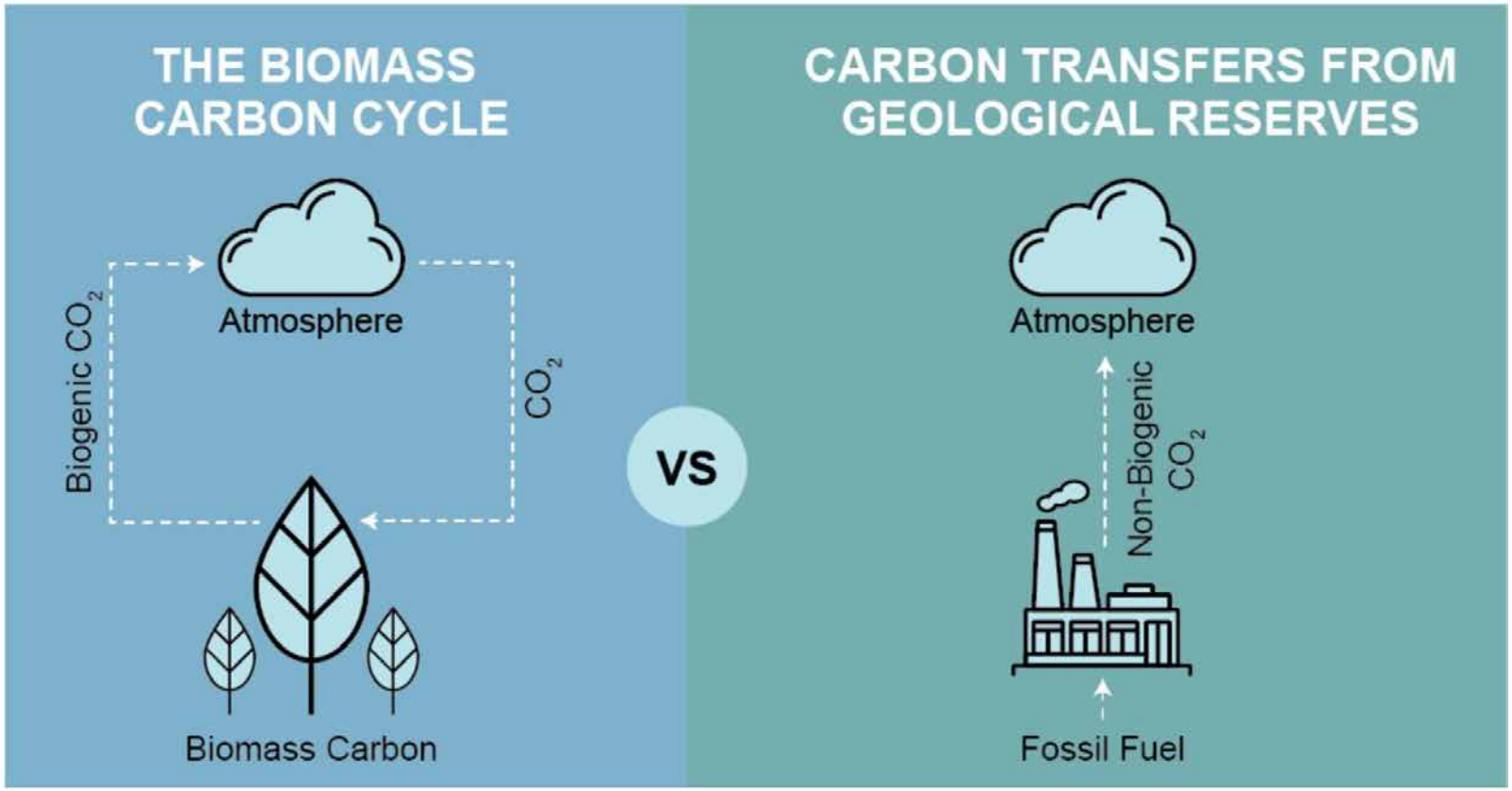


What is available?





Not all gasses are the same



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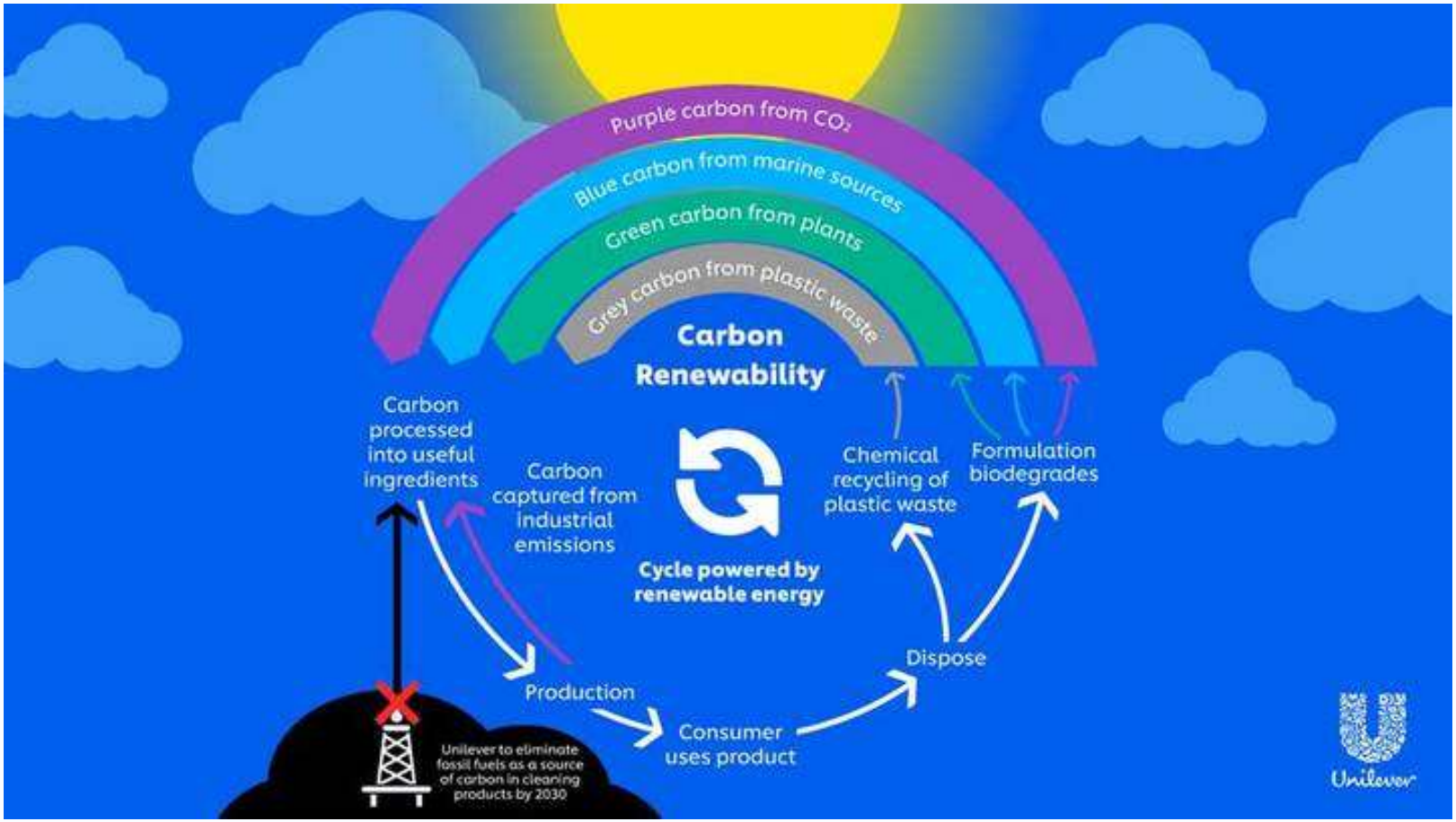


Not all sources are the same

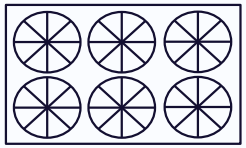
Higher Quality CO_2
Concentration = >90%

Industrial Brewers & Ammonia Plants

Lower Quality CO_2
Concentration = 10-60%

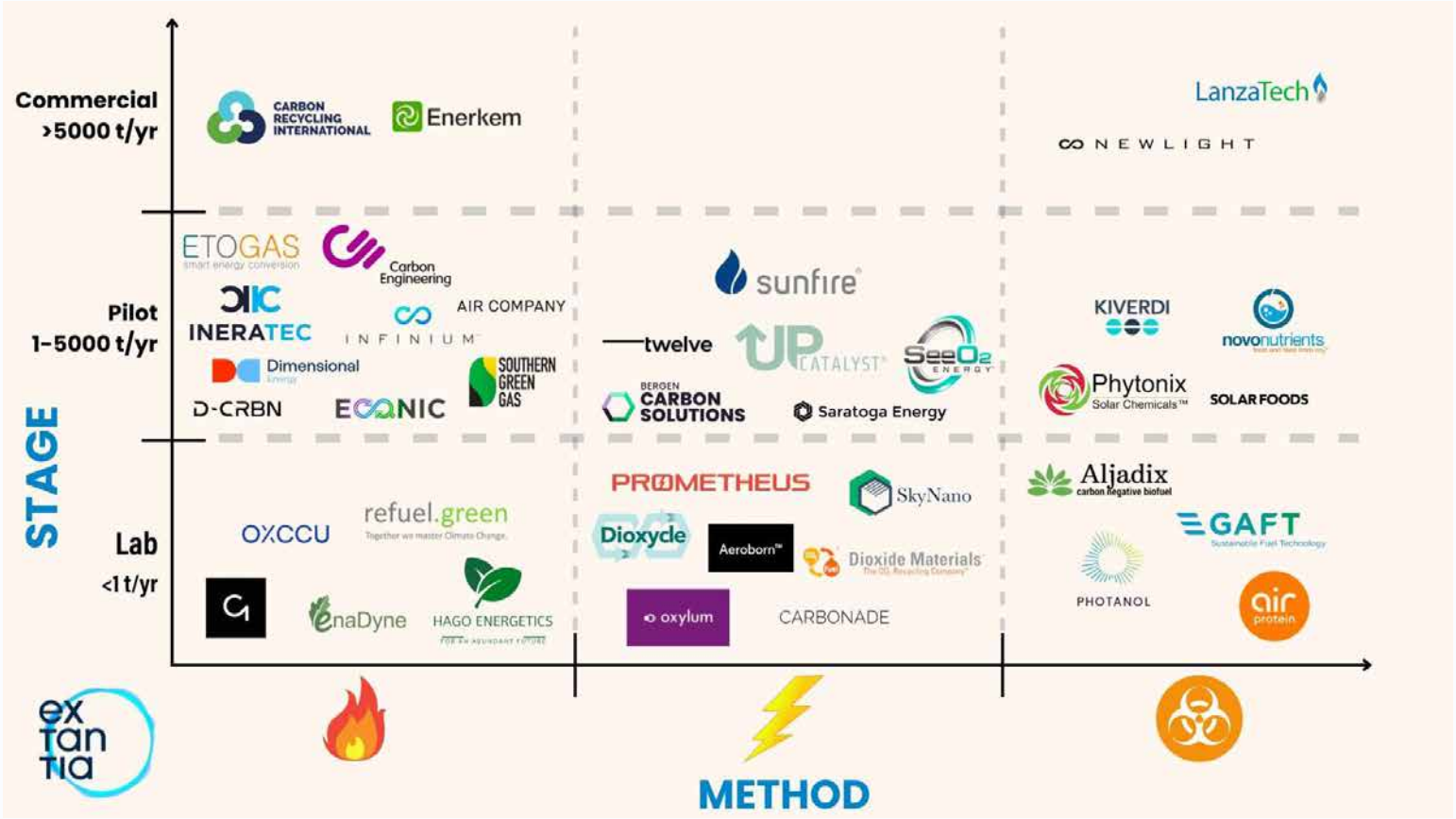
Cement, Steel, Petrochemicals

The future of CO_2 (2030?)
Concentration >50%



Direct Air Capture

Not all technologies are the same



Sustainable Chemicals Will Be Worth >£3 Trillion

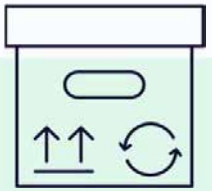
- 90% are made from petroleum
- By 2050, 50% of chemicals will be produced using biology (McKinsey)

We want to make ethanol from CO_2

Cosmetics

Disinfectants

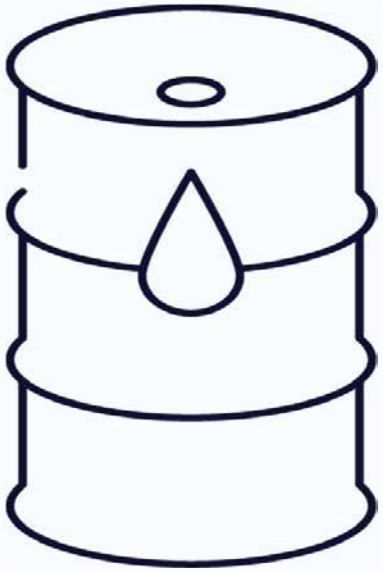
Pharmacare

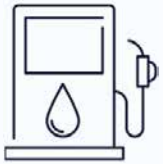


Print
Packaging

Synthetic ethanol is made from ethylene and is used in these application industries

Massive Secondary Markets





Aviation Fuel
£250 billion

Sustainable aviation fuel (SAF)
Alcohol 2 Jet (A2J) is approved
3 – 5% CAGR (next 5 years)

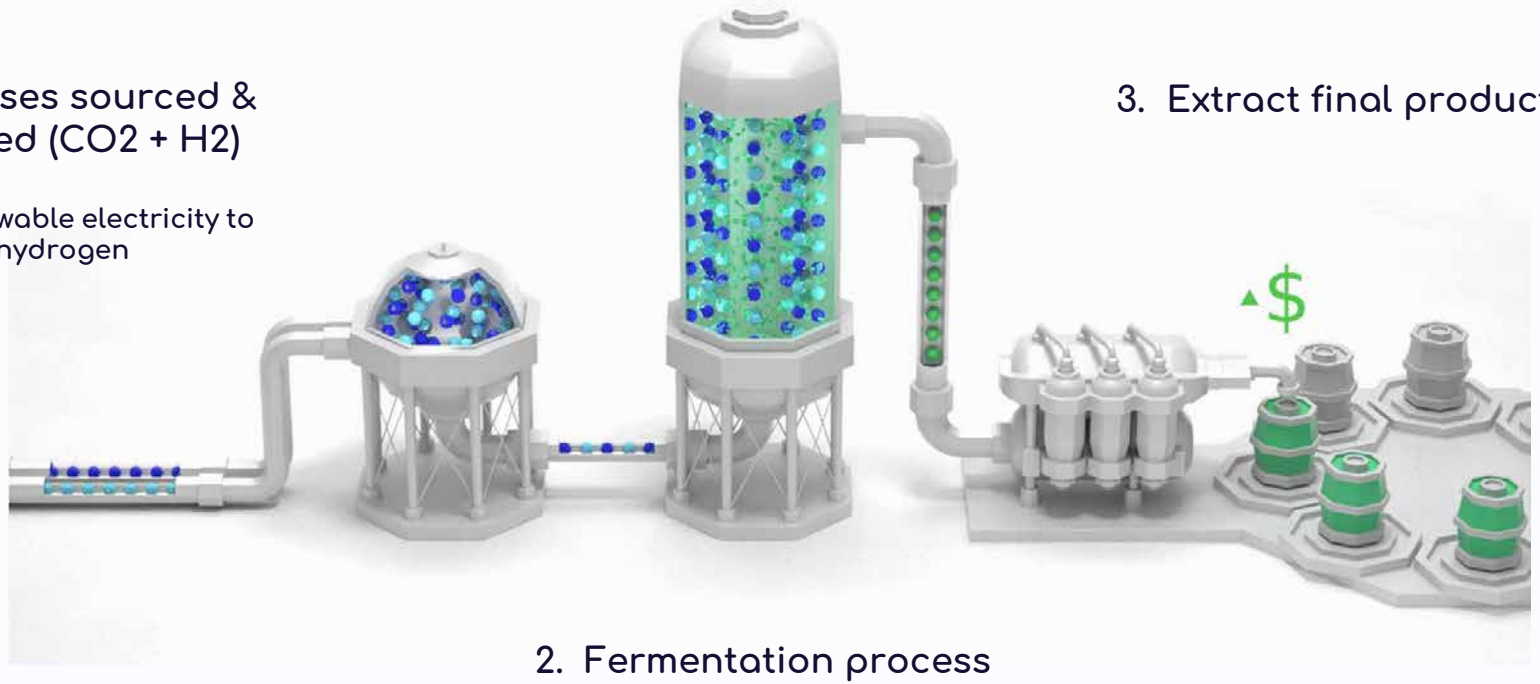
Ethylene
£150 billion market

limited availability of renewable plastics
8 – 9% CAGR (next 5 years)

Gas fermentation technology

1. Gasses sourced & mixed (CO_2 + H_2)

Use renewable electricity to produce hydrogen



2. Fermentation process converts gasses

3. Extract final product

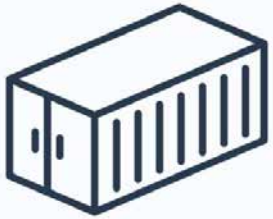
Roadmap

Current

Lab-scale

(TRL4)

g / day



2024

Pilot

(TRL5)

kg / day

2026

Demo

(TRL7)

T / year

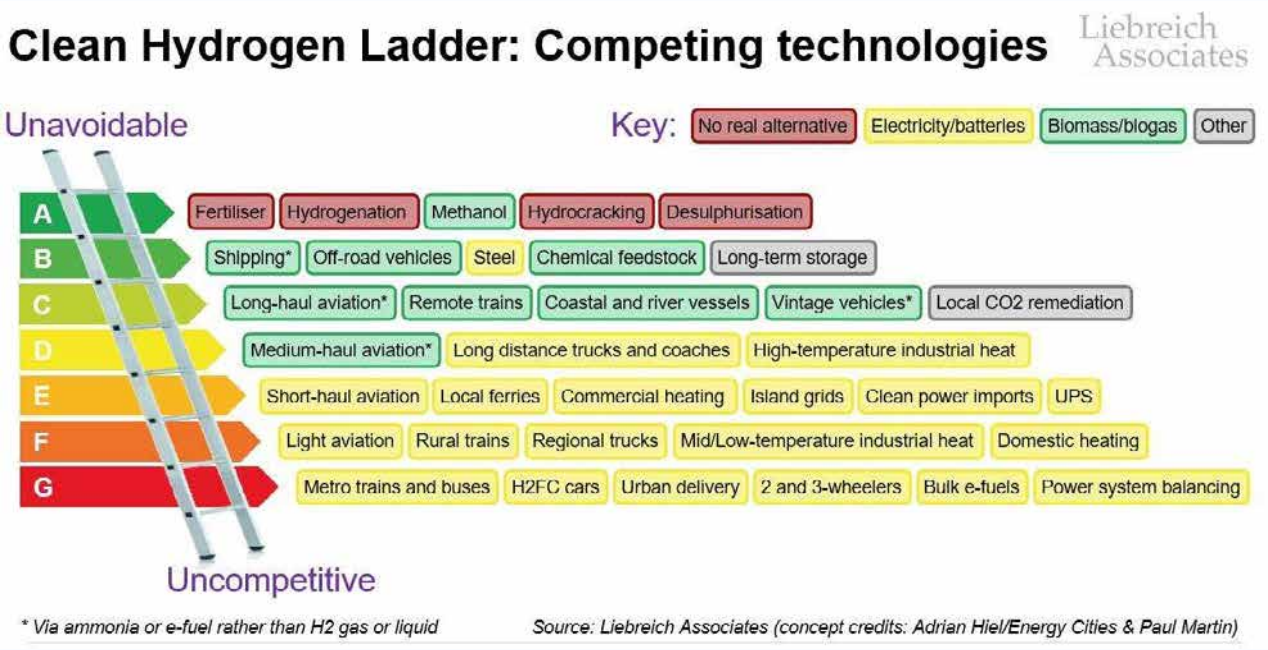
2028

Commercial

(TRL9)

kT / year

Importance of H2 for chemicals



PHASE
BIOLABS
Join us in delivering a low carbon future
www.phasebiolabs.com
David@phasebiolabs.com

Funding and Networking Opportunities:

BCB: CO_2 to Chemicals Webinar
1st March 2023

Dr Catherine Julia Mort, Innovate UK KTN

www.ktn-uk.org

UKRI Innovate UK KTN

Key Message Today:

Relevant funding calls and associated networking activities to the BCB Audience:

Reimagining Materials and Manufacturing:

- *Sustainable bio-based materials and manufacturing.*
- *Resource Efficiency for materials and manufacturing (REForMM).*

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Reimagining materials and manufacturing together

Two CR&D study competitions

Resource efficiency for materials and manufacturing

- Up to £12 million total funding
- Open 31s March 2023 for 8 weeks

Sustainable bio-based materials and manufacture

- Up to £12 million total funding
- Opens 7 March 2023 for 8 weeks

✓ **Focus on**

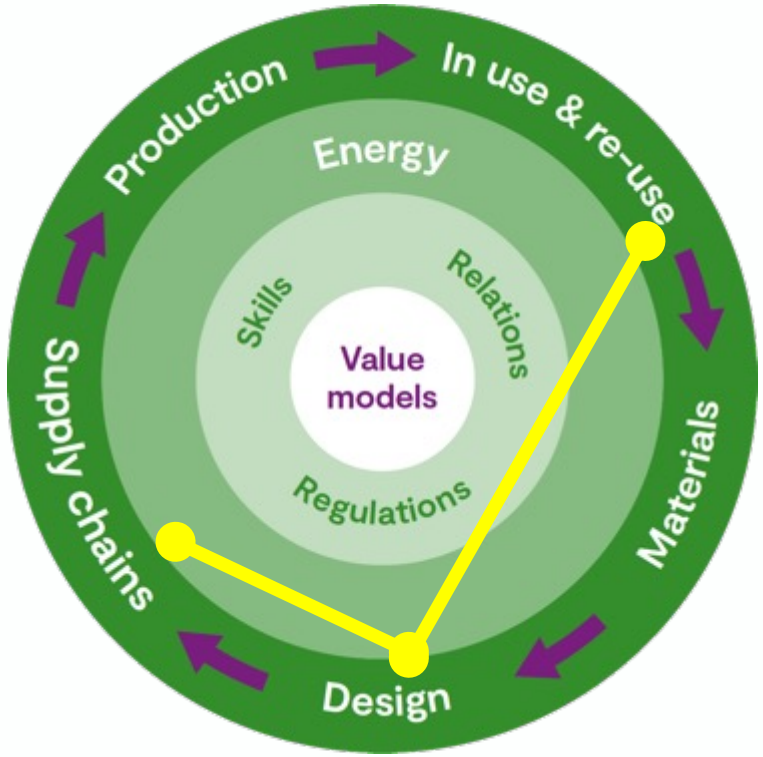
Core areas

future economy materials
smart design
resilient supply chains
world-class production
longer in use & re-use

✓ **Do not focus on**

Enabling areas

clean energy
proactive regulations
future skills
networked relations
evolving value models



✓ **Join the dots**

✓ **Collaboration is encouraged**

Sustainable bio-based materials and manufacturing: CR&D Competition

Innovate UK KTN

£12m Sustainable bio-based materials and manufacture - CR&D Competition

UK registered organisations can apply for a share of up to £12 million for collaborative research and development.

This is to develop step-change improvements to sustainable biomanufacturing in the UK.

Competition opens:
Tuesday 7 March 2023

Competition closes:
Wednesday 3 May 2023
11:00am

Project's between:
£300,000 & £1,000,000

Your project must focus on one or more of the following themes:

- Improving extraction of existing bio-based feedstocks and optimizing these processes
- Using biotechnology-based systems for developing alternatives to traditional manufacturing processes, including processing and catalysis for sustainability
- The design and development of future advanced bio-products with improved or differentiated properties
- The discovery of novel or optimization of enzymes to whole organisms for biomanufacturing
- Securing value from non-food crop biomass and other waste streams
- Improving manufacturability and consistency at scale and progressing the development and adoption of biotechnology, across multiple manufacturing industries and sectors

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Sustainable Bio-based materials and manufacturing: CR&D Competition Webinar

Event Link: https://iuk.ktn-uk.org/events/sustainable-bio-based-materials-and-manufacture-crd-competition-launch/?utm_campaign=2298949_SustBio%20%2B%20REforMM%20Mailshot%20CR%26D%20Competition%20Briefs%20Invite%20%5BChem%20%26%20IB%5D&utm_medium=email&utm_source=dotdigital&dm_t=0,0,0,0,0

Innovate UK
KTN

Networking Brochure:

Call to action!

- **You've got to be in it to win it!**

Please register and submit your networking slide **TODAY**

Innovate UK KTN

Organisation Name

Your Name

Email Address

What we do:

Where you sit in the supply chain?

What is our project idea or innovation challenge:

Partner(s) required? (Y/N):
If yes what type?:

Logo

Your Photo

LinkedIn QR code

Innovate UK KTN

REForMM: CR&D Competition

- Up to £12 million total funding

Innovate UK KTN

REForMM: CR&D Competition Briefing Webinar

Event Link: https://iuk.ktn-uk.org/events/resource-efficiency-for-materials-and-manufacturing-briefing-event/?utm_campaign=2298949_SustBio%20%2B%20REforMM%20Mailshot%20CR%26D%20Competition%20Briefs%20Invite%20%5BChem%20%26%20IB%5D&utm_medium=email&utm_source=dotdigital&dm_t=0,0,0,0,0

Innovate UK KTN

F2F Event, 4th April, QE11 London

- Networking
- ED&I
- IUK M+M Vision
- Networking in the afternoon (REForMM)
- Drop in stands (IUK KTN, IUK, Catapults and RTO's)
- Sign up now!

Event Link https://iuk.ktn-uk.org/events/reimagine-materials-and-manufacturing-event/?utm_campaign=2298949_SustBio%20%2B%20REforMM%20Mailshot%20CR%26D%20Competition%20Briefs%20Invite%20%5BChem%20%26%20IB%5D&utm_medium=email&utm_source=dotdigital&dm_t=0,0,0,0,0

UKRI Innovate UK KTN

Supporting your applications:

How can we support you?

- We can help innovators ***find new partners*** for their project proposal – we can facilitate introduction to key stakeholders across several sectors including Chem and IB, Materials and Manufacturing.

- We can also ***review draft proposals*** if you are new to IUK funding and provide guidance.

UKRI Innovate UK KTN

Additional relevant funding calls:

- ***Comprehensive funding slide will be made available***
- EngBio funding call: https://apply-for-innovation-funding.service.gov.uk/competition/1455/overview/adf16349-5484-42e5-87f2-2b1b81b3aeb0
- IBioIC conference: https://ibioicconference.com
- SE CO2 Util challenge https://www.scottish-enterprise.com/support-for-businesses/funding-and-grants/business-grants/co2-utilisation-challenge. Open now, closes 31st March 2024. The grant is only available to companies based in Scotland, or those with the goal of establishing a presence within Scotland to carry out research and development and create jobs.

UKRI Innovate UK KTN

Get in touch!

- **Unsure which funding opportunity is best suited for you?** We warmly recommend joining the events, where our team will be able to support and advise you further

Raj Mistry| **Biomanufacturing**

- Raj.mistry@iuk.ktn-uk.org

Dr Dana Heldt | **Biomanufacturing**

- Dana.heldt@iuk.ktn-uk.org

Dr Michael Burnett | **Chemistry**

- Michael.Burnett@iuk.ktn-uk.org

Dr Megan Ronayne | **Industrial technologies and manufacturing**

- Megan.ronayne@iuk.ktn-uk.org

Dr Ajay Kapadia | **Materials**

- Ajay.ikapadia@iuk.ktn-uk.org

Materials, Manufacturing, KTN Chem and IB Newsletter's – sign up!

UKRI Innovate UK KTN

Bioeconomy
Cluster Builder

Project achievements 2020-2023

Kim Cameron – Business Engagement Manager
Industrial Biotechnology Innovation Centre

IBioIC

UKRI Innovate UK KTN

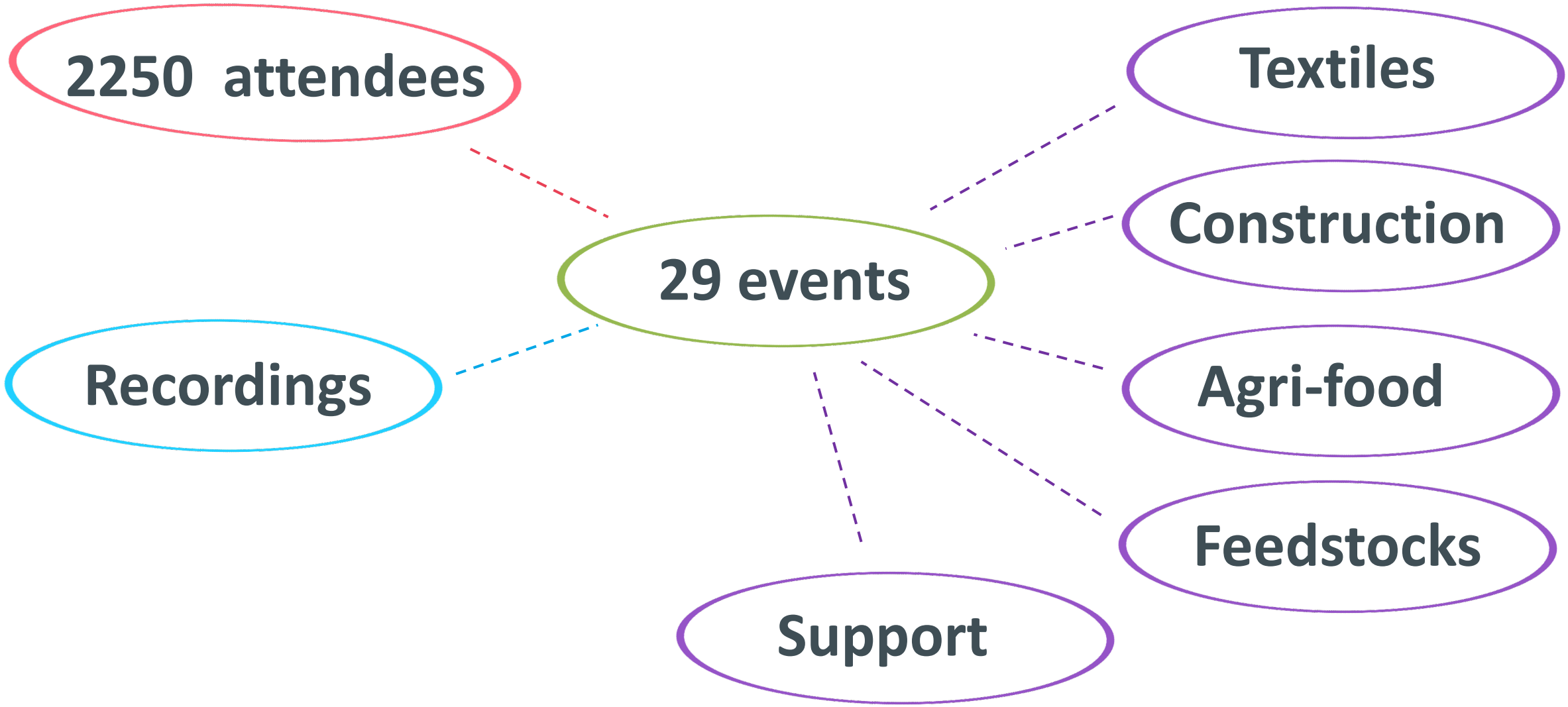
Scottish Enterprise

European Union gov.scot

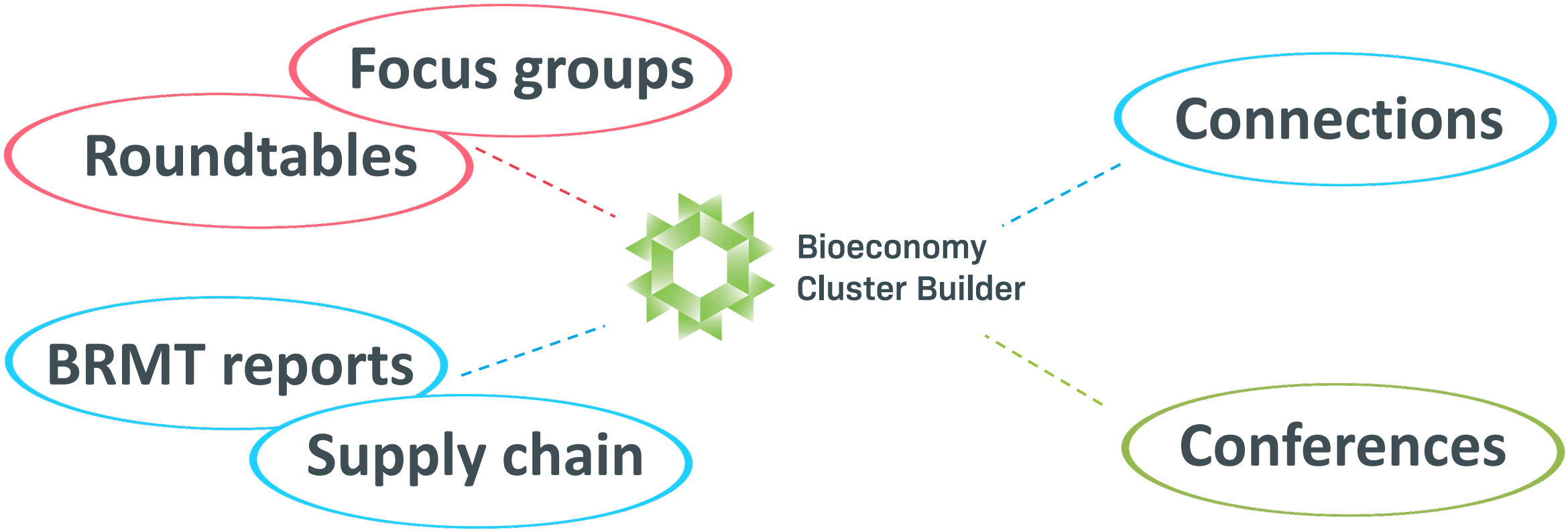
EUROPE & SCOTLAND
European Regional Development Fund
Investing in a Smart, Sustainable and Inclusive Future

Events delivered

Bioeconomy Cluster Builder



Further activity



Looking to the future

Bioeconomy Cluster Builder

- Bioeconomy Cluster Builder activity will continue beyond March 2023
- Continued collaboration between IBioIC and Innovate UK KTN
- Website, Twitter and LinkedIn to be retained **www.bioeconomybuilder.com**

Key contacts:

IBioIC – Kim Cameron – kim.cameron@ibioic.com

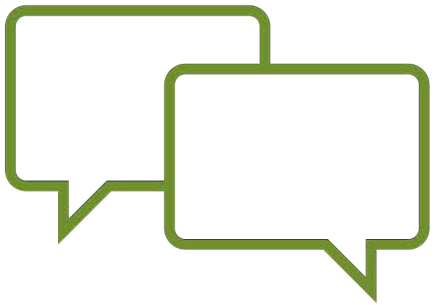
Innovate UK KTN – Dana Heldt – dana.heldt@iuk.ktn-uk.org

IBioIC

UKRI Innovate UK KTN

Bioeconomy
Cluster Builder

- Keep an eye out for events!
- Get in touch if you'd like support!
- Send people our way!



- Potential partner organisations
- Companies to engage with
- External events to target

- All suggestions welcomed!

www.bioeconomybuilder.com

IBioIC

IBioIC

Resilience and the Bioeconomy

- IBioIC Annual Conference
- Wednesday 15th and Thursday 16th March
- Technology and Innovation Centre, Glasgow

www.ibioicconference.com

Bioeconomy Cluster Builder

Made with biology! Bio-based Product Showcase

- Tuesday 14th March 0800-1900
- Glasgow Queen Street Station – main concourse
- Public engagement event

Bioeconomy Cluster Builder

Thank you

www.bioeconomybuilder.com

European Union
gov.scot
EUROPE & SCOTLAND
European Regional Development Fund
Investing in a Smart, Sustainable and Inclusive Future

Looking Ahead

Transforming Industrial Waste Gases to Chemicals Action Plan: Next Steps 2023/24

- We will continue to champion the move towards a circular carbon future and will engage with the community and facilitate the delivery of the action plan by
    - acting upon the actions KTN can lead on or support
    - generating active support/leadership for other actions
- Strategically we want to develop of deployment projects within clusters and support the development of new technology for dispersed sites
- Establishing more challenges using the Innovate UK KTN collaboration exchange pilot programme
- If you can contribute this challenge and the action plan then please get in touch

Join the Innovate UK KTN Circular Economy Innovation Network

https://info.ktn-uk.org/p/2VFU-COI/circular-economy-innovation-network

UKRI Innovate UK KTN

We connect **innovators, funders and collaborators** to transform ideas into solutions

Our **Collaboration Exchange (cX)** pilot programme builds multi-partner collaborations between industry, SMEs and/or academics addressing a specific industrial challenge.

We are looking to work with companies who want to develop solutions and require new partners!

Our unique cross-sector approach connects businesses with opportunities beyond their existing thinking.

Collaboration exchange builds upon KTN's successful **Innovation Exchange (iX)** platform which connects companies with specific technical challenges to innovators who are already working on the solutions.

Do you have a chemicals or industrial biotechnology challenge that we can help you with?

UKRI Innovate UK KTN

Thank you for your time, input and support

Contact us if you would like to discuss further

Michael Burnett, michael.burnett@ktn-uk.org

Dana Heldt Dana.Heldt@iuk.ktn-uk.org

Sign up to our newsletter in www.ktn-uk.org

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