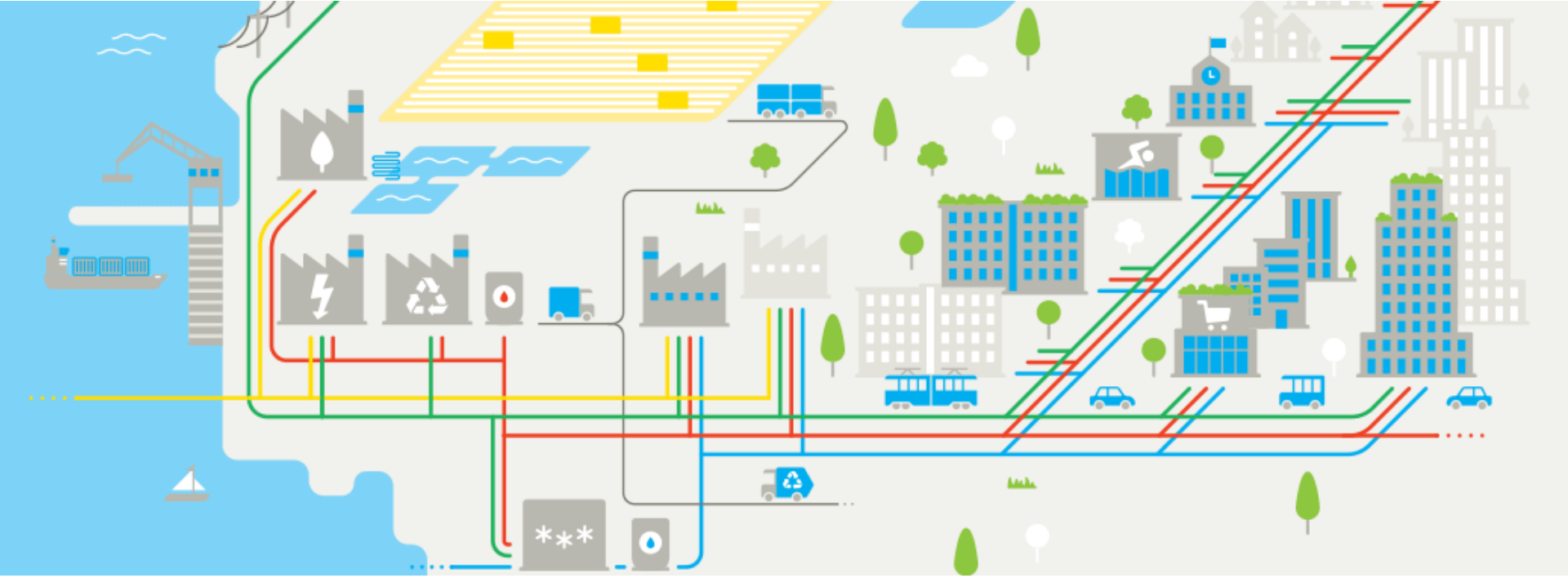
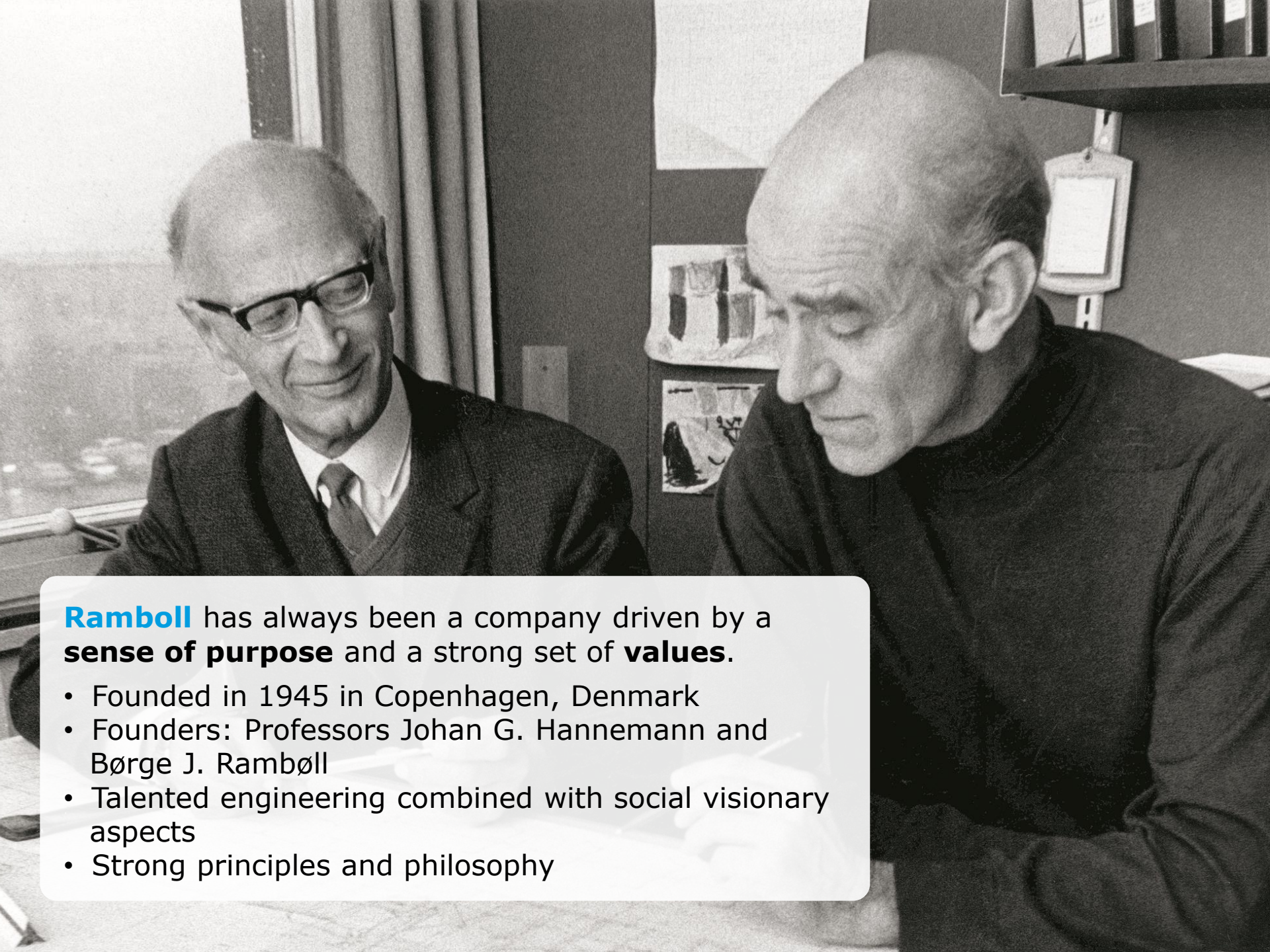


ETS Compliance Conference – 13 November 2018

Identification and analysis of promising carbon capture and utilisation technologies

Overview of the study for the European Commission DG CLIMA

RAMBØLL · IASS POTSDAM · UNIKASSEL VERSITÄT · CESR Center for Environmental Systems Research · IOM LAW · CE Delft



Ramboll has always been a company driven by a **sense of purpose** and a strong set of **values**.

- Founded in 1945 in Copenhagen, Denmark
- Founders: Professors Johan G. Hannemann and Børge J. Rambøll
- Talented engineering combined with social visionary aspects
- Strong principles and philosophy

CONTENT OF THE PRESENTATION

I. Introduction to CCU

II. Overview of study tasks

III. Findings

- I. Technology assessment
- II. Climate and energy assessment
- III. Possible eligibility criteria under ETS Innovation Fund
- IV. Market and societal assessment
- V. Regulatory assessment

IV. Conclusions

INTRODUCTION TO CCU
WHAT ARE CCU TECHNOLOGIES?

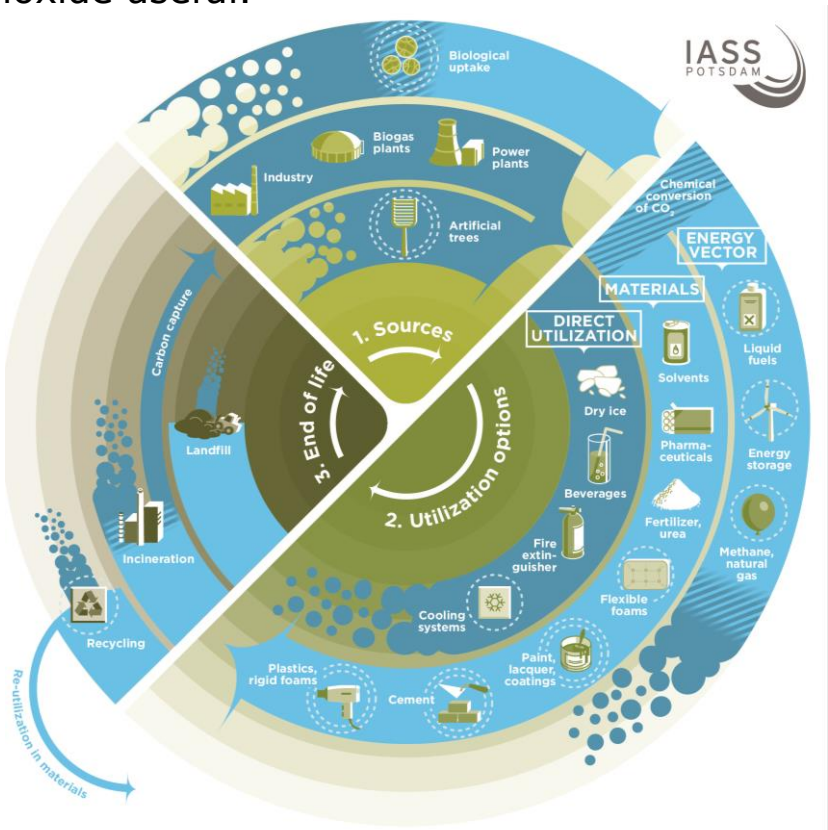
Carbon Capture and Utilization (CCU) refers to technologies and processes which **use carbon dioxide as a component of a carbon dioxide compound in materials or energy sources**, thus rendering the carbon dioxide useful.[1]

CCU processes involve:

- **capture** and compaction of CO_2
- its transport (if necessary)
- **functional utilization** of the CO_2
- also **end of life** needs to be taken into account in a circular approach

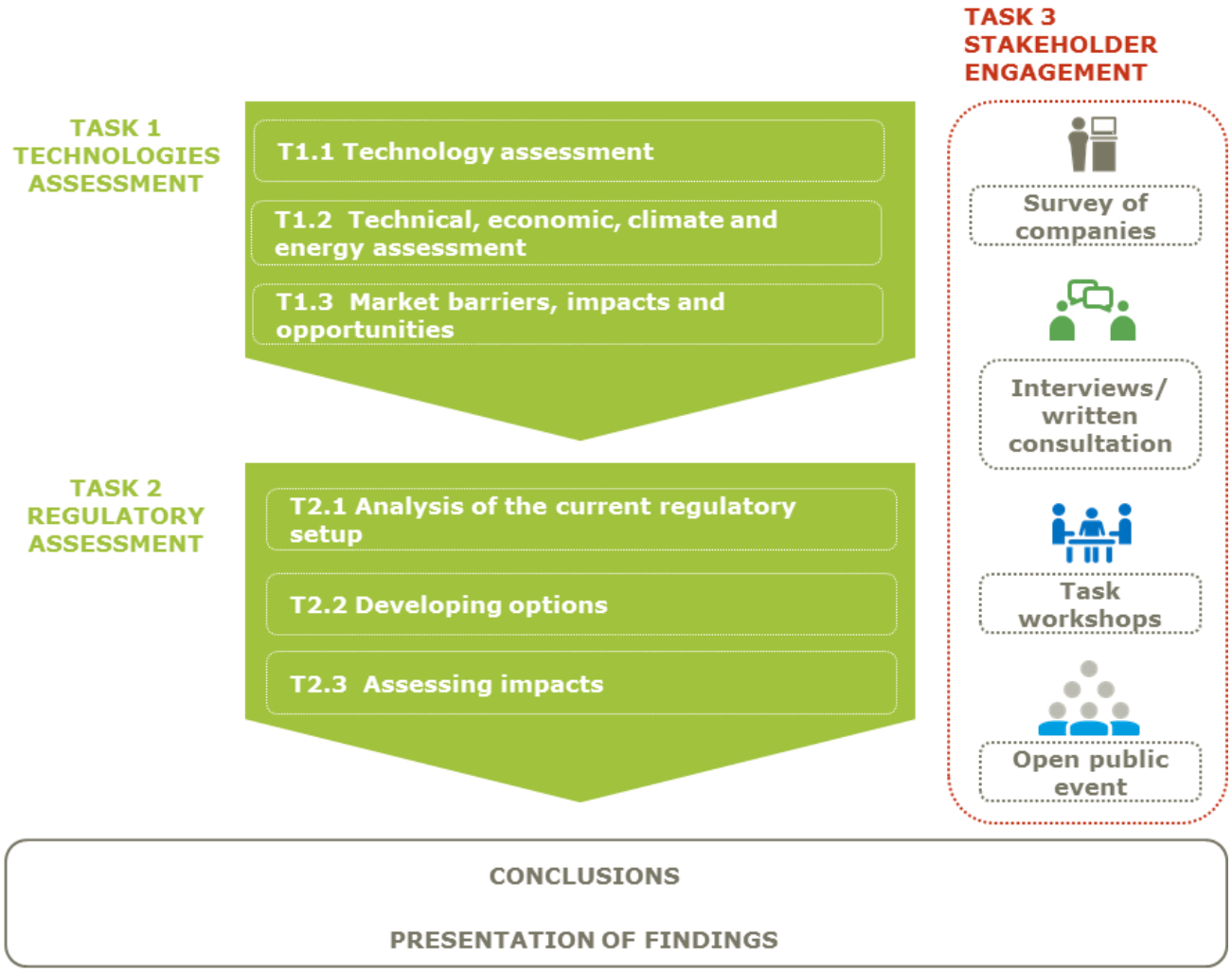
Excluded related processes are:

- CCS (generally)
- EOR/EGR (generally)
- Not novel processes
- Fine chemicals



[1] von der Assen et al. 2013

OVERVIEW OF STUDY TASKS



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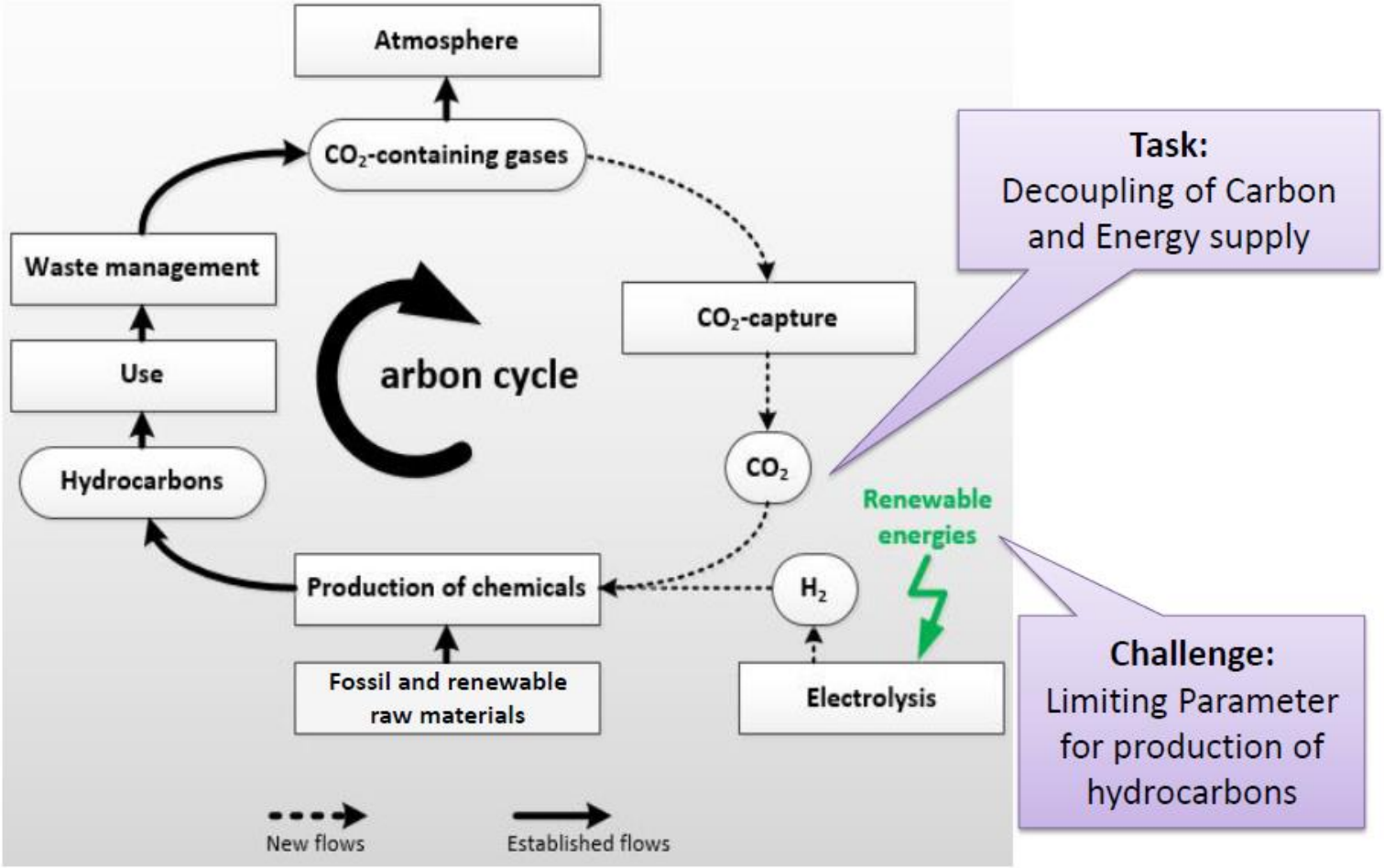
TECHNOLOGY ASSESSMENT
TECHNOLOGY SHORTLIST

Product	Abbreviation
Biological	
Ethanol	EtOH
Methane	Methane
Chemical hydrogenative	
Ethylene	Ethylene
Methane	Methane
Methanol	Methanol
Monooxymethylether (OME1)	OME1
Polyethylene (PE)	PE
Polyoxymethylene (POM)	POM
Polypropylene (PP)	PP
Propylene	Propylene
Synthetic fuels	Fuels
Chemical non-hydrogenative	
Polycarbonate (BisA-PC)	BisA-PC
Polyols for Polyurethane (PU) foams production	PU
Inorganic	
Calcium carbonate	CC
Sodium carbonate	SC

CLIMATE AND ENERGY ASSESSMENT

CCU AT A GLANCE

- **CO2 reuse can close the carbon cycle**



CLIMATE AND ENERGY ASSESSMENT

Measuring GHG emission mitigation from CCU

Comparative LCA of production processes

- CO2 based production process vs. conventional process.
- Various CO2 sources (biogenic, non biogenic, air)
- Process routes representative for the EU

Indicators

- Global Warming Impact [kgCO2 equivalents equivalents /kg product]
- Raw Material Input [kg raw material equivalent /kg product]
- Cumulative Energy Demand [MJ energy equivalents /kg product]
- Water input [kg water /kg product]

Scenarios

- Spatial variation (transport routes for chemicals favorable)
- Intersectoral use (methane use for transport or base chemical)
- Energy supply (renewable energy amount necessary)

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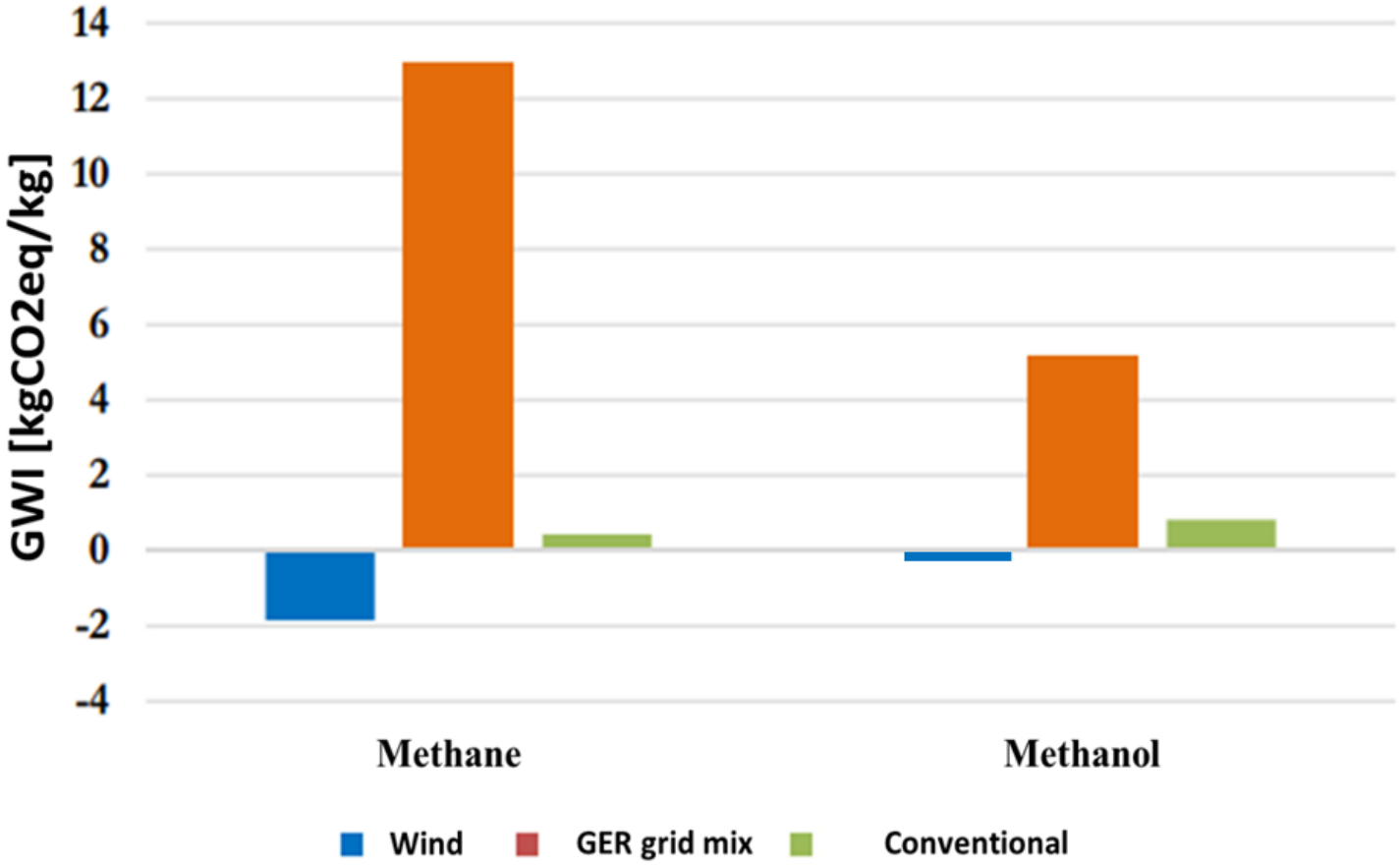
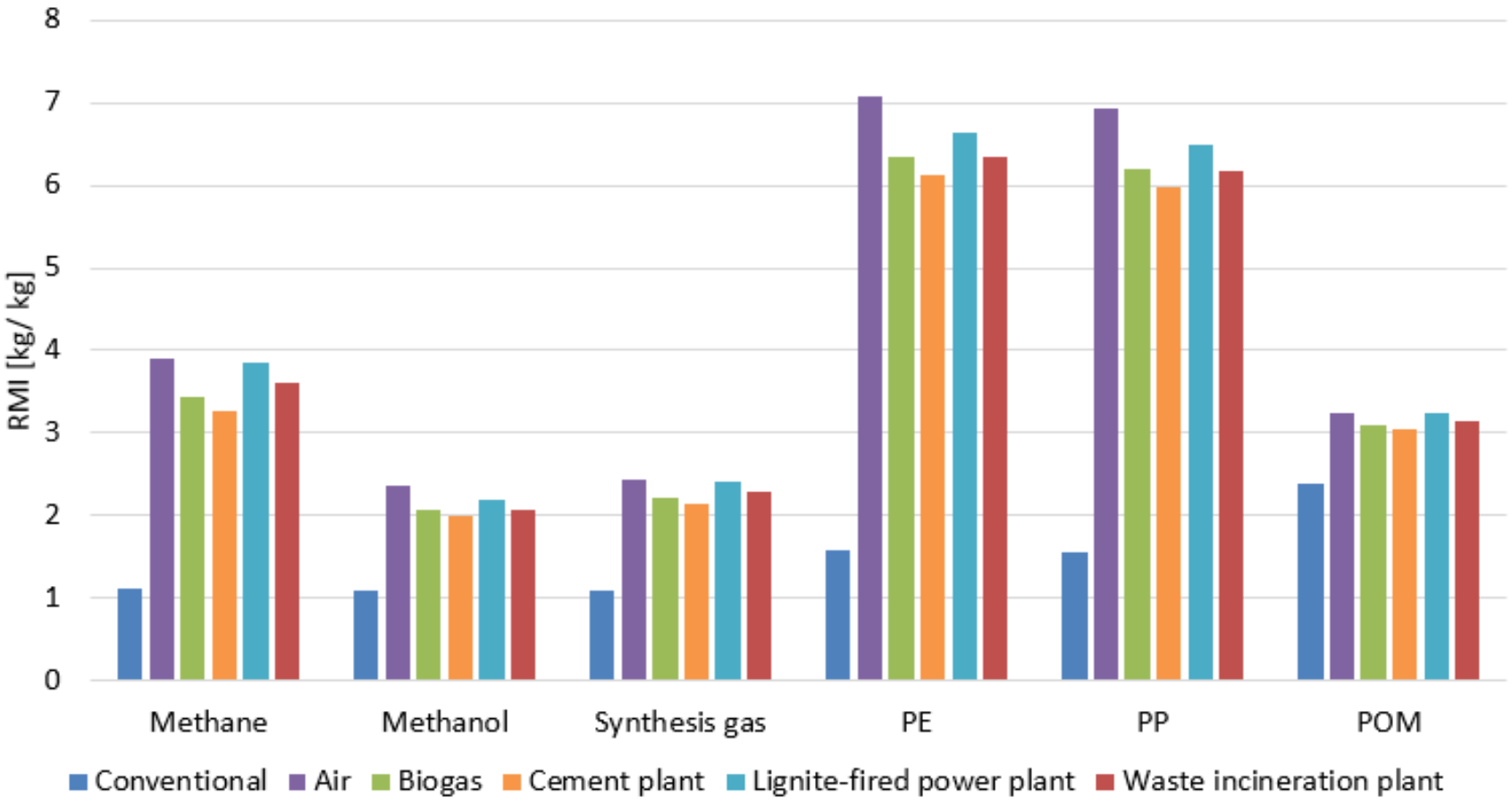
CLIMATE AND ENERGY ASSESSMENT

LCA results: Global Warming Impact (GWI)per energy source
Example: methane and methanol



CLIMATE AND ENERGY ASSESSMENT

LCA results: Raw Material Input (RMI)



CLIMATE AND ENERGY ASSESSMENT

Measuring GHG emission mitigation from CCU: What did we learn?

- Only **production-phase GHG** differ: use-phase, CO2 retention time, and end-of-life are not relevant, except in ETS reasoning.
- Higher **raw material requirements** and **cumulative energy demand** than conventional routes.
- Use of **renewable energy** is determinant for net reduction of carbon emissions.
- CCU can help **circular economy of carbon in chemical industry**, where carbon is needed.

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POSSIBLE ELIGIBILITY CRITERIA FOR CCU-PROCESSES IN THE ETS INNOVATION FUND

Criteria

- Contribution to climate *and* resource policy goals
- A minimum of climate footprint savings (in %) compared to the conventional reference.

Methods

- Climate footprint savings need to be *relatively higher* than additional raw material requirements
- Cradle-to-gate LCA to determine environmental impacts
- Comparison between CCU-product and conventional reference
- Integration of renewable energy supply

Indicators

- Global Warming Impact (GWI)
- Raw material input (RMI)
- Normalized GWI and RMI

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MARKET AND ECONOMIC ASSESSMENT

Market and economic considerations:
Challenges:

- Competition with fossil resources and fossil energy.
- Competition for renewable energy.
- Dependency on policy support (fuels).
- Risk of mismanagement of public and private investments in CCU.

Opportunities:

- European technological advantage.
- Access to new markets is usually not necessary, products are the same.
- Cross-sectoral collaborations (industrial symbiosis).
- Reduction of dependency on import of fossil resources.

REGULATORY ASSESSMENT
MAPPING OF LEGISLATION

Climate and energy	Products and labelling	Waste and circular economy	Environmental pollution	Environmental risk	Environmental impact assessment
Emission Trading System	Ecolabel	Action Plan for CE	Industrial Emissions	Major Accident Hazards	Strategic IA
Monitoring and Reporting	Construction Products	Plastics Strategy	REACH	Environmental Liability	Environmental IA
Accreditation and Verification		Waste Framework	Extractive Waste		
Benchmarking			EPRTR		
Energy Efficiency			Persistant Organic Pollutions		
Renewable Energy			Water Framework		
Fuel Quality			Groundwater Protection		
Carbon Capture and Storage					
Effort Sharing					
Land Use, LU Change and Forestry					

REGULATORY ASSESSMENT
PRODUCT CLUSTERS / LEGISLATION

Climate and energy	Products and labelling	Waste and circular economy	Environmental pollution	Environmental risk	Environmental impact assessment
Emission Trading System	Ecolabel	Action Plan for CE	Industrial Emissions	Major Accident Hazards	Strategic IA
Monitoring and Reporting	Construction Products	Plastics Strategy	REACH	Environmental Liability	Environmental IA
Accreditation and Verification		Waste Framework	Extractive Waste		
Benchmarking			EPRTR		
All clusters Energy Efficiency		Polymers, Minerals	Persistant Organic Pollutions		
Renewable Energy			Water Framework		
Fuels			Groundwater Protection		
Carbon Capture and Storage					
Effort Sharing					
Land Use, LU Change and Forestry					

Legend:

No specific hurdles.

REGULATORY ASSESSMENT

CCU and the EU ETS:

- EU ETS recognises CCU but does not incentivise CO2 capture except for geological storage.
- Capturing installations must still report used CO2 as emitted.

Risk of loophole:

- CCU processes **capture CO2 temporarily**, CO2 is re-emitted after use or disposal.
- ETS sector coverage is limited, the rest is under Effort Sharing.
- Risk to the **environmental integrity of the ETS**: carbon emissions may go unreported when transferred outside of the scope of the ETS.
- ETS MRV **not equipped** to monitor CCU.

REGULATORY ASSESSMENT

Reforming the ETS?

- Options for accurate **MRV of CCU seem costly**.
- Is ETS the right tool?

However, financing becoming available:

- CCU will be financed by ETS **Innovation Fund**.
- Other EU financing programmes could synergetically finance CCU:
  - Horizon 2020
  - European Fund for Strategic Investments
  - European Structural Investment Funds
  - Research for Coal and Steel Fund

Other support mechanisms exist:

- Renewable Energy Directive II recognises CCU fuels from renewable energy and recycled carbon fuels under certain conditions

KEY CONCLUSIONS

- **CCU needs support to be viably developed and deployed.**
- **Each CCU project must prove environmental benefits.**
- **CCU climate mitigation potential limited by available renewable energy, but contributes to circular economy (closing the carbon cycle), replacing fossil feedstocks and reducing fossil imports.**
- **CCU projects cut across sectors (industrial symbiosis).**
- **CCU fuels can store renewable energy otherwise curtailed.**

THANK YOU

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