

C123 Techno-economic and sustainability assessment of process routes to C3 products from methane

Mieke Nieder-Heitmann

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VALORISING METHANE RESOURCES

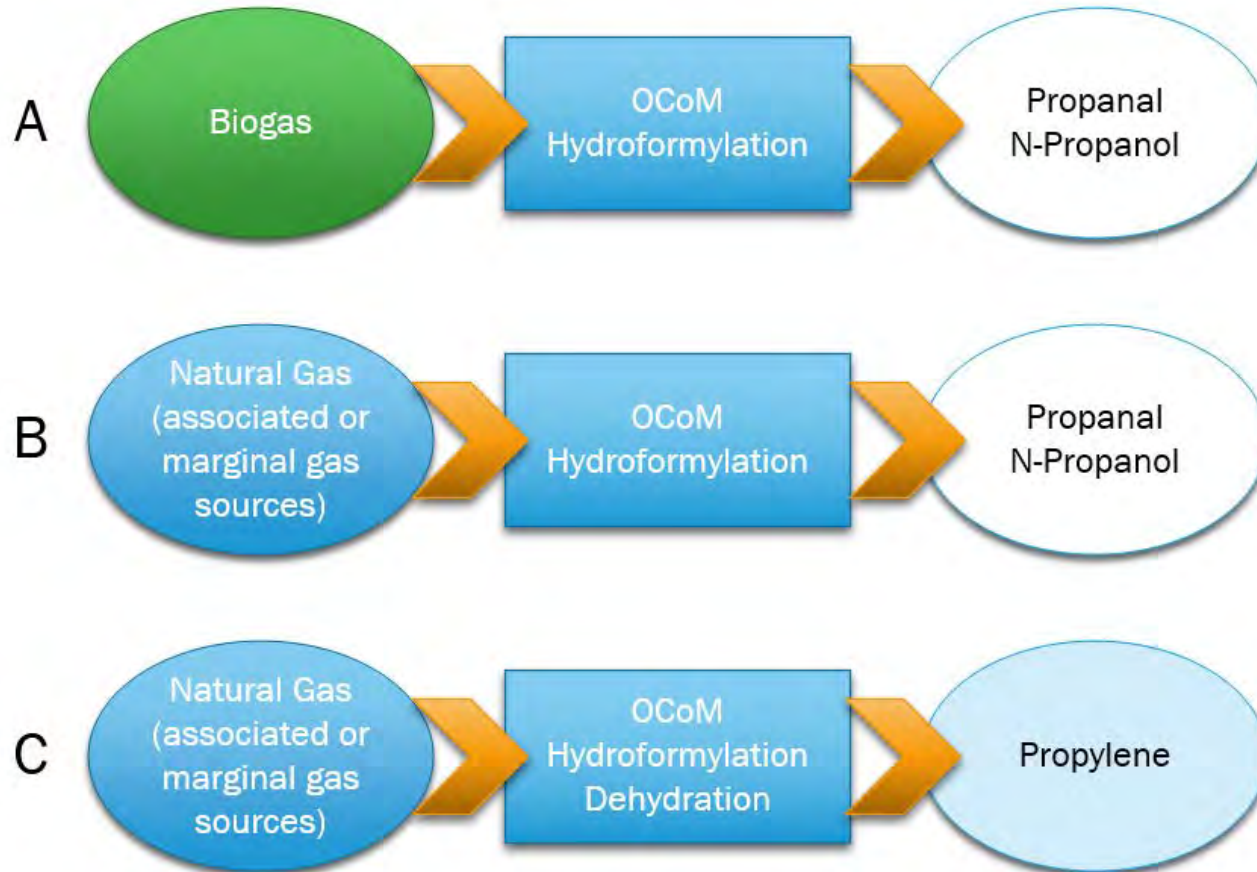
Techno-economic and sustainability assessment objectives

1. To set the **industrial baseline** for the techno-economic analyses and sustainability assessments of the C123 scenarios
2. To **validate the technical and economic feasibility** of the C123 process scenarios at two different scales of capacity
3. To **perform environmental life cycle analysis (eLCA)** of the developed C123 scenarios

Objective 1: Industrial baseline for the scenarios

- Differences between scenarios include
 - Feedstock
 - Location
 - Production scale
 - C3 product
- These parameters will impact the process design and the techno-economic evaluation and environmental assessment results

C123 Scenarios



Feedstock and Location

- Generally accessible, unexploited, cheap methane resources (stranded gas (CH_4) and biogas ($\text{CH}_4 + \text{CO}_2$))
- Stranded natural gas
 - Associated gas
 - Marginal gas or remote fields
 - Deep off-shore reserves
- Biogas
 - Landfill sites
 - Anaerobic digestors

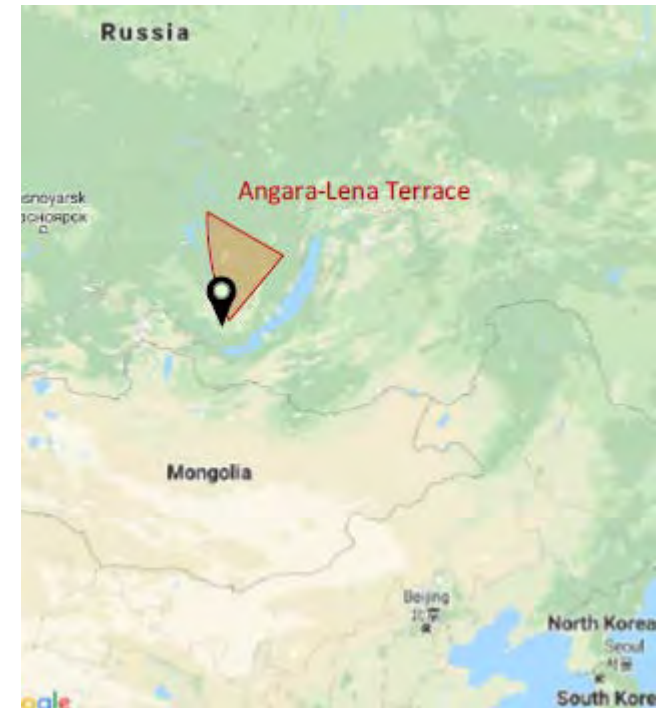
C123 Scenario A

- Feedstock: Biogas
- Location: Germany
- Scale: Modular (~ 10 kt/yr)
- Products: n-propanol
- **Impact on process configuration**
 - Technology selection
 - Biogas composition
 - By-products can be sold
 - Transport of raw materials and products
 - Utilities



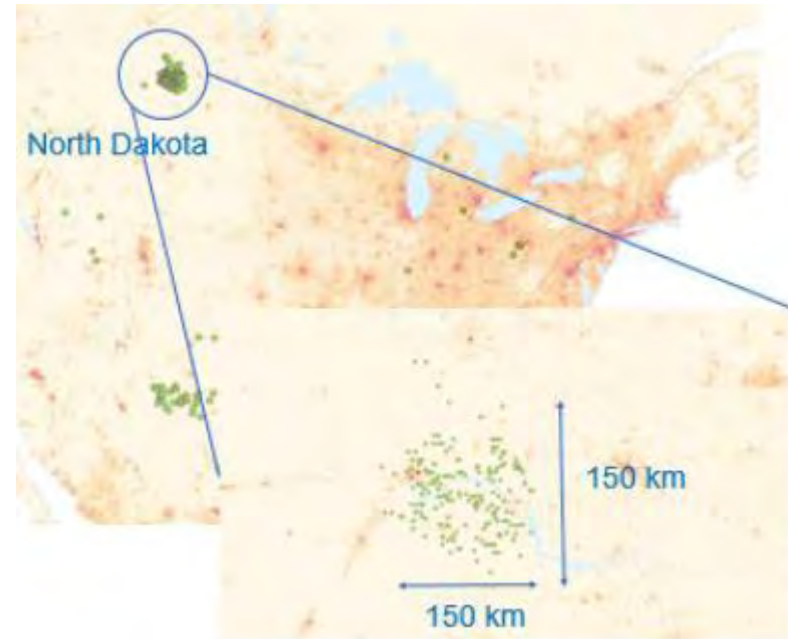
C123 Scenario B1

- Feedstock: Marginal gas
- Location: Russia
- Scale: Modular (~ 10 kt/yr)
- Products: n-propanol
- **Impact on process configuration**
 - Technology selection
 - Close to an existing refinery (📍 on map)
 - Use of existing refinery's infrastructure
 - E.g. raw materials, utilities, waste generated
 - C3 product could be processed further in the existing refinery



C123 Scenario B2

- Feedstock: Associated gas
 - Location: North-Dakota, USA
 - Scale: Modular (~ 10 kt/yr)
 - Products: n-propanol
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- **Impact on process configuration**
 - Technology selection
 - Highly remote area: self-sufficient plant (utilities)
 - Minimum waste or by-products generated
 - C3 product to be transported to market(s)



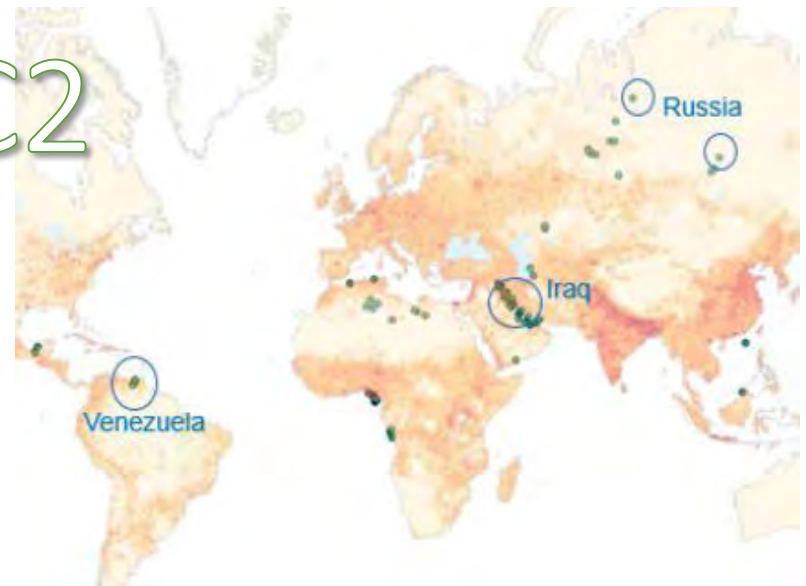
C123 Scenario C1

- Feedstock: Marginal gas
 - Location: Azerbaijan, Absheron gas field in the South Caspian Basin
 - Scale: Add-on unit (200 – 500 kt/yr)
 - Products: Propylene
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- **Impact on process configuration**
 - Technology selection
 - NG pretreatment can be centralized
 - Use of existing refinery's infrastructure
 - Brownfields
 - E.g. raw materials, utilities, waste generated



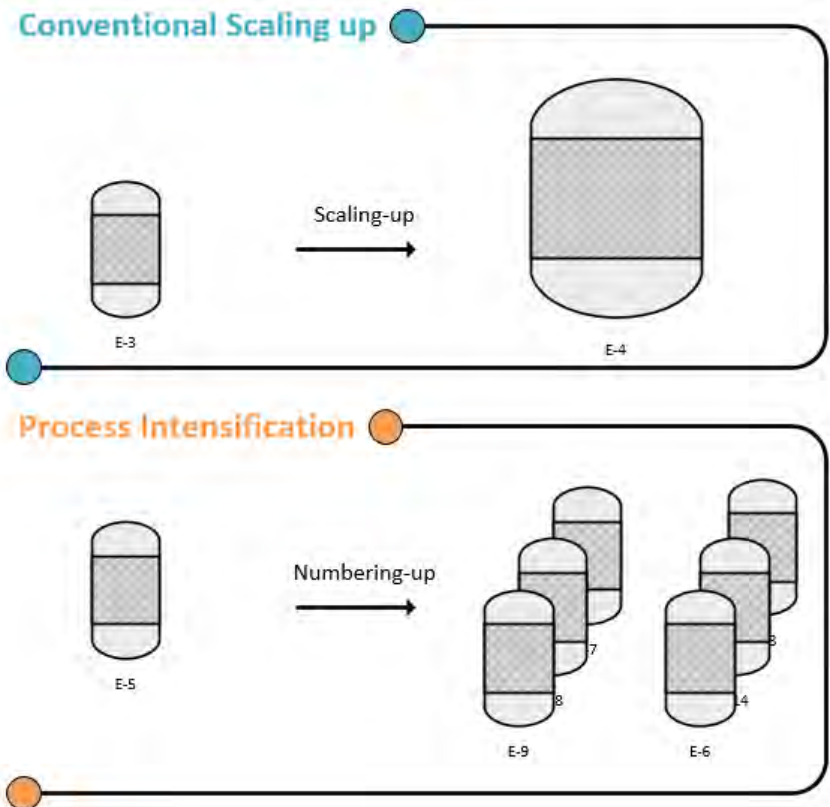
C123 Scenario C2

- Feedstock: Associated gas
- Location: Middle east
- Scale: Add-on unit (200 – 500 kt/yr)
- Products: Propylene
- **Impact on process configuration**
 - Similar to Scenario C1
 - Pipelines may need to be installed



Objective 2: Techno-economic assessment

- PROSYN™ Costing
 - Capital and operational costs (CAPEX & OPEX)
 - Manufacturing costs
- Modular concept
 - Economies of scale
 - Row housing

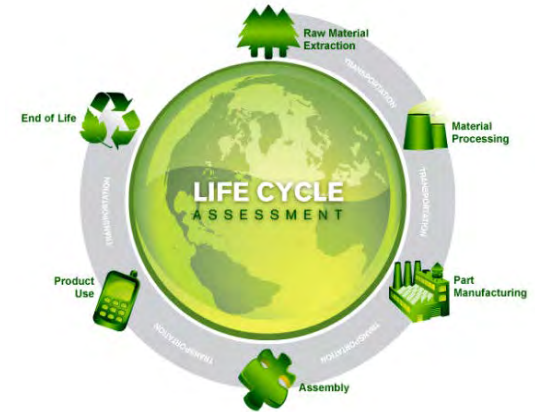


Techno-economic assessment

- Preliminary TEA done on Scenario A & B:
 - In Scenario A, by-products can be sold
 - In Scenario B, cheaper, cost-effective O₂ producing technology is required
 - Product costs are in the correct order of magnitude (n-propanol market price is 1680 \$/t) (results look promising)
- Future work:
 - N-propanol production volumes
 - Reactor concept(s) and catalyst costs
 - Heat integration and optimization done with OCoM reactor concept

Objective 3: Environmental Life Cycle Analysis

- Cradle to gate
- Methods
 - Attributional approach
 - Alternative approach with system expansion
- C123 LCA results are benchmarked against state of the art technologies, i.e. reference cases
- Functional unit is 1 kg of product
- Resource efficiency analysis
 - Exergy analysis
 - CEENE-method



Preliminary LCA results – GHG emissions

- For the biogas **C123 Scenario A**



Foreground (C123-process)

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Background (supporting processes)

- Electricity from German grid
- Oxygen production via cryogenic air separation
- Heat, district or industrial, natural gas with boiler
- Maize silage production
- Cooling energy for absorption chiller
- Heat, district or industrial, natural gas, conventional power plant

- For the natural gas **C123 Scenario B1 & B2**



Foreground (C123-process)

- Propanol from marginal gas via C123-technology

Background (supporting processes)

- Oxygen production via cryogenic air separation
- Marginal gas extraction
- Steam production in chemical industry
- Heat, district or industrial, natural gas with boiler
- Cooling energy with absorption chiller
- Heat, district or industrial from light fuel oil in industrial furnace
- Electricity production, natural gas, conventional power plant

Avoiding flaring can reduce GHG emissions and emissions of harmful components for humans such as NO_x, CO, SO₂, etc.,

Acknowledgements



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Thank you for your attention!