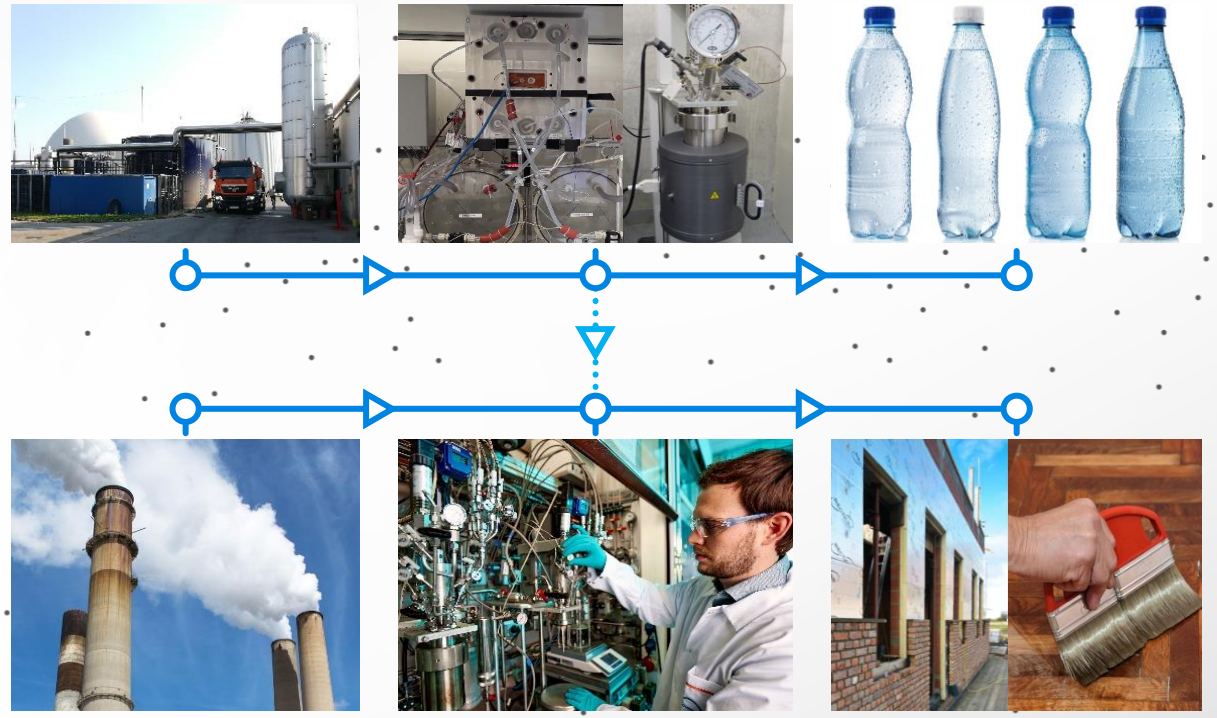

LESSONS LEARNT

Dr. Liv Adler, Coordinator Carbon4PUR
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Laboratory to demonstration

- **Analytics** is easily underestimated
- **Computational chemistry** and support by **reaction kinetics & thermodynamics** accelerate the identification of suitable candidates for catalysts, solvents, etc.
- **Pilot plant trials** could differ to **lab trials**
- The development of an idea to a product **takes time**

Manage expectations on up-scaling

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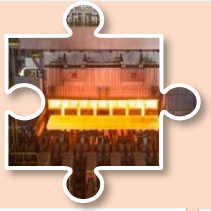
Parallel development along the value chain

CO/CO_2



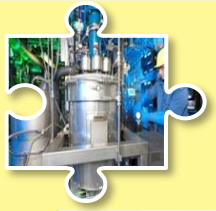
Commercial

Gas cond.:
TRL 1→3
TRL 2→6

INTERMEDIATES & POLYOLS PRODUCTION

New CO_2-polyols:
TRL 2 → 4

CO-intermediates:
TRL 2→ 5



CO-polyols:
TRL 3 → 6

PRODUCTS & APPLICATION

Ins. Boards:
→TRL 6

Coatings:
→TRL 6

CO_2 SUPPLY

→ Mature
→ But diff. purpose

ELECTROCATALYTIC CONVERSION

→ Stability
→ Selectivity
→ Current density

ETHYLENE ENRICHMENT

→ Selectivity
→ Energy demand

CHEMICAL CONVERSION

→ Stability
→ Compati-bility

- Combining technologies of **different technology readiness levels** (TRL)
- Individual steps with individual challenges; interfaces additional challenges
- Model gas mixtures & commercial available intermediates allowed **detailed investigation** of single steps **in parallel to accelerate overall project**; but only to limited extent

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Interaction along the whole value chain

LCA, economic and social analysis

Parallel technology development & assessment

→ Every decision influences all process steps

→ Development in **scenarios**

→ Data are dynamic and typically available late in project

→ **Agile and iterative assessment,** hot spot & sensitivity analysis

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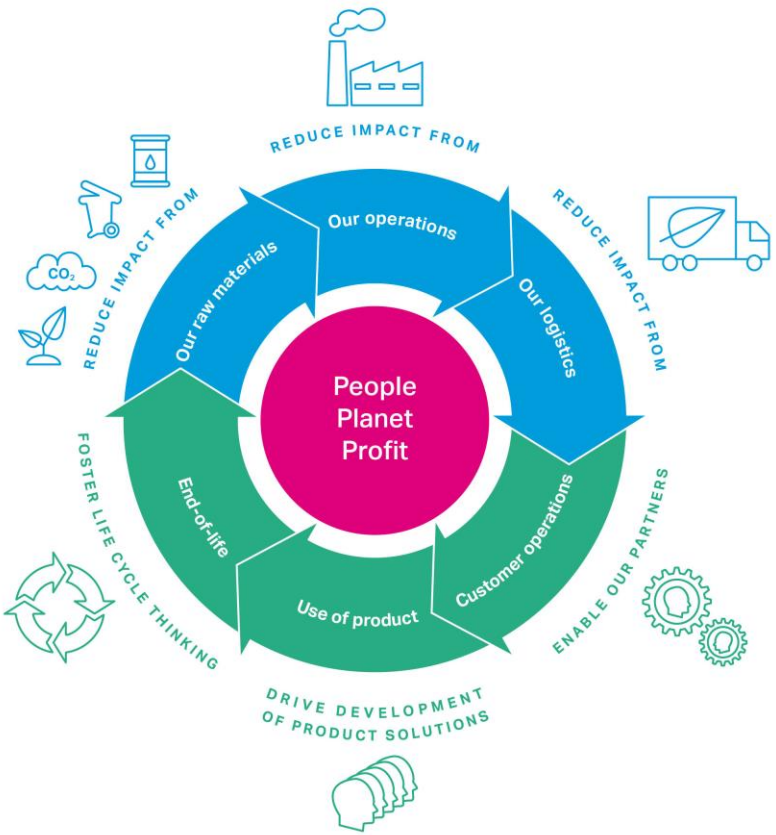
Technology assessment in scenarios



- Keep certain **parameters fixed & data sets consistent** (wording, units, e.g. mol% vs mass%)
- **Prioritize** and start assessment with the most promising scenario
- There might be more than one benchmark
  → **Iterative selection of references**
- Clear documentation & easy visualization
- Common understanding necessary: **LCA & economic assessment** at middle TRL are still **preliminary snap-shot results**, which **will further develop** towards higher TRL (as will the references)

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Products and markets

- **Allocation**: How to allocate environmental/economic benefits and burdens along the value chain?
- **Technical and marketing dependencies:** How could two CO_2-based and CO-based products be reasonably combined with regards to the efficient gas conversion and to market needs?
- What is the **value for the customer**?
  → Performance & costs
  → Fossil production is highly optimised
  → Sustainable products currently in niches

Entrance into market by legislation needed

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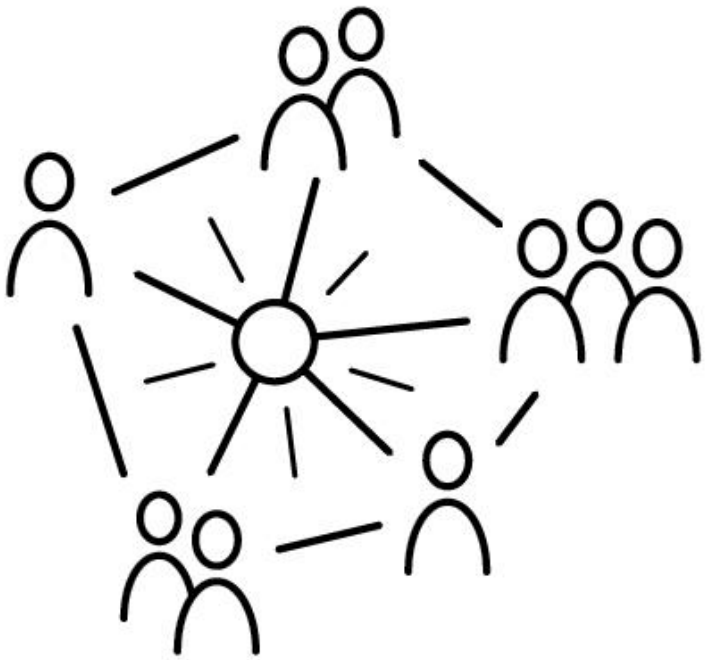
Collaboration

Not one idea alone, but **many projects and products combined** can lead towards a fully sustainable circular economy



- The **style of communication** can vary with cultural backgrounds
- Be aware of different **scientific languages** of chemists, engineers, lawyers, … → interdisciplinarity
- Balance single vs. common **interests**
- Be open for different **perspectives**
- **Trust** is key for open innovation
- **Dare to discuss** preliminary results

Manage expectations towards realistic ambitions

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Thank you for your attention

A great Thank you to the EC for funding and of course to all collaboration partners

Carbon4PUR

Consortium meeting, Leverkusen, Germany, Sept. 2019

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FINAL SYMPOSIUM JOINTLY ORGANIZED BY Carbon4PUR AND CO2EXIDE