

'TEMOIGNAGE' STUDY CCUS CIRAIG

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CCUS R&D in Total, LCA activities, benefits and challenges

- CCUS R&D in Total: ~100 people, 100 M€/y budget, covering CO₂ capture, transport, CO₂ conversion, EOR, CO₂ storage, maturity between TRL 1 to 6.
- LCA assessments have been performed on low TRL technologies to:
 - Analyze hot spots (→ future R&D activities suggestions)
 - Benchmark different R&D pathways for same objective (prioritize/remove pathways)
 - Shape business case (identifying better region for technology implementation)
- Why LCA?
 - Make sure we are on good pathways (positive environmental impact on society)
 - Make comparison possible (through same functional unit)
 - Better prepare future business case
- Challenges:
 - Data availability
 - Database evolution
 - Communication of LCA results to non-LCA audience in company
 - Society vs company scope

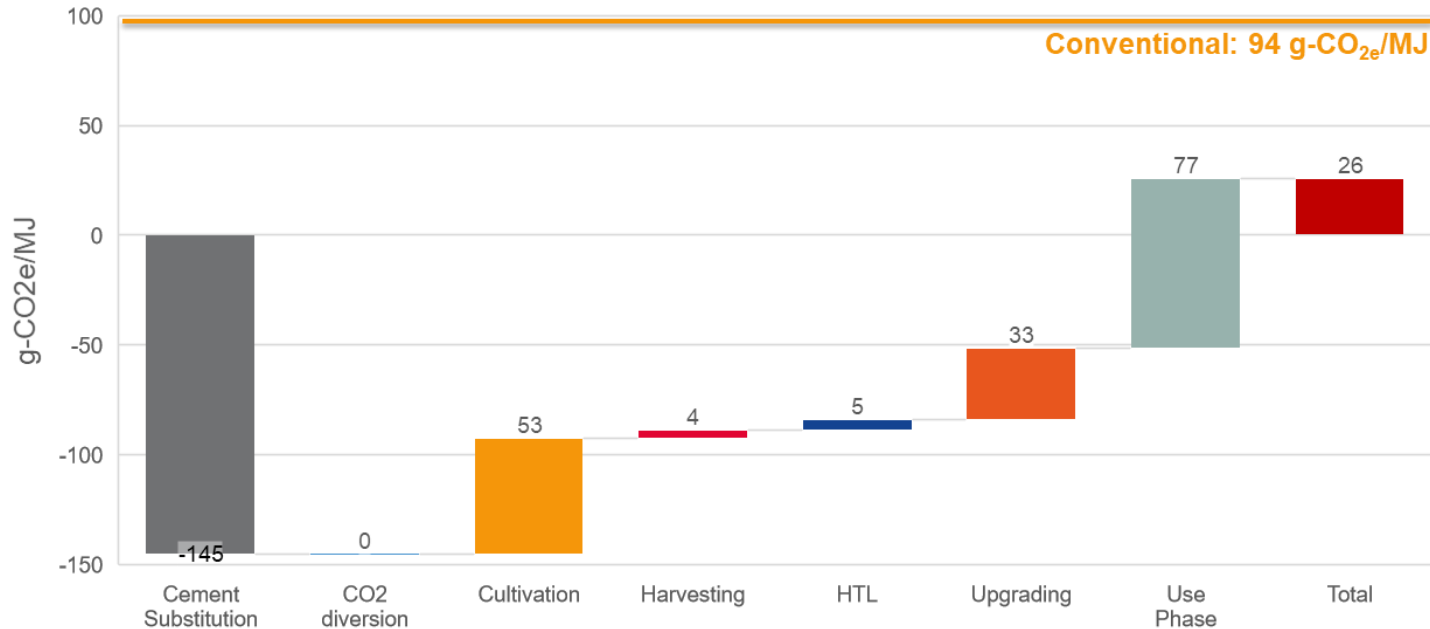
How CIRAIG study is helpful for us?

- Confirm we use good guideline, confirm methodological challenge is for CCU but not for CCS.
- Confirm our methodological choices, for CCU (scope, functional unit, multi-functionality, etc.).
- Clarify the issue between methodology and policy (overall positive impact on society vs who gets credit).
- Confirm our vision: a close interaction between process development team and LCA team is necessary to ensure data accuracy and LCA credibility.
- Give some ideas to enrich our future works:
 - Dynamic LCA for long-lived CCU products
 - Use of Socioeconomic pathways for prospective LCA of low TRL technologies

Illustration: using LCA to analyze hotspot and propose future R&D activity

- **CO₂ to microalgae to biofuel LCA:**

GHG emissions of biofuel production and use
(French grid with heat recovery)

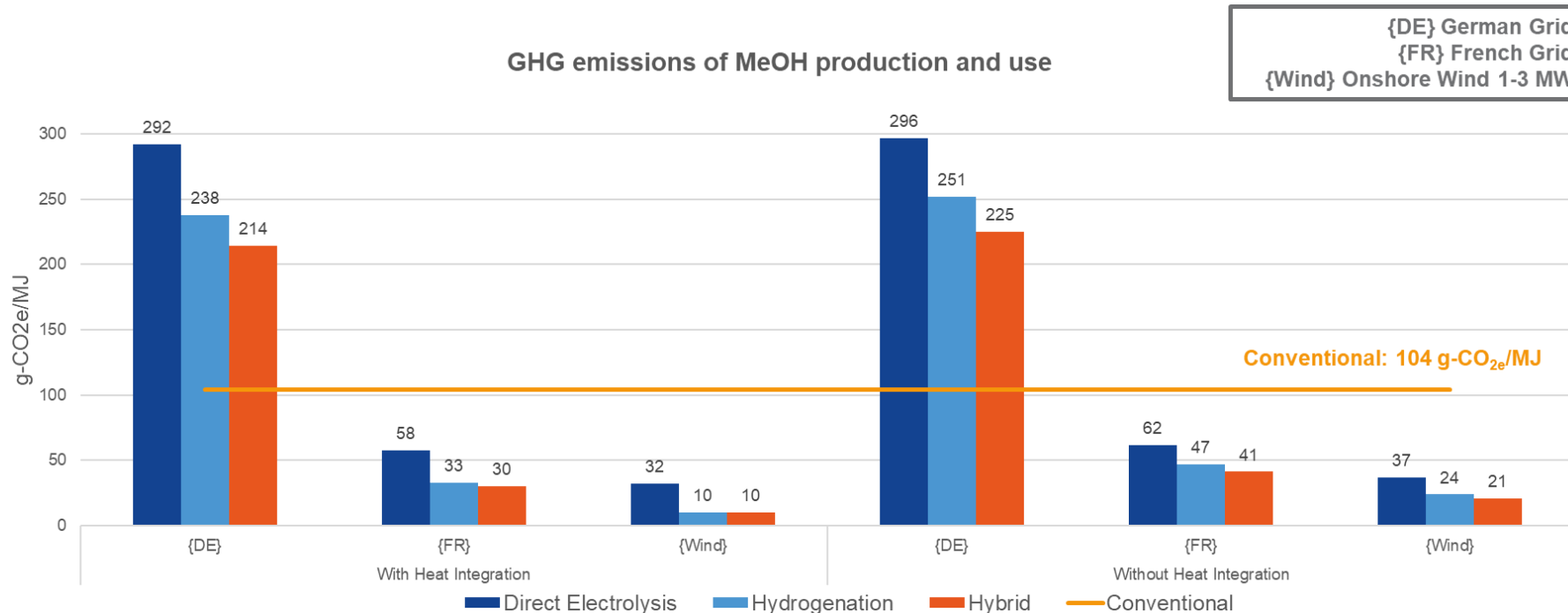


- Cradle-to-grave
- Goal: Hot spots identification
- Midpoints + damages assessed
- Sensitivity analysis on energy supply
- Reviewed by external LCA expert

Conclusion: R&D should focus on improving cultivation and upgrading performance

Illustration: using LCA to benchmark 3 pathways under different electricity origin

- CO₂ to MeOH 3 pathways benchmark LCA



- Cradle-to-grave
- Goal: Benchmark + hot spots
- Midpoints + damages assessed
- Several scenarios (electricity mix, heat integration)

Conclusion: Low carbon power is needed, whatever the CCU pathway considered