

Innovative Prozesstechnologien und ihr Beitrag zur Dekarbonisierung der energieintensiven Industrie in Europa

Tobias Fleiter

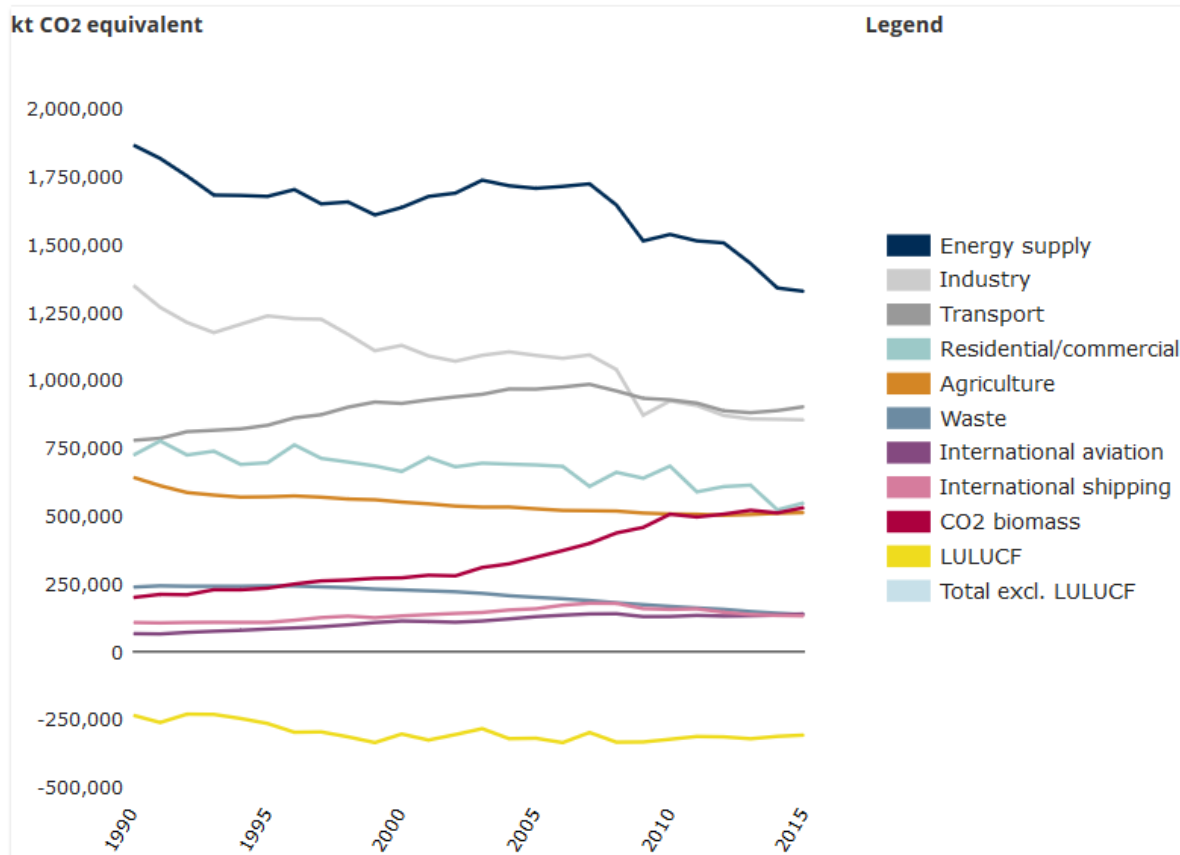
Fraunhofer Institut für System- und Innovationsforschung

VDI Expertenforum Emissionshandel, 13.11.2018, Düsseldorf

AGENDA

1. Introduction: Challenges in industry decarbonisation
2. Innovations for deep decarbonisation
3. Scenarios for decarbonisation towards 2050
4. Conclusions

Industry GHG emissions about 19% of EU total in 2015

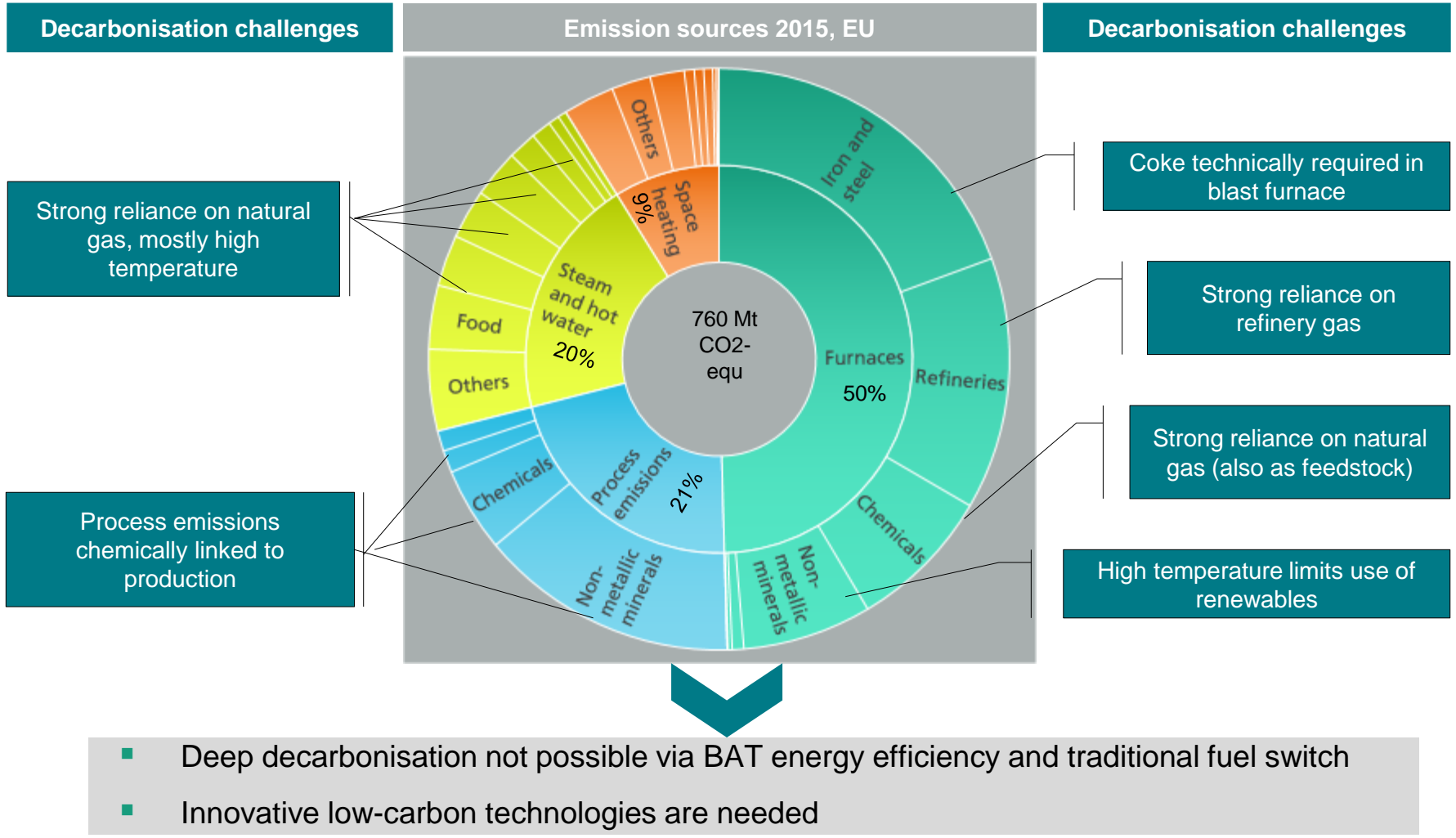


Industry sector:

- Industry in 2015 about **19 % of total GHG** emissions
- **37% reduction** from 1990 to 2015 in industry sector
- **EU Low-Carbon Roadmap** from 2011 requires emission **reduction of 83-87%** by 2050 for all sectors

Source: EEA

Today's available technologies are not sufficient for decarbonisation



Many process innovations are under development

Grass paper (Creapaper)

Grass based fibres replacing wood fibres

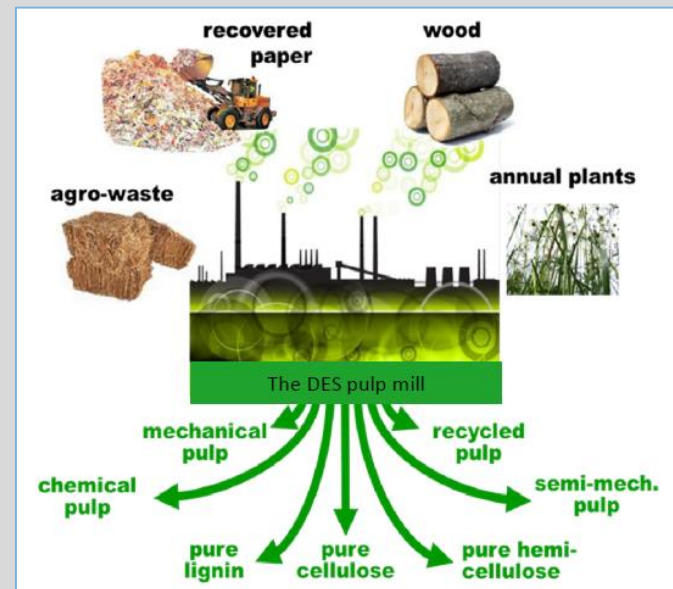


Source: <http://www.graspapier.de/>



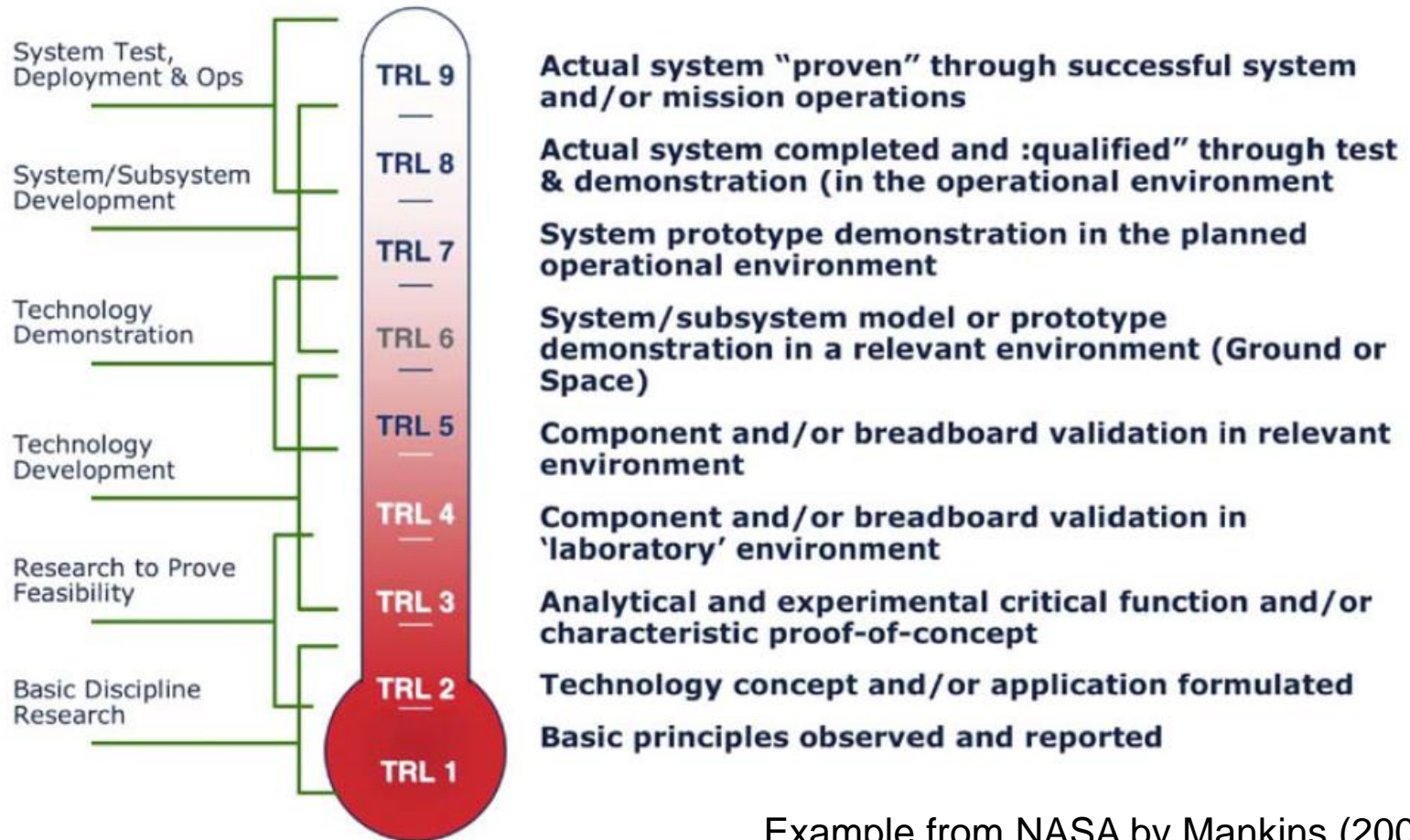
Hybrid

Deep Eutectic Solvents (Provides)
Dissolving ligno-cellulose raw material as used for paper production



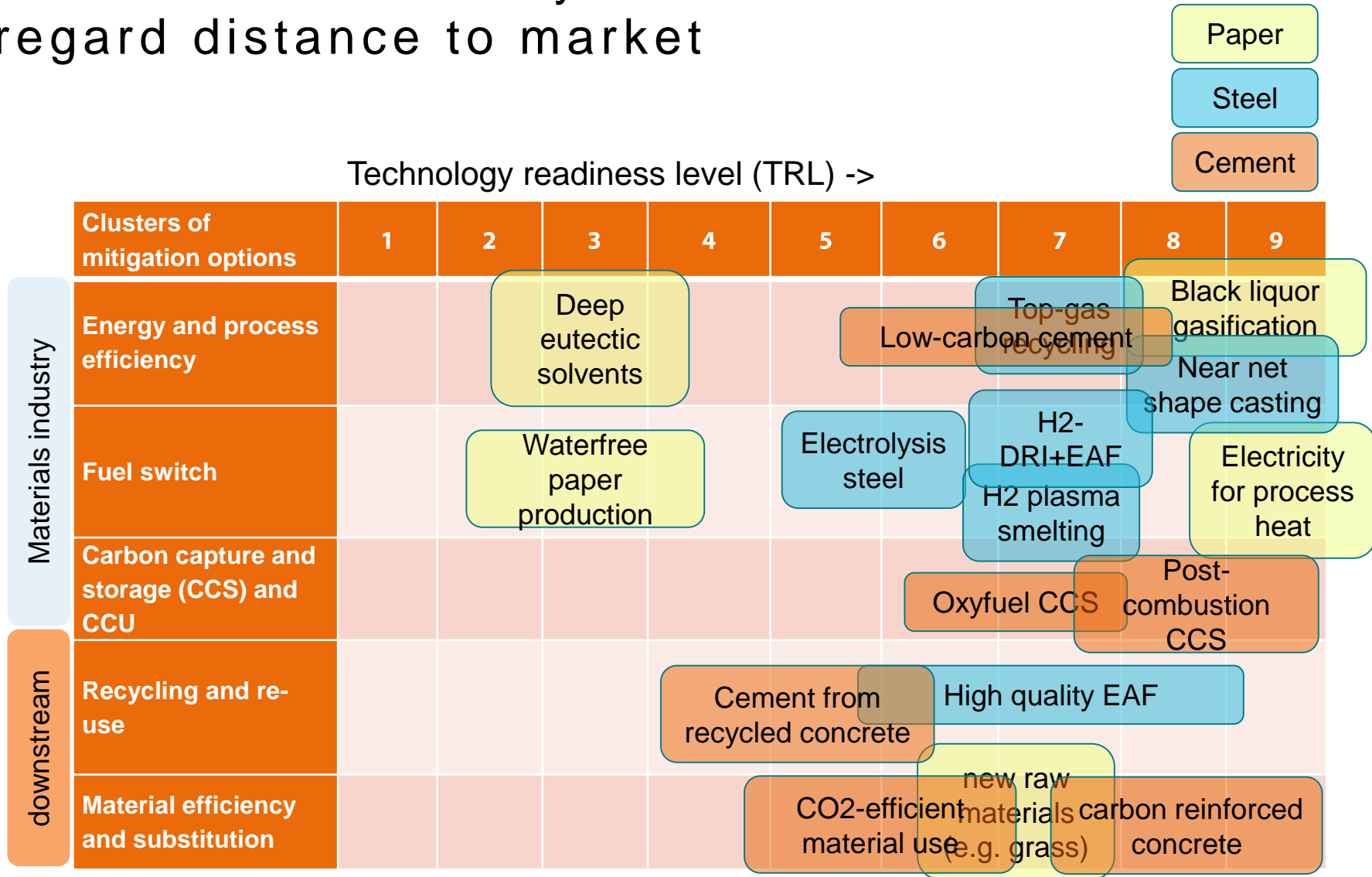
Source: Towards the EU ETS Innovation fund workshops (online available)

Use technology readiness levels (TLR) to measure distance to market entry



Example from NASA by Mankins (2009)

TRLs reveal diversity of innovations with regard distance to market



3 scenarios are simulated with bottom-up model FORECAST

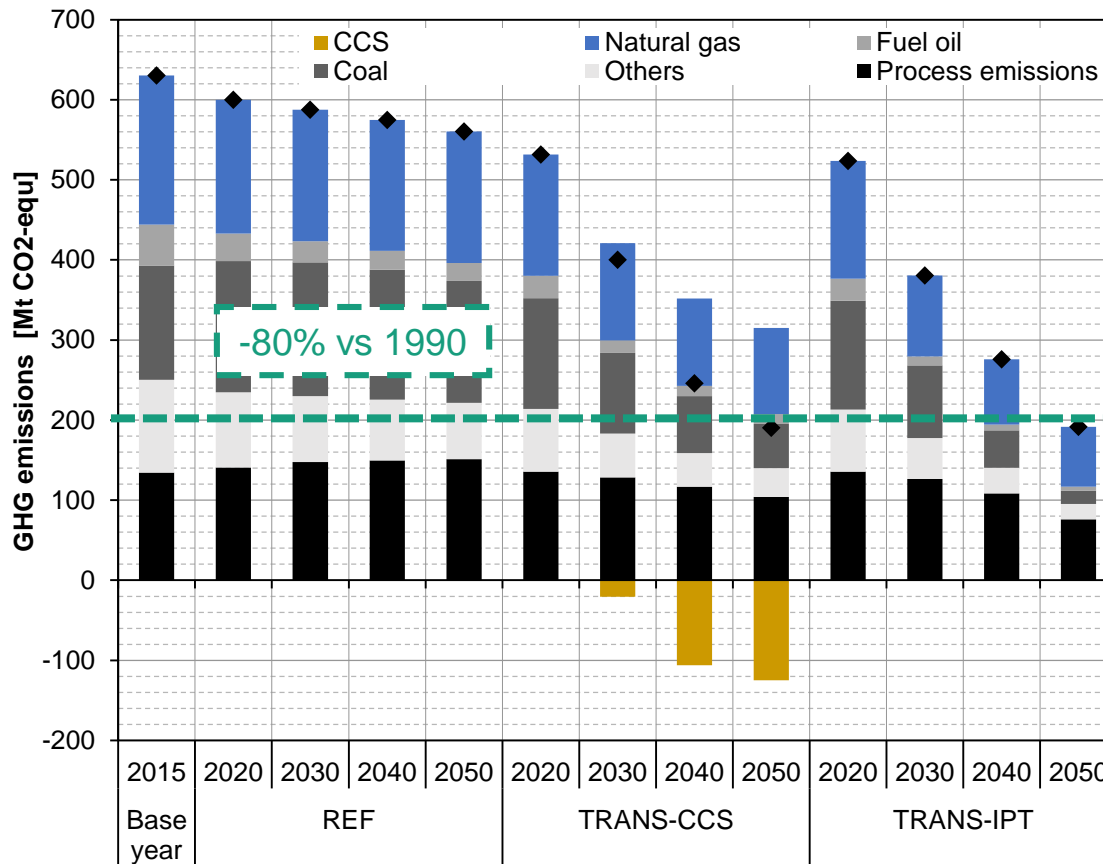
Scenario definition			
Mitigation options	REF	TRANS-CCS	TRANS-IPT
Energy efficiency	According to current policy framework and historical trends.	Faster diffusion of incremental process improvements (BAT & INNOV \geq TRL 5).	= TRANS-CCS + selected radical process innovations (INNOV \geq TRL 5)
Fuel switch	Fuel switching driven by energy and CO ₂ -prices	Financial support for Fuel switching to biomass and PtH	= TRANS-CCS + Higher financial support for biomass and PtH
CCS	-	CCS for major processes	-
Recycling and re-use	Slow increase in recycling rates based on historical trends .	Faster increase in recycling (e.g. steel, aluminium, paper).	= TRANS-CCS
Material efficiency and substitution	Based on historic trends.	Increase in material efficiency & substitution.	= TRANS-CCS

Simulation

- Bottom-up simulation
- High technology detail
- Country level
- Policy instruments

Results: CO2 reduction of >80% possible – without CCS

EU 28 industrial GHG emissions by scenario



Reference scenario (REF):

- Slow decrease in GHG, driven by energy efficiency, some recycling and fuel switch away from fuel oil

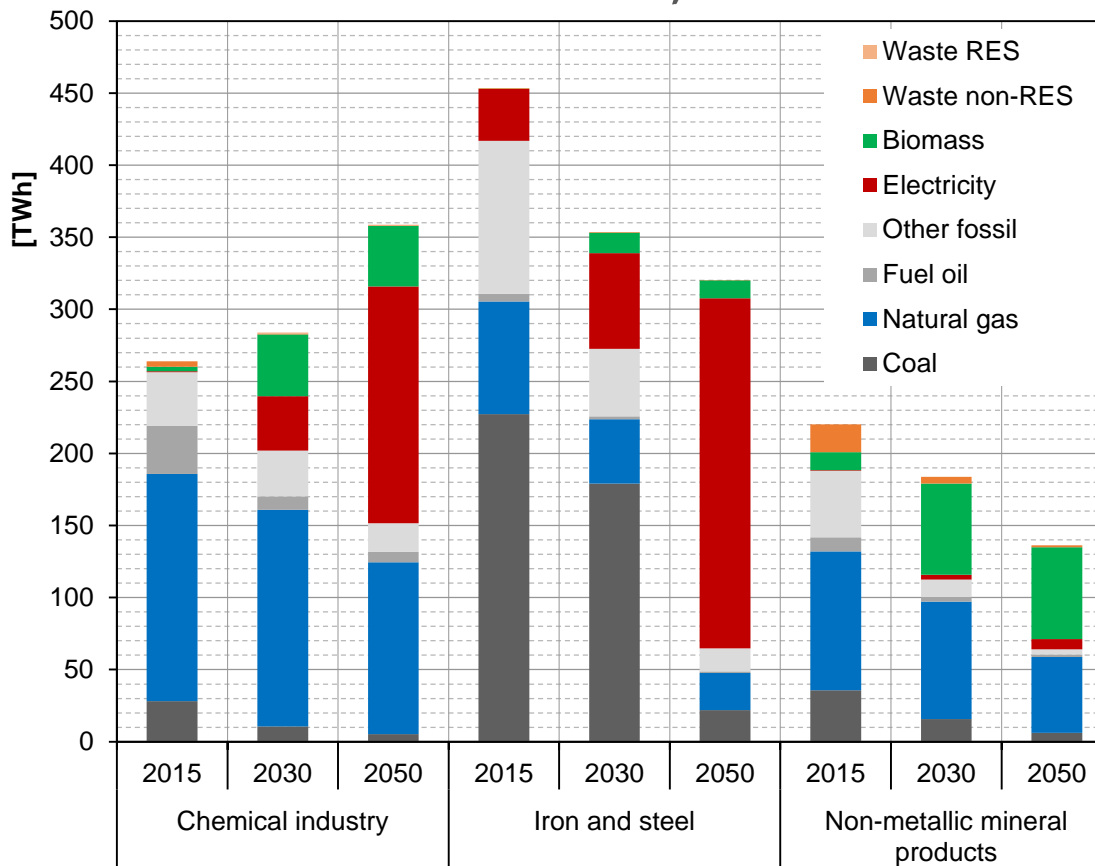
Scenarios TRANS-CCS and TRANS-IPT:

- Reduction in industrial GHG emissions:
 - ~70% by 2050 compared to 2015
 - ~83% by 2050 compared to 1990
- Remaining challenges:
 - Process-related emissions
 - Remaining natural gas

Source: FORECAST

Decarbonisation (without CCS) increases electricity demand drastically

**Final energy demand for process heating (>500°C)
scenario TRANS-IPT, EU28**

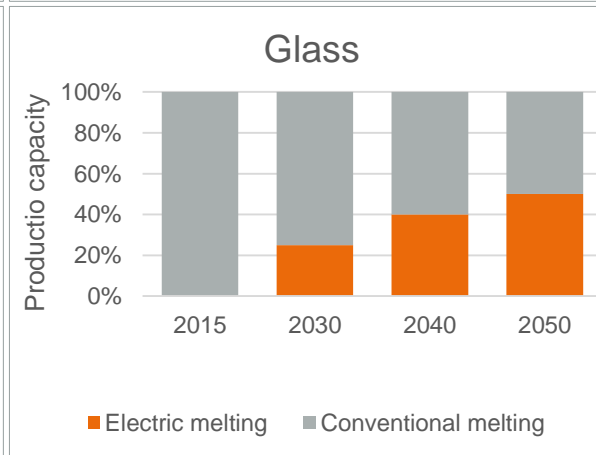
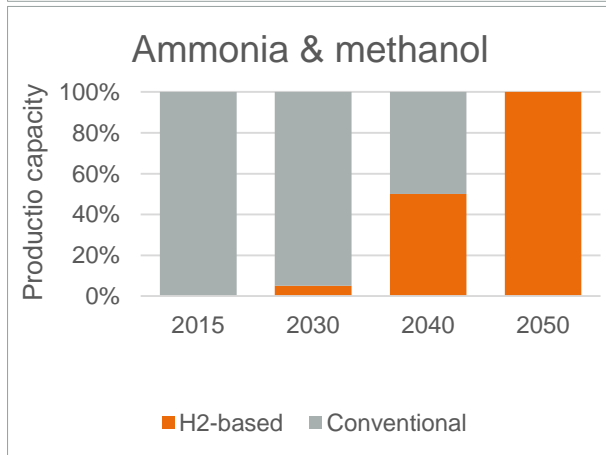
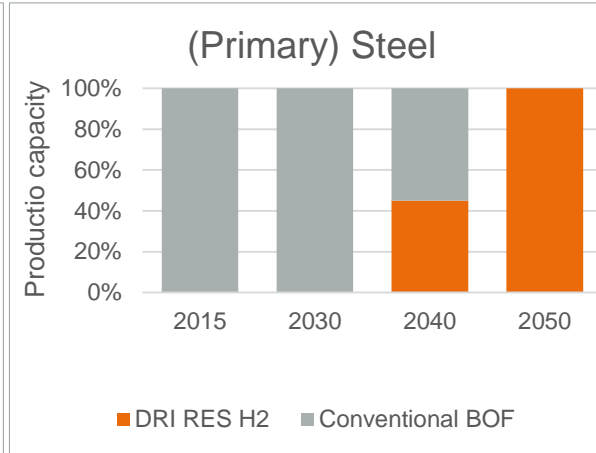
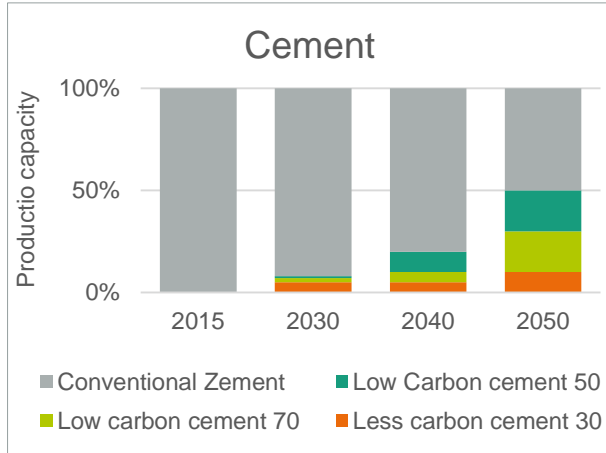


Fuel switch in TRANS-IPT scenario:

- Definition: Hydrogen accounted as electricity with 70% efficiency
- Increase in electricity driven by radical process switch (e.g. H2-Direct Reduction replacing Basic oxygen furnace steel)
- Biomass often co-firing in existing processes (e.g. clinker kiln)
- Timing: Biomass before 2030 and electricity/hydrogen after 2030
- High financial support for biomass, PtH and H2 needed (CO2 price was not sufficient)
- Across all sectors and scenario still a substantial amount of natural gas is used

Source: FORECAST

Scenario TRANS-IPT requires fundamental change in process technologies



Assumptions

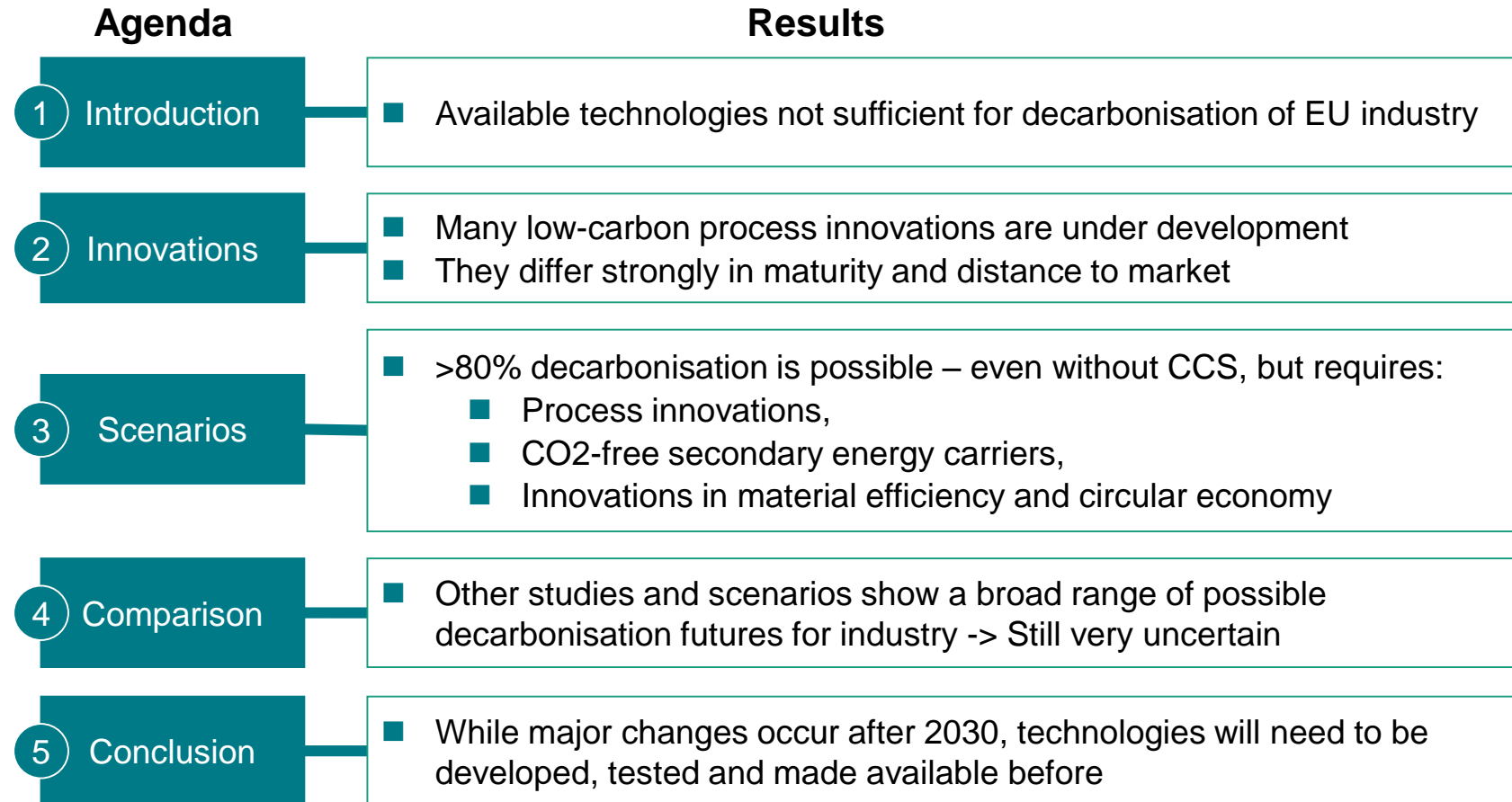
- Market entry in 2030
- Reaching saturation in 2050
- Requires replacement of entire capital stock within only 20 years
- Technologies need to be ready for fast market introduction by 2030

Comparison: Relevance of technologies varies across studies for Germany

Comparison of selected industry decarbonisation studies for Germany

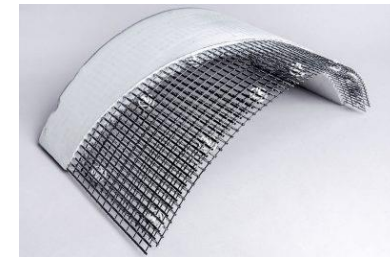
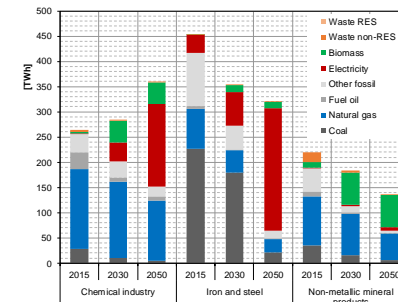
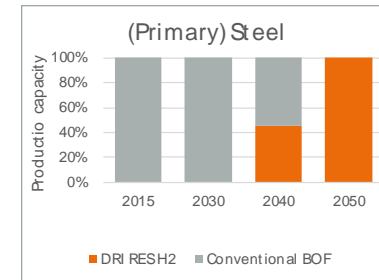
Scenario	GHG reduction	Energy efficiency	Biomass	PtH	PtG	CCS	New processes	Circular economy	Material efficiency & substitution
BMUB KS95	-99%	High	High	Low	None	High	Low	High	Low
UBA THGND	-95%	High	None	High	High	None	High	High	None
BDI 95%Pfad	-95%	High	High	None	Low	High	None	Low	None
BMWi Langfrist	-84%	High	High	Low	None	High	Low	High	Low
BMUB KS80	-75%	High	High	Low	None	None	None	Low	None
BDI 80%Pfad	-65%	High	High	None	None	None	None	Low	None

Summary: Innovations facilitate decarbonisation of EU industry



Is the EU ETS sufficient to achieve deep decarbonisation of industry?

- Phase 4 needs to make the process innovations ready for large-scale **market entry in 2030** latest
- The EU ETS needs to make new solutions **cost-effective**, e.g. technologies with high operational costs due to hydrogen or electricity use
- The ETS needs to generate sufficient trust to allows for **billion euros investments** to take place
- Innovations in material efficiency and circular economy require effective **price signals along the entire value chain**



Thank you for your attention!



Further material:

- **Set-Nav Issue Paper on industry**
- **Set-Nav Report on industry**

Available at:

<http://www.set-nav.eu/content/pages/results>

-> „Energy Systems: Demand perspective“