Innovative process technologies and their contribution to decarbonise the EU industry sector

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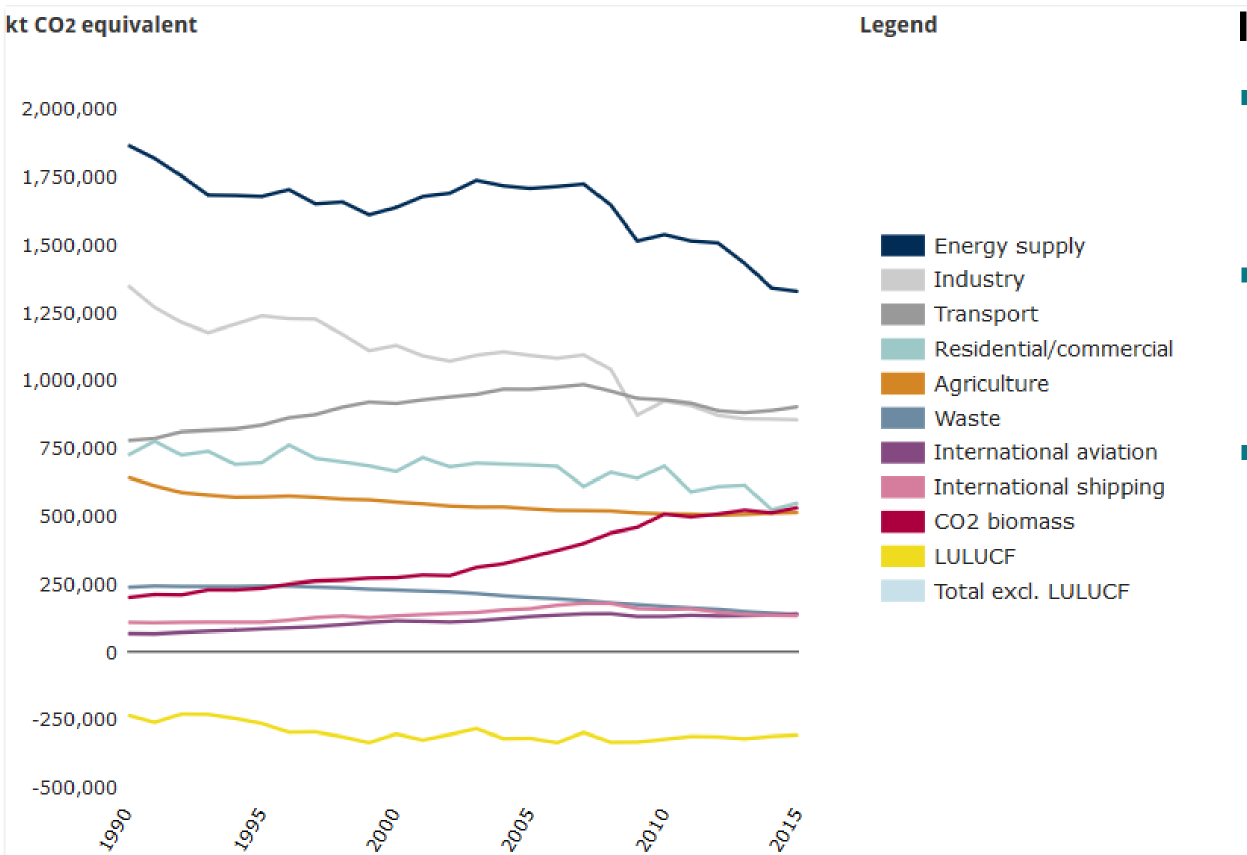
Climate Recon Webinar, November 26

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



Source: EEA

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

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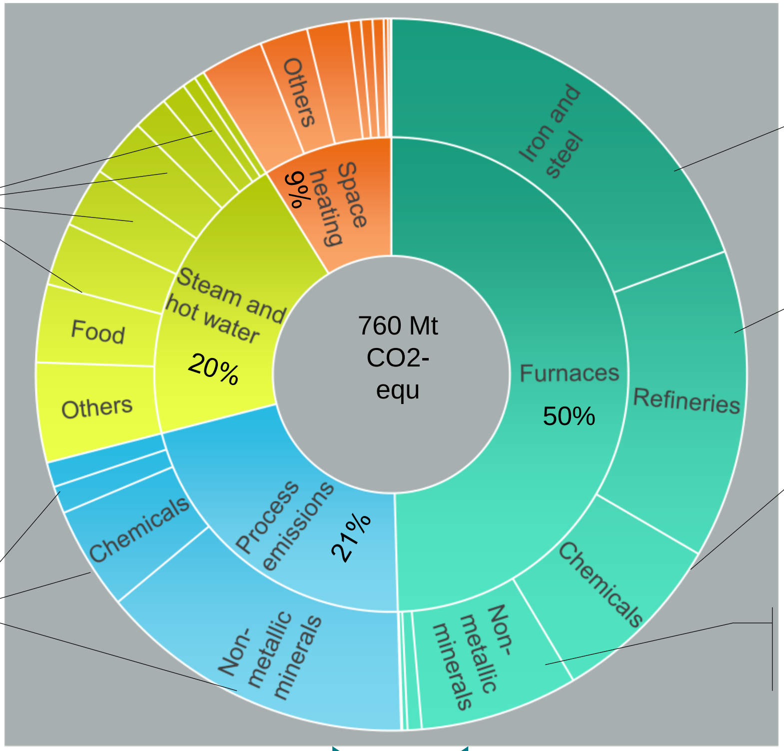
Today’s available technologies are not sufficient for decarbonisation

Decarbonisation challenges	Emission sources 2015, EU	Decarbonisation challenges

Strong reliance on natural gas, mostly high temperature

Process emissions chemically linked to production



Coke technically required in blast furnace

Strong reliance on refinery gas

Strong reliance on natural gas (also as feedstock)

High temperature limits use of renewables

- Deep decarbonisation not possible via BAT energy efficiency and traditional fuel switch
- Innovative low-carbon technologies are needed

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Many process innovations are under development

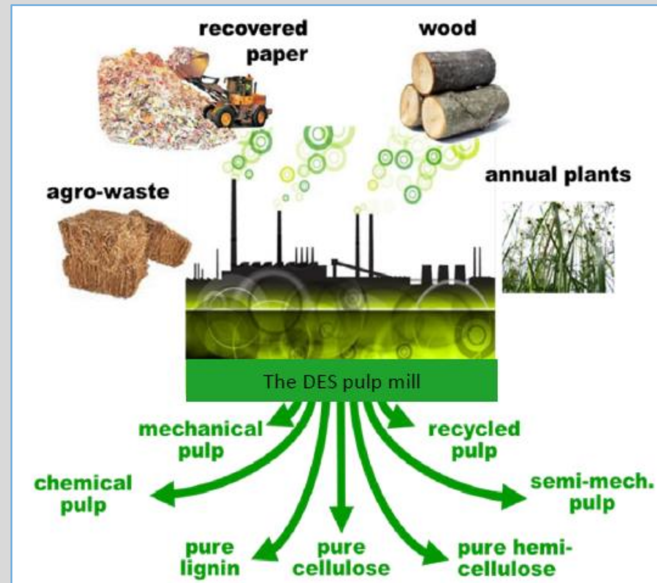
Grass paper (Creapaper)

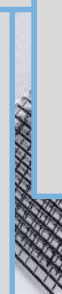
Grass based fibres replacing wood fibres

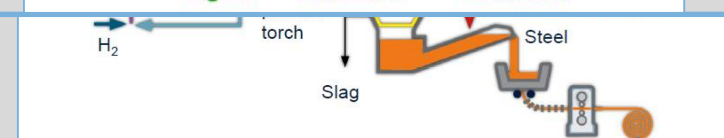
Source: http://www.graspapier.de/

Deep Eutectic Solvents (Provides)

Dissolving ligno-cellulose raw material as used for paper production







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

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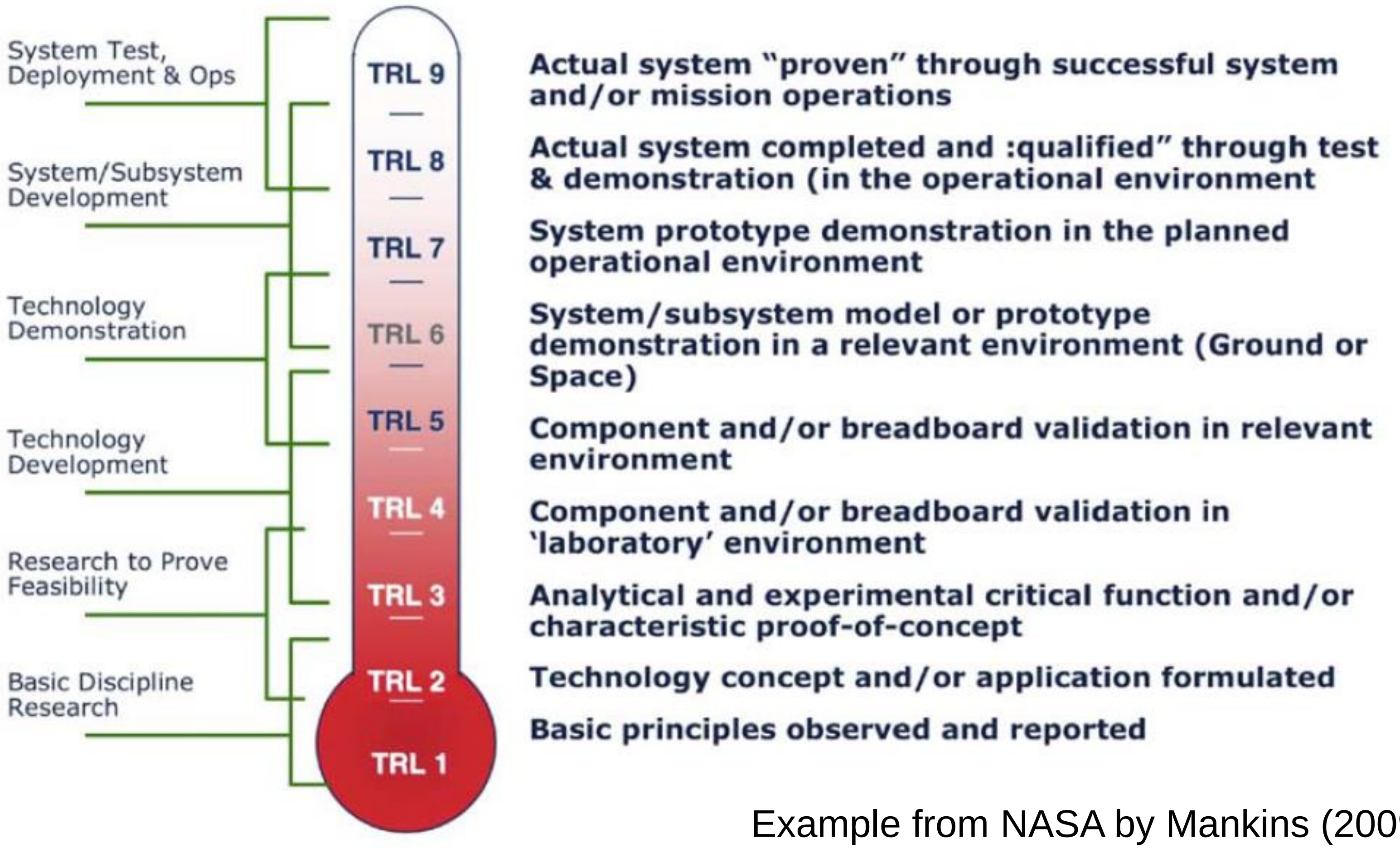
Use technology readiness levels (TLR) to measure distance to market entry



Example from NASA by Mankins (2009)

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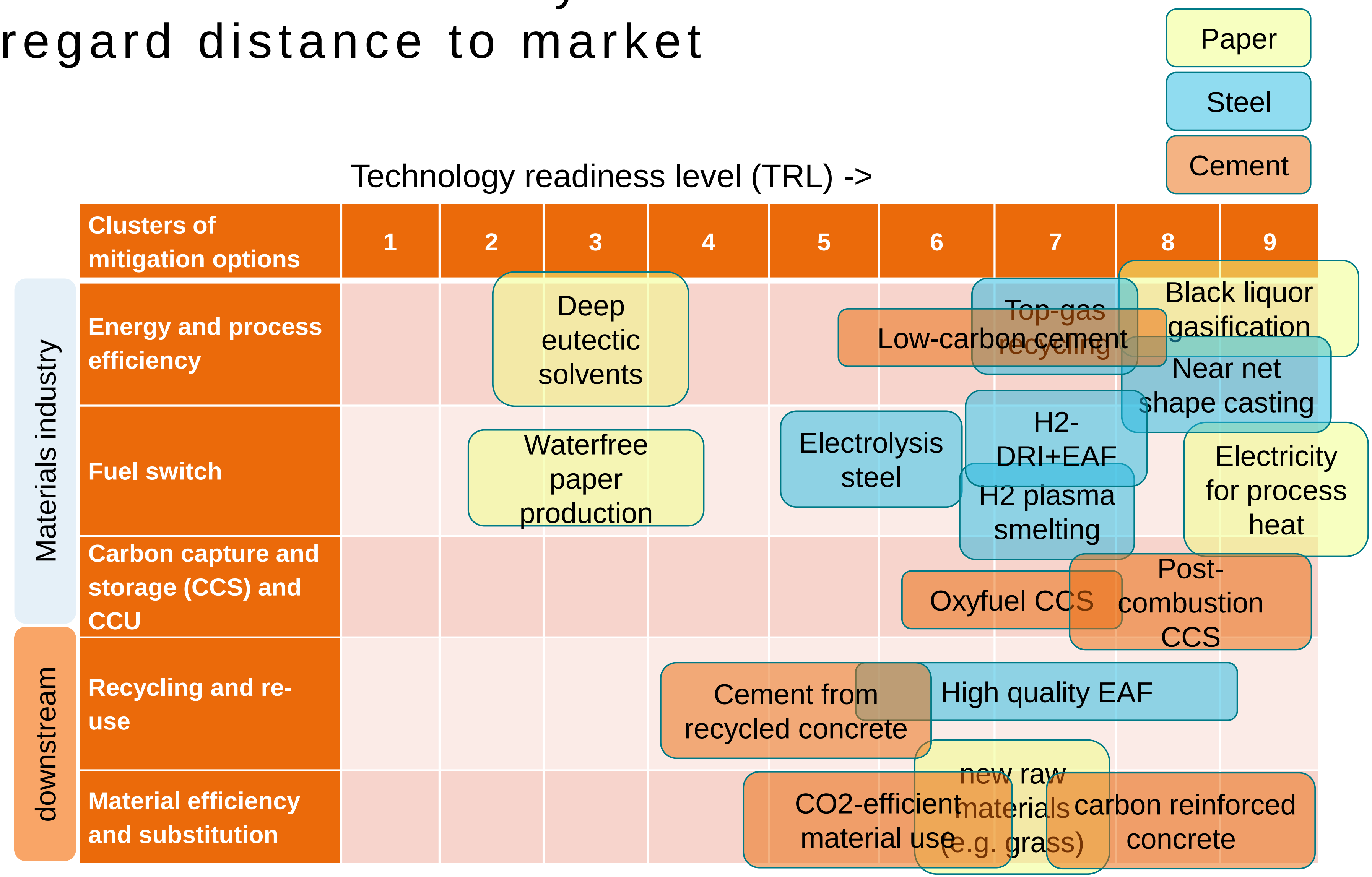
TRLs reveal diversity of innovations with regard distance to market



3 scenarios are simulated with bottom-up model FORECAST

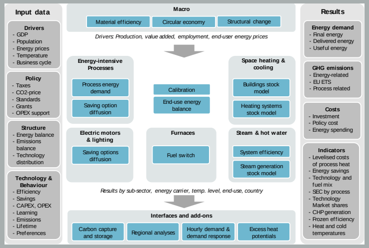
SET-Nav Strategic Energy Roadmap

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 ≥TRL 5).	= TRANS-CCS + selected **radical process innovations** (INNOV ≥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

FORECAST
FORecasting Energy Consumption Analysis and Simulation Tool



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

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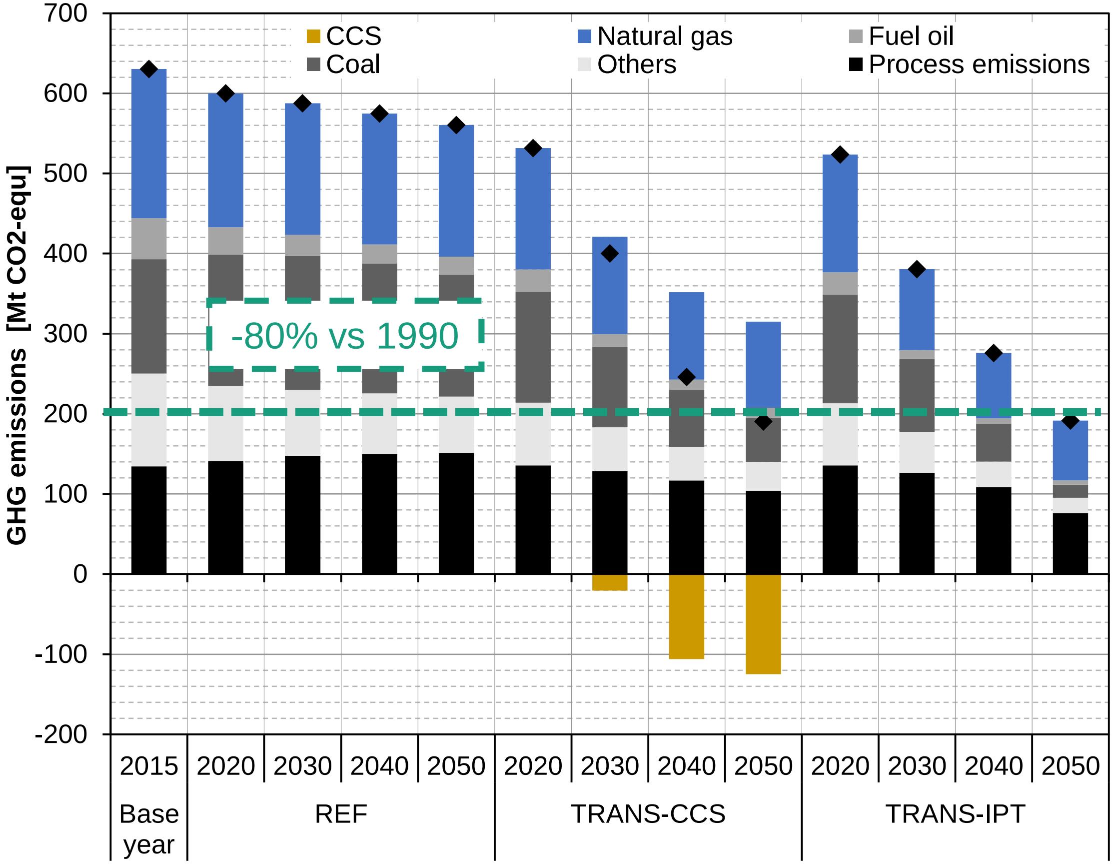
Results: CO2 reduction of >80% possible – without CCS

SET-Nav
Strategic Energy Roadmap

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

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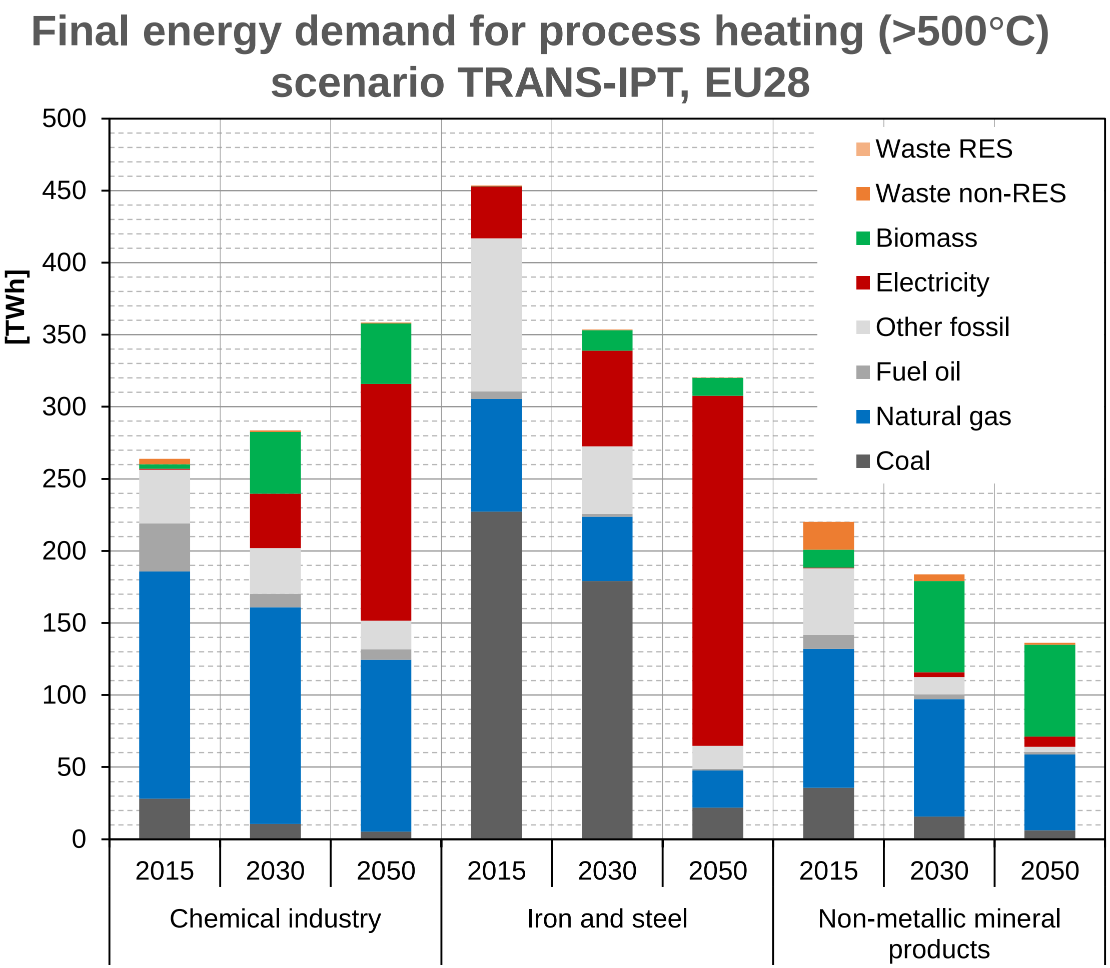
Decarbonisation (without CCS) increases electricity demand drastically

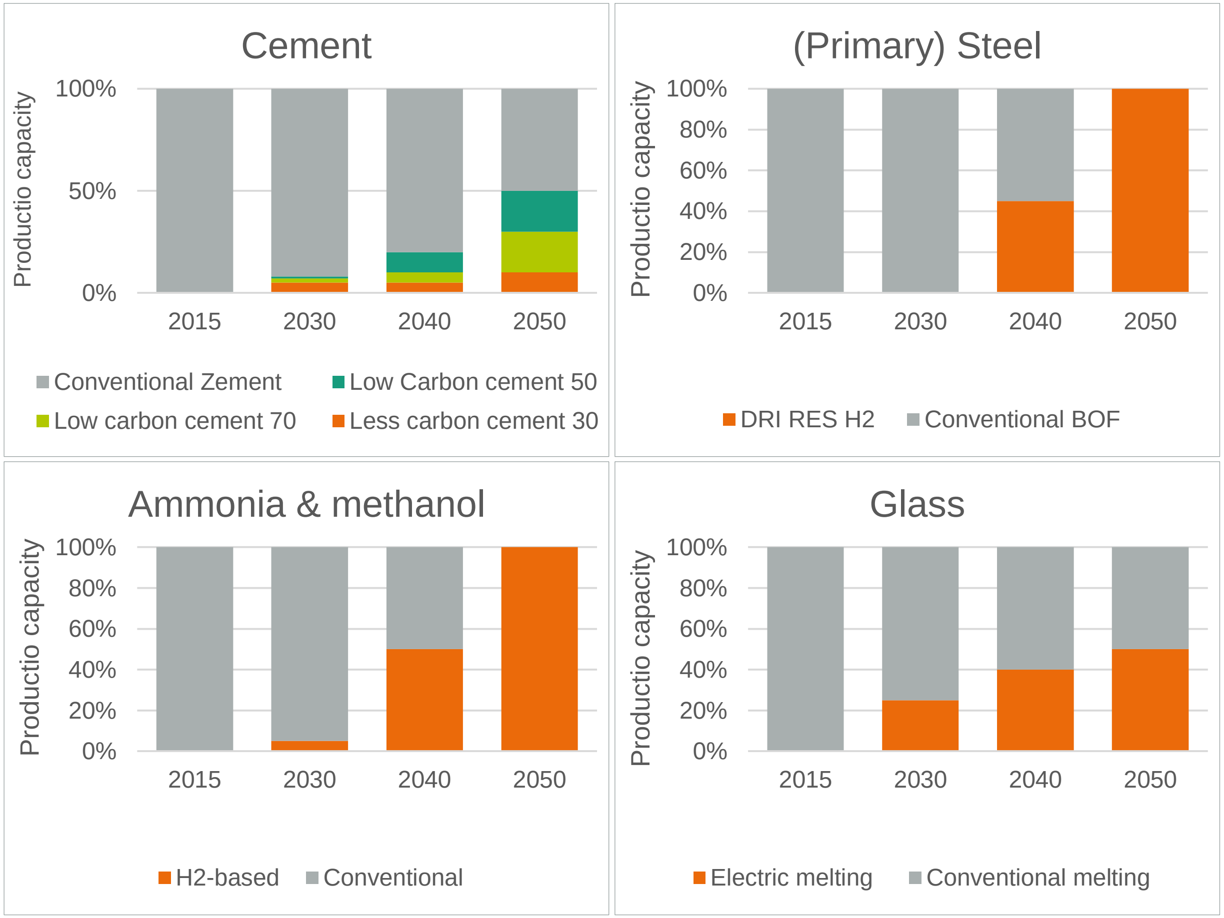


Fuel switch in TRANS-IPT scenario:

- **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

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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%								
UBA THGND	-95%								
BDI 95%Pfad	-95%								
BMWi Langfrist	-84%								
BMUB KS80	-75%								
BDI 80%Pfad	-65%								

Summary: Innovations facilitate decarbonisation of EU industry

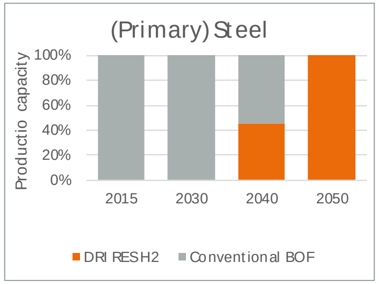
Agenda	Results
1 Introduction	■ Available technologies not sufficient for decarbonisation of EU industry
2 Innovations	■ Many low-carbon process innovations are under development ■ They differ strongly in maturity and distance to market

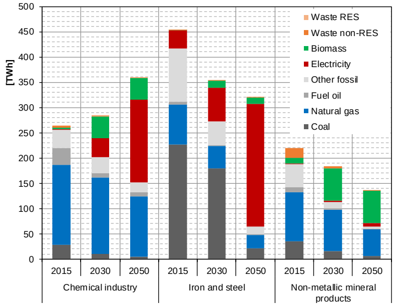
3 Scenarios	■ >80% decarbonisation is possible – even without CCS, but requires:
	  ■ Process innovations,
	  ■ CO2-free secondary energy carriers,
	  ■ Innovations in material efficiency and circular economy

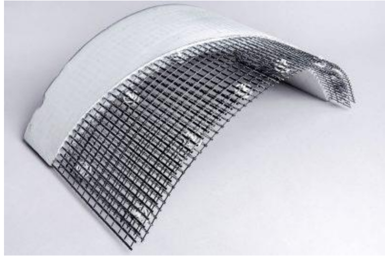
4 Comparison	■ Other studies and scenarios show a broad range of possible decarbonisation futures for industry -> Still very uncertain
5 Conclusion	■ While major changes occur after 2030, technologies will need to be developed, tested and made available before

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**







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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“