Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation

SET-Nav
Strategic Energy Roadmap

Decarbonizing Industry:

Extending the scope of mitigation options

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Strategic Energy Roadmap

I. **Introduction**

II. Methodology

III. Pathways

IV. Results

V. Conclusions

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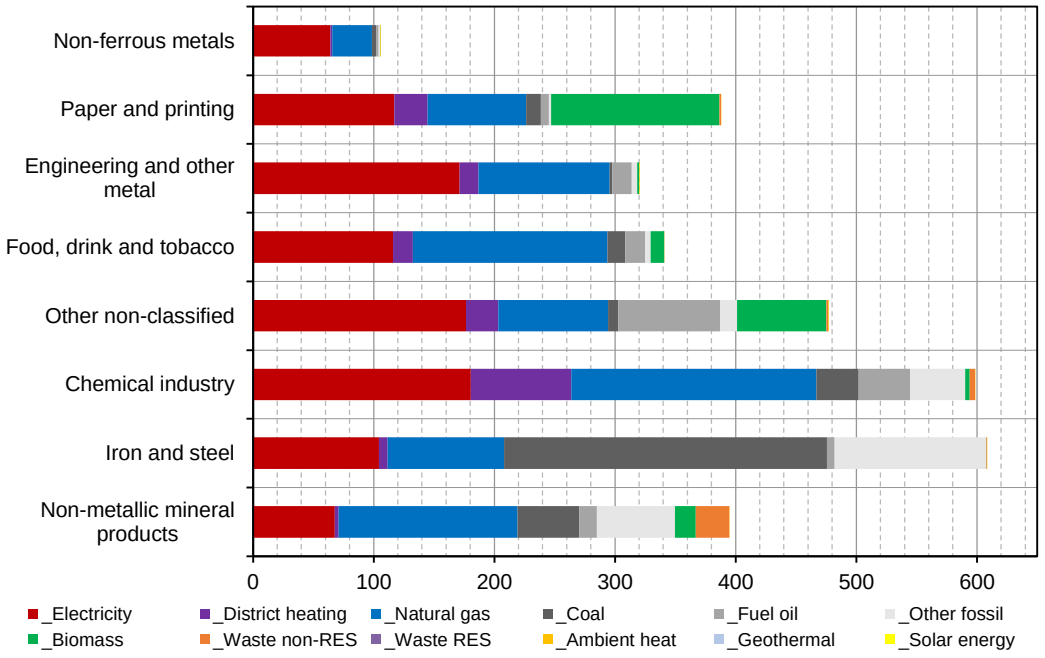
Industry accounts for 25% of EU final energy consumption

- Dominant energy carriers: **gas, electricity, coal and oil**
- Current **policy** is **not on the right track to decarbonisation** and deep emission reductions require significant changes in the sector

EU28 industrial final energy demand (2015)



Source: FORECAST

TODAYS AVAILABLE TECHNOLOGIES ARE NOT SUFFICIENT FOR DECARBONISATION

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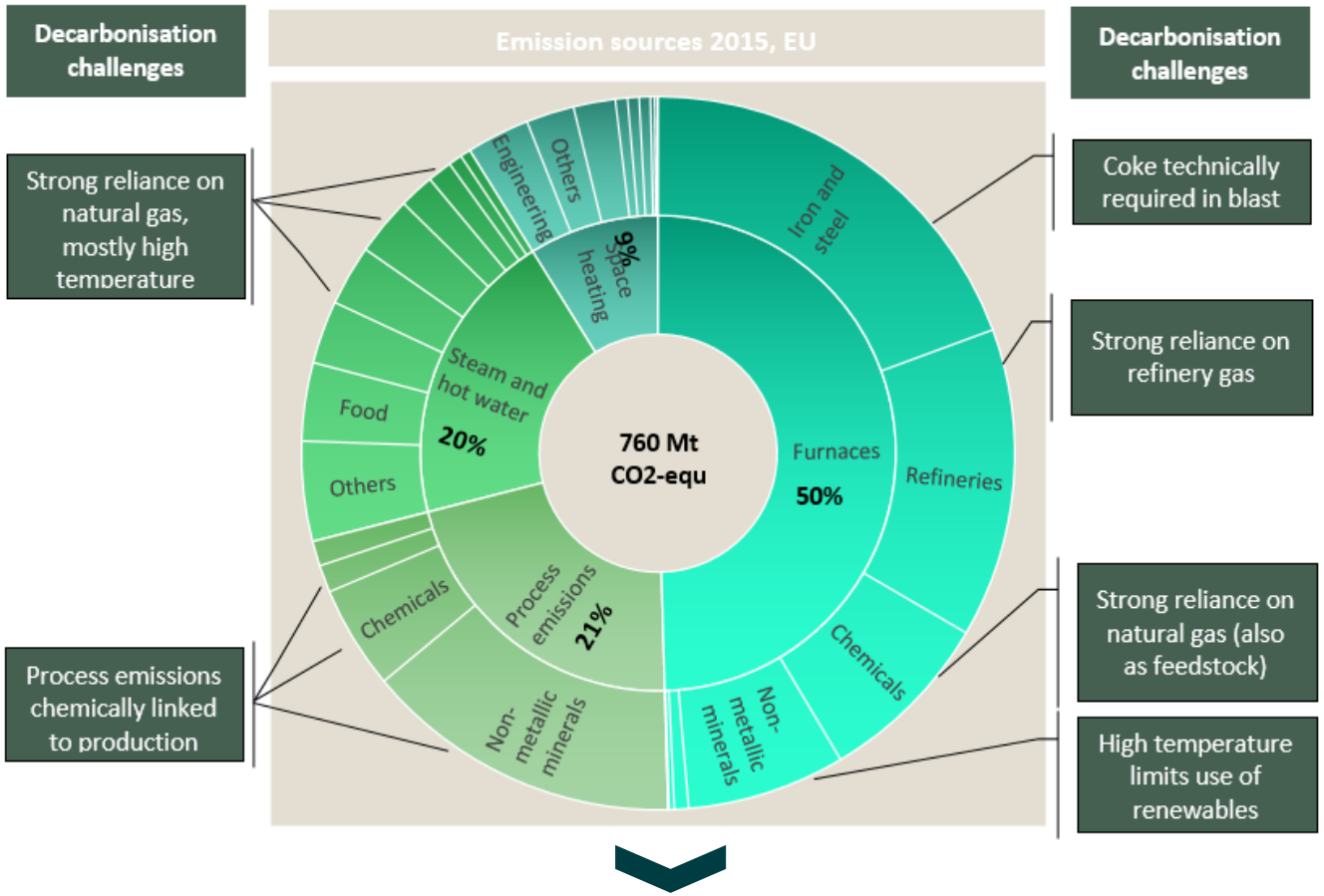

- Deep decarbonisation not possible via BAT energy efficiency and traditional fuel switch
- Innovative low-carbon technologies are needed

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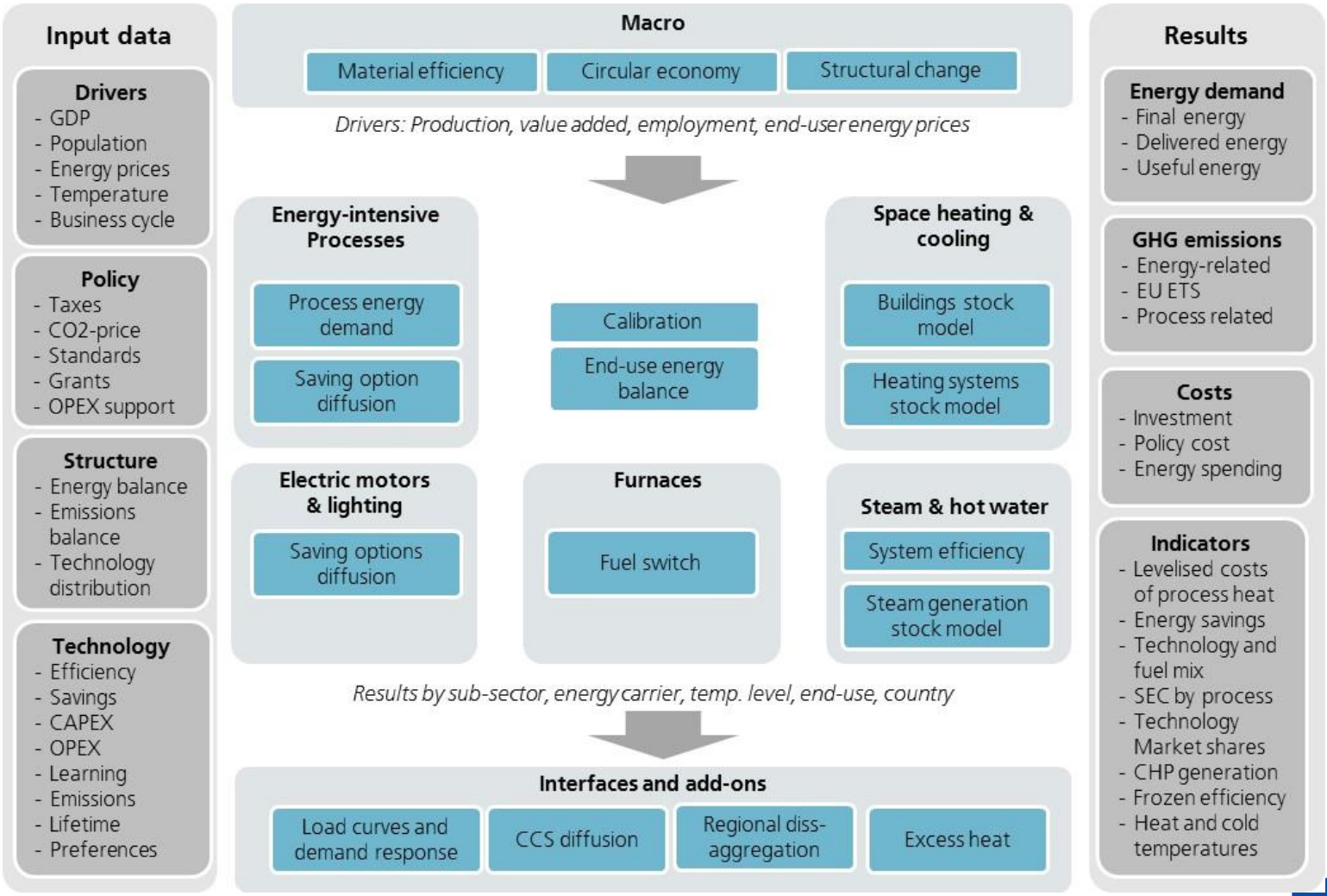
FORECAST:
BOTTOM-UP SIMULATION MODEL

FORECAST
FORecasting Energy Consumption Analysis and Simulation Tool



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Pathway characterization by mitigation option

Clusters of mitigation options	REF	Directed Vision/ National Champions	Diversification/ Localisation
Incremental efficiency improvement	Energy efficiency progress according to current policy framework and historical trends.	Faster diffusion **of incremental process improvements** (BAT & INNOV ≥TRL 5).	Faster diffusion of **incremental process improvements** (BAT & INNOV ≥TRL 5).
Fundamental processes improvement **energy efficiency, process emissions**	-	-	**Radical process improvements** (INNOV ≥TRL 5)
Fuel switching to RES towards decarbonized electricity and/or hydrogen	Fuel switching driven by energy prices and assumed CO_2-price increase	Fuel switching to **biomass** and **power-to-heat** (<500°). Use of existing technologies (no radical changes in industrial processes technologies). More district heating demand.	Stronger fuel switching to **biomass, power-to-heat and power-to-gas** technologies. **Radical changes** in industrial process technologies drive fuel switch (e.g. switch to **hydrogen**). Lower demand for district heating.
Carbon capture and storage (CCS)	-	**CCS** for major energy-intensive point sources.	-
Recycling and re-use	Slow increase in recycling rates based on historical trends.	Stronger switch to **secondary production.**	Stronger switch **to secondary production.**
Material efficiency and substitution	Based on historic trends.	Less efforts in material efficiency & substitution	Decrease in **clinker factor**. Increase in **material efficiency & substitution**.

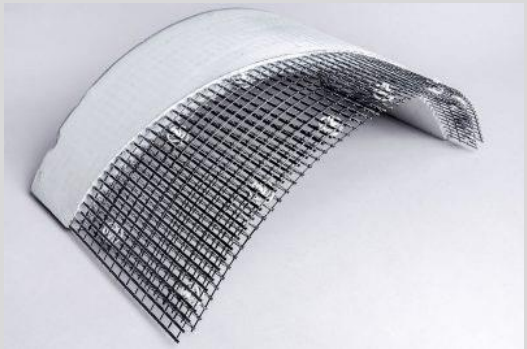
Break-through innovations with different levels of maturity are under development

Source: Towards the EU ETS Innovation fund workshops (online available), Dechema 2017

Break-through innovations with different levels of maturity are under development

Solidia concrete
recarbonating cement for precast concrete

Carbon concrete (C3)
Carbon nanofibres reinforced concrete replacing steel concrete



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

Source: Towards the EU ETS Innovation fund workshops (online available), Dechema 2017

Break-through innovations with different levels of maturity are under development

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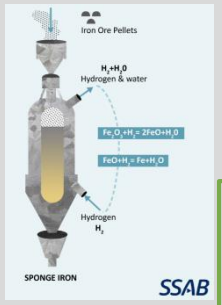
Siderwinn (ArcelorMittal)
Fully electric steelmaking via electrolysis

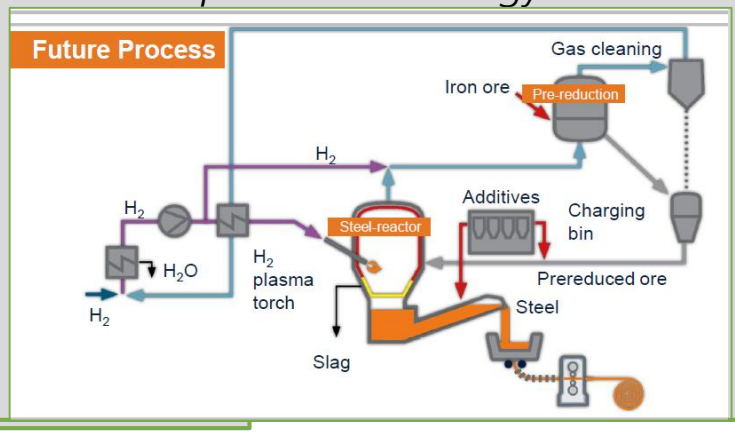
Hybrit (SSAB)
H2 direct reduction of iron ore with EAF



https://www.greencarcongres
04/ssab.html

Source: http://www.g

SuSteel (VoestAlpine)
H2 based reduction of iron ore using plasma technology



Source: Towards the EU ETS Innovation fund workshops (online available), Dechema 2017

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BREAK-THROUGH INNOVATIONS WITH DIFFERENT LEVELS OF MATURITY ARE UNDER DEVELOPMENT

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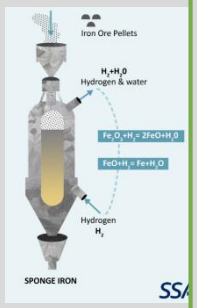
Hybrit (SSAB)

H2 direct reduction of iron ore with E



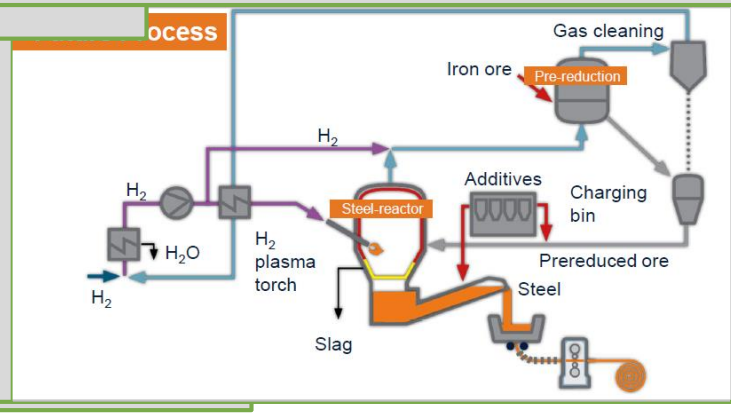
https://www.greencarcongress.com/2018/04/ssab.html

Source: http://www.g

Grass paper (Creapaper)

Grass based fibres replacing wood fibres

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



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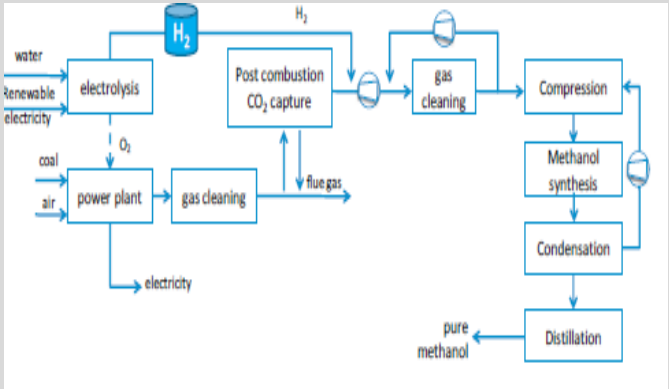
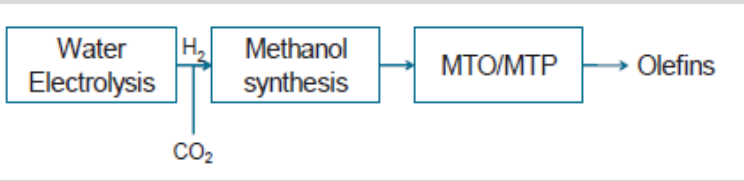
H2 Methanol
RES H2 from water electrolysis plus hydrogenation of CO2 as carbon source



H2 Methanol to Olefins
Ethylene and propylene production from RES H2 methanol



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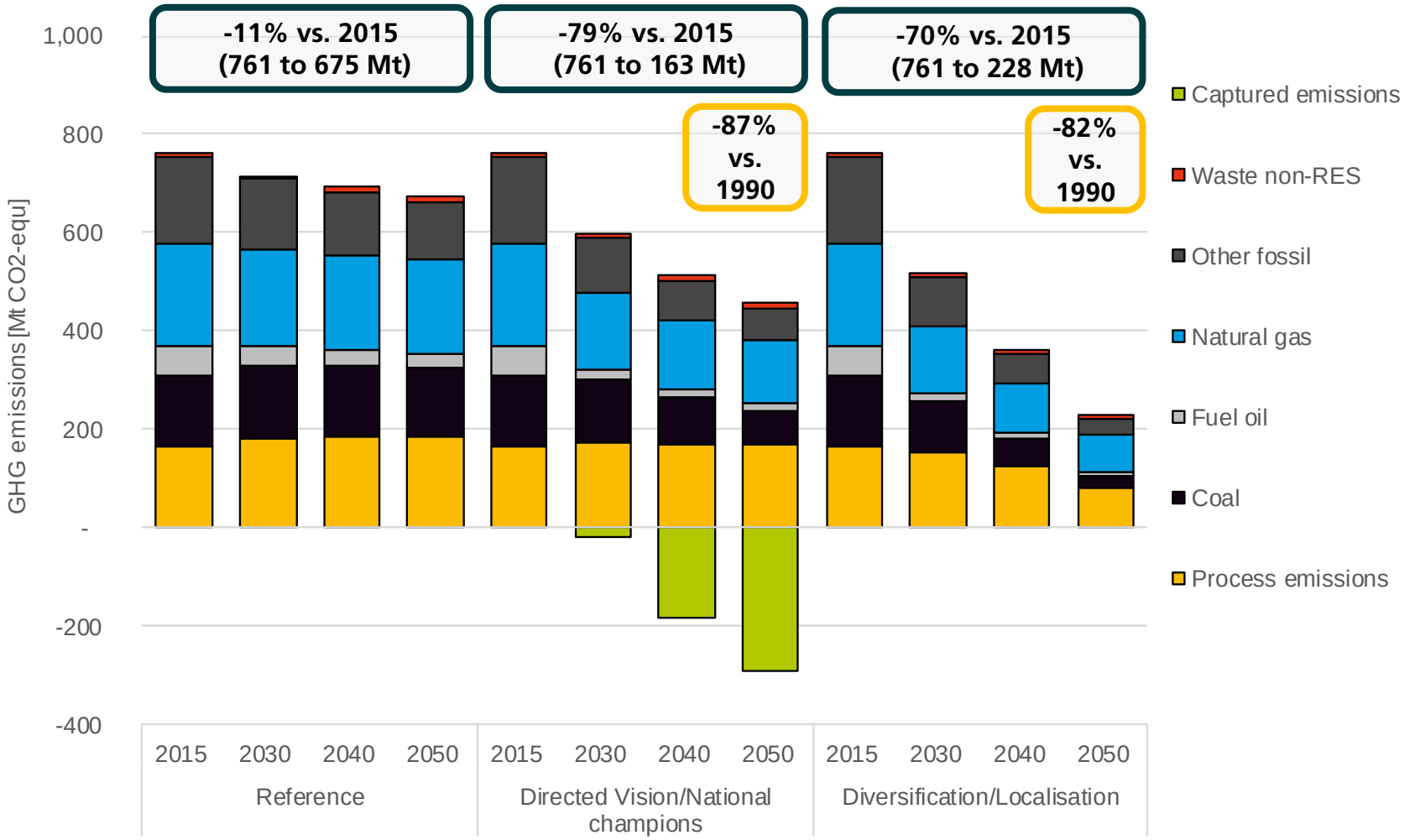
Very high level of ambition enables a high reduction in CO_2 emissions [EU28]



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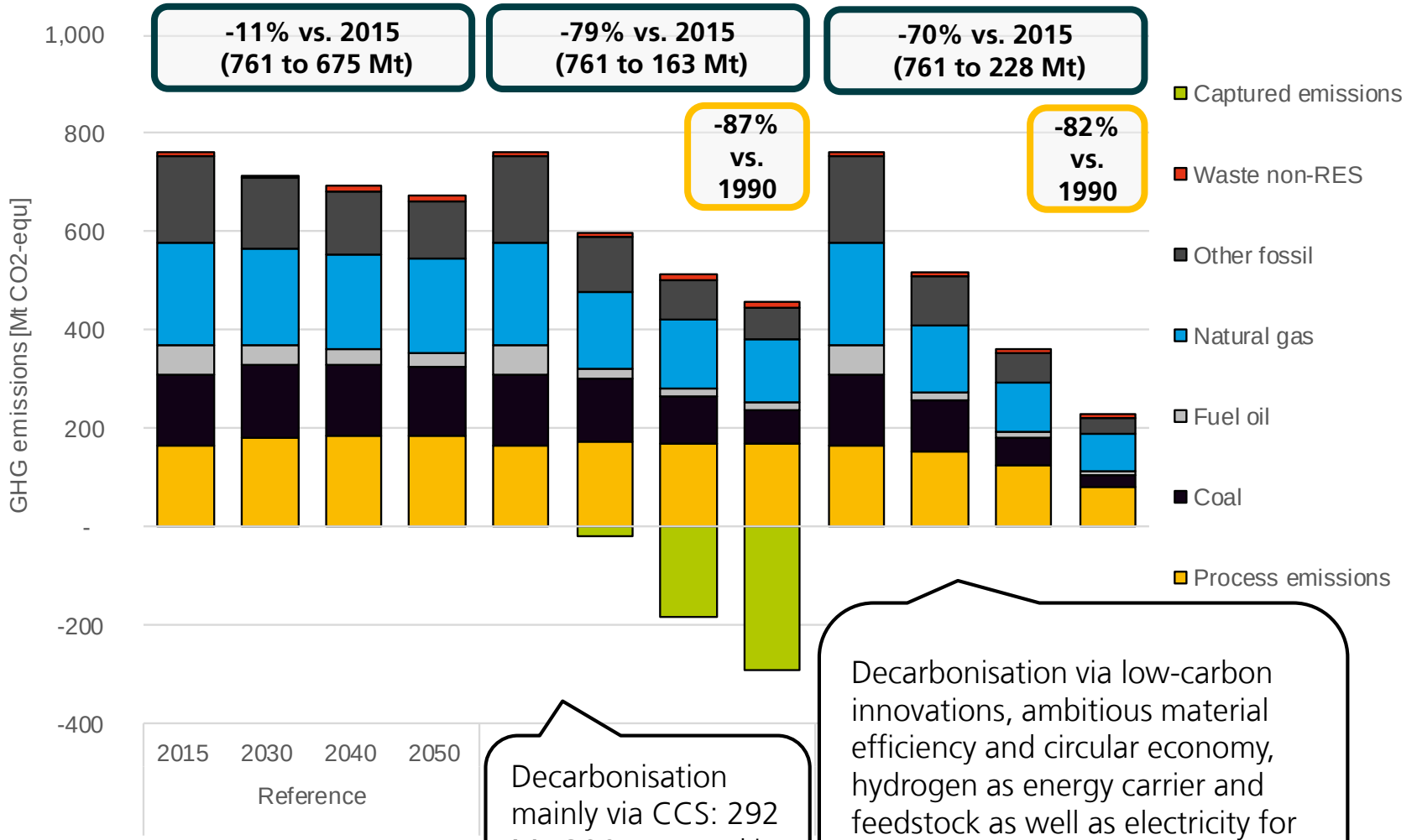

Decarbonisation mainly via CCS: 292 Mt CO2 captured in 2050

Decarbonisation via low-carbon innovations, ambitious material efficiency and circular economy, hydrogen as energy carrier and feedstock as well as electricity for process heating

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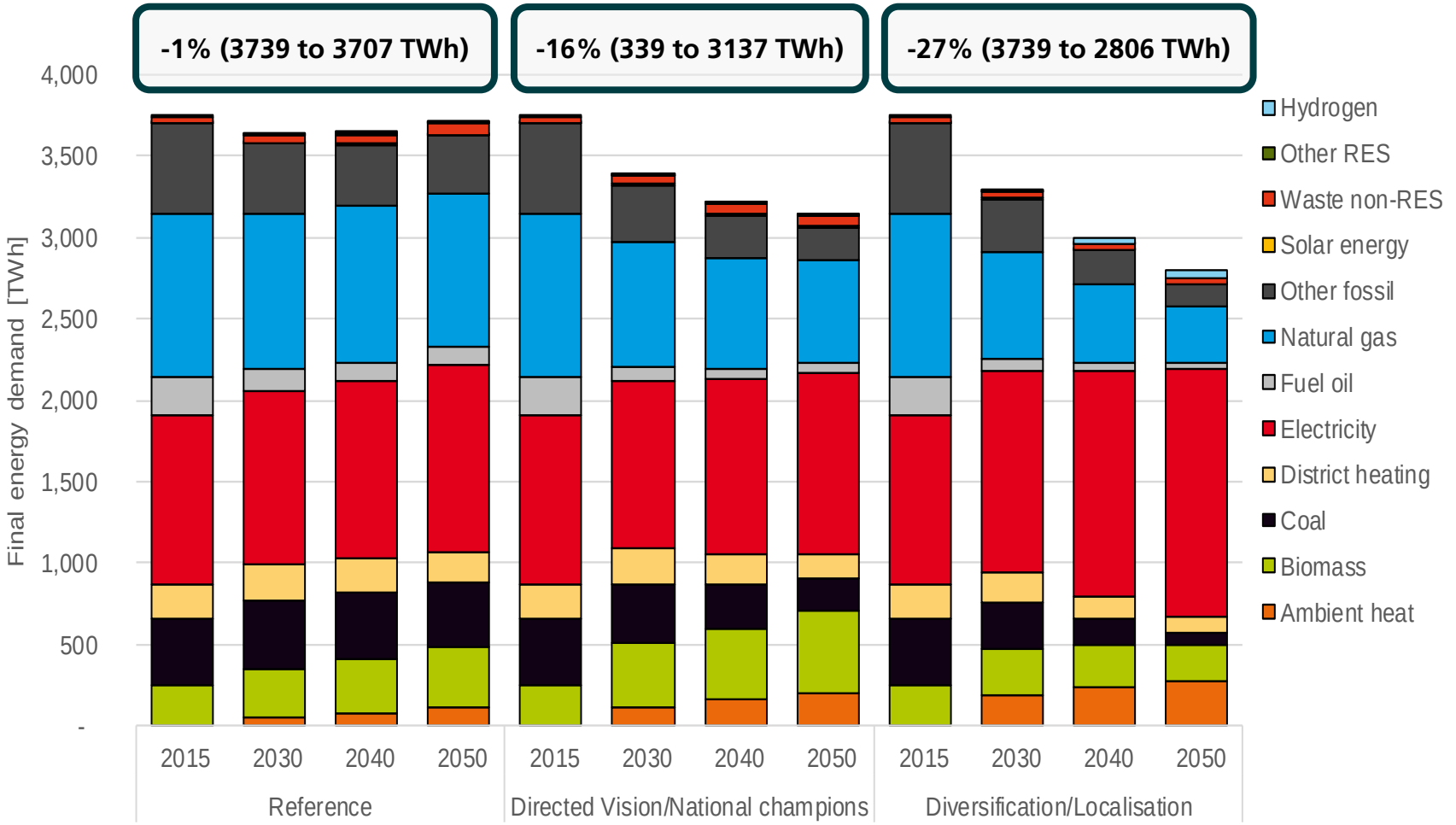
Reduction in final energy demand less pronounced than emissions [EU28]



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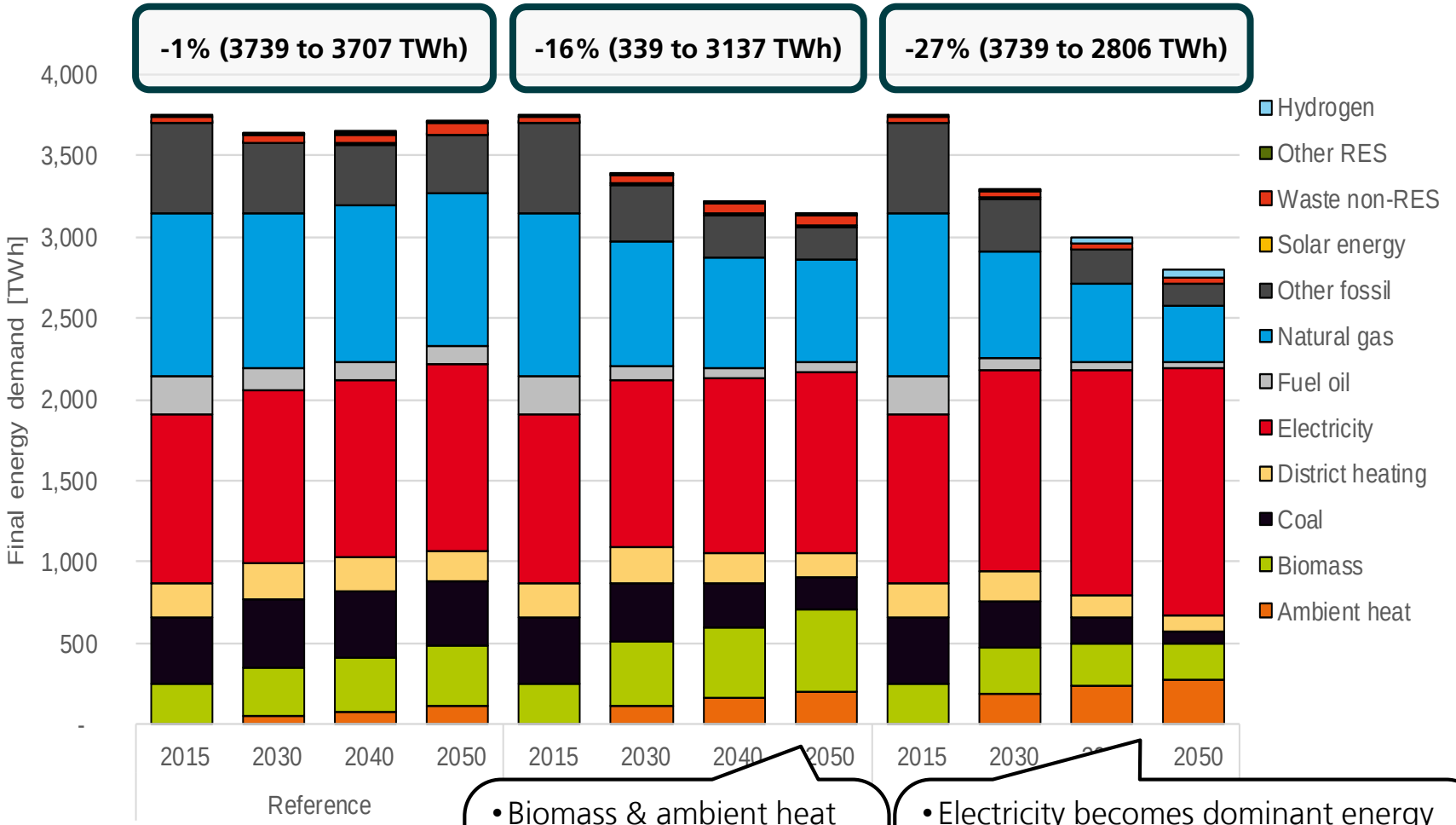

- Biomass & ambient heat gain shares.
- Fuel oil is nearly phased out by 2050 & coal is falling substantially.

- Electricity becomes dominant energy carrier by 2050
- E.g. new uses for process heat: steel electrolysis, flat glass electric furnace, etc.

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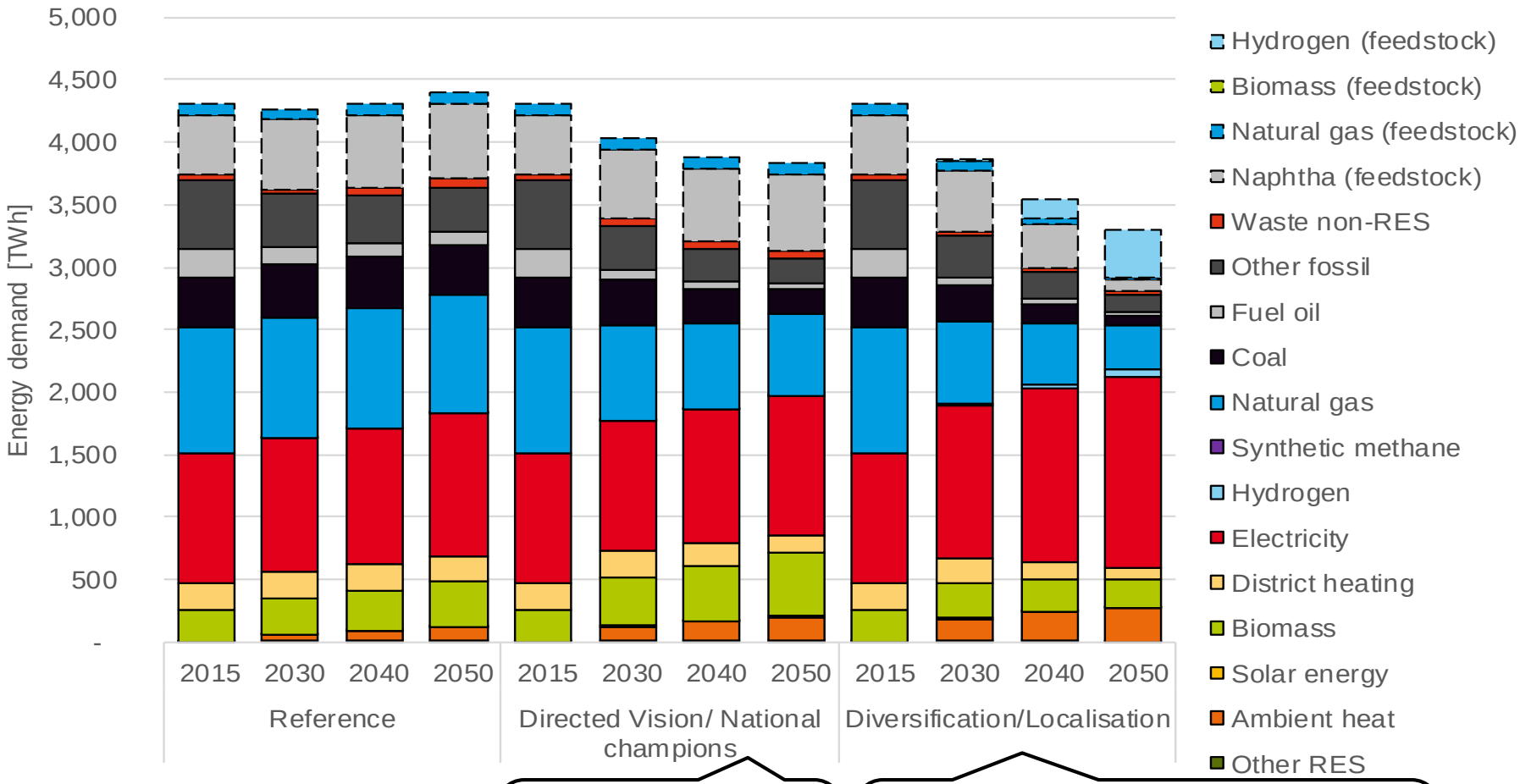
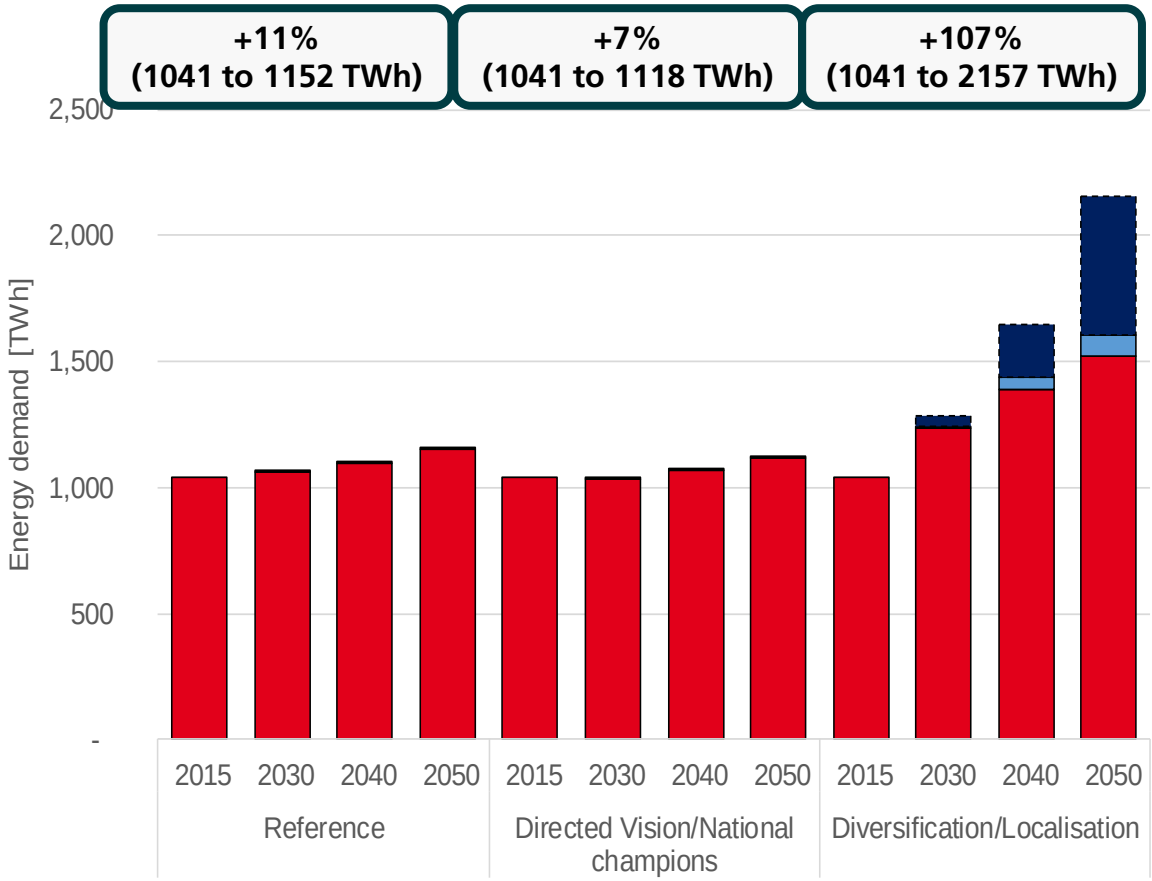
RES H2 FEEDSTOCK DEMAND CHANGES ENERGY BALANCE BOUNDARIES [EU28]



- Feedstock for chemicals still based on fossil fuels

- Feedstocks are dominated by RES hydrogen for the production of ammonia, methanol and methanol-based ethylene

Large volumes of renewable electricity will be needed [EU28]



Hydrogen (feedstocks) for ammonia, methanol and ethylene (**549 TWh** in 2050)

Hydrogen is mainly used in the steel industry with H2-DR replacing oxygen steel (**83 TWh** in 2050)

Process heating in all sectors (glass electric furnace, steel electrolysis, etc.)

Shift towards electricity & Biomass for process heating via furnaces [EU28]

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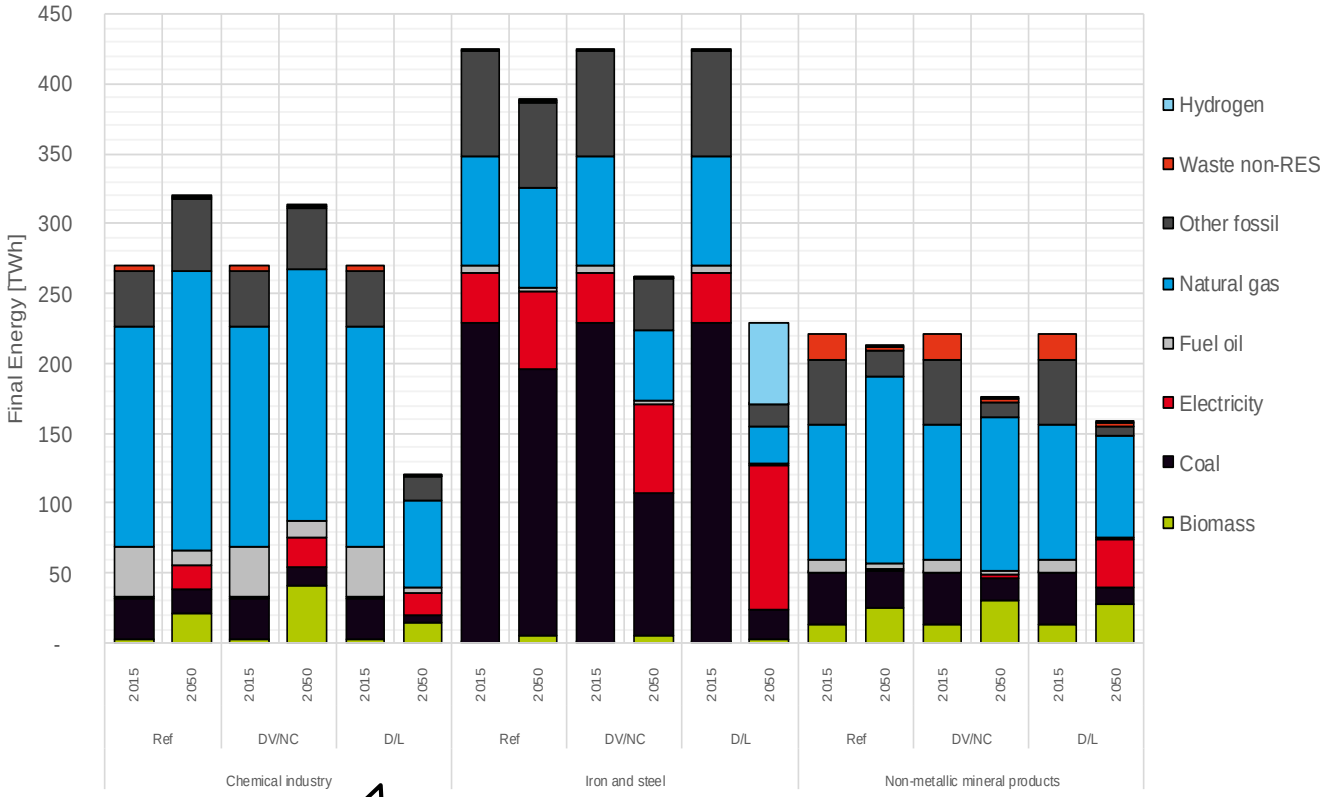
EU 28 final energy demand for process heating (>500°C)



+384 TWh
H2 feedstock

High financial support for biomass

Biomass is used where **technically possible** (e.g. cement & lime)

Increase in **electricity** driven by **process switch**: e.g. electric furnaces (glass,steel), DR electrolysis

Use of **hydrogen** in steel production replacing BOF

Across all sectors and scenario still a **substantial amount** of **natural**

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Summary: Innovations facilitate decarbonisation of EU industry

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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 Pathways

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

4 Policy

- Support for RES and energy efficiency
- Extending the ETS with a minimum price path to provide long-term certainty
- Public RD funding for low-carbon innovations
- Targeted public procurement to support low-carbon products
- CO2 tax to provide incentives for companies outside the ETS
- Policies to boost material efficiency & circular economy as well as energy efficiency

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Many thanks for your attention!

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