DECARBONIZING INDUSTRY

Extending the scope of mitigation options

Andrea Herbst, Tobias Fleiter, Matthias Rehfeldt

International Sustainable Energy Conference ISEC
3rd – 5th October 2018, Graz

Fraunhofer ISI

OUTLINE

I. **Introduction**

II. Methodology

III. Scenarios

IV. Results

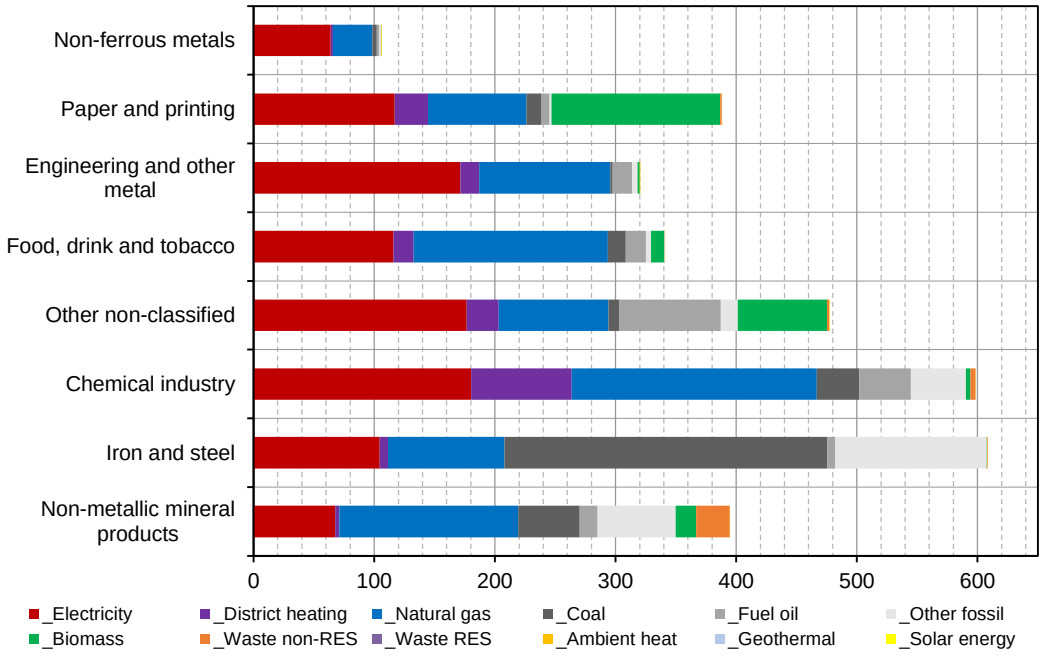
V. Conclusions

Fraunhofer ISI

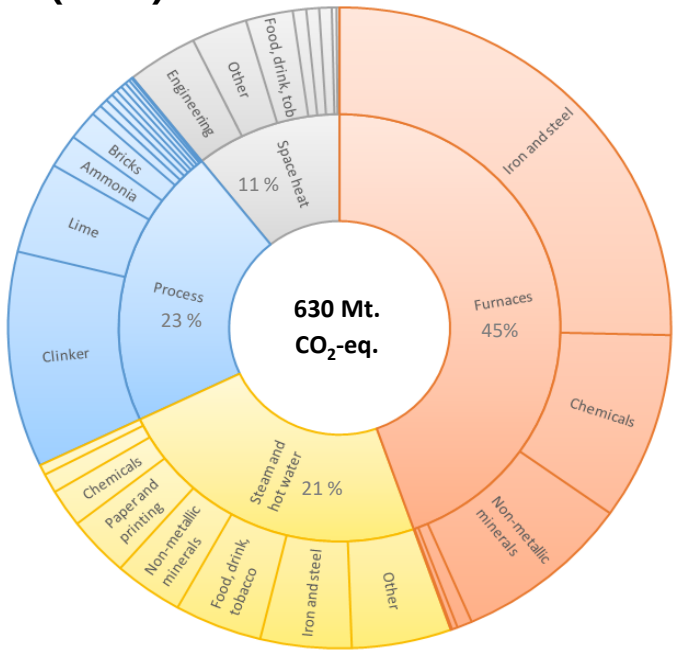
Status-quo: industry accounts for 25% of EU final energy consumption

- Dominant energy carriers: **gas, electricity, coal and oil**
- Challenge: **direct CO2 emissions** (energy- and process-related)
- 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)



EU 28 direct industrial emission by type of use (2015)



Source: FORECAST

OUTLINE

I. Introduction

II. Methodology

III. Scenarios

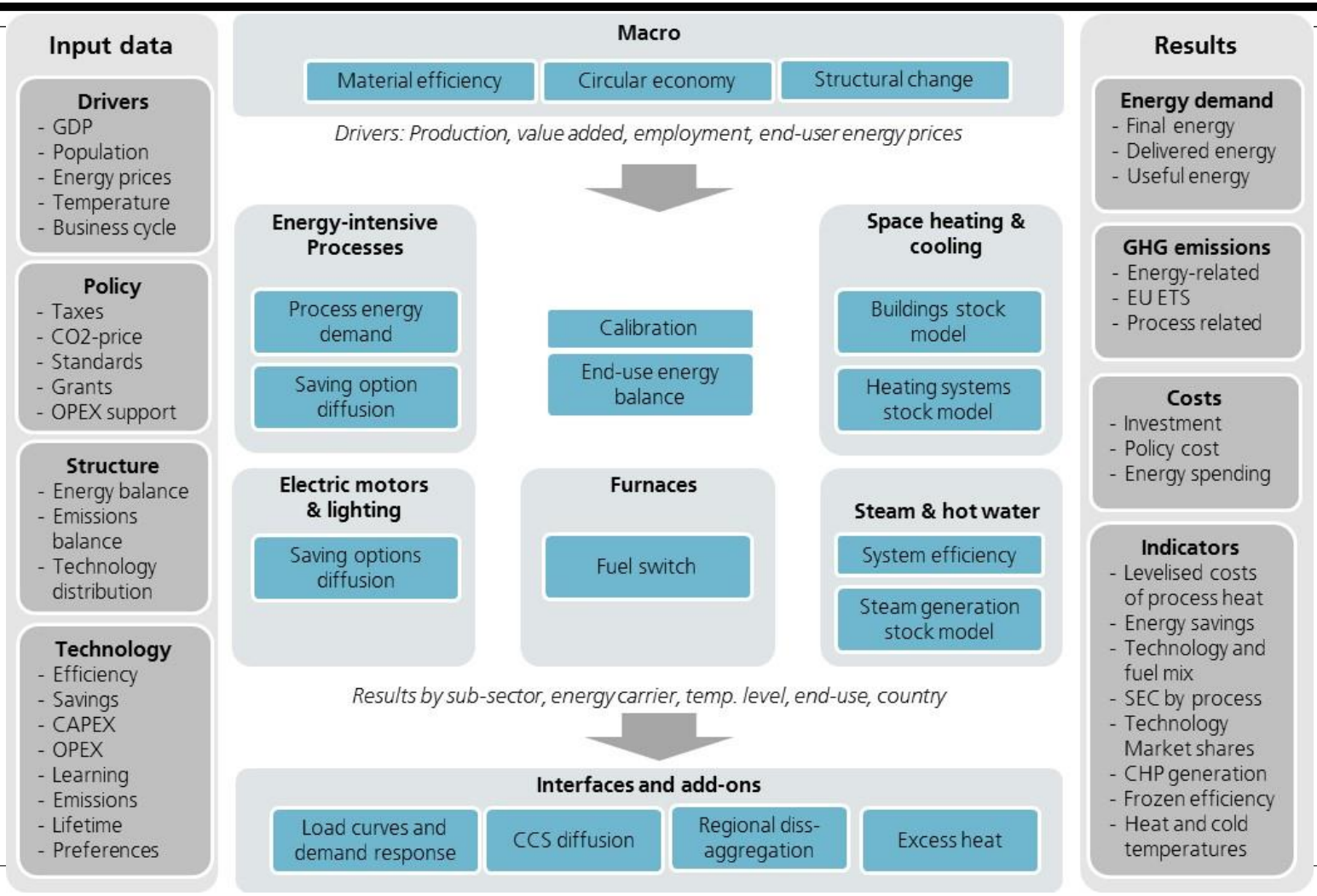
IV. Results

V. Conclusions

Fraunhofer ISI

FORECAST: bottom-up simulation model

FORECAST
FORecasting Energy Consumption Analysis and Simulation Tool



Fraunhofer ISI

OUTLINE

I. Introduction

II. Methodology

III. Scenarios

IV. Results

V. Conclusions

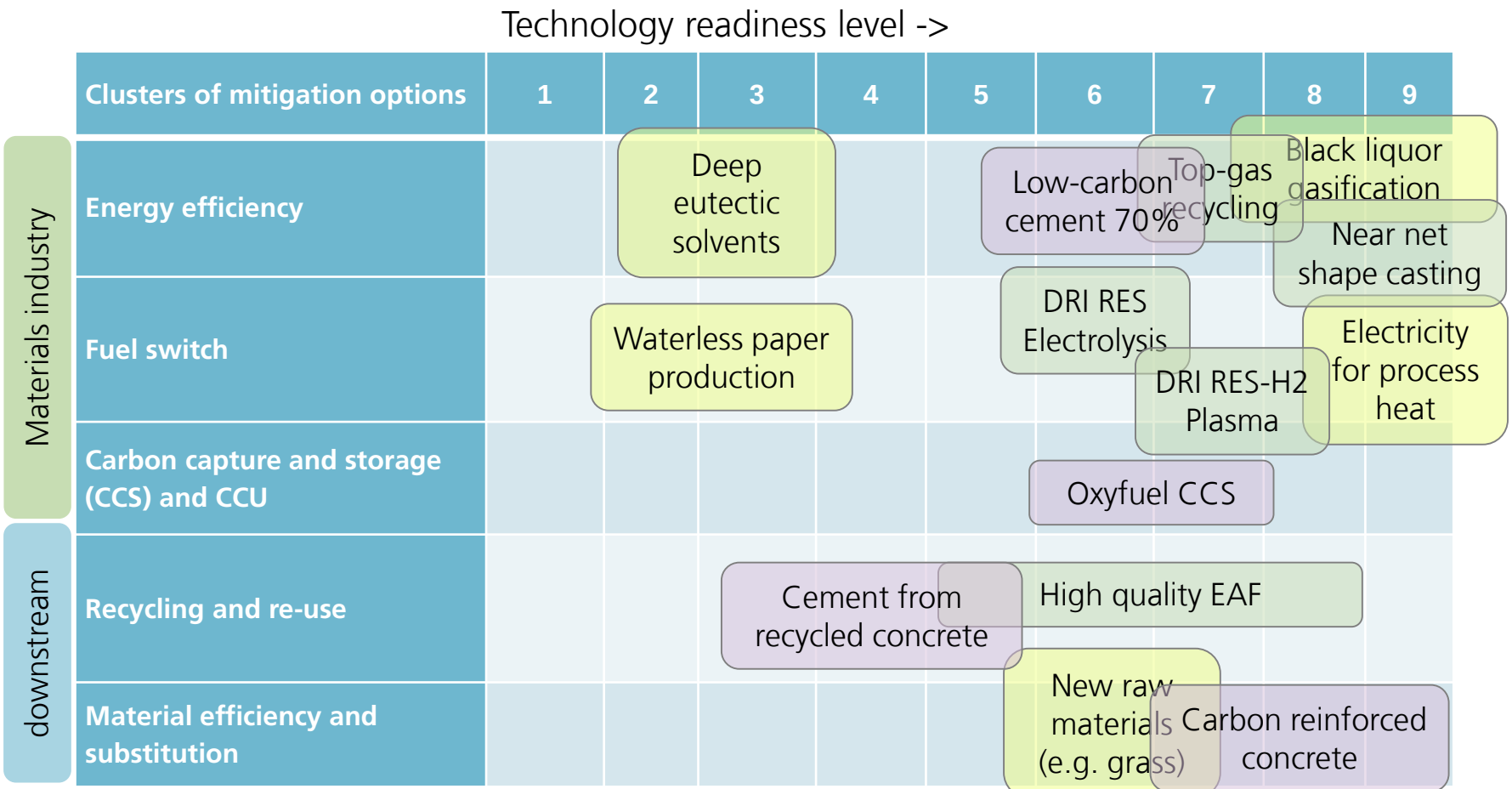
Fraunhofer ISI

Scenario characterization by mitigation option

Clusters of mitigation options	REF	TRANS-IPT
Incremental efficiency improvement	Energy efficiency progress according to current policy framework and historical trends.	Faster diffusion of **incremental process improvements** (BAT & INNOV ≥TRL 5).
Fundamental processes improvement **energy efficiency, process emissions**	-	**Radical process changes** (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	**High financial support** for RES technologies: 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**).
Carbon capture and storage (CCS)	-	-
Recycling and re-use	Slow increase in recycling rates based on historical trends.	Stronger **switch to secondary production** (e.g. electric steel, secondary aluminium).
Material efficiency and substitution	Based on historic trends.	Decrease in clinker factor. **Increase in material efficiency & substitution**.

Fraunhofer ISI

Maturity of technologies: Mitigation options (selection) by TRL



Fraunhofer ISI

OUTLINE

I. Introduction

II. Methodology

III. Scenario definition

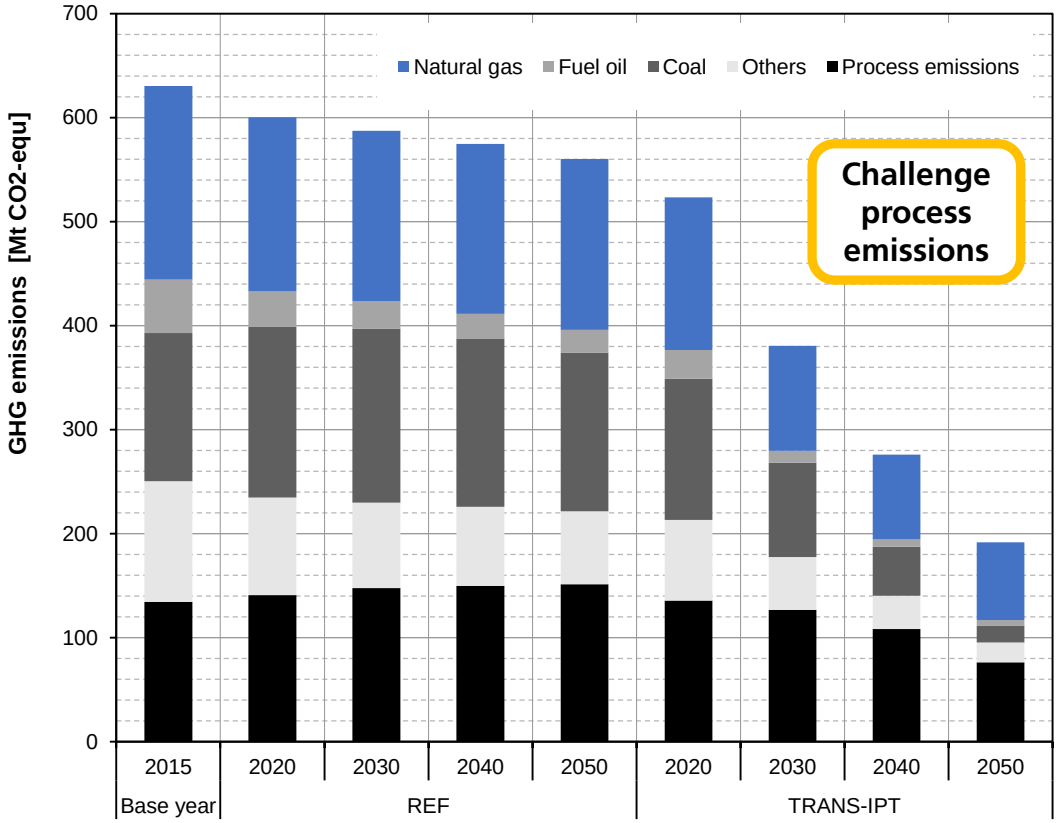
IV. Results

V. Conclusions

Fraunhofer ISI

Very high level of ambition enables a high reduction in industrial CO_2 emissions

EU 28 industrial CO2 emissions by EC and scenario



Reference:

- Slight improvements visible (e.g. process switch in the steel industry)

Mitigation scenario:

- Reduction in industrial CO_2 emissions:
  ~-70% by 2050 compared to 2015
  ~-83% by 2050 compared to 1990

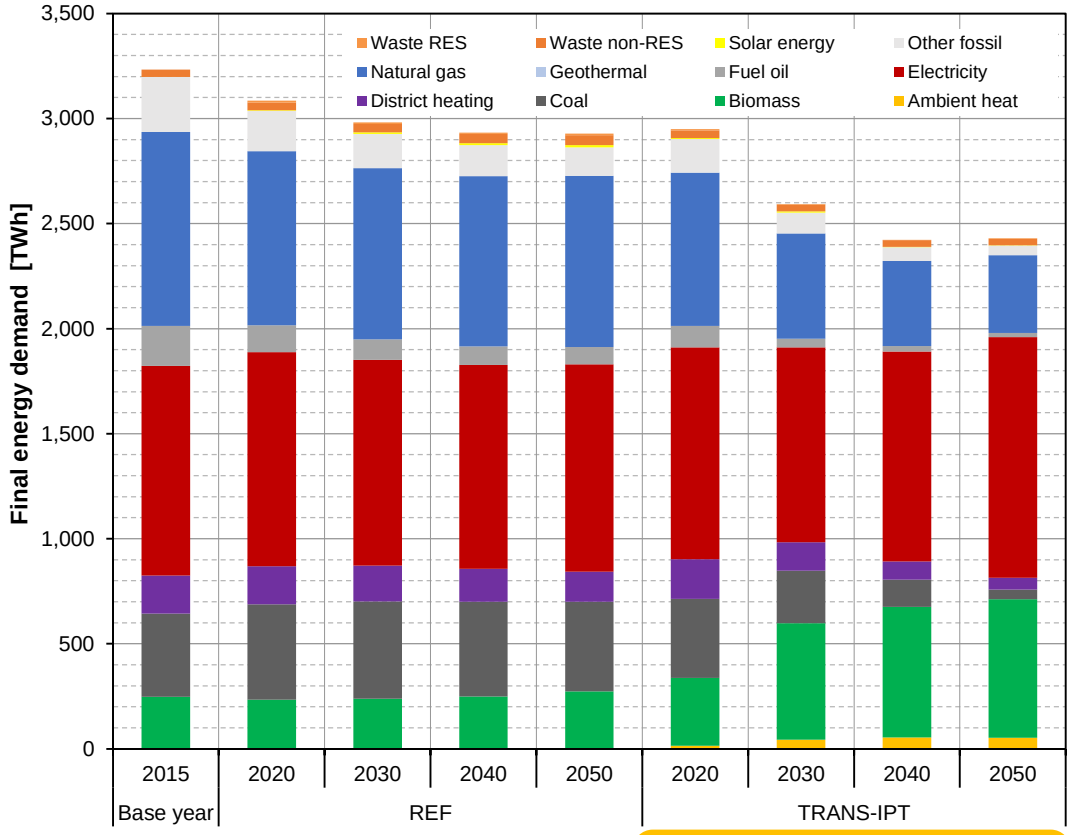
- Abatement of **process-related emissions more difficult:**
  Radical process changes

Source: FORECAST

Fraunhofer ISI

Two contrary trends can be observed in the evolution of industrial energy demand

EU 28 industrial final energy demand by EC and scenario



-25% (3233 to 2430 TWh)

Source: FORECAST

Mitigation scenario:

- **Demand decreases** due to integrated process improvements and fuel switch
- **Large volumes** of renewable **electricity** will be needed due to radical process changes

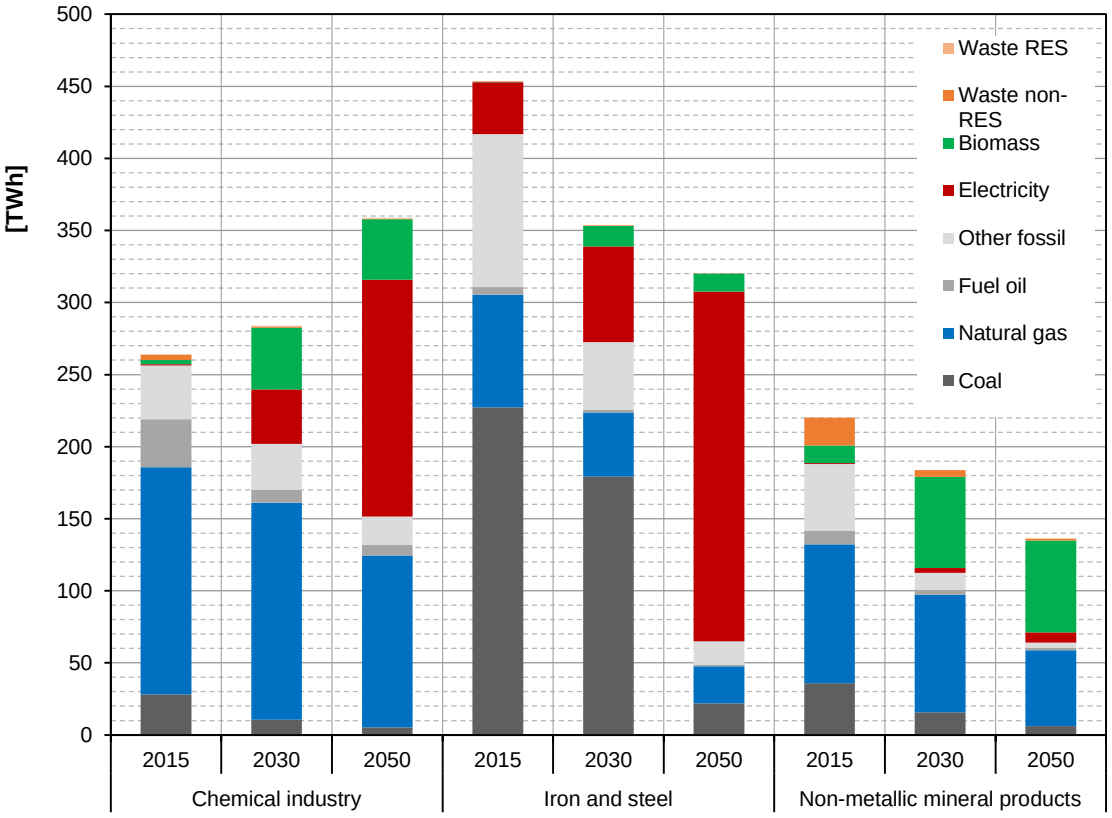
Trans-IPT scenario:

1144 TWh of electricity in 2050 (+15% compared to 2015)

Fraunhofer ISI

Strong shift towards biomass and electricity for process heating via furnaces

EU 28 final energy demand for process heating in furnaces



TRANS-IPT scenario:

- **High financial support for biomass**
- Biomass is used where **technically possible** (e.g. cement & lime)
- Increase in **electricity** driven by **radical changes**: e.g. the use of **hydrogen** in steel production replacing BOF
- Across all sectors and scenario still a **substantial amount of natural gas** is used

Source: FORECAST

Fraunhofer ISI

OUTLINE

I. Introduction

II. Methodology

III. Scenarios

IV. Results

V. Conclusions

Fraunhofer ISI

Transition scenarios show that industry can reduce its CO2 emissions drastically

- **Deep emission cuts require substantial changes** in the iron and steel, cement and chemicals industries, but also **support for RES and energy efficiency** in other sectors and companies.
- Radical shifts in steel and chemicals towards the use of **RES-hydrogen might increase electricity use drastically**.
- **Biomass is the an important RES in industry**, particularly in the medium term. **Biomass resource potentials and their sustainability are limited** (competition with other sectors).
- **RES-based electricity (PtH) can play a more important role**, particularly if electricity generation has very low emission levels. However, electricity is **not yet cost-competitive with biomass** even in the most ambitious transition policy scenario.
- Replacing biomass by electricity would require policies to **reduce the operation costs of PtH.**
- **Improved material efficiency and the circular economy have a huge mitigation potential.** Still unclear what an effective policy mix would look like and this probably encompasses a wide range of individual measures.

Fraunhofer ISI

Policy mix needs to be adjusted in order to effectively support R&D activities

- **Extending the ETS with a minimum price path** (i.e. a floor price) could provide more long-term clarity and the certainty needed for investors in low-carbon innovations.
- **Public RD funding** will be necessary to accelerate the market introduction of innovative low-carbon processes (e.g. Innovation Fund).
- **Targeted public procurement** can support the market introduction of low-carbon products by establishing niche markets.
- **CO2 tax** as the central element of a broader energy tax reform could provide the incentives needed for fuel switching (especially for companies outside the ETS).
- Increase **policies to boost material efficiency and a circular economy** (e.g. evaluate building codes and regulative framework in construction to facilitate efficient (re-use) of materials).
- Implement **policies to overcome barriers to energy efficiency** (energy management schemes, audits, soft loans, and energy service market).

Fraunhofer ISI

Decarbonizing industry: Extending the scope of mitigation options

Many thanks for your attention!

Dr. Andrea Herbst
Competence Center Energy Technology and Energy Systems
Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Straße 48, 76139 Karlsruhe, Germany
Tel.: +49 (0) 721 6809 -439
E-Mail: andrea.herbst@isi.fraunhofer.de
http://www.forecast-model.eu

SET-Nav
Strategic Energy Roadmap

The analysis was executed within the EU project SET-Nav (Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation), which received funding from the European Union's Horizon 2020 research and innovation programme [GA-No. 691843]. For further information, see: http://**www.set-nav.eu/.**

Fraunhofer ISI