ENERGY EFFICIENCY FIRST
#EE1st SUMMIT
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# In-depth quantification of industrial energy efficiency potentials

## Impact on the future European industrial energy demand

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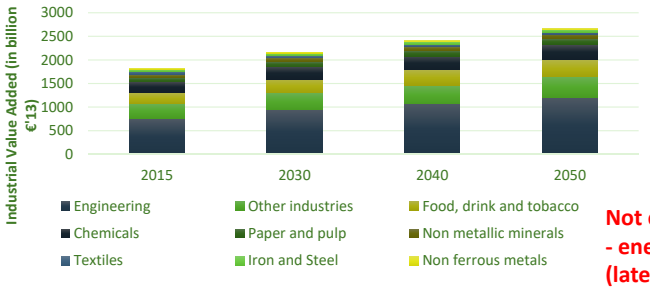
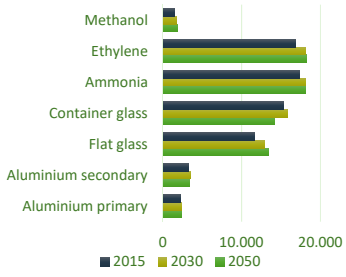
## Future material production

| | |
|---|---|
| **Reference scenario:** | **Final energy consumption per country and per industrial sub-sector is equal to the reported reference scenario in PRIMES 2016.** ***Main assumption: current policies are continued but not tightened.*** |
| **Frozen efficiency scenario:** | Same socio-economic changes (i.e., industrial value added and production volumes) with the Reference scenario. *Main assumption: no energy efficiency or technological changes are allowed.* |





**Not considered:**
**- energy shortages (late 2021) and,**
**- war between Ukraine and Russia!**

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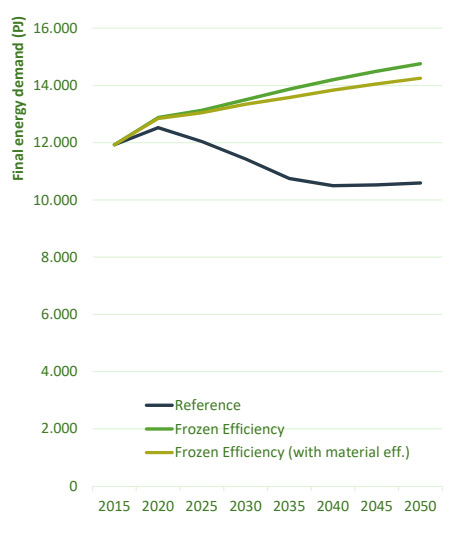
## Future industrial energy demand

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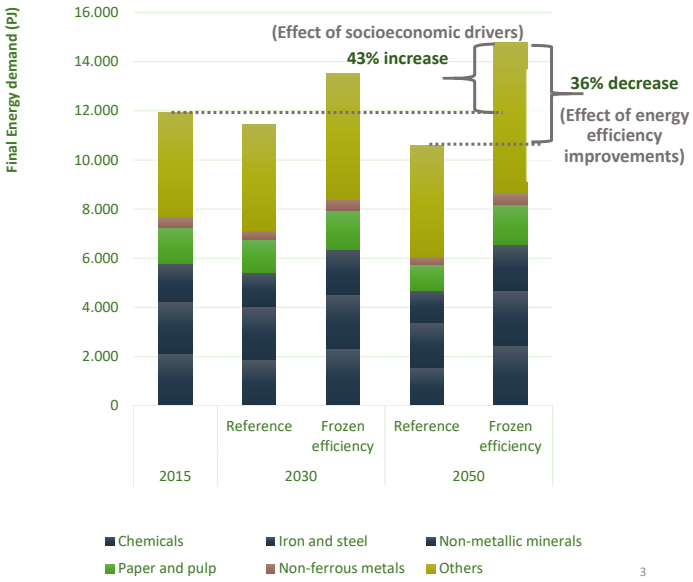


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## Technologies for deep decarbonization

| | Scenarios | Iron & steel | Non-metallic minerals | Nonferrous metals | Chemicals | Pulp & paper |
|---|---|---|---|---|---|---|
| No significant transformation | **Frozen efficiency** | No uptake of energy efficiency. Energy efficiency remains to the 2015 level. | | | | |
| | **Reference scenario** | PRIMES assumptions:<br>- BATs;<br>- Incremental increase in recycling levels. | | | | |
| Significant transformation | **Energy Efficiency** | Wide adoption of energy efficiency measures (BATs); (# measures: 23 cement; 10 glass, 20 iron and steel, 8 aluminium, 21 pulp and paper, 24 chemicals)<br>no material efficiency and/or increased recycling | | | | |
| | **Energy Efficiency + high recycling** | Wide adoption of energy efficiency measures (BATs);<br>**Increased recycling:** | | | | |
| | | Share of EAF steel increase from 39% to 67% | Clinker to cement ratio decreases from 76% to 66% | Share of secondary aluminium increases from 60% to 70% | - | Share of paper from recovered fibres increases slightly |
| | **Electrification** | Wide adoption of BATs;<br>Material efficiency same as in BAT high recycling;<br>Innovative measures; and<br>**Electrification measures:** | | | | |
| | | DR electrolysis (Ulcowin, Siderwin, Ulcolysis), electric furnaces | Thermal plasma torches (cement); electric melters (glass) | Induction furnaces (aluminium) | Hydrogen used as feedstock (ammonia, ethylene, methanol); Heat pumps and electric boilers for steam generation | Heat pumps and electric boilers for steam generation |
| | **Hydrogen** | Wide adoption of BATs;<br>Material efficiency same as in BAT high recycling;<br>Innovative measures; and<br>**Hydrogen measures:** | | | | |
| | | Hydrogen based direct reduction (H-DR) | Hydrogen fired kilns | - | Hydrogen used as feedstock (ammonia, ethylene, methanol);<br>Hydrogen boilers for steam generation | Hydrogen boilers for steam generation |

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## Closing remarks

**Bottom-up details in IndustryPLAN**

**Future material production**
(per product & country)

**Energy intensities**
(per product, energy carrier & temperature level)

**Details on Best Available Technologies and Deep Decarbonization Technologies**
(Investment costs, Change in Operation & Maintenance costs, Current diffusion rates, Future Implementation rates)

**Waste heat availability from industrial flue gases**
(per process, per temperature level, with and w/o waste heat recovery)

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# Energy efficiency and renewable energy in European industry


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**Energy efficiency first summit - Energy efficiency in industry in sEEnergies**

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## IndustryPLAN tool overview

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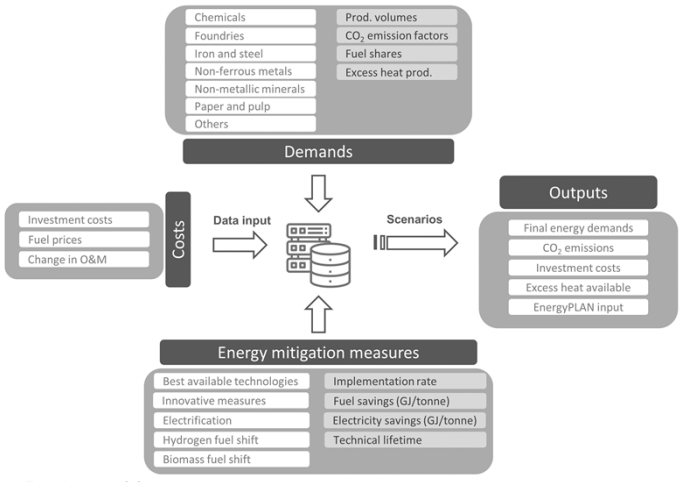
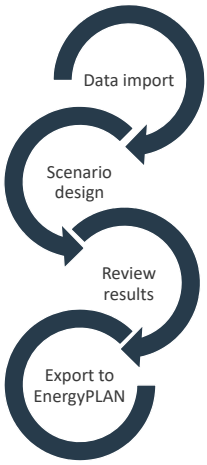
### IndustryPLAN tool




### Industry sector modelling process






## Energy savings cost curves

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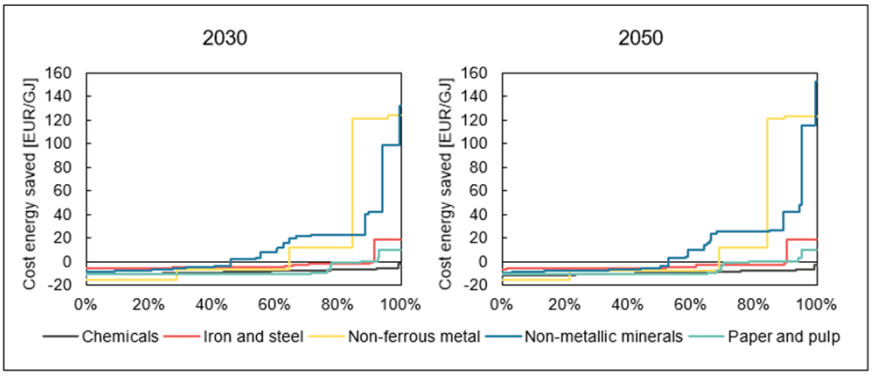
**Cost of conserved energy BAT measures (3% discount rate)**
**Cost of conserved energy BAT measures (15% discount rate)**




- **~80% of energy savings** from BAT technologies can be realised as **cost saving** measures
- **Top-end measures** in **non-ferrous metals** (aluminium) **and non-metallic minerals** (cement) **are expensive**
- Cost-curves **based on technical lifetimes** – **industries may have other requirements**
- Cost-curves **based on long-term natural gas price projections**
  - **Current high prices** would make EE improvements **more attractive**

## 100% RE industry scenarios

Modelled scenarios

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**1 Low EE scenario**

- No increase in recycling
- Limited implementation of EE measures and electrification
- Extensive biomass fuel shift

**2 High EE scenario**

- High increase in recycling
- Extensive implementation of EE measures
- Limited electrification
- Medium biomass fuel shift

**3 High EE and electrification**

- High increase in recycling
- Extensive implementation of EE measures
- Extensive implementation of electrification
- Low biomass fuel shift

**4 High EE, electrification and hydrogen**

- High increase in recycling
- Extensive implementation of EE measures
- Extensive implementation of electrification
- Extensive implementation of hydrogen measures
- Low biomass fuel shift



## 100% RE industry scenarios

Aggregate EU27+UK results

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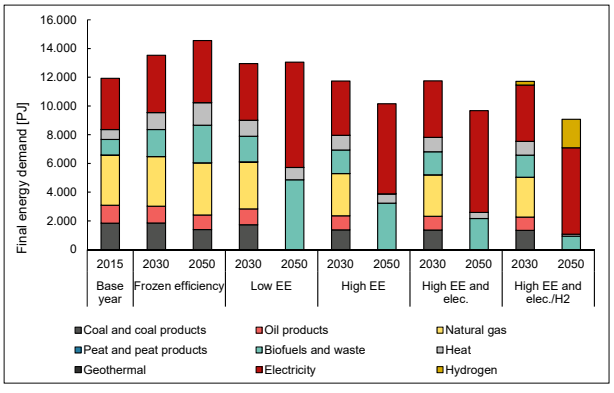
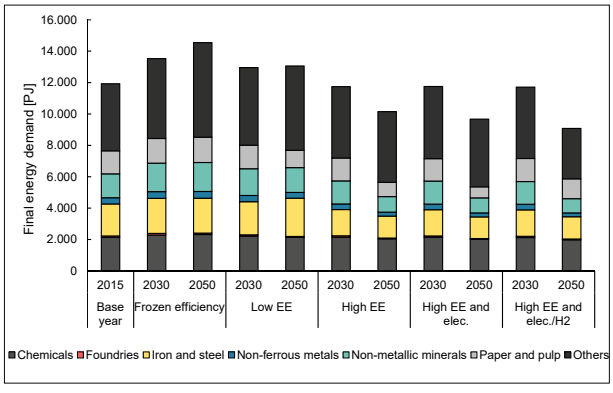
Final energy demand by scenario disaggregated by fuel type (EU27+UK).




Final energy demand by scenario disaggregated by industrial sub-sector (EU27+UK).

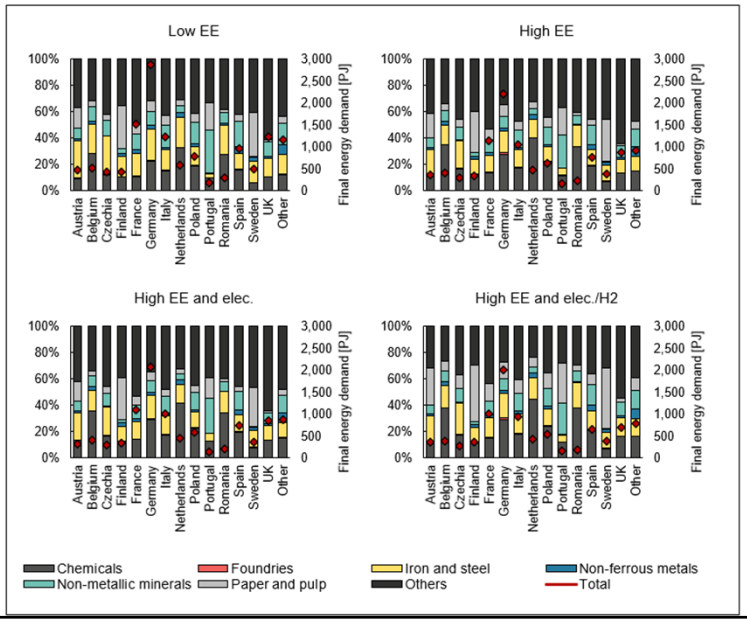



- **All scenarios** (even low EE) **can negate the increasing industry demand** in the Frozen Efficiency scenario
- **Foregoing focus on EE and electrification results in large biomass demands**
- **Hydrogen potential is (relatively) limited** – especially before 2030
- **Electrification is by far** the **most important measure** for enabling the industry transition

## 100% RE industry scenarios

Individual country results

- **Germany dominates European industrial energy demands** – also in high EE scenarios
- **All countries can achieve substantial energy savings** across all sub-sectors
- "Others"-sub-sector constitutes significant portion of demand in most countries
  - Leaves room for further disaggregation in future studies






## Summary and conclusion

- **Four different pathways** to **100% renewable energy** in **industry** established
  - **Extensive scope** covering **all EU countries** and **all industry sub-sectors** in **a bottom-up approach**
- **Most energy and $CO_2$ saving measures** can be implemented at a **negative cost** – from a socio-economic perspective
- A **lacking emphasis** on **EE improvements and electrification results in extensive biomass consumption** if pursuing 100% renewable energy
- **Hydrogen needs to be prioritised for hard to abate processes – total demand is (relatively) low**
- **EE improvements** and the **RE transition** is **pivotal** in increasing **security of supply and reducing natural gas dependency**
- Future **integrated energy system modelling needs to consider** the **industry** sector **in greater detail** – **opening the "black box"** of the industry sector

## Thank you for your attention!

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## Energy savings cost curves

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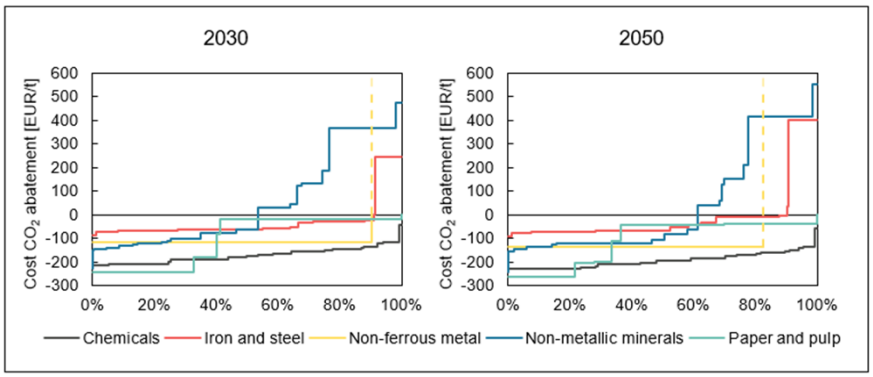
Cost of $CO_2$ abatement for BAT measures (3% discount rate)




- **~80% of the $CO_2$ reduction** potential can be realised as **cost reducing measures**
- **Differences from previous energy savings cost curves a result of fuel distribution across sub-sectors**
  - **I.e. Iron and steel with a large share of low-cost coal with high $CO_2$ emissions**
- Paper and pulp is largely electrified already, resulting in a low $CO_2$ reduction potential

## 100% RE industry scenarios

Individual country results

- **EE improvements can significantly reduce need for biofuels** in all countries
- **$H_2$ constitutes relatively small share of total demand**, even in scenario with high implementation rate
  - Mainly applied in chemicals and iron and steel sub-sectors