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POLICY BRIEF

In-depth quantification of Industrial energy efficiency potentials

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Key messages

- This project shows an extensive scope for covering all EU countries and all industry sub-sectors in a bottom-up approach. Individual country projections are made and an IndustryPLAN model was developed.
- IndustryPLAN enables the identification of synergies between industry and renewable smart energy systems and facilitates the implementation of the Energy Efficiency First Principle for industry.
- Increased energy eficiency uptake and recycling can reduce the industrial energy demand intensity in the EU by 10% in 2030 and by 23% in 2050.

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- Most energy efficiency measures are identified as cost effective - from a socioeconomic perspective.
- By 2050, fully decarbonised scenarios are possible for the European industry sector.
- A lacking emphasis on energy efficiency and electrification results in extensive biomass consumption if pursuing 100% renewable energy.
- Hydrogen produced from renewable sources can decarbonise fossil-fuel intensive industries, such as chemicals and iron and steel. However, the wide adoption of hydrogen-based technologies, combined with a limited uptake of energy efficiency and electrification, will make the transition costlier and will induce energy losses.
- Future integrated energy system modelling needs to consider the industry sector in greater detail – the IndustryPLAN model and the results established in this project constitute a significant step towards opening the "black box" of the industry sector.

Key findings and key recommendations

The objectives of this work package were to quantify energy efficiency potentials in all industry sub-sectors, in all EU-27 + UK countries, create scenarios for the reference years of 2030 and 2050, as well as to develop an IndustryPLAN model in which each industry sector in each member state can be analyzed in depth.

As a first step, we developed a **frozen efficiency scenario** which, although it does not allow for energy efficiency improvements, does allow for the same socio-economic changes (i.e., industrial value-added and production volumes) as the PRIMES reference scenario. The main aim of the frozen efficiency scenario is to measure the extent to which energy efficiency is already incorporated in the reference scenario in which the energy demand decreases annually by 1% in the 2020-2035 period and by 0.1% in the 2030-2050 period due to i) energy efficiency improvements and ii) structural changes in the industrial activities.

The main results of this task are the final energy demand projections for the decomposed PRIMES reference and the frozen efficiency scenario for the years 2015, 2020, 2025, 2030, 2035, 2040, 2045, and 2050 per EU country: 1) Total final energy demand per industrial sub-sector (split into coal, peat, oil, natural gas, electricity, biomass and waste, geothermal, solar, heat and others), and 2) Total final energy demand for heating and cooling per industrial sub-sector (per temperature category). In contrast to the decreasing energy demand in the reference scenario, the energy demand in the frozen efficiency scenario is shown to increase at an annual growth rate of 0.6%. The differences in energy demand projections between the two scenarios were determined for the chemicals, iron and steel, non-metallic minerals, paper and pulp, non-ferrous metals, and the other industries for the 27 countries in the European Union (+ the UK).

As a second step, we identified the **energy efficiency potentials**. After identifying the measures/technologies that can offer significant energy savings and are applicable to the EU industrial sector, we gathered data on the current diffusion rates of the technologies in the EU, the energy savings potentials (for both fuel and electricity), and required investment costs. All the data were combined, and a database was built that lists all the collected data for every measure. By combining the activity of each industrial sub-sector in each of the EU-27 + UK countries, determined in step 1, with the energy savings potential of each technology/measure, the overall amount of the energy that can be saved in the EU was calculated. In addition, the cost of conserving energy (in €/GJ_{saved}) and the overall investment cost (in million €) were determined for each country separately and for the EU-27 + UK as a whole. Results show that in the frozen efficiency scenario, the energy demand reaches 14.2 EJ by 2050; 22% higher than in 2015. Energy efficiency improvements and increased recycling can

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decrease the industrial energy demand by 23% (11.3 EJ in 2050). When innovative technologies in combination with electrification or H_2 technologies are widely implemented the 2050 energy demand can further decrease to 9.7 EJ or 10.3 EJ, respectively.

As a third step, the **IndustryPLAN model**, a freeware tool, was developed. UU supplied data and advice for the construction of the IndustryPLAN model, while AAU was the main responsible for the data connection and data implementation in the model. The tool is based on seven guiding principles, to open up the "black box" of industry, quantify such strategies and apply them to EU-27 + UK. The tool enables the user to conduct country-specific, sector-specific, or aggregated European analyses of climate mitigation measures by implementing the best available technologies (BAT), innovative measures and technologies, electrification, shift to hydrogen-based processes, and excess heat utilisation. Also, resilience against fluctuating fuel, electricity, and technology processes can be analysed to illuminate geopolitical or supply chain issues. The combination of the guiding principles methodology and the IndustryPLAN tool identifies at least 30% short-term feasible final energy demand savings and possible full decarbonisation. By applying the IndustryPLAN model for 100% renewable energy scenarios it is found that 1. Known technologies can decarbonise most of the industrial sector; 2. Costs and efficiencies are improved by energy savings and electrification; 3. Limiting bioenergy consumption is a key challenge and the alternative of using hydrogen or hydrogen-based electrofuels will make the transition more expensive and induce energy losses. A full transition to renewable energy and a decarbonised energy system may be possible before 2050, however, this requires that all investments are sustainable from 2030 onwards and that grid electricity is fully decarbonised. Several pathways toward 100% renewable energy supply in the European industrial sector were established, finding that electrification and energy efficiency improvements are going to be pivotal components of the renewable energy transition in the European industry.

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