Material and energy flows in the Polish industry
Resource Efficiency Collective is a research initiative at Cambridge University. Together, we seek answers to a challenging question: how can we deliver future energy and material services, while at the same time reducing resource use and environmental impact?

www.refficiency.org
Global steel flows

Resource 25% of crude steel never make it into a product
Global chemical flows

Materials mapping is important for linking intervention actions back to the emissions

Global map of chemical flows, from fossil fuel feedstocks to chemical products.
Resource Efficiency
Can we deliver future energy and material services, while reducing resource use and environmental impact?
Resource efficiency

Resource input

Energy inputs

Material inputs

Process

Useful Output

Useful By-products

Waste products

Losses

Useful output

Resource efficiency = Useful output / Resource input
Poland energy and material use

- Poland is the third largest producer of cement in Europe, after Germany and Italy.
- Poland is fifth largest producer of steel in Europe, after Germany, Italy, France and Spain.
- Poland is sixth largest producer of plastic in Europe, after Germany, Italy, France, Spain and UK.

- Poland is the fourth largest material consumer (DMC) in Europe, after France, Turkey, and Germany
- Poland is the fourth largest producer of waste in Europe, after Romania, UK, France and Germany
- Poland is a the seventh largest energy consumer in Europe, after Spain, Turkey, Italy, UK, France, Germany
- Poland is the sixth largest producer of GHG in Europe, after Italy, France, UK, Turkey and Germany

- The combustion hard coal, lignite and crude oil contributes in 89% of territorial CO₂ emissions in Poland.
Previous mapping work

Mapping energy and material flows of 5 key industries

- Basic metals
- Non-metallic minerals
- Paper
- Chemicals
- Rubber and plastics
Industrial energy use in Poland, 2015, traced from primary to final energy, (in petajoules, PJ)
Material and energy flows in Poland, 2015

Material and energy flows for the five key industrial sectors in Poland (in petajoules, PJ).

- Basic metals
- Non-metallic minerals
- Paper
- Chemicals
- Rubber and plastics
Latest mapping work

Mapping energy and material flows of all industrial sectors

Overview
- Agriculture, forestry and fishing
- Manufacturing
- Construction
- Mining and quarrying,
- Electricity, gas, steam and air conditioning supply
- Water supply; sewage, waste management and remediation activities
- Transportation and storage
- Information and communication (when the data is available)
- Other consumption

Detailed analysis
- Mining and quarrying
- Manufacture of metals and metal products
- Bioproducts and non-metallic mineral products
- Plastic, rubber and chemical products
- Construction
- Information and communication and Transportation and storage.
Resource flows in Poland, 2019

Material flows traced from production to use by economic activity, with water (million tonnes, Mt)
Resource flows in Poland, 2019

Material flows traced from production to use by economic activity, without water (million tonnes, Mt)

Total energy use 2,286 PJ (65% of the national energy use of 3,356.7 PJ)

Energy flows in Poland, 2019

Direct energy use (energy, including electricity and heat production) measured in PJ

The sum of all energy materials is 101 Mt (25% more than all non-energy materials use)
Direct material use, 2019

Direct material use (measured in mass) in the Manufacture of plastic, rubber and chemical products

The sum of all materials is 6.1 Mt (excl. water) 6.1Mt
Direct material use, 2019

Direct material use (measured in mass) in the Manufacture of plastic, rubber and chemical products

Total energy use 480 PJ

- Manufacture of chemicals and chemical products (196.3 PJ)
- Manufacture of textiles (3.9 PJ)
- Manufacture of wearing apparel (1.0 PJ)
- Manufacture of coke and refined petroleum products (252.1 PJ)
- Manufacture of rubber and plastic products (26.5 PJ)

Cullen J.M., Azevedo J.M.C., Cervantes Barrón K., Drewniok M.P., 2021
Direct material use, 2019

Energy materials use (measured in mass) in the Manufacture of plastic, rubber and chemical products

The sum of all energy materials is 18 Mt (300% more than all non-energy materials use)

Poland energy and material use

- Fossil fuels (hard coal, lignite and oils) – 60% of material use (excl. water) – should be reduced.
- Fossil fuels (hard coal and lignite) are mainly used for electricity and heat production.
- The losses from electricity production are 58% and 15% from heat production – increasing efficiency will decrease energy material use.
- Switching to renewable energy sources should be accelerated.
- Electrification of industrial production should be accelerated, especially for Manufacture basic metals, Manufacture of chemicals and chemical products, manufacture of coke and refined petroleum products and manufacture of non-metallic minerals.
- Transport electrification should be accelerated.
- Heat recovery, especially from energy and heat intensive industries should be explored.
- Efforts should be made to reduce the impact of the production of non-metallic minerals such as Portland cement.
Next steps

- Use of exergy - energy and material flows in the same units, a direct comparison between the useful outputs of industry and all the required inputs (which represent the resources required to produce goods) would enable the evaluation of the resource efficiency of industry in Poland. This might contribute to identify opportunities for reducing resource use that would not be identified otherwise. Good resource management enables: waste avoidance, wise use of scarce resources, cost reduction, responsiveness to future regulation, and reduction in industrial energy-related CO₂ emissions.

- Resource flows (MFA) can be used for the waste flow in Poland. This could lead to proposing interventions to close the Circular Economy gap in Poland.

- The flow of greenhouse gas (GHG) emissions in the relevant industrial activities could be used to identify the biggest areas of improvement. The GHG intensity of material production can vary significantly so extending the current analysis to consider GHG emissions (from Whole Life Carbon perspective) would provide a deeper understanding of the environmental impact of industry in Poland.
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