Mobilising the circular economy for energy-intensive materials

How Europe can accelerate its transition to fossil-free, energy-efficient and independent industrial production

Oliver Sartor (lead), Nelly Azaïs, Helen Burmeister, Paul Münnich, Camilla Oliveira, Wido Witecka

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Increasing focus on transition to climate-neutral industry, but mostly on new methods for virgin materials production – secondary routes missing

⇒ Enormous time and political capital spent on topics such as:

- ⇒ Clean hydrogen
- ⇒ Low carbon gas
- ⇒ CCS (Carbon Capture and Storage)
- ⇒ CCfDs (Carbon Contract for Difference)
- ⇒ TEN-E Infrastructure Funding for H2, Clean power, CCS

All necessary.
But an *excessive* focus on *primary* materials; circularity and material efficiency missing.

E.g.: EU ETS Innovation Fund (first round):

⇒ 22 *large-scale* projects => only 1 of these was a (chemical) recycling project of MSW
⇒ 30 *small-scale* projects: nothing targeted for enhanced recycling of steel, aluminium, plastics or cement & concrete (3 "circular" projects = 1 battery re-use + 1 CCU + 1 H2 project using MSW).

An industrial strategy that focuses too heavily on new processes for virgin materials production is highly energy-and resource-inefficient

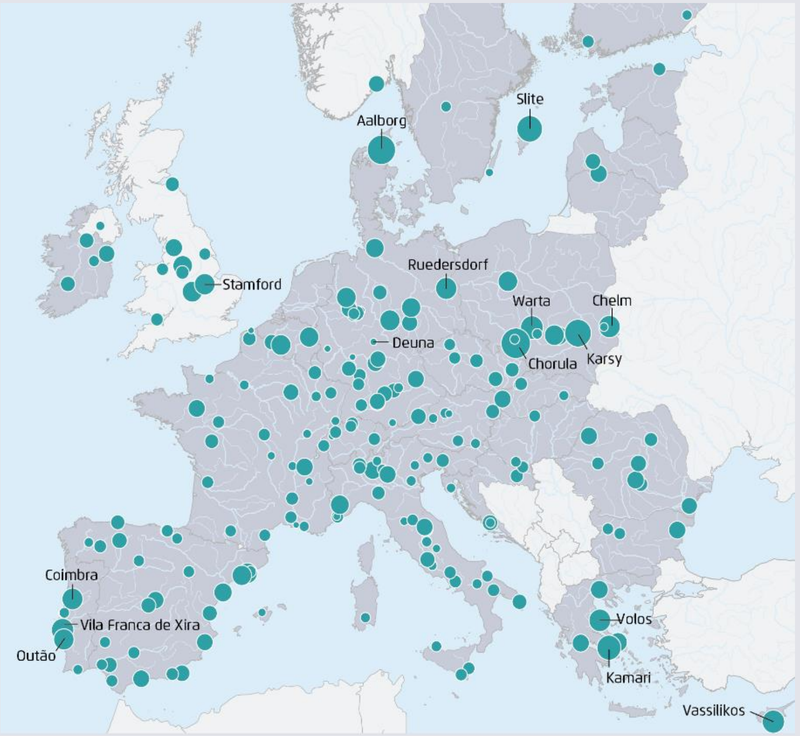
Additional power needs for climate neutral steel, cement and chemicals

Agora Industry, based on data from Eurostat (2021) and Material Economics (2022)

- → Inherent challenges of massive infrastructure build out to supply green power, green hydrogen, bio-feedstocks, CCS transport and storage, etc.
- → Risks of increasing cost and dependencies on foreign supplies.
- → Enhanced, high quality circularity + material efficiency offer very large potentials to reduce total clean energy needs for industry.
- → This will lower costs for industry to competitively go green (EU has abundant scrap and waste)

For example, for cement and concrete, how realistic is it to rely on very high levels of CCS?

CCS for all? Cement sector capacities across Europe…

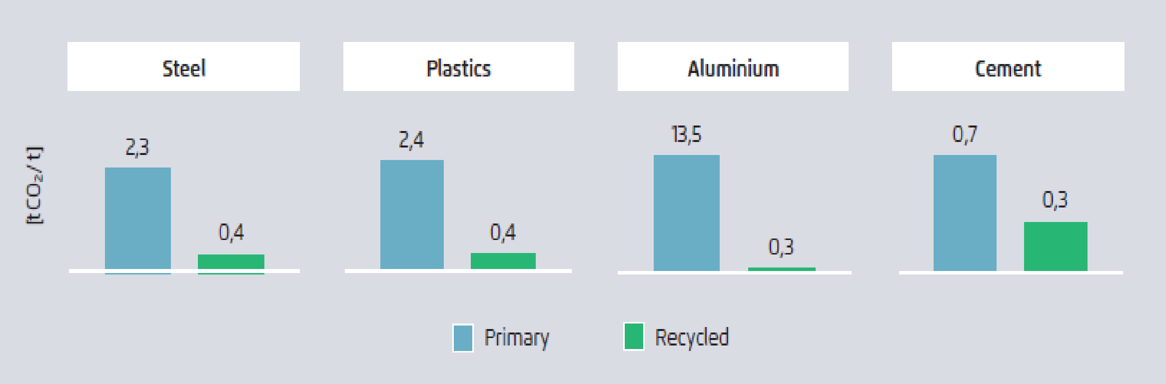


Note: Green dots represent cement production sites; sizes reflect capacity levels (1 000 to 4 000kt/year)
Source: Agora Industry, based on Wuppertal Institute data (2020)

- → Some level of CCS – combined with storage of bio-carbon to create negative emissions – will be needed.
- → However, there are natural limitations in terms of public acceptance, cost and technical limits.
- → Difficult to see how the cement sector can achieve net zero emissions without combination of measures to reduce virgin material and CO_2 demand.

More circular and efficient use of materials offers enormous potentials to reduce emissions and energy consumption

CO_2 intensity factors of virgin (primary) vs. recycled (secondary) production routes (global averages) Figure 5



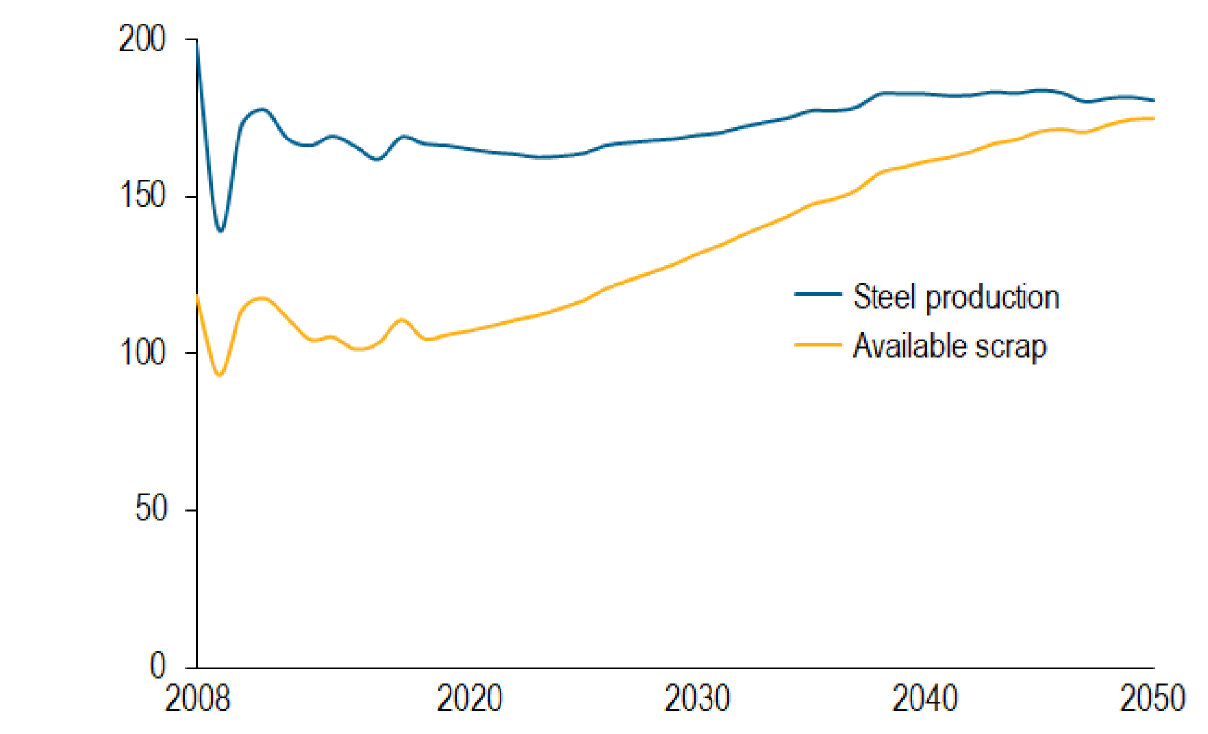
Material Economics analysis based on Wood Mackenzie and S&P Global Platts Analytics (2021)

Reducing EU gas and oil consumption :

Material efficiency and circularity measures on *plastics alone* could save on annual hydrocarbon use linked to up to **149m boe** of oil consumption and up to **2.7 bcm of gas** consumption **by 2030**.

It also plays to the EU's economic advantages and industrial security interests

Steel scrap availability and steel production (mt per year)

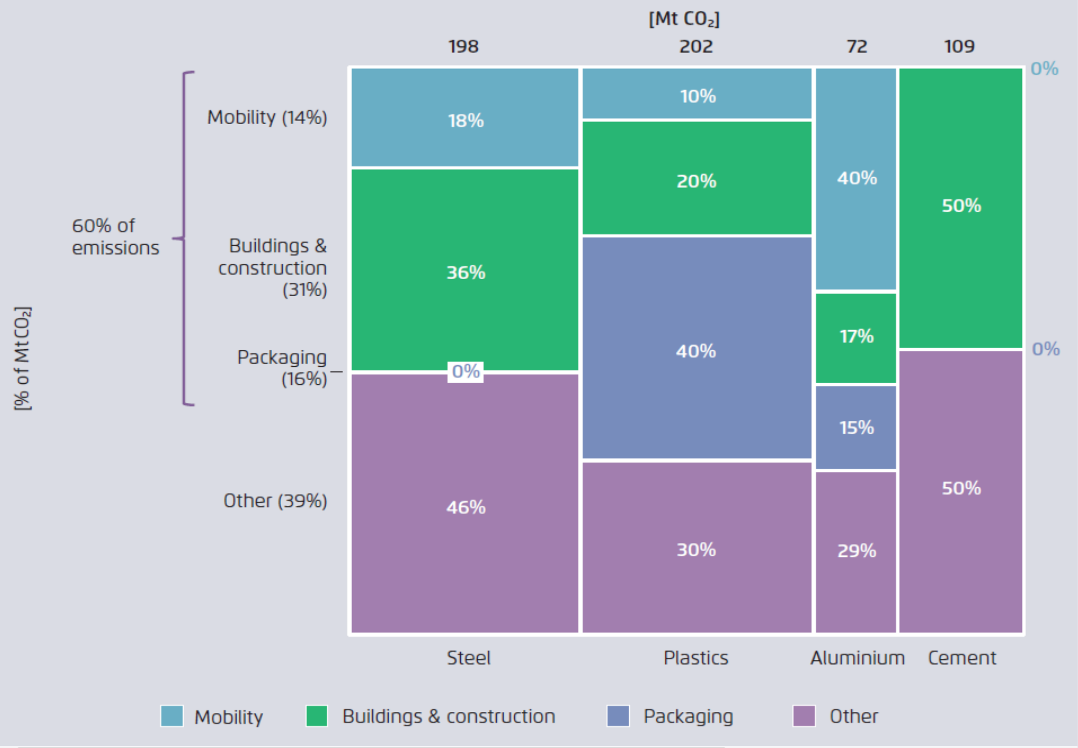


Source: Material Economics (2019)

- The EU lacks abundant and cheap clean energy today…
- But does have large and growing scrap and waste in energy-intensive sectors.
- Circularity also plays to EU advantages in digital, logistics, advanced and additive manufacturing, market creation via smart regulation.

Current circularity policies are fine, but are not optimised to reduce fossil fuel, energy and CO2 consumption

Emissions by material and value chain, EU (2019 data). % of MtCO2 from materials used, 2019 (out of total)



Agora Industry, based on data from Material Economics (2019)

→ The EU's 2018 Circular Economy Action Plan did many goods things.

→ Yet the strongest measures mainly focused on single use plastic waste and certain kinds of plastic packaging (e.g. PET bottle recycling quotas)

→ From a CO_2 viewpoint, one must also systematically tackle:

- Steel
- Aluminium
- Cement and concrete.
- The *full set* of plastic packaging products
- Buildings & construction
- Vehicles

Despite existing policies and private efforts, there are massive untapped potentials...

- **Downcycling is pervasive**: While up to 70-85% of steel, aluminium and even concrete is technically defined today as “recycled”, this almost always means *down-cycled*.

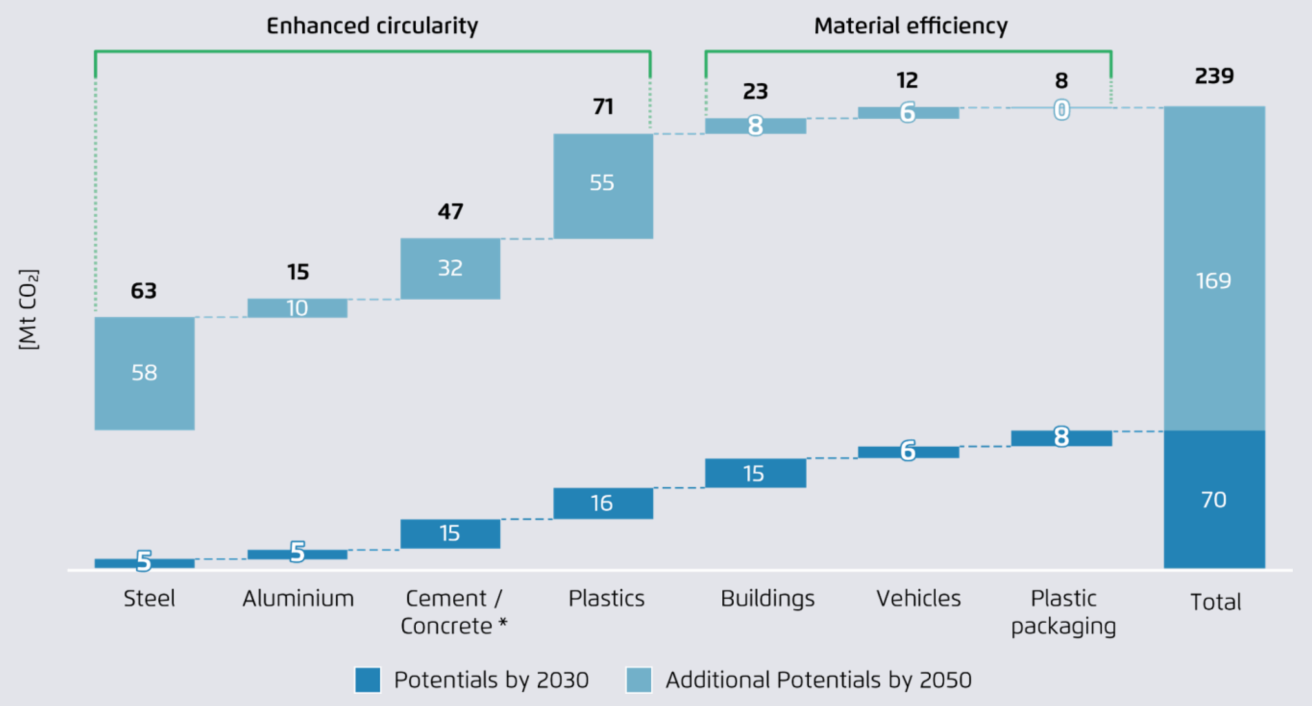
- **Policy targets focuses on quantity not *quality* of recycling**: The EU now has a number of quantitative targets for recycling of certain waste streams. But they tend to privilege *total quantity* of “recycling” (including downcycling), rather than also target quality of recycling.

- **Statistics on plastics recycling are incomplete, and so unreliable**: Current data and statistical methods used *fail to count an estimated 50%* of all end-of-life plastic waste. The correct rate of recycling for EU plastic waste is thus closer to 15%.

- **Material efficiency is largely forgotten**. Which EU or Member State policy today incentivizes reductions in material use per unit of material services?

Fixing these gaps would add up to very large CO2 abatements, energy savings, making the transition more realistic

Estimated abatement potentials from enhanced circularity and material efficiency by material or product in 2030 and 2050.

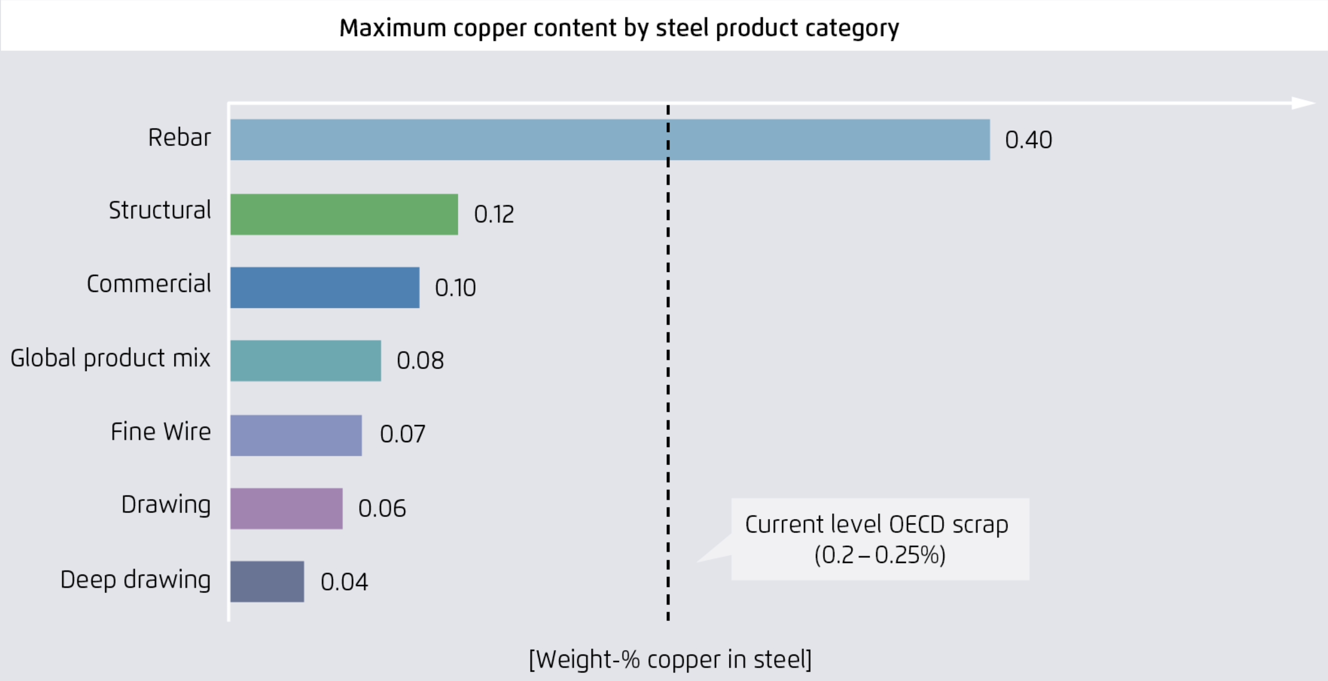


Source: Agora Industry (2022), based on modelling tools provided by Material Economics

- Combined CO_2 abatement potential up to 70Mt by 2030 and 239Mt by 2050, or 10% and 34% of total EU-wide industrial emissions
- New infrastructure costs in these sectors could be reduced by €1.5 billion/year.
- Electricity savings significant for the steel, cement and chemicals sectors: reduction of total electricity demand by over 400 TWh annually – equivalent to avoiding the installation of 60 000 wind turbines
- Fossil fuels savings

Steel: Scrap-based steelmaking in the EU can increase significantly and brings a lot of advantages – but only if copper levels in scrap are addressed

Copper tolerances of dierent steel products

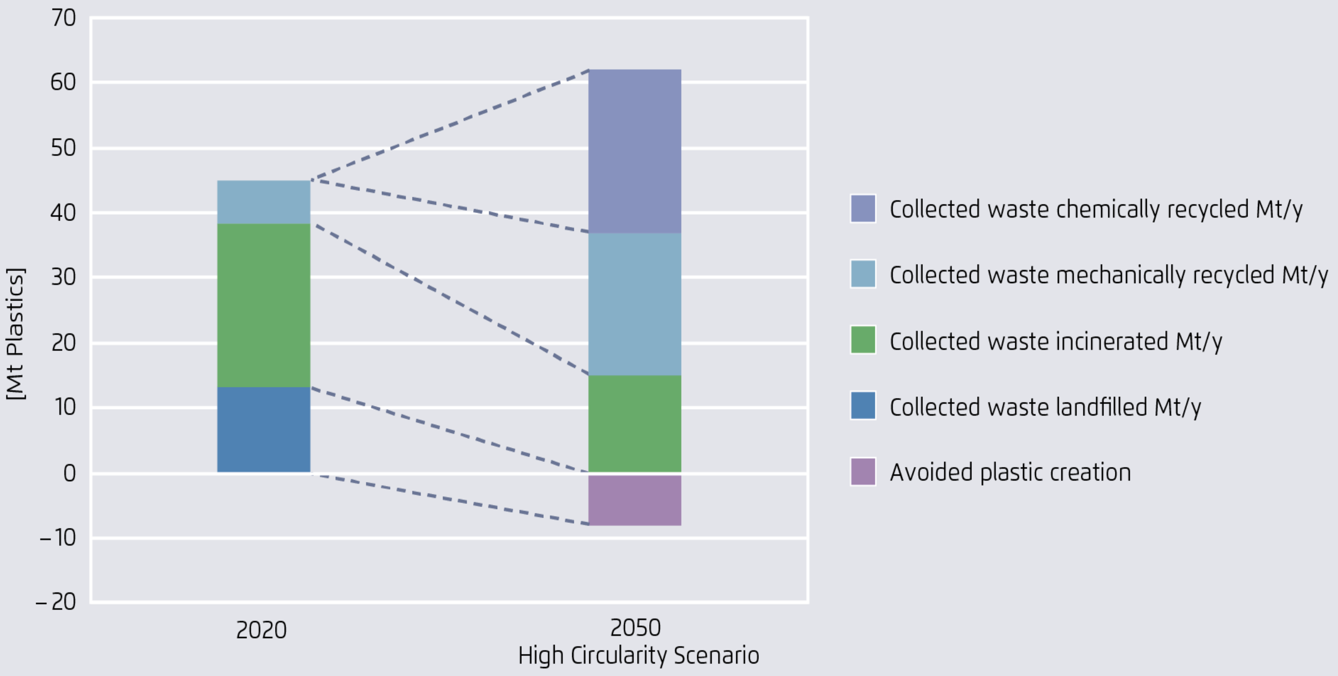


Material Economics (2018)

- → Maintaining **clean scrap flows** for steel and aluminium is of paramount importance. Today contaminations of steel scrap with copper is a challenge that leads to downcycling.
- → Measures such as **advanced copper separation technologies** or to eliminate **adverse recycling & sorting practices** will be key.
- → Scrap is an **EU domestic resource**. A higher share of scrap-based steel production in the EU will increase the **resilience**, **energy efficiency, resource efficiency** and ultimately **competitiveness** of the EU steel industry.
- → **By 2050** roughly **35 Mt of virgin steel** production (**or 63 Mt of CO_2 emissions)** could be replaced with secondary steel, if copper issues are addressed. **By 2030**, this number is **16 Mt of virgin steel production (equivalent to 24 Mt of CO_2 reductions**).

Plastics

How the end-of-life treatment of plastics could evolve in a high circularity scenario



Agora Industry (2022)

In a circular economy, waste plastic is a valuable resource. Plastic waste collection increases from 45 Mt in 2020 to 62.5 Mt in 2050.

A higher circularity of plastics **reduces CO_2 emissions**, **plastic pollution**, and **virgin feedstock imports**.

CO_2 reduction potentials and conditions:

→ **Reduce & Reuse** (-8 $MtCO_2$): avoid unnecessary plastics; innovative business models; awareness of consumers.

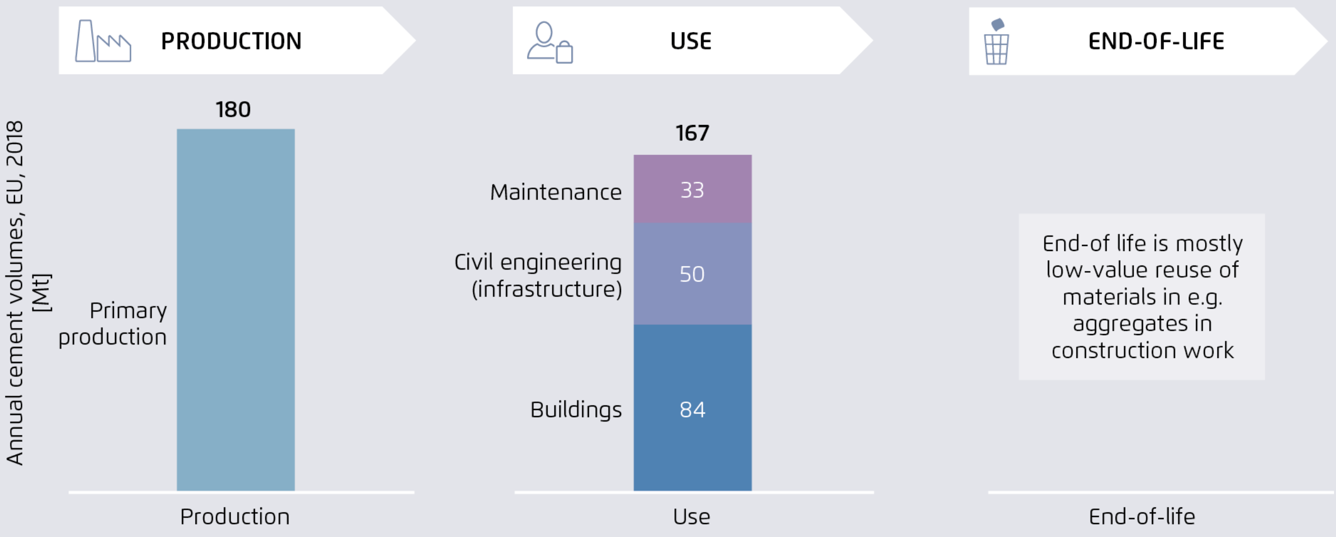
→ **Mechanical recycling** (-27 $MtCO_2$): improve collection rates (35%) and sorting of plastic waste.

→ **Chemical recycling** (-44 $MtCO_2$): ensure high degree of efficiency; renewable electricity.

→ **Waste incineration for bio-based plastics.**

Cement and concrete

Cement production, use and end-of-life statistics

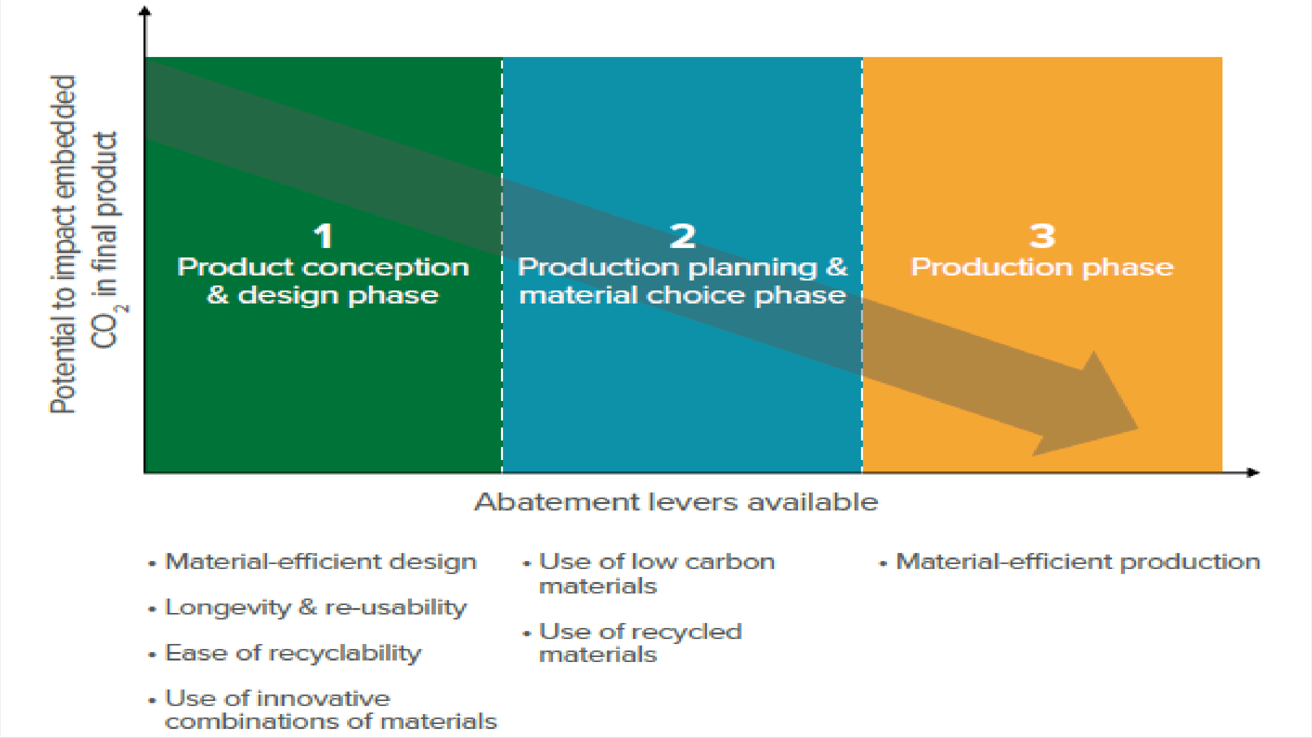


Note: Relative sector split based on Favier et al. (2018), A sustainable future for the European Cement and concrete industry. Source: Material Economics (2018)

- → Circular and material efficiency approaches are in development, including using **recycled inputs** for new cement production, **recarbonation**, and **optimisation of cement and concrete formulas**.
- → **Alternative binder** approaches could lead to emission reductions in the concrete sector in the order of up to **31 million tons of CO_2 by 2050**, which would constitute a **30 per cent CO_2 reduction versus the BAU**.
- → Additional emissions reductions in the order of up to **16-24Mt of CO_2 per year by 2050** could be achieved through **cement recycling**.
- → However, **current standards prevent** the use of such innovative alternative production routes. Also, the **current EU ETS design** disadvantages CE strategies in cement.

Material efficiency & substitution

Potentials for material efficiency along the value chain (e.g. building projects)



Agora Energiewende, CISL (2021)

→ **Buildings –** optimise building design for CO_2 and material intensity, optimisation of concrete formulas, right concrete to right applicati on, prefabricated components, material substitution in appropriate applications, prolong lifetime.

→ **Vehicles –** optimise design to reduce embedded carbon, reduce vehicle size and weight, material substitution, prolong lifetimes.

→ **Plastic packaging –** limit excess packaging, re-usable product formats, substitution to fibres

→ **Up to 29Mt of savings technically possible by 2030 and 43 Mt by 2050**.

→ Key challenges today are:
- Missing incentives at product/project conception phase
- Lack of carbon price pass-through
- Higher costs of labour, logistics
- Technological immaturity & skills

To unlock these potentials, a policy package is needed – targeting both demand and supply (1/2)

Comparison of plastics demand vs recycled plastic demand (2019)

Agora Energiewende and CISL (2021) based on data from European Commission

Demand side

→ Key priority is to create market demand for high quality, closed loop materials (not downcycling) + material efficiency

→ Main levers here include:

  → **Wider use of recycled content quotas to kick start HQ value chains (e.g. PET bottles)**

  → **Put limits on embedded carbon in buildings, vehicles and packaging**

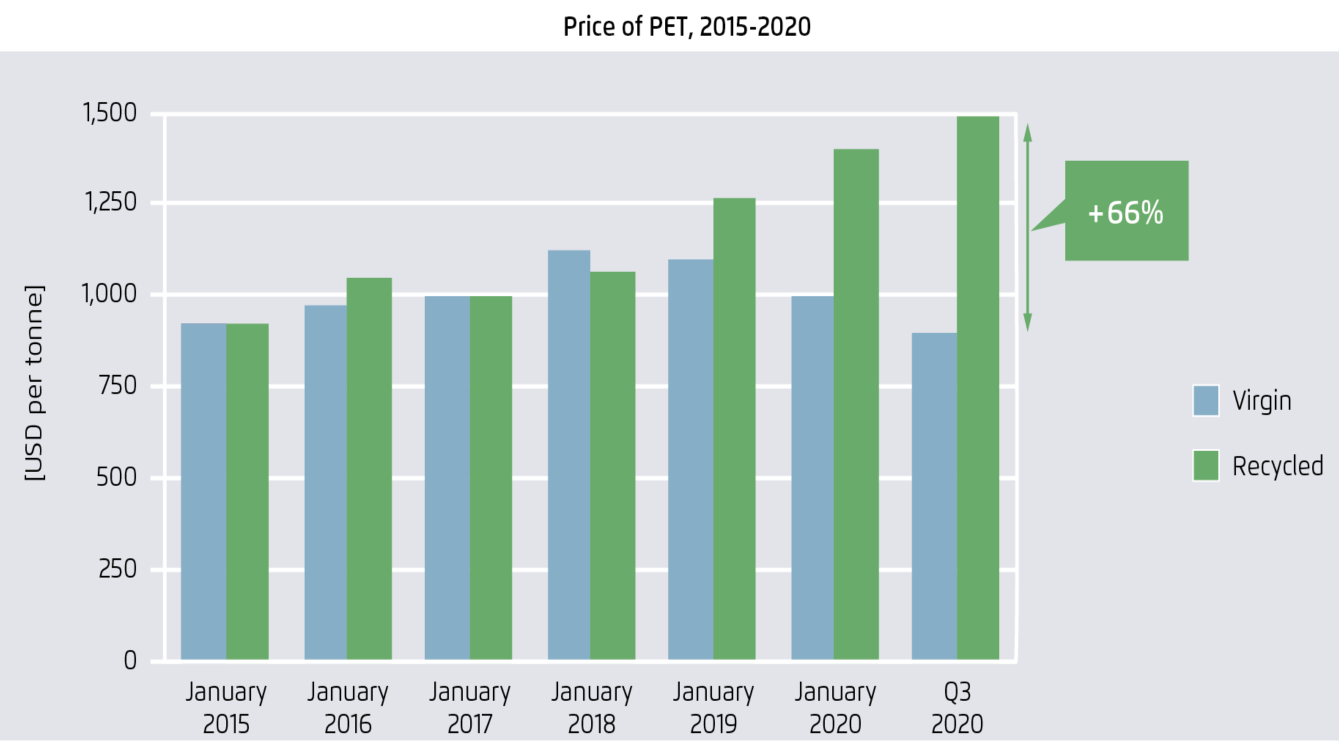
→ Other relevant policies:

  → **Integrated low-CO_2 + circular labelling and lead market tools**

  → **Reduce free allocation under ETS as CBAM comes in + include incineration**

To unlock these potentials, a policy package is needed – targeting both demand and supply (2/2)

Impact of recycled content quotas on demand and value of recycled PET plastics



Data from Material Economics (2021)

Supply side – and other market facilitation measures

- Without enabling tools to improve supply, quotas may be difficult to meet in practice (unduly raising costs)
- To scale up requires facilitation of supply:
  - **Support advanced recycling + material efficiency technologies**
  - **Require best available collection & recycling techniques**
  - **Reform EPR schemes to incentivize *closed loop* recycling**
  - **Remove outdated product standards**
  - **Robust sustainability criteria (chemical recycling)**
  - **Strengthen limits on exports and landfill**

Agora Energiewende
Anna-Louisa-Karsch-Str.2
10178 Berlin

T +49 (0)30 700 1435 - 000
F +49 (0)30 700 1435 - 129
www.agora-energiewende.de

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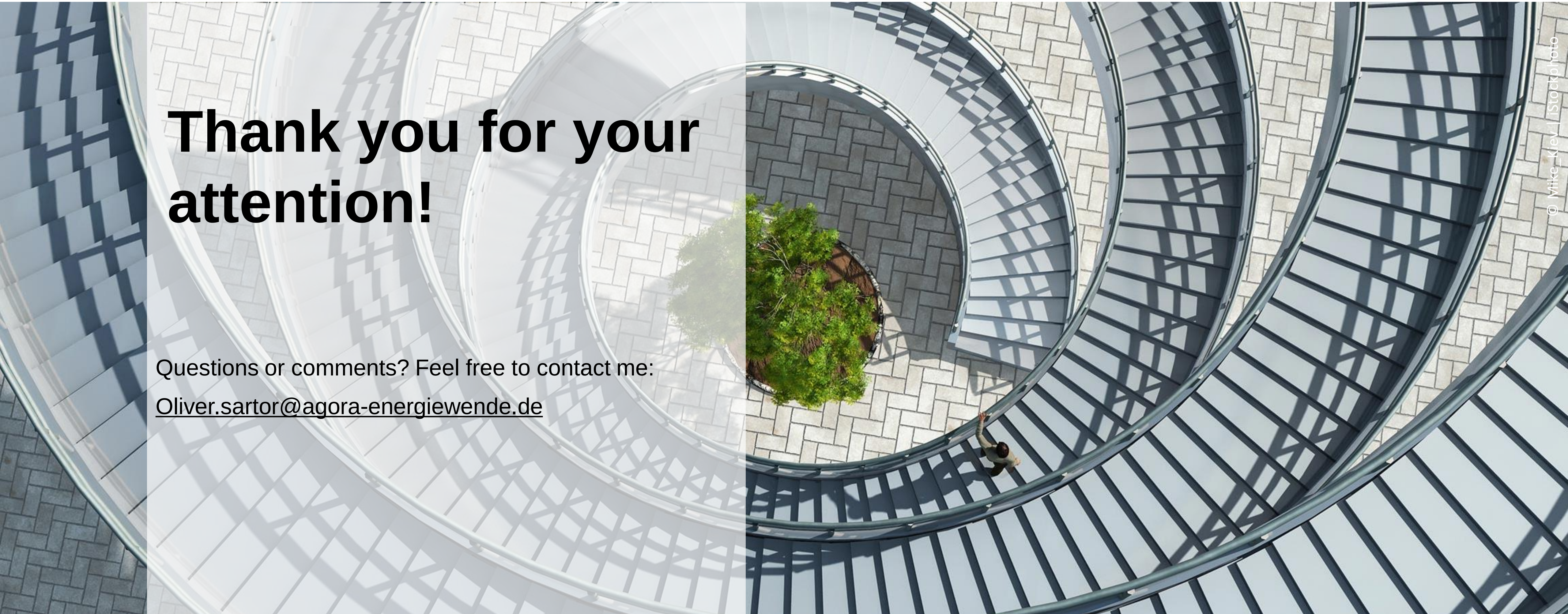

Thank you for your attention!

Questions or comments? Feel free to contact me:

Oliver.sartor@agora-energiewende.de

Relevant policy files to pursue these aims under European Green Deal

EU level legislative initiative	Opportunities for enhanced circularity of CO_2-intensive materials
The Sustainable Products initiative	Recycled content quotas & Incentives for recyclability in design of products; facilitate removal of product standards that inhibit market entry
Green Claims Initiative	Develop labelling and embedded CO_2 reporting that gives higher performance rating to recycled post-consumer scrap/waste (not only virgin materials)
Packaging & Packaging Waste Directive	Expanded quotas for recycled content beyond PET bottles; requirements on better collection and sorting (to maximise quality of recycled content, not just throughput. Revise targets on plastic recycling.
End of Life Vehicles and New Vehicles legislation,	Require use of best available end of life recycling techniques to maximise copper separation and maintain clean scrap flows
Energy Performance in Buildings Directive; CO_2 standards for vehicles	Limits on embedded carbon (to incentivize material efficiency, circularity, substitution and low-CO_2 virgin materials all on a level playing field)
Industrial Emissions Directive	Ensure only best available techniques on chemical recycling and presorting of recyclable plastics from mixed general waste before incineration
EU ETS and CBAM Regulation (ETS Innovation Funds)	Include incineration in ETS and remove free allocation to virgin production as CBAM phases in; Higher priority to enhanced circularity investments in funding awards
Single use Plastics Directive	Labelling or banning unrecyclable and material-inefficient product formats
Waste Framework Directive	Improve requirements on the quality of recycling for member states under EPR schemes; improve collection incentives + revise existing statistics on “missing” waste plastics; mandates for best collection and sorting techniques; stronger disincentives on landfilling and exports of waste (if incineration in ETS)
EU Industrial Strategy and Sectoral Pathways Development	Ensure full integration of enhanced circularity + material efficiency potentials compared to current approach