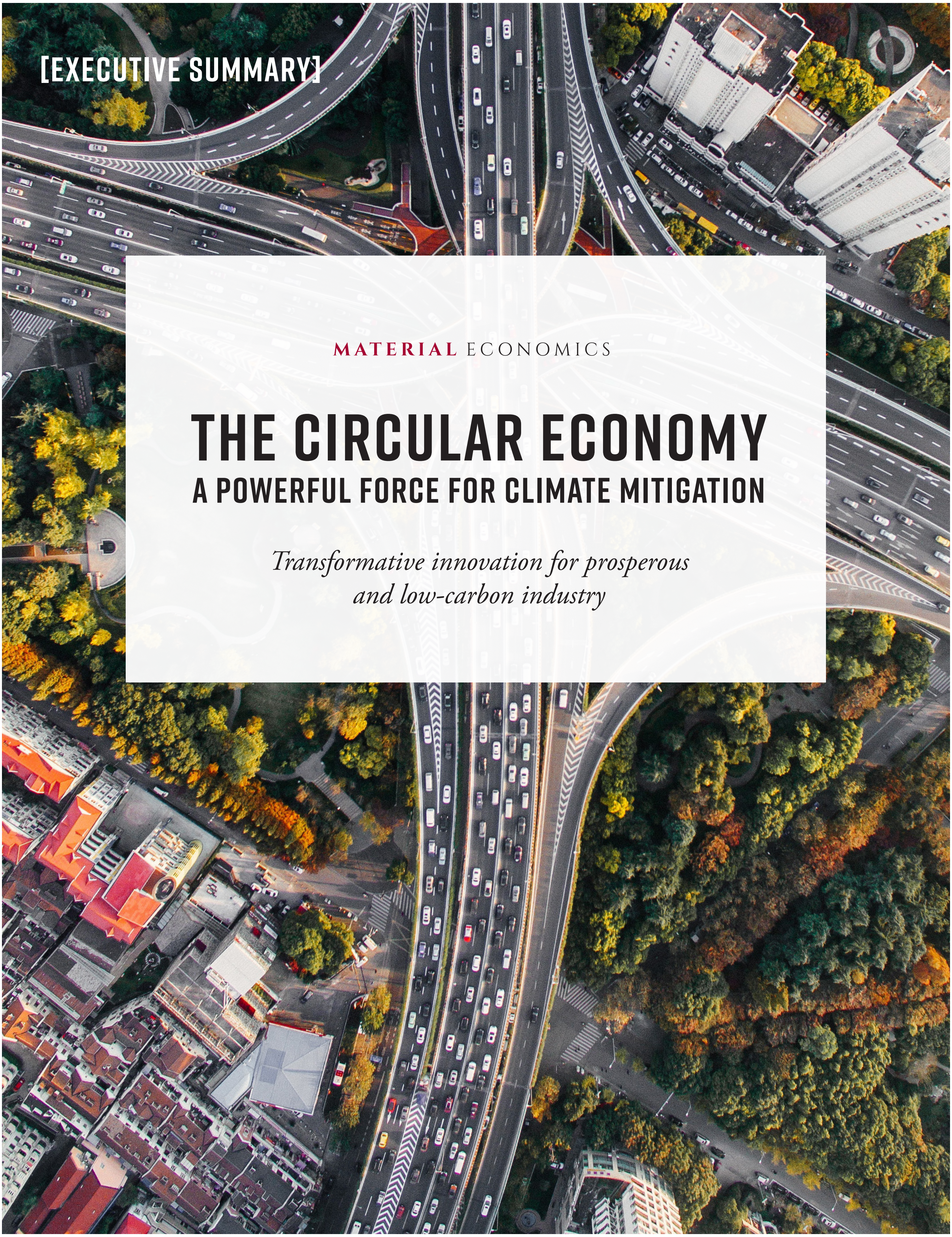
[EXECUTIVE SUMMARY]



MATERIAL ECONOMICS

THE CIRCULAR ECONOMY

A POWERFUL FORCE FOR CLIMATE MITIGATION

Transformative innovation for prosperous and low-carbon industry

SITRA
European Climate Foundation
Climate-KIC
Climate-KIC is supported by the EIT, a body of the European Union
ENERGY TRANSITIONS COMMISSION
ELLEN MACARTHUR FOUNDATION
MAVA FONDATION POUR LA NATURE
ClimateWorks FOUNDATION

EXECUTIVE SUMMARY

Industrial CO_2 emissions are a major concern as Europe tries to achieve the deep emission reductions required for its climate commitments. In the European Commission's 'Roadmap 2050', one-quarter of the CO_2 emissions remaining mid-century were from industry, especially from heavy industry producing basic materials. With more ambitious targets after the Paris Agreement, the EU must now articulate how to combine net-zero emissions with a prosperous industrial base.

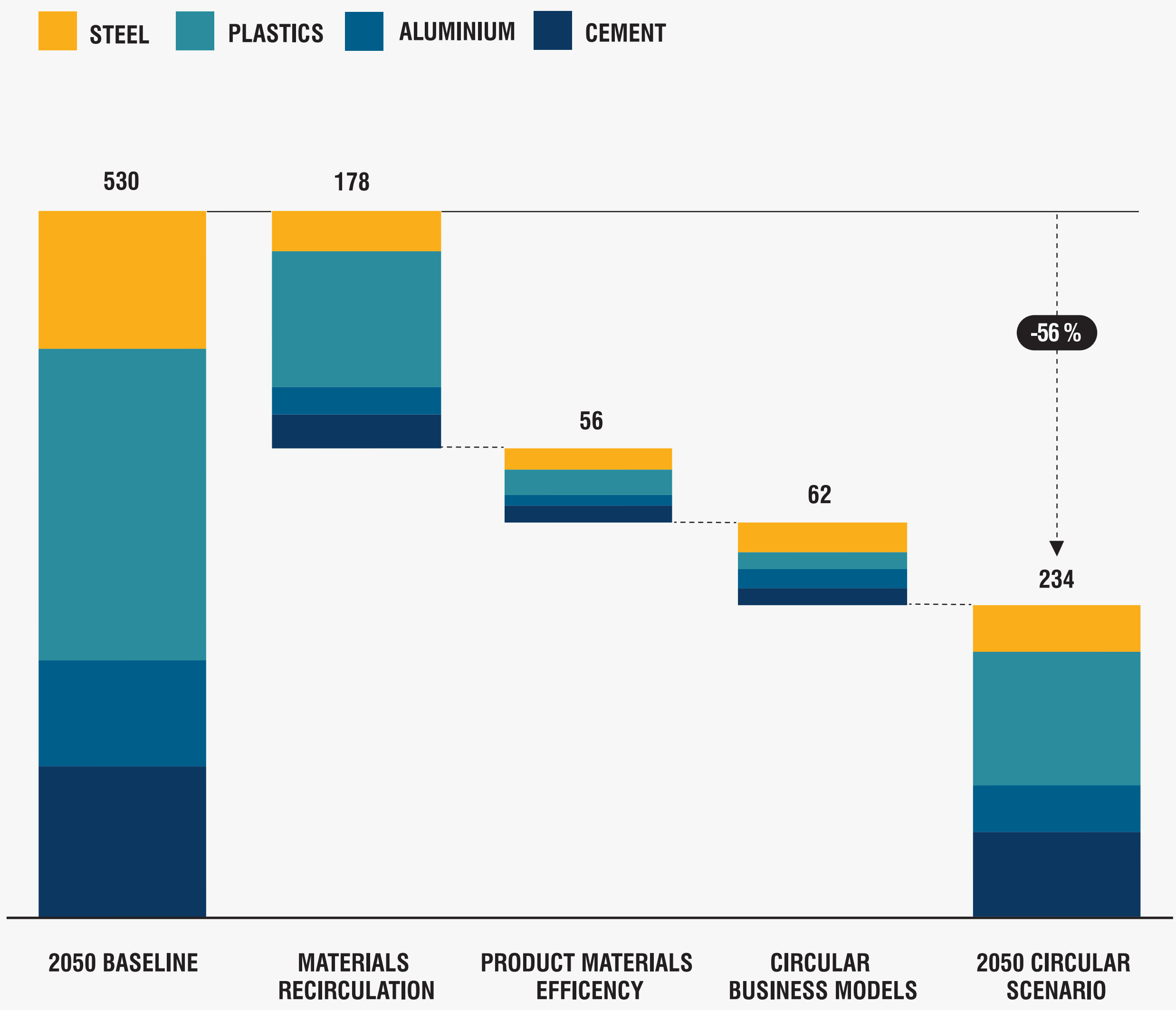
So far, discussions of industry emissions have focussed on the supply side: reducing the emissions from the production of steel, cement, chemicals, etc. Far less attention has been given to the demand side: how a more circular economy could reduce emissions through better use and reuse of the materials that already exist in the economy. This study aims to bridge that gap. It explores a broad range of opportunities for the four largest materials in terms of emissions (steel, plastics, aluminium and cement) and two large use segments for these materials (passenger cars and buildings).

The key conclusion is that a more circular economy can make deep cuts to emissions from heavy industry: in an ambitious scenario, as much as 296 million tonnes CO_2 per year in the EU by 2050, out of 530 in total – and some 3.6 billion tonnes per year globally. Demand-side measures thus can take us more than halfway to net-zero emissions from EU industry, and hold as much promise as those on the supply side. Moreover, they are often economically attractive.

Opportunities for more productive use of materials therefore deserve a central place in EU climate policy. Much like improving energy efficiency is central to the EU's efforts to achieve a low-carbon energy system, a more circular economy will be key to developing European industry while cutting its CO_2 emissions. As industry associations and the European Commission consider new mid-century 'roadmaps' for industry, they should include circular economy measures for cost-effective ways to achieve deep emissions cuts.

A MORE CIRCULAR ECONOMY CAN CUT EMISSIONS FROM HEAVY INDUSTRY BY 56% BY 2050

EU EMISSIONS REDUCTIONS POTENTIAL FROM A MORE CIRCULAR ECONOMY, 2050
Mt OF CARBON DIOXIDE PER YEAR



Demand-side opportunities could reduce EU industrial emissions by almost 300 Mt per year by 2050, or 56 %, with attractive economics. These abatement opportunities fall into three major categories:

A. Materials recirculation opportunities (178 Mt per year by 2050). The EU economy is accumulating large stocks of metals and plastics, and by 2050 could meet a large share of its need for these materials by recirculating what has already been produced: 75% of steel, 50% of aluminium, and 56% of plastics (cement is less amenable to recycling, although it is possible to reuse some unreacted cement). Recirculating materials cuts CO_2 emissions and requires much less energy than new production does. However, current practice is not set up to facilitate these high recycling rates. An influx of new materials is required both to replace metals and plastics that are lost, and to compensate for downgrading of quality. In some cases, metals are mixed or downgraded because materials specialisation requires it, but there also are many cases where this could be avoided or much reduced. For steel, the key is to ensure much cleaner scrap flows that allow for high-quality secondary steel, and less pollution of steel with copper; for aluminium, smaller losses and less mixing of different alloys will be crucial. Mixing and downgrading effects are particularly serious problems for plastics, making a large share of used plastics literally worthless. This study shows how 56% of plastics could be mechanically recycled, with a focus on the five main types of plastic that account for 70% of volumes. The aim must be to move these to a tipping point where recycling is economically viable, driven by the inherent material value. For this, as with steel and aluminium, product design and end-of-life disassembly need to change to enable high-value recovery.

B. Product materials efficiency (56 Mt per year by 2050). These opportunities have in common that they reduce the total materials input to key products. One strategy is to reduce the amount of materials that are lost in production: for example, half the aluminium produced each year does not reach the final product, but becomes scrap, while some 15% of building materials are wasted in construction. Another opportunity is to use more advanced materials and construction techniques, such as high-strength steel that can cut materials use by 30%. There also are opportunities to reduce over-specification, such as the near 100% overuse of steel in buildings relative to what is strictly required to meet design specifications. Further gains can be achieved by tailoring products better to specific uses; for example, to the extent that fleets of shared cars can replace individual ownership (see below), many of the cars needed will be smaller, just big enough for a one- or two-passenger trip in the city. Companies already have incentives to use these strategies to some extent, but some opportunities are missed through split incentives in complex supply chains. Many measures will become much more economic with greater digitalisation in the mobility and buildings value chains and other technological development now underway.

C. New circular business models in mobility and buildings, notably through sharing (62 Mt per year by 2050). This opportunity pivots on making much greater use of vehicles and buildings, which together represent a majority of European demand for steel, cement and aluminium. Currently, the utilisation of many of these assets is very low: about 2% for the average European car, and about 40% for European offices, even during office hours. Sharing enables much more intensive use. For vehicles, this in turn means that higher upfront costs of electric drivetrains, more advanced automation technology, or higher-performance materials can be paid back over many more miles. In addition, professionally managed fleets of such higher-value cars are more economical to maintain, reuse, remanufacture and recycle. Vehicle lifetimes, on a per-kilometre basis, can thus increase drastically. The result is a self-reinforcing loop of incentives for higher utilisation, lower-carbon energy, and less materials use. In a circular scenario, the materials input to mobility falls by 75%. It also brings many other benefits, including a much lower total cost of travel. Sharing models are taking root by themselves, but much more could be done to accelerate their growth, and to find ways to resolve the concerns that have arisen with some early iterations of such business models.

Many of these abatement opportunities are economically attractive on their own terms, provided that we are willing to organise the mobility and real estate sectors somewhat differently in the future. Many others cost less than 50 EUR per tonne CO_2 avoided, less than most other ways to reduce these emissions, including supply-side measures for industry. Circularity is strongly aligned with the digitalisation trend that is sweeping across industry; for example, digitalisation means it is ever cheaper to keep track of complex supply chains and material flows, optimise sharing business models, and automate materials handling in construction. A more circular economy would have many other benefits as well, such as reduced geopolitical risks, local job creation, lower air pollution, and reduced water use. They therefore can contribute to several of the Sustainable Development Goals.

A more circular economy is indispensable for meeting global material needs without exceeding the available carbon budget. The Intergovernmental Panel on Climate Change has estimated a remaining 'carbon budget' for this century of around 800 billion tonnes (Gt) CO_2. This is the amount of emissions that can be emitted until 2100 for a good chance of keeping warming below 2°C – with still less for the 'well below 2°C' target set by the Paris Agreement. This study estimates that, on current trends, materials production alone would result in more than 900 Gt of emissions. Energy efficiency and low carbon energy will help, but do not resolve this dilemma: emissions add up to 650 Gt even with rapid adoption. This is because so much carbon is either built into the products themselves and then released at their end of life (plastics), or is inherent to the process chemistry of production (steel, cement). For context, note that 2°C scenarios typically 'allocate' about 300 Gt CO_2 to these sectors for the total world economy.

Options to get to 300 Gt include a) aggressive scale-up of carbon capture and storage; b) the rapid introduction of radical process changes that are currently in early development stages; and c) reducing demand for primary materials through the range of circularity measures discussed above. This report argues that it is almost impossible to achieve the cut to 300 Gt without a major use of category c) – hence our assertion that a low-carbon economy must be much more circular than today's. While this study has focussed on Europe, an extrapolation to other world regions suggests that the measures identified could contribute 3.6 Gt CO_2 per year to global efforts to cut greenhouse gas emissions by 2050. The claim on the carbon budget could be reduced by 333 Gt by 2100. In this setting, the additional supply-side measures required start to look manageable, and a well-below 2°C objective within reach.

Achieving these opportunities is doable and requires 'energy efficiency-type' interventions. Many of the abatement opportunities identified are low-cost or even profitable, but are held back by multiple barriers. For example, product manufacturers lack incentives to enable high-value recycling several steps later in the value chain, and many externality advantages of sharing business models are not accounted for. A higher carbon price would help on the margin, but capturing a large share of the opportunities will require addressing those barriers directly. We estimate that up to 70–80% of the abatement opportunities are additional to ones already addressed by existing climate policy approaches. The situation resembles that for energy efficiency, where careful analysis of cost-effective potentials and barriers has motivated a range of interventions, from aggregate efficiency targets to product standards and labelling schemes. Many of the circularity measures are similarly cost-effective, or could be once scaled-up, but require that barriers are overcome. The next task is to explore which policy instruments would be most effective in pursuing different opportunities.

The priority now should be to firmly embed circular economy measures in the low-carbon agenda. This study is an early quantitative investigation into the low-carbon benefits of the circular economy. Much more work is required, but we hope this report nonetheless shows the potential available for European industry. The most urgent priority now is to build a solid knowledge base – and then to incorporate circular economy opportunities alongside low-carbon energy supply, electrification of transport and heat, and energy efficiency as a core part of the transition to a low-carbon economy. A more circular economy could play a key role in helping Europe and the world to meet our climate targets.

Demand-side measures *thus can take us more than halfway to net-zero emissions from EU industry, and hold as much promise as those on the supply side. Moreover, they are often economically attractive.*

This project has been carried out by Material Economics, with the support of Climate-KIC, ClimateWorks, Ellen MacArthur Foundation, Energy Transitions Commission, European Climate Foundation, MAVA Foundation, and SITRA. The Steering Group has comprised Mari Pantsar (SITRA), Janez Potočnik (International Resource Panel), Martin Porter (European Climate Foundation), Adair Turner (Energy Transitions Commission), Jocelyn Blériot (Ellen MacArthur Foundation), Christoph Wolff and Simon Wolf (European Climate Foundation) and Anders Wijkman (Climate-KIC). Research guidance have been provided by Dr Jonathan Cullen and Prof. Frank Geels. Material Economics is extremely grateful for all the contributions of these organisations and individuals, as well as many other researchers, policymakers, and business representatives who have contributed their knowledge and insight to this project. Partner organisations and their constituencies do not necessarily endorse all findings or conclusions in this report. All remaining errors and omissions are of course the responsibility of the authors.

THE CIRCULAR ECONOMY

A POWERFUL FORCE FOR CLIMATE MITIGATION

Transformative innovation for prosperous and low-carbon industry

This report investigates how a more circular economy can contribute to cutting CO_2 emissions. It explores a broad range of opportunities for the four largest materials in terms of emissions (steel, plastics, aluminium, and cement) and two large use segments for these materials (passenger cars and buildings).

The key conclusion is that a more circular economy can make deep cuts to emissions from heavy industry: in an ambitious scenario, as much as 296 million tons CO_2 per year in the EU by 2050, out of 530 Mt in total – and some 3.6 billion tonnes per year globally. Making better use of the materials that already exist in the economy thus can take EU industry halfway towards net-zero emissions. Moreover, doing so often is economically attractive. Initiatives for a more circular economy therefore deserve a central place in EU climate and industrial policy.

Access the full report here

Launch your camera app and point at the QR code (iOS)
www.sitra.fi/en/publications/circular-economy-powerful-force-climate-mitigation/

MATERIAL ECONOMICS

Material Economics Sverige AB   Grev Turegatan 30, 114 38 Stockholm, Sweden   info@materialeconomics.com