International Energy Agency

Material Efficiency in Clean Energy Transitions

Tiffany Vass

IETS Deep Decarbonization in Industry workshop

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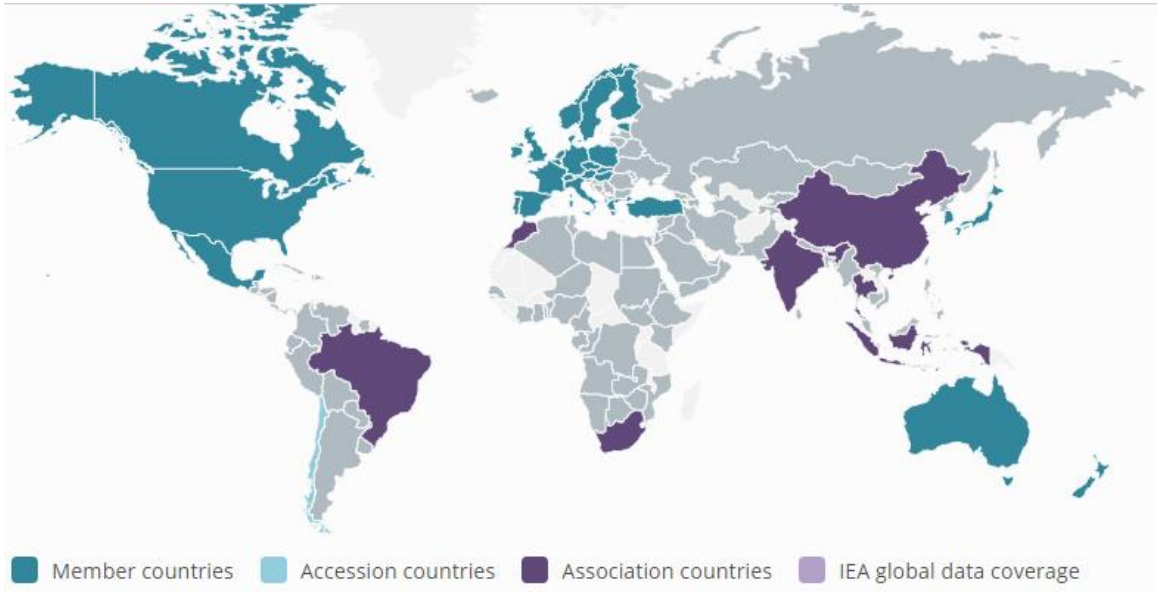
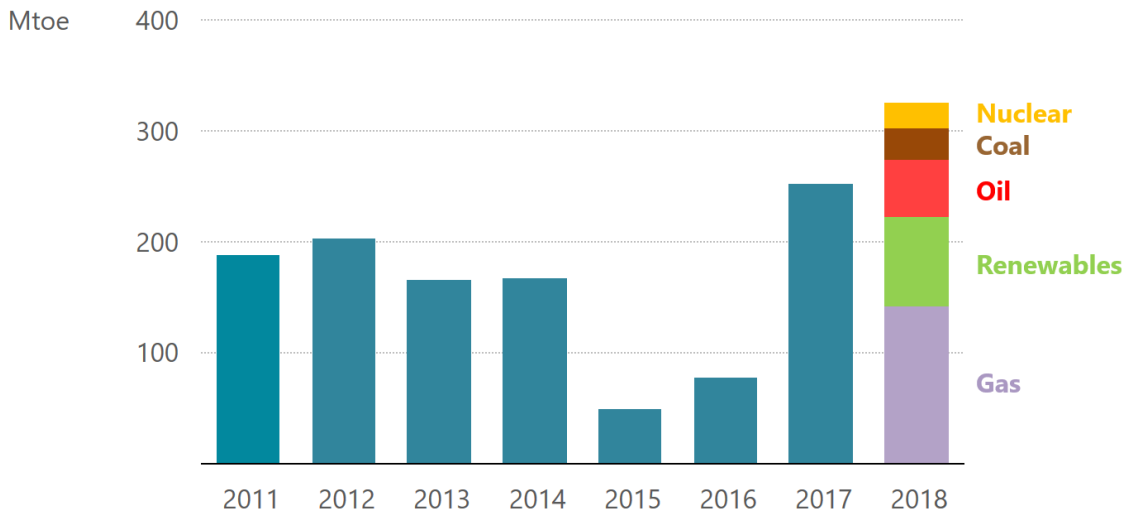
The IEA Global Family



The IEA works around the world to support accelerated clean energy transitions with unparalleled data, rigorous analysis and real-world solutions.

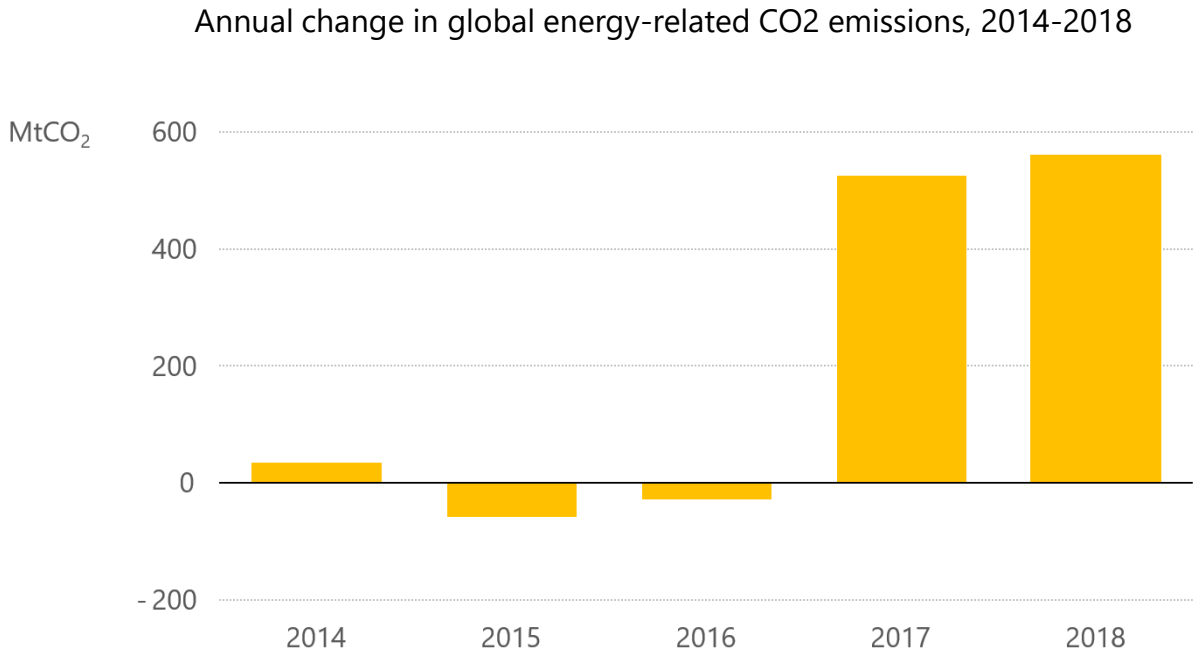
2018 – a remarkable year for energy

Annual change in global primary energy demand, 2011-18



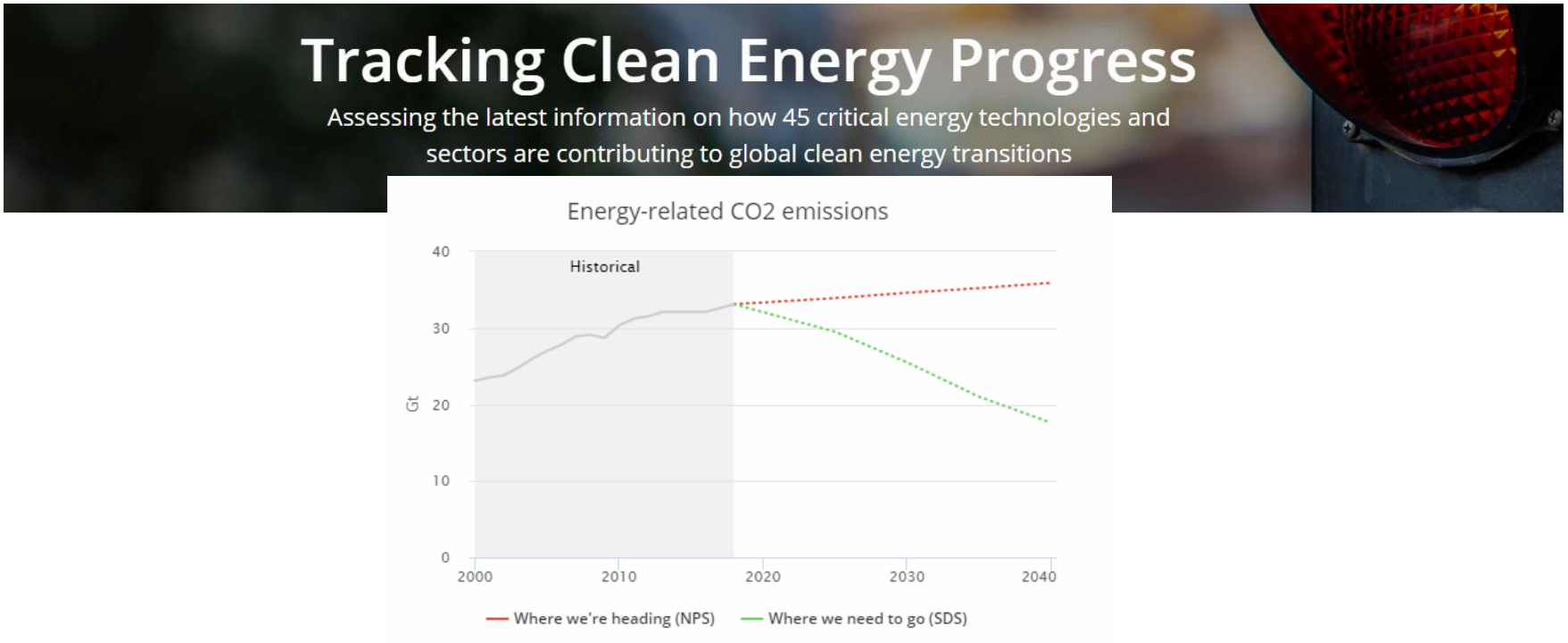
Global energy demand last year grew by 2.3%, the fastest pace this decade, an exceptional performance driven by a robust global economy, weather conditions and moderate energy prices.

Energy-related CO_2 emissions hit a record high in 2018



Higher demand for fossil fuels drove up global CO_2 emissions for a second year after a brief hiatus. Increases in efficiency, renewables, coal-to-gas switching and nuclear avoided 640 Mt of CO_2 emissions.

The global climate challenge: How are we doing?



The IEA tracks the progress of sectors and technologies critical to a successful clean energy transition.

Tracking Clean Energy Progress 2019

Power

- Renewable power
  - Solar PV
  - Onshore wind
  - Offshore wind
  - Hydropower
  - Bioenergy
  - Geothermal
  - Concentrating solar power
  - Ocean
- Nuclear power
- Natural gas-fired power
- Coal-fired power
- CCUS in power

Industry

- Chemicals
- Iron and steel
- Cement
- Pulp and paper
- Aluminium
- CCUS in industry & transformation

Transport

- Electric vehicles
- Fuel economy
- Trucks & buses
- Transport biofuels
- Aviation
- International shipping
- Rail

Buildings

- Building envelopes
- Heating
- Heat pumps
- Cooling
- Lighting
- Appliances & equipment
- Data centres and networks

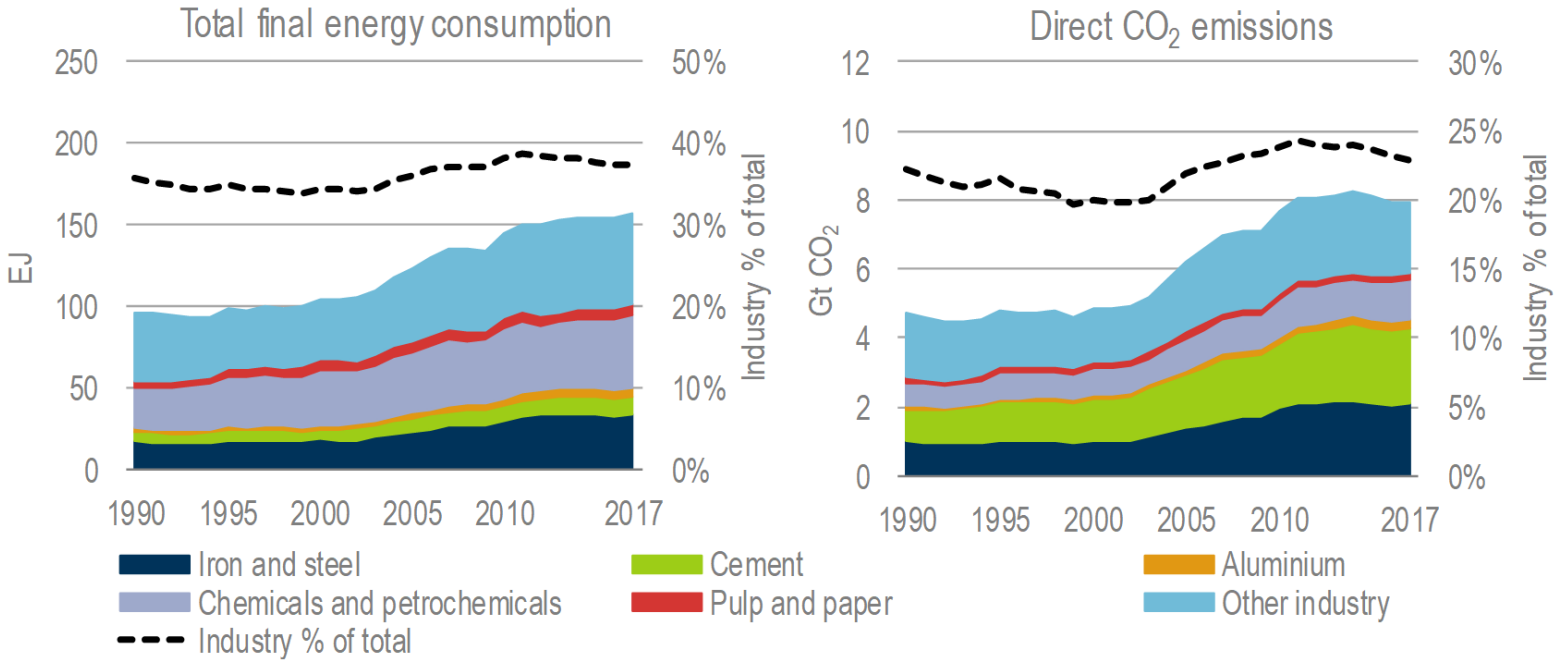
Fuel supply

- Methane emissions from oil and gas
- Flaring emissions

Energy integration

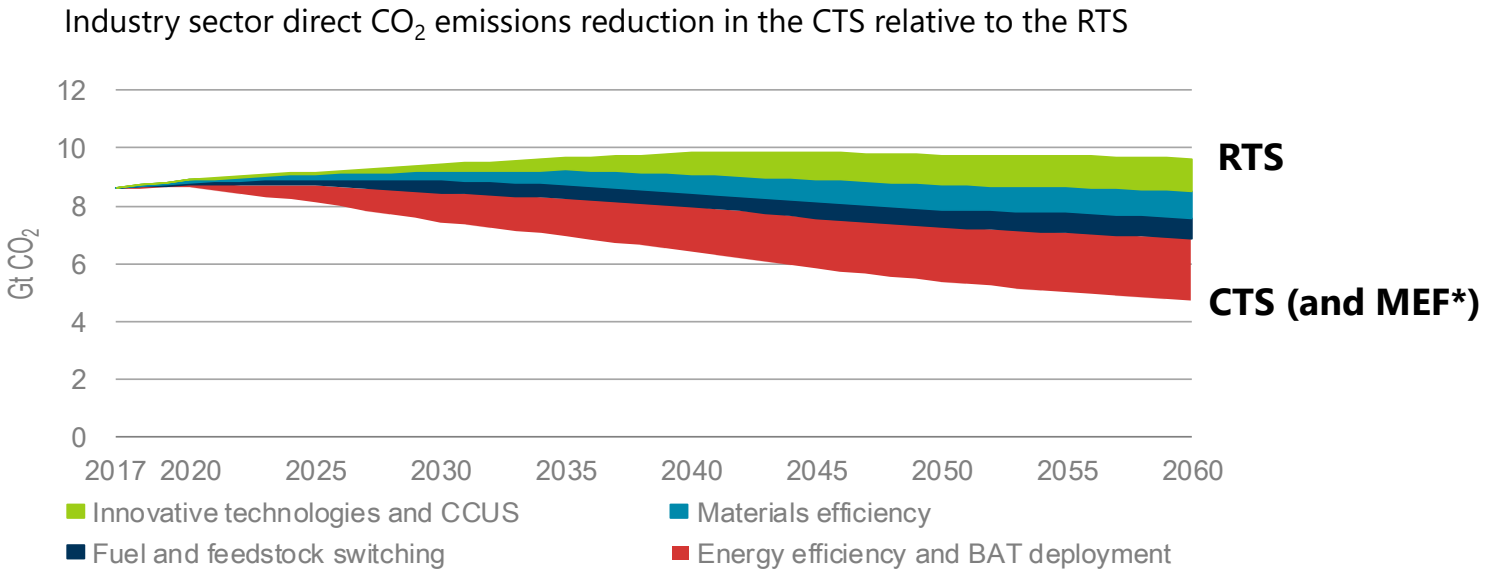
- Energy storage
- Hydrogen
- Smart grids
- Demand response

Industry contributes a large share of global energy use and CO_2 emissions



Industrial total final energy consumption and direct CO_2 emissions have grown more than one and a half times over the last 25 years.

Multiple strategies are needed to reduce industry emissions



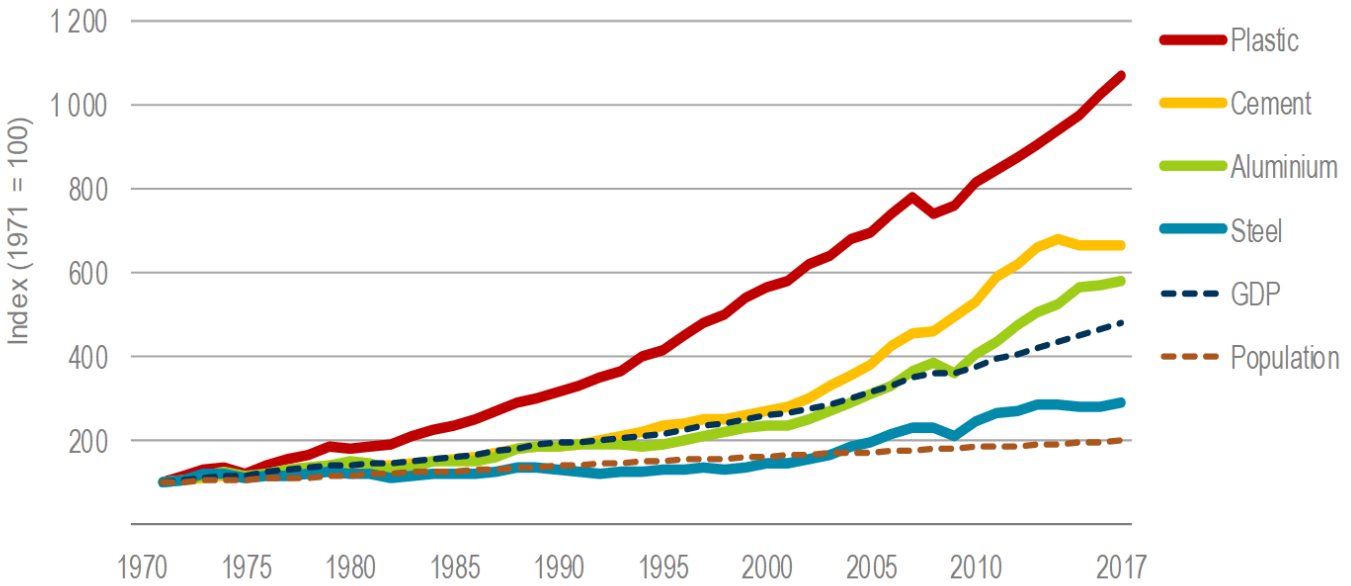
RTS = Reference Technology Scenario. CTS = Clean Technology Scenario. MEF = Materials Efficiency variant.

*MEF contribution by strategy differs from CTS

The Clean Technology Scenario lays out an ambitious climate mitigation pathway. Material efficiency contributes to industry emissions reductions; it is pushed further in the Materials Efficiency variant.

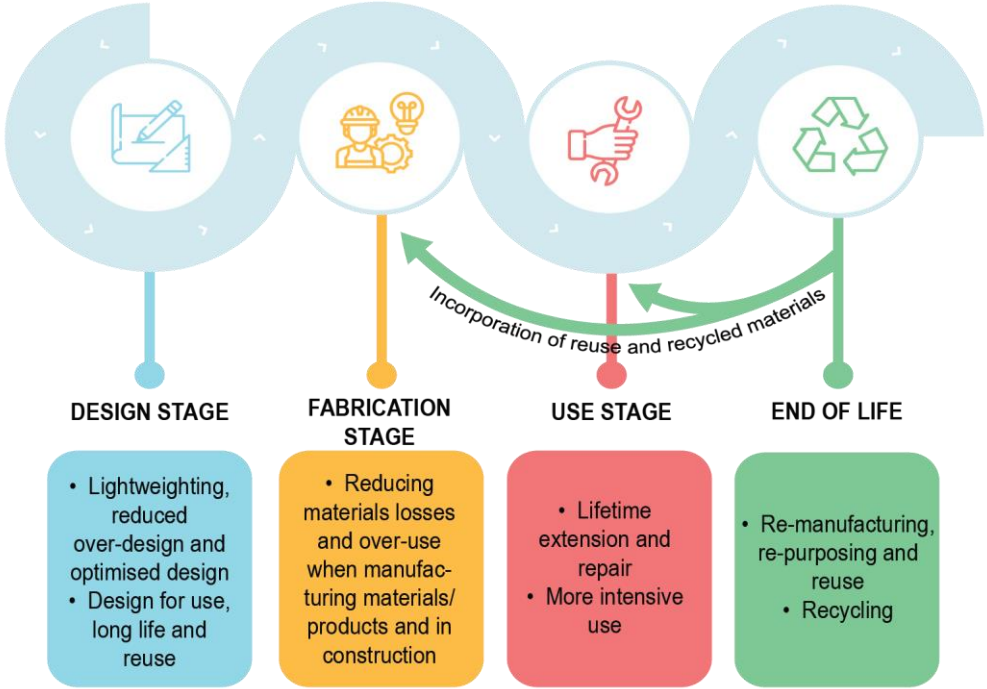
Demand for materials drives growth in industry emissions

Demand growth for key materials, GDP and population



Demand for materials – a key driver of industrial emissions – has grown considerably over past decades. Much of the growth since 2000 has been due to rapid development in China.

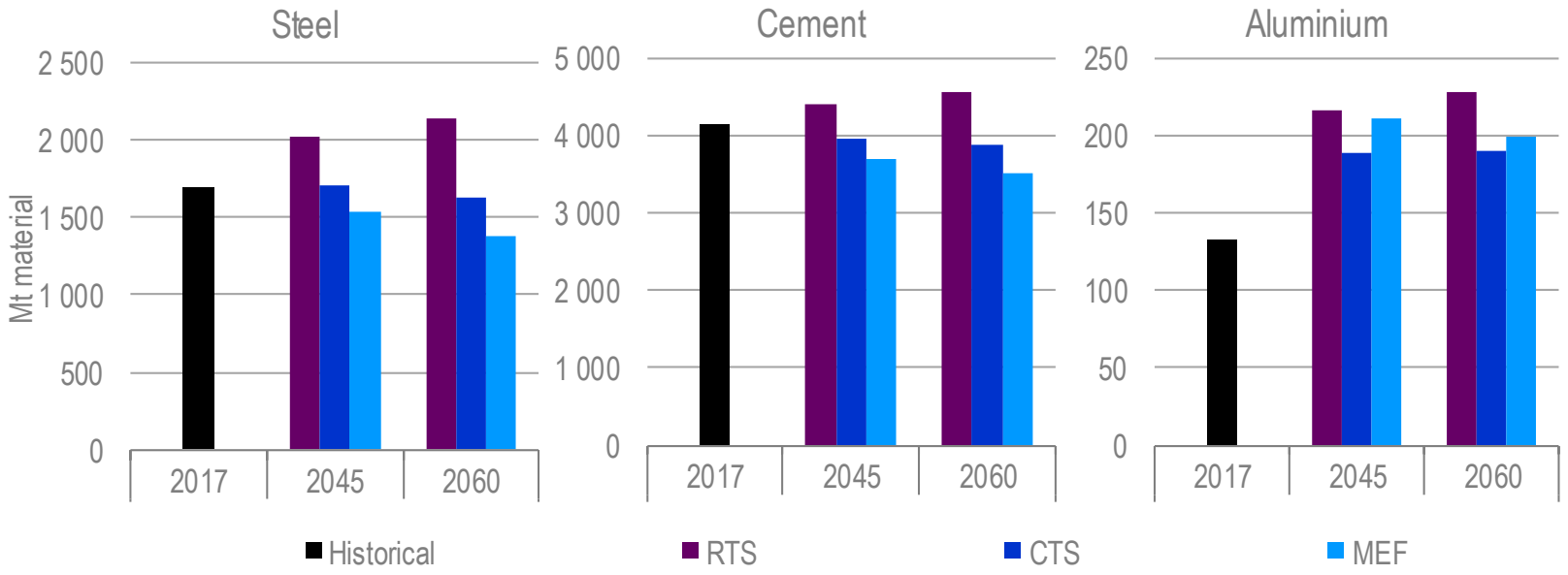
Opportunities for material efficiency are found across value chains



Numerous material efficiency strategies can be applied in the design, fabrication, use and end-of-life stages.

Material efficiency can drive changes in material demand

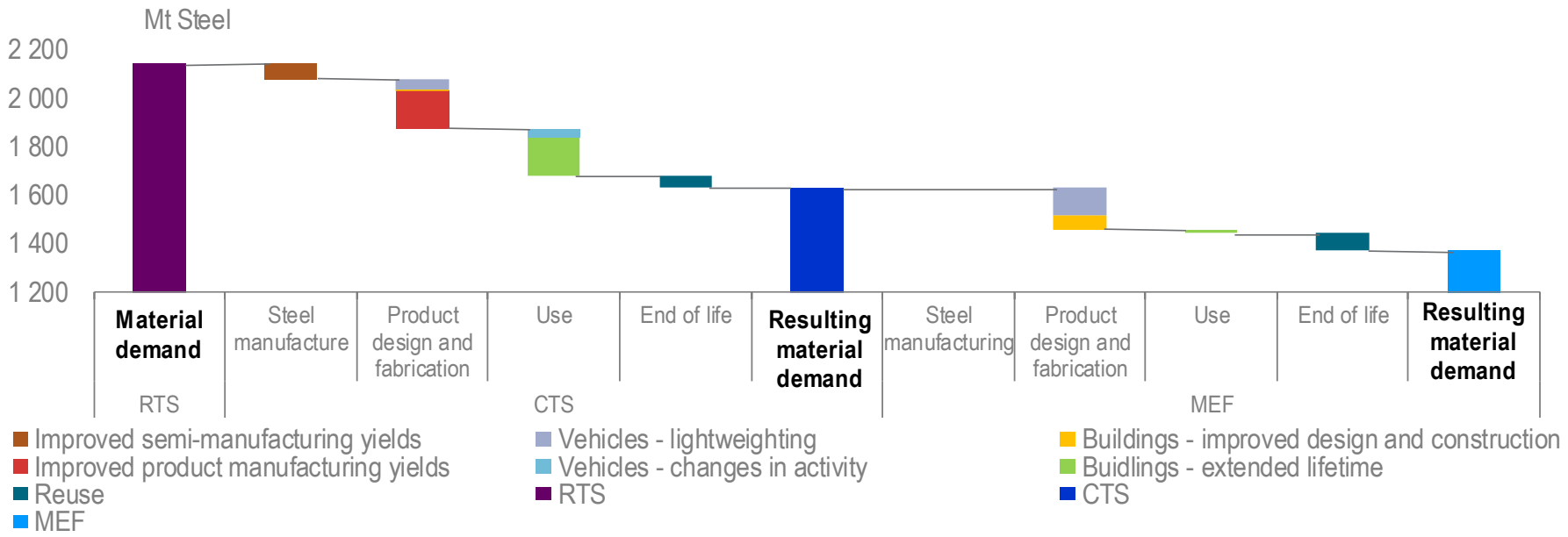
Demand for steel, cement and aluminium by scenario



While material demand grows over time in the RTS, it is considerably reduced in the CTS and MEF.

Steel demand reductions are driven by multiple strategies

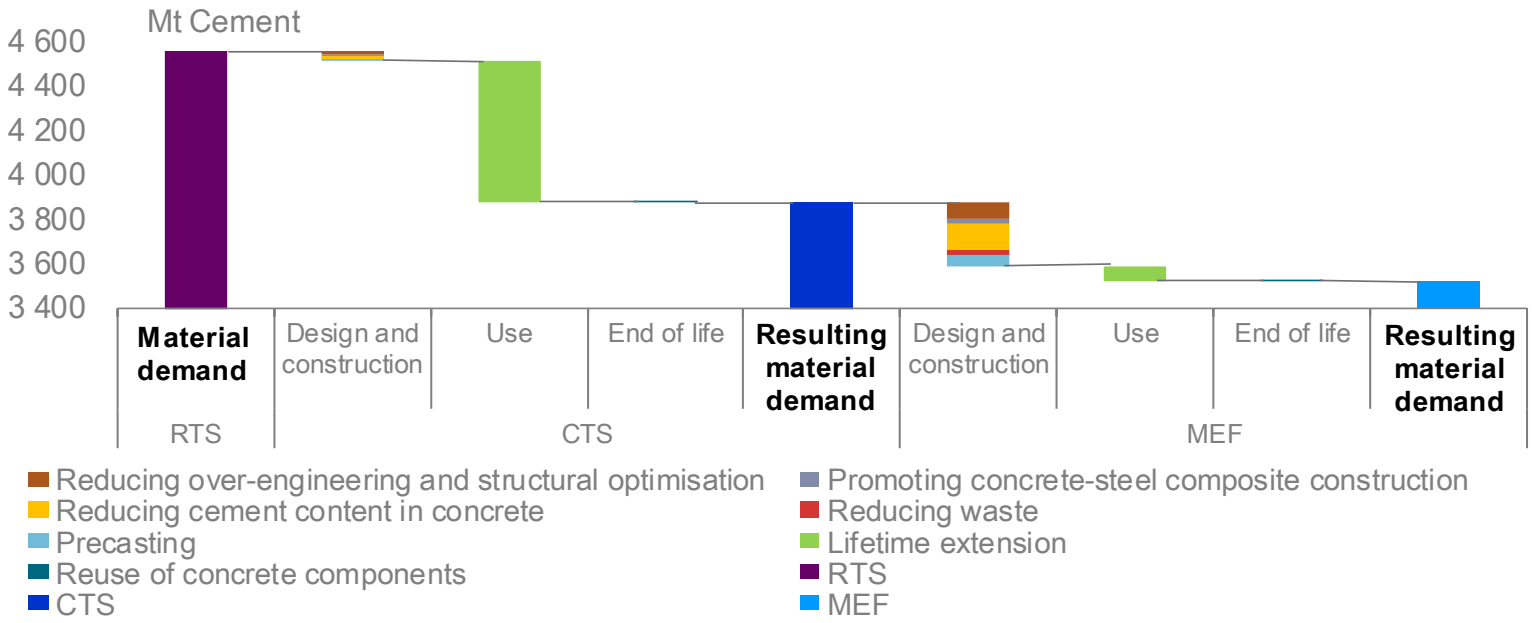
Steel demand change by value chain stage across scenarios in 2060



Considerable potential to reduce steel demand exists at all stages of product and buildings life cycles. Key contributors are yield improvements, buildings lifetime extension and vehicle lightweighting.

Cement demand is reduced through buildings sector efforts

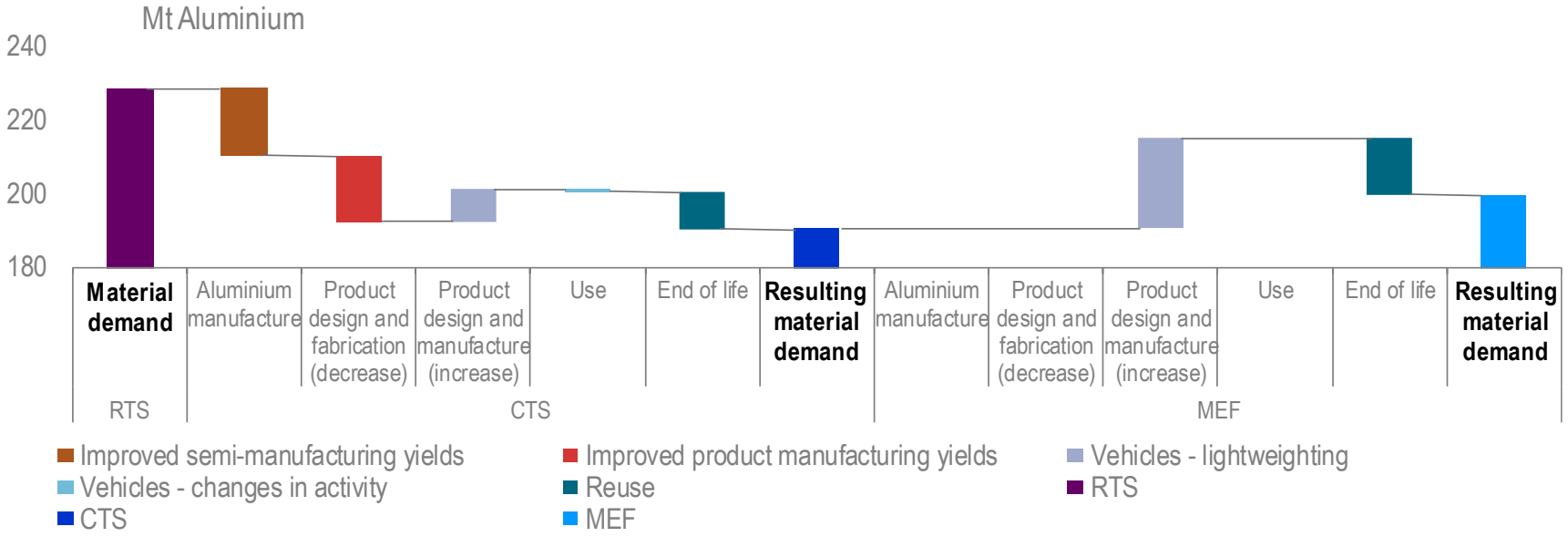
Cement demand change by value chain stage across scenarios in 2060



The buildings use phase offers the largest potential to reduce cement demand, followed by the design and construction stage.

Aluminium demand sees both downward and upward pressures

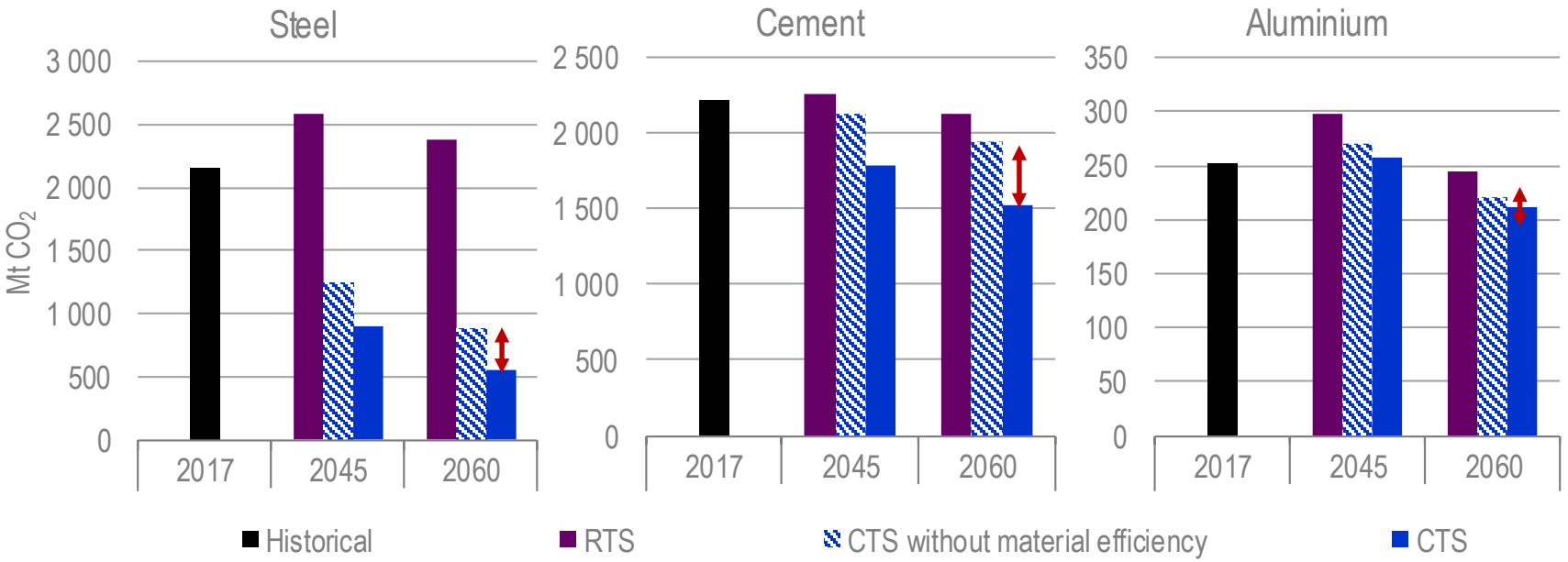
Aluminium demand change by value chain stage across scenarios in 2060



While reductions in aluminium demand can be achieved at various stages in value chains, a large portion of these reductions is offset by increases in demand from lighter vehicles.

Material efficiency is important to reducing industry emissions

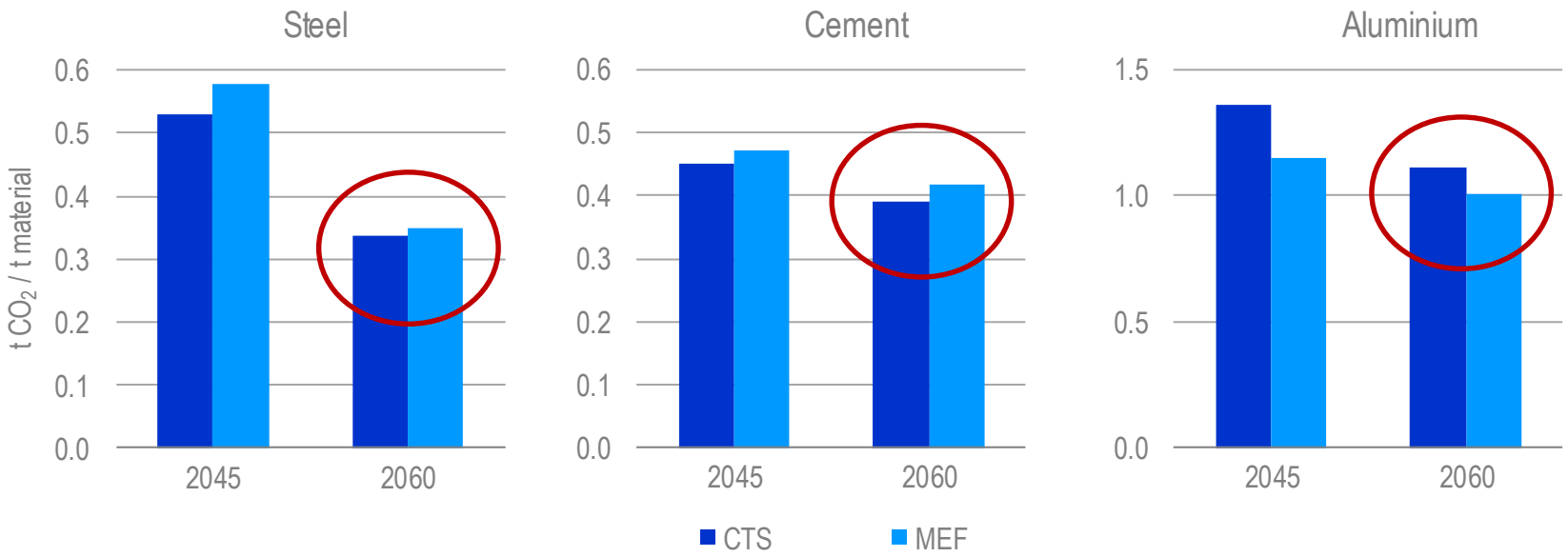
Direct CO_2 emissions from steel, cement and aluminium production in the RTS and CTS



Material efficiency accounts for approximately 30% of the combined emissions reduction for steel, cement and aluminium in 2060 in the CTS.

Demand changes can reduce deployment needs for other strategies

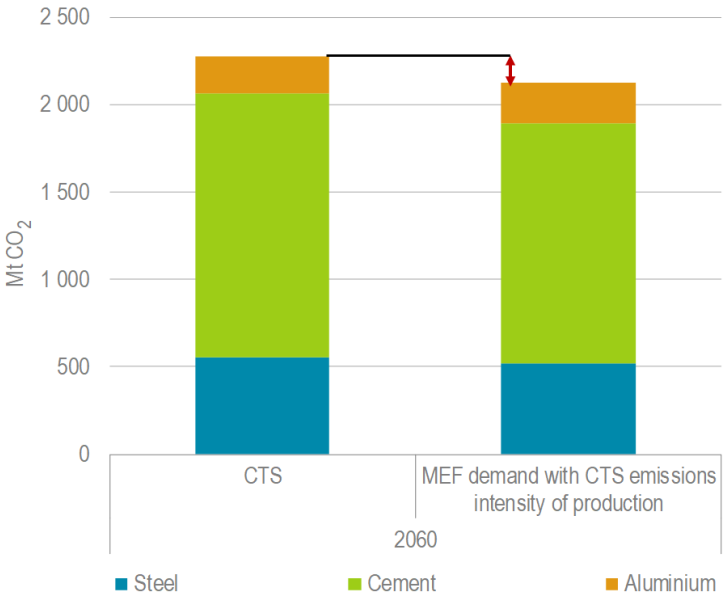
Direct CO_2 intensity of production for steel, cement and aluminium in the CTS and MEF



Lower material demand levels result in higher direct CO_2 intensity of steel and cement production in the MEF while remaining within the CTS industrial emissions level.

A stronger push on material efficiency could reduce additional emissions

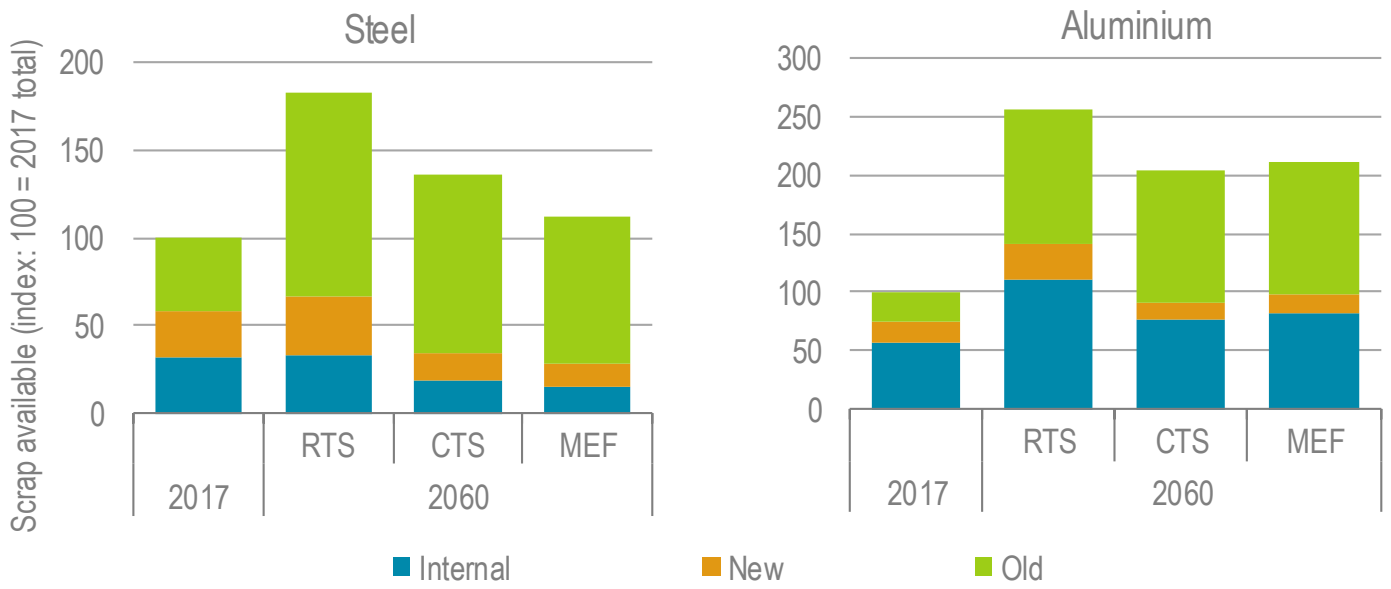
Direct CO_2 emissions for steel, cement and aluminium in different contexts



If CTS levels of process technology deployment were maintained, additional material efficiency would result in an additional 7% net decrease in steel, cement and aluminium emissions in the MEF.

Material efficiency tightens material cycles

Scrap availability for steel and aluminium by scenario



Material efficiency changes scrap availability and opportunities for secondary production. Reduced scrap availability can result due to reduced inflows, reduced losses, and longer lifetimes.

Policy and stakeholder action is needed to advance material efficiency

- Increase **data collection**, life-cycle assessment and benchmarking
- Improve consideration of the life-cycle impact at the **design stage** and in **climate regulations**
- Increase **end-of-life** repurposing, reuse and recycling
- Develop **regulatory frameworks** and incentives to support material efficiency
- Adopt **business models** and practices that advance circular economy objectives
- Train, **build capacity** and share best practices
- Shift **behaviour** towards material efficiency

Efforts from government, industry, researchers and consumers can together help improve material efficiency in support of climate change mitigation.

Full report available online at:
www.iea.org/publications/reports/MaterialEfficiencyinCleanEnergyTransitions/