



# Electricity well below 2 degrees: from challenges to opportunities

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# On the journey towards well below 2

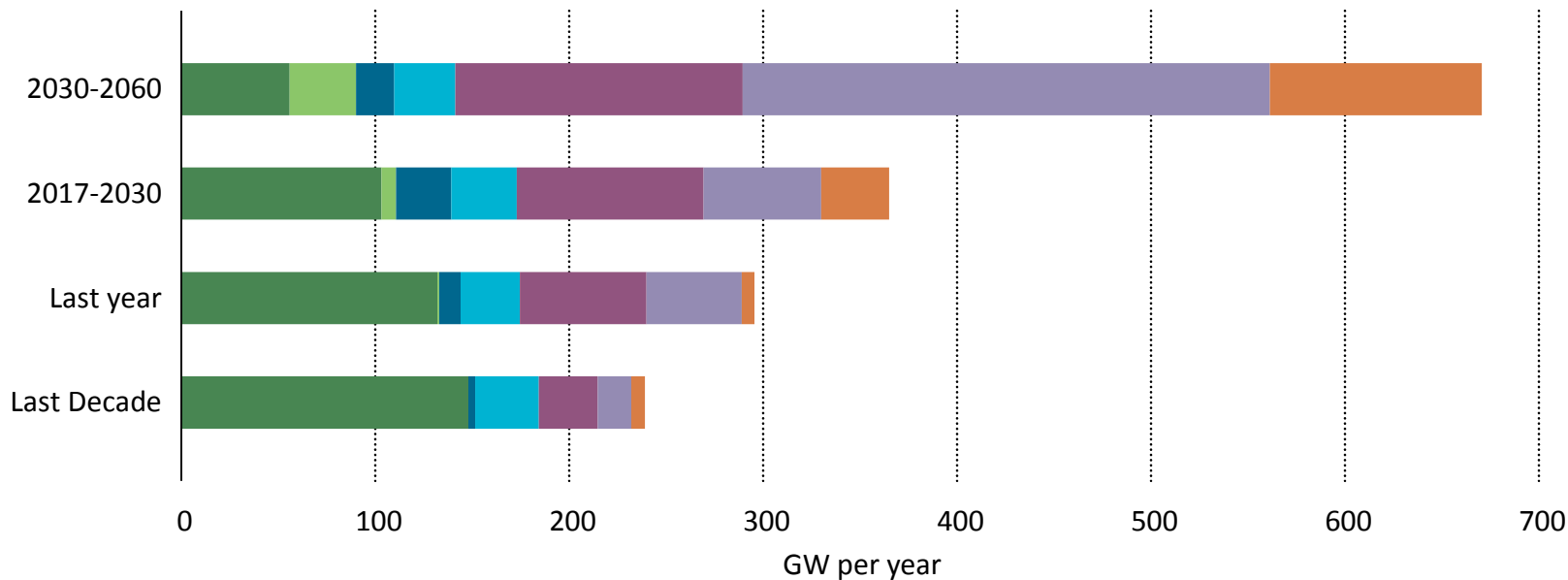
... but there's a tough climb still ahead



We made it to the base camp...

# Can we push up the low-carbon power deployment pace?

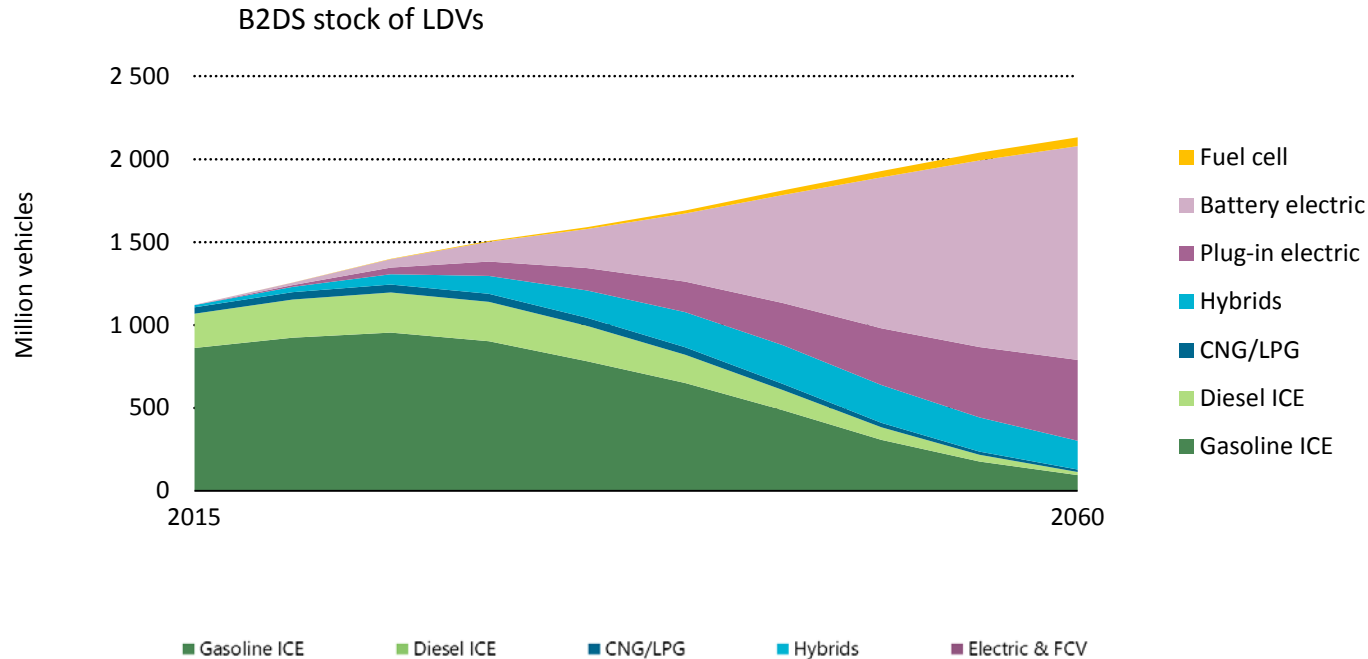
Average capacity additions in different periods in the B2DS



**This decade the slowdown of nuclear and hydro has largely compensated the acceleration of wind and solar**

# Can we change the landscape of transport ?

Vehicle sales and technology shares under different scenarios

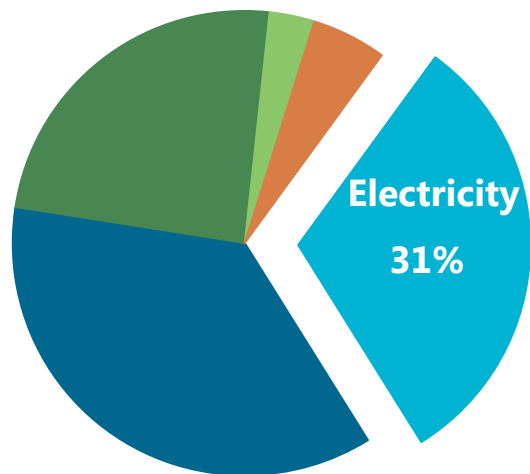


**A well below 2 path has 500 million less cars due to smart transport systems and accelerated electrification**

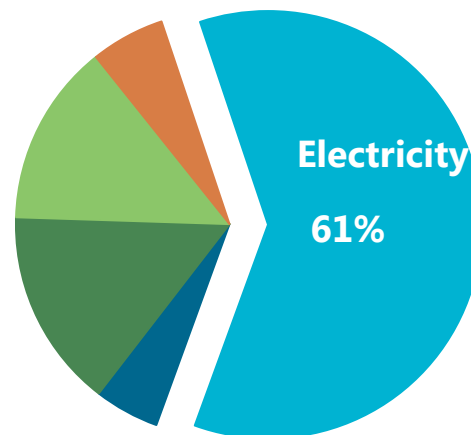
# Enhanced buildings efficiency with high electrification

Energy use in the buildings sector under different scenarios

2014  
(123 EJ)



B2DS 2060  
(112 EJ)



Fossil fuels

Traditional biomass

Renewables

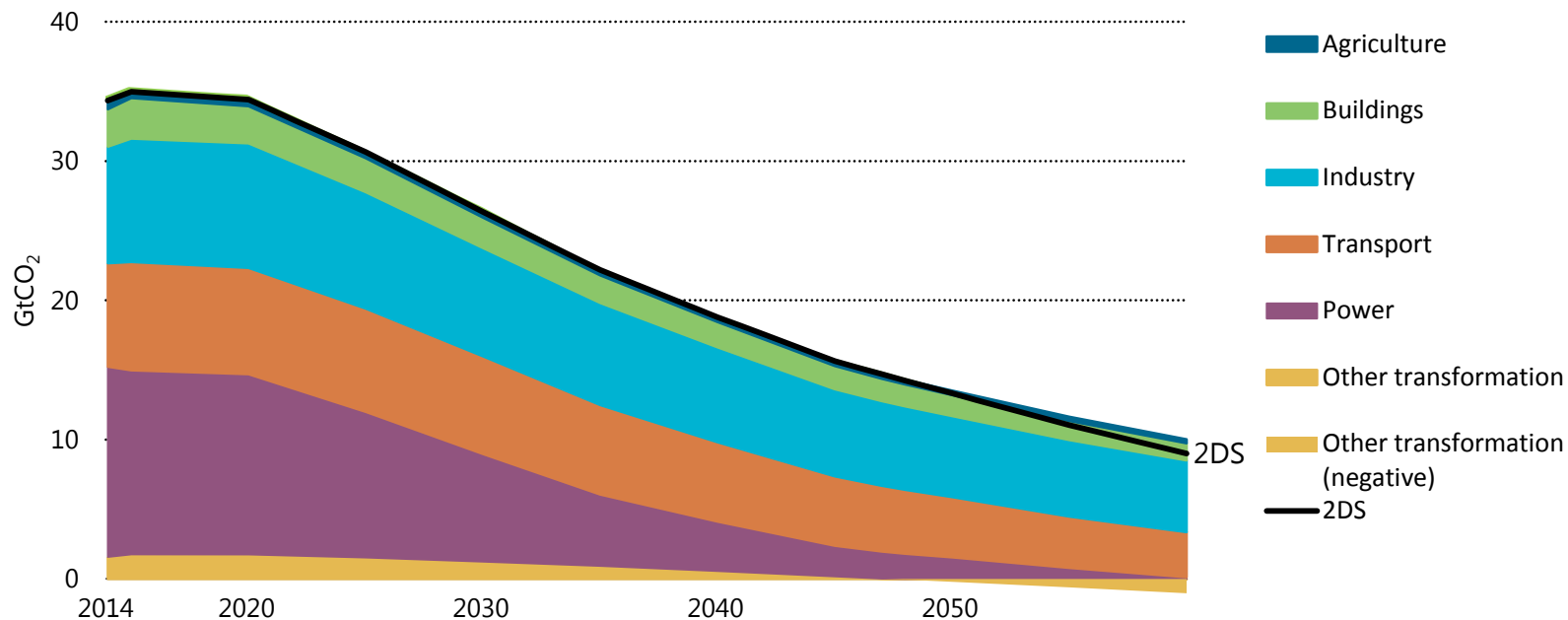
Other

Electricity

**Efficiency technologies can provide the same level of comfort while reducing energy demand despite doubling floor area**

# Moving below 2: the challenge of industry and heavy transport

Energy- and process-related CO<sub>2</sub> emissions by sector in the 2DS



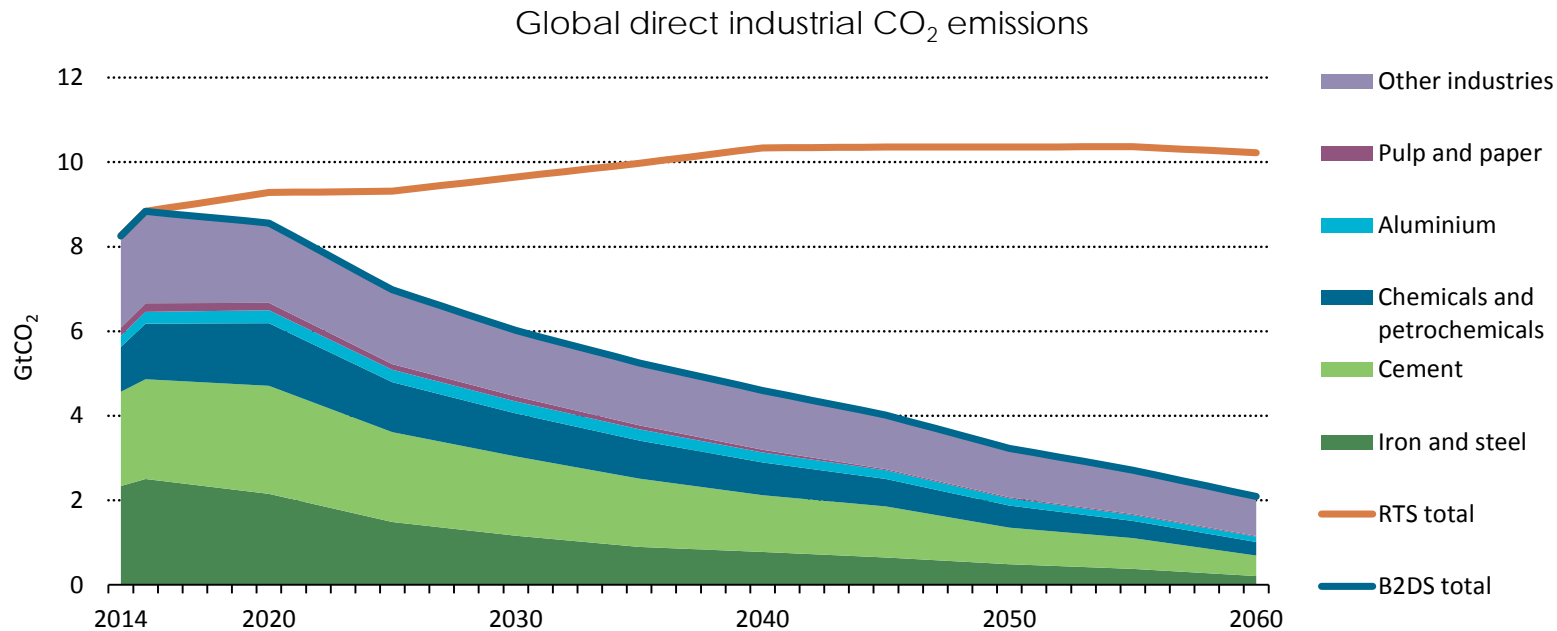
**Industry and transport account nearly all remaining emissions in the 2DS in 2050.**

# Heavy duty transport: no easy routes



**Overhead lines are a mature technology than needs policy driven rollout whereas fuels cells still need innovation and R&D but less infrastructure**

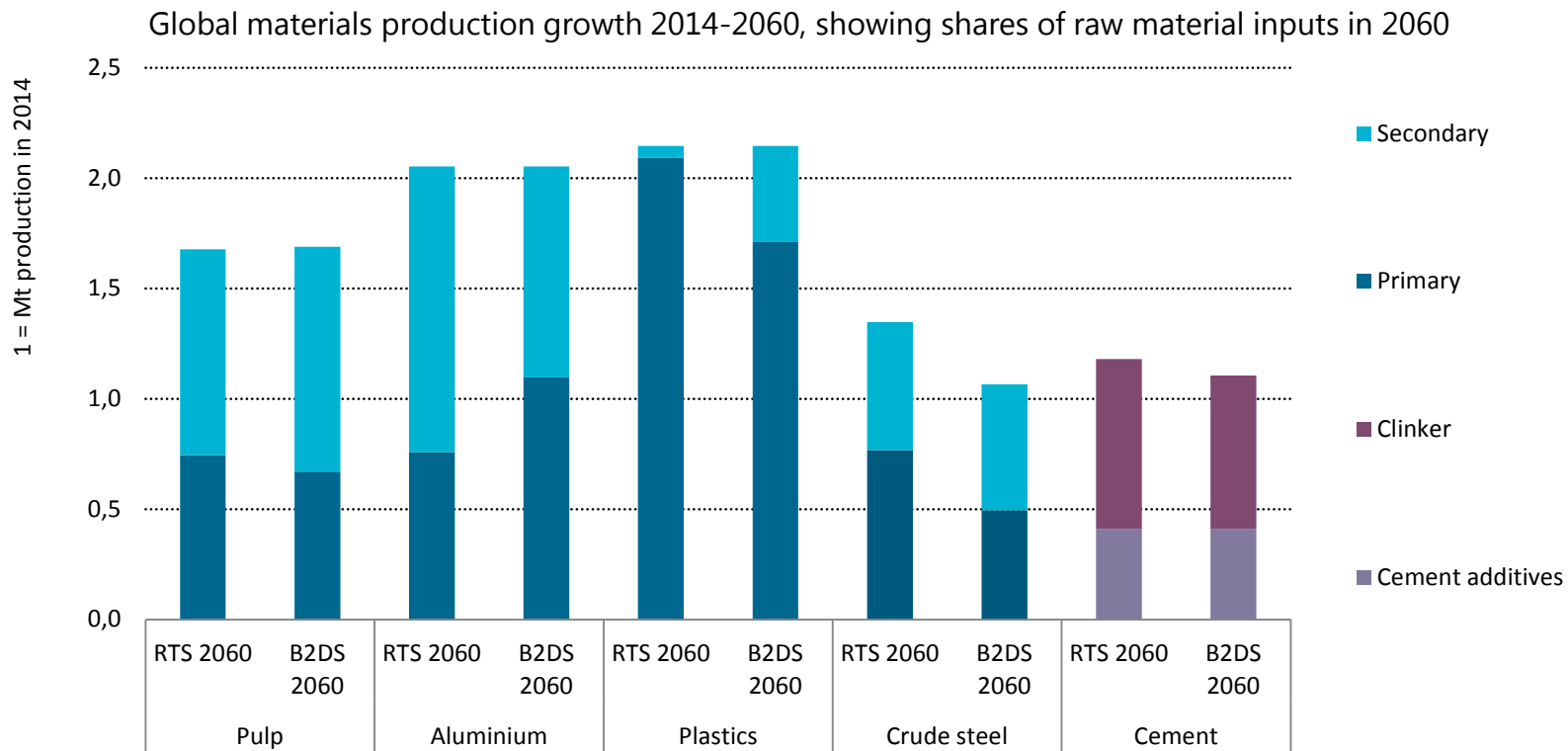
# Translating the climate challenge into industrial terms



**Significant transformations would be needed in all industrial sectors to achieve a 75% reduction of direct CO<sub>2</sub> emissions by 2060 compared to current levels**



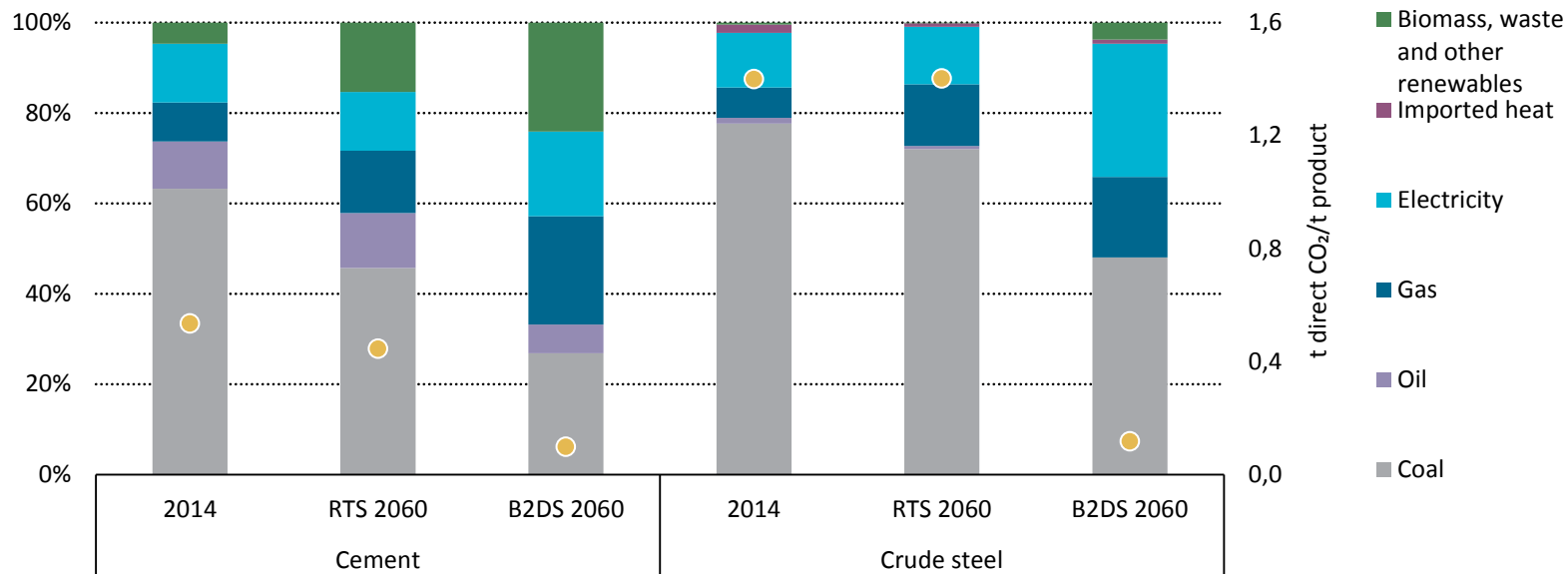
# Material efficiency opens opportunities for energy savings



**Wider implementation of material efficiency strategies leads to a reduced demand of materials, as well as to increased shares of secondary routes of production in the B2DS**

# Switching to lower-carbon fuels: every tonne of CO<sub>2</sub> counts in a B2DS world

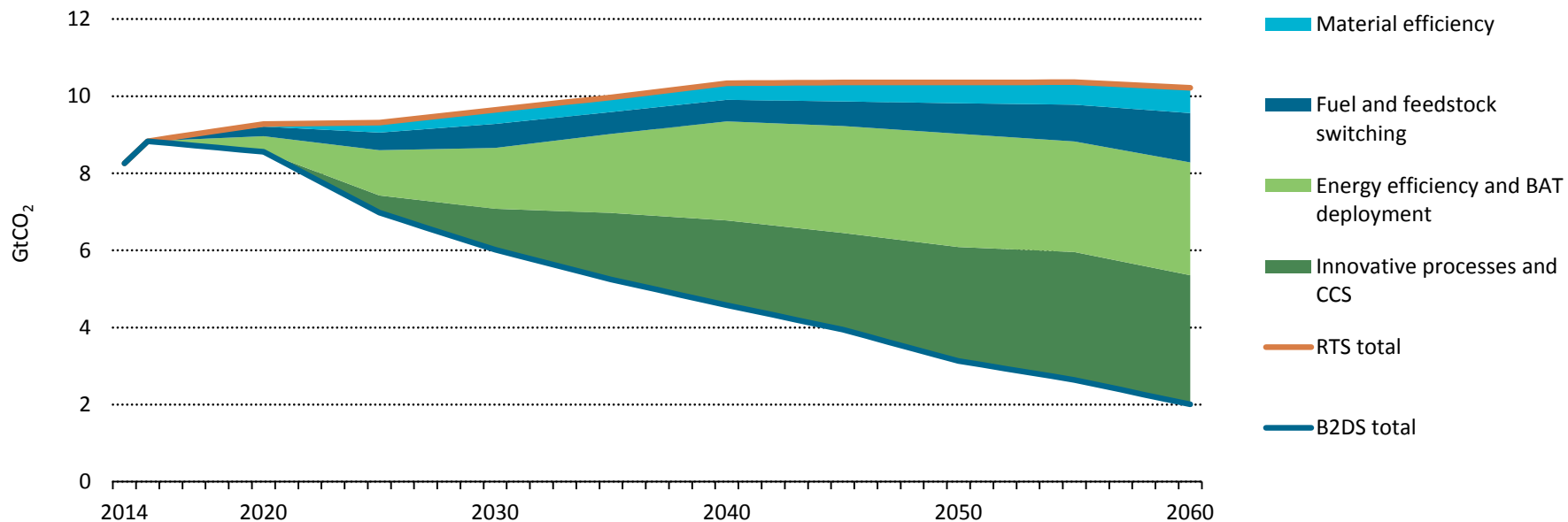
Global crude steel and cement energy mix and direct CO<sub>2</sub> intensity



**The energy mix of fossil fuel-reliant sectors get significantly transformed in the B2DS**

# How can the industrial low-carbon transition be realised?

Global direct industrial CO<sub>2</sub> emissions



**A number of strategies contribute to industrial emissions reductions – there is no silver bullet**

Status	Gate
DELAYED	B3
DELAYED	C12
CANCELLED	C14
DELAYED	A4
DELAYED	B9
DELAYED	C9
CANCELLED	A7
DELAYED	B11
DELAYED	C6
CANCELLED	B3
DELAYED	C17
CANCELLED	A10
DELAYED	C5

- **Cement based on magnesium oxides from magnesium silicates**

- Could enable net negative CO<sub>2</sub> emissions by circumventing carbon-based raw materials and absorbing CO<sub>2</sub> while curing.
- Research needed to prove feasibility.



- **Iron production through molten oxide electrolysis**

- Carbon-free process when coupled with renewable electricity
- Technology development phase.



- **Power-to-gas fuels for high temperature heat**

- Displacing fossil fuels in industrial processes can be achieved by producing hydrogen fuel from low-carbon electricity, but hydrogen storage or stabilisation (by conversion to methane) need to be solved
- Electrolysis is on track, but pilot plants needed for hydrogen technologies

