Energy Technology Perspectives 2020:

A focus on transport

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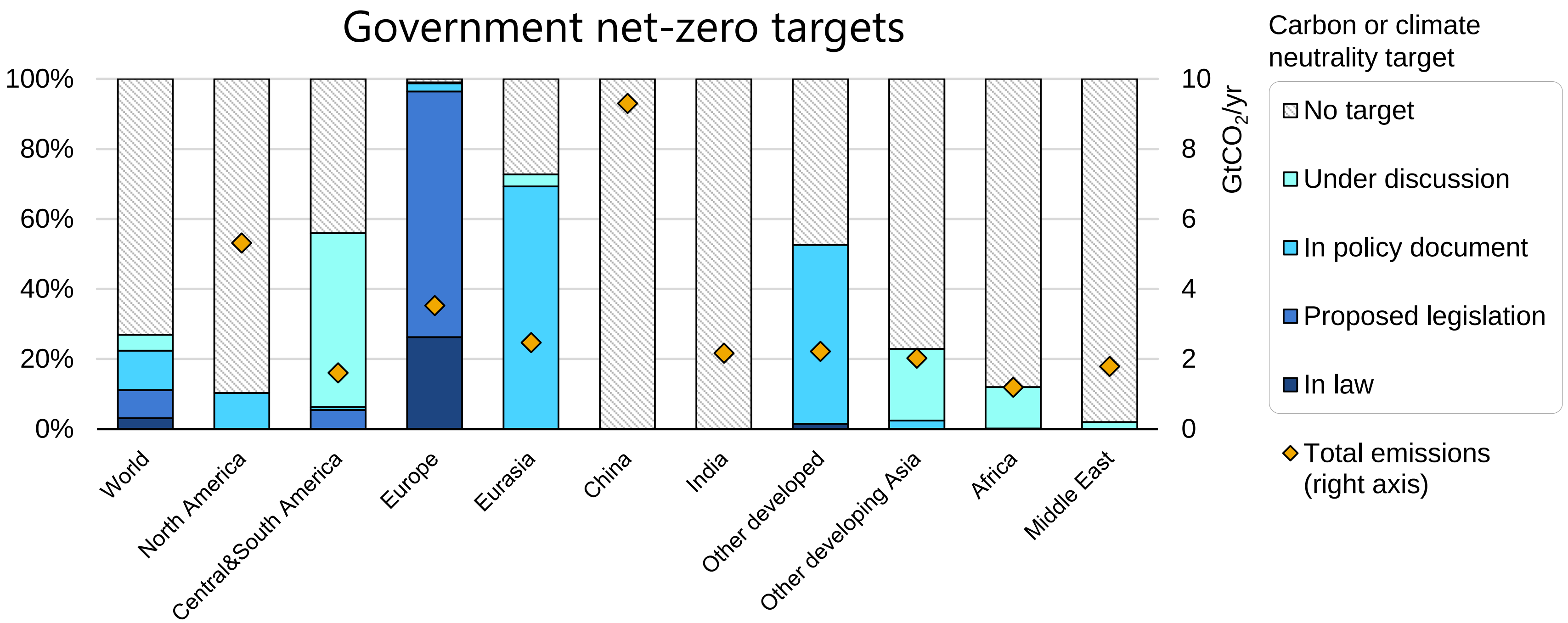
Tracking Clean Energy Progress 2020; Transport; Hydrogen

The Covid-19 Crisis and Clean Energy Progress: Impact on sectors and technologies

Setting the scene:

Despite considerable inertia, momentum is building for the clean energy transition

Governments are setting ambitious goals…

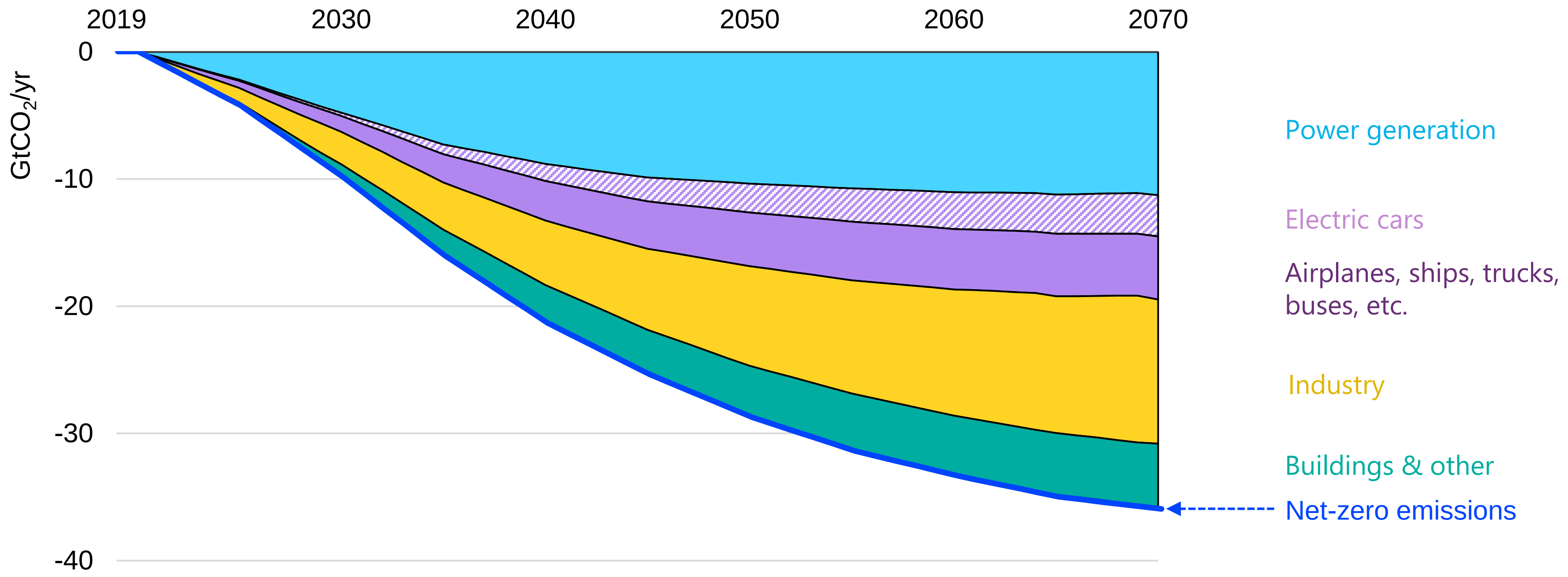


Net-zero emissions targets from China, Japan and South Korea have been announced subsequent to the publication of ETP 2020

More and more sub-national, national, and supra-national governments are setting targets to attain net-zero greenhouse gas emissions in the coming decades.

Focusing on the power sector is not enough to reach climate goals

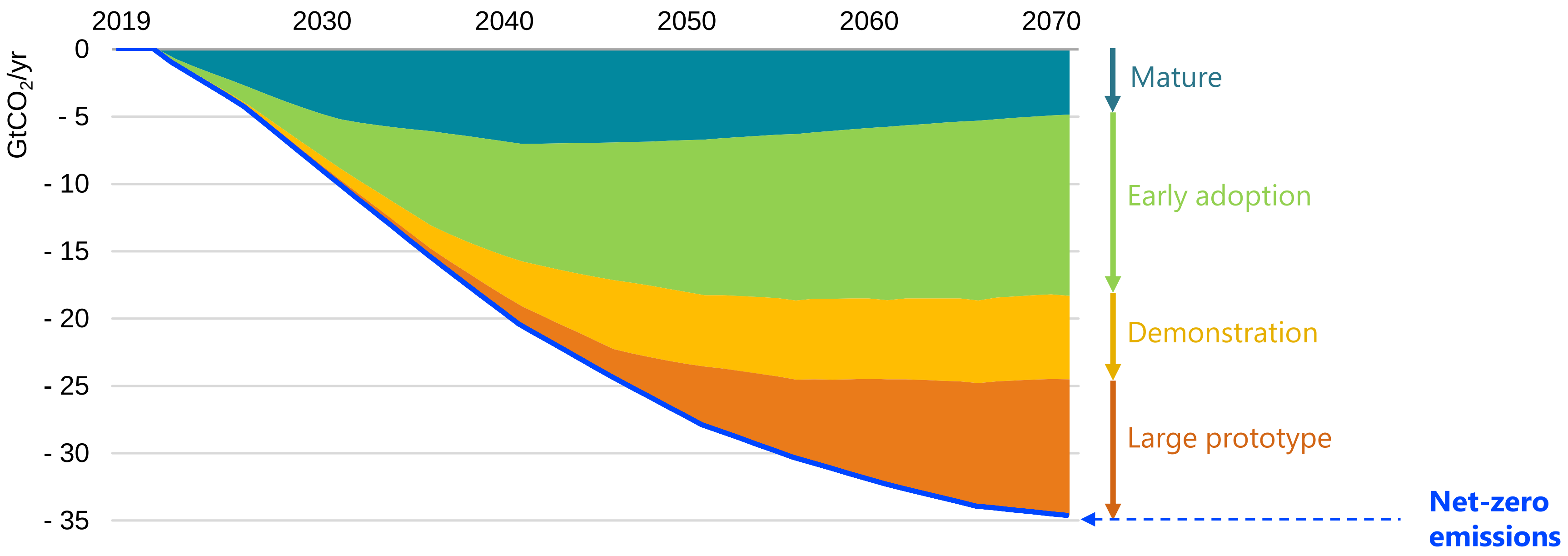
Global CO_2 emissions reductions in the Sustainable Development Scenario, relative to baseline trends



Clean energy technology progress in the power sector and with electric cars is encouraging, but alone not sufficient to reach climate goals. About half of all CO_2 emissions today are from industry, transport and buildings.

Net-zero emissions is not viable without a lot more innovation

Global CO_2 emissions reductions in the Sustainable Development Scenario, relative to baseline trends

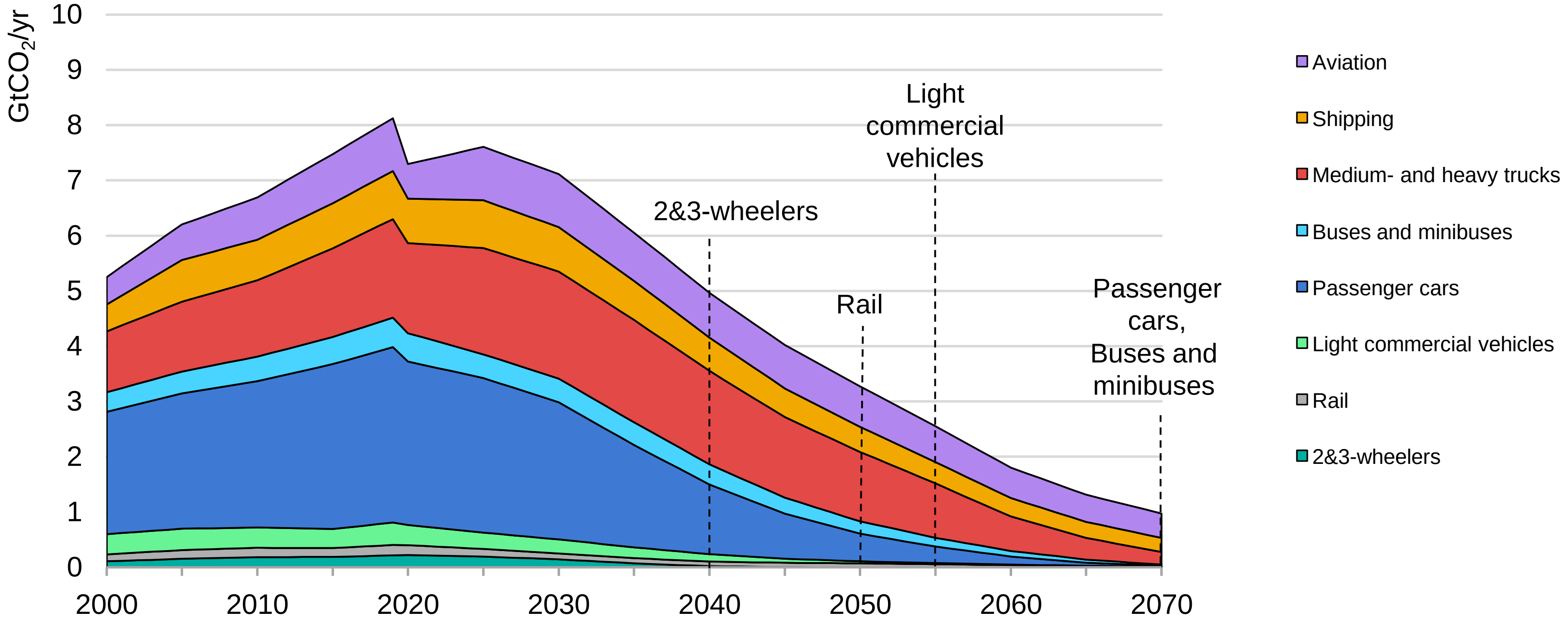


Technologies at prototype or demonstration stage today contribute almost 35% of the emissions reductions to 2070; a further 40% comes from technologies that are at early stages of adoption.

Transport

Heavy-duty trucks, shipping, and aviation remain net emitters

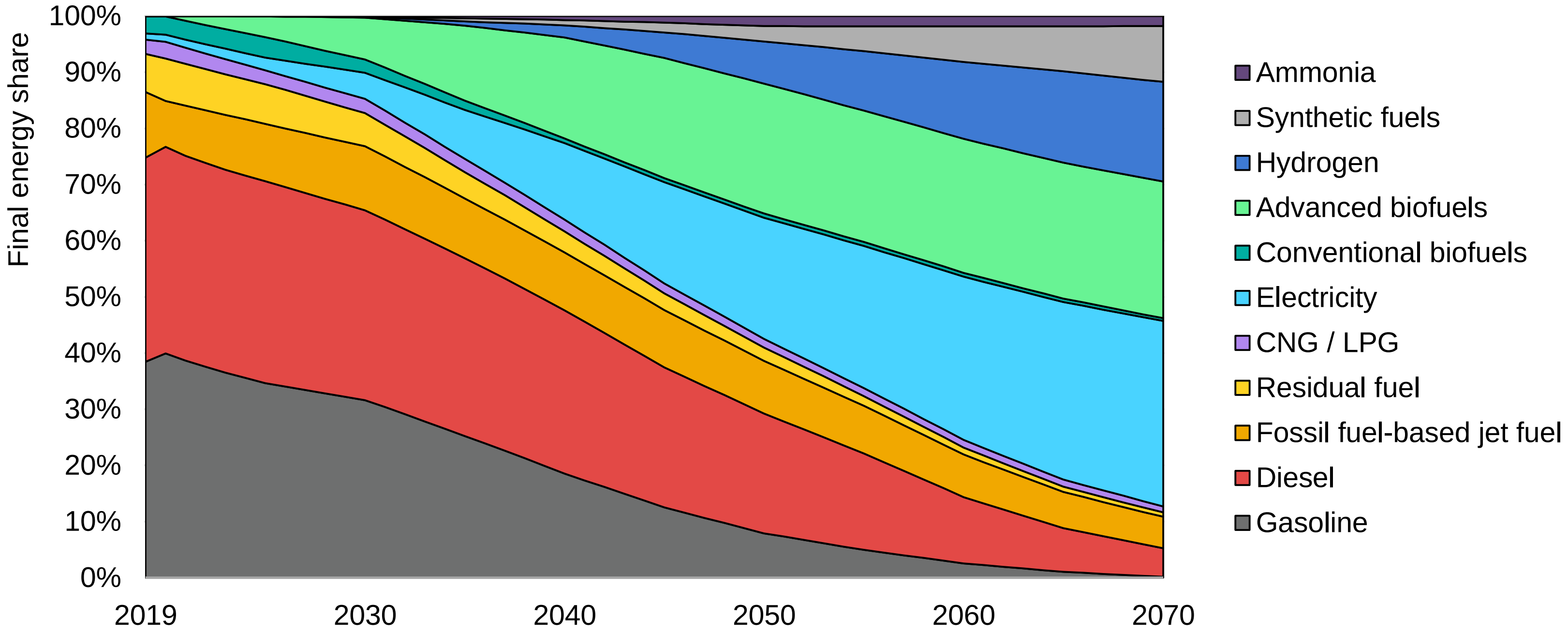
Global CO_2 emissions in transport by mode in the Sustainable Development Scenario



Most modes of transport are decarbonised by 2070 in the Sustainable Development Scenario, but trucking, shipping and aviation continue to emit due to challenges decarbonizing these modes.

Decarbonising transport necessitates a shift to low-carbon fuels

Transport final energy demand in the Sustainable Development Scenario, 2019-2070

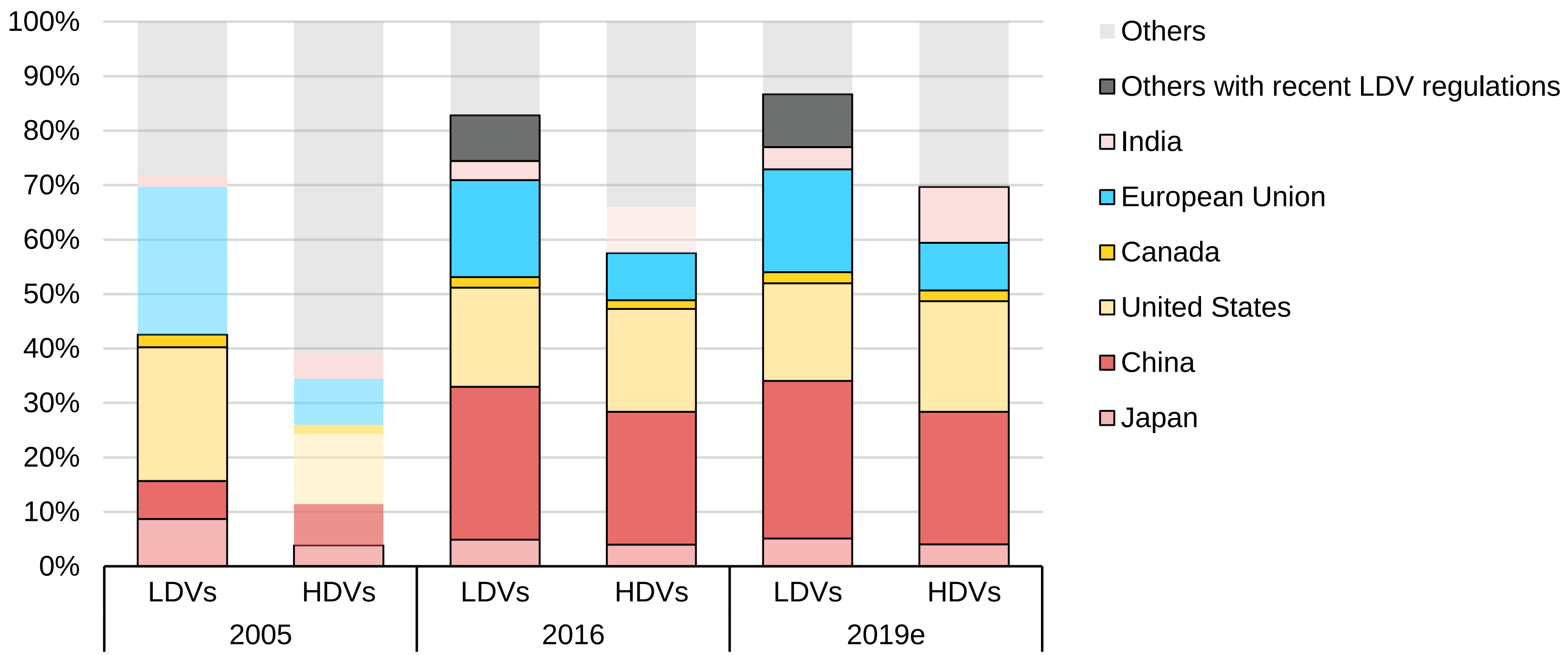


In the Sustainable Development Scenario, electricity accounts for more than 35%, and hydrogen and hydrogen derived fuels account for more than 30% of final energy demand in the transport sector by 2070

Heavy duty trucking

Regulations for heavy-duty vehicles are a critical first step

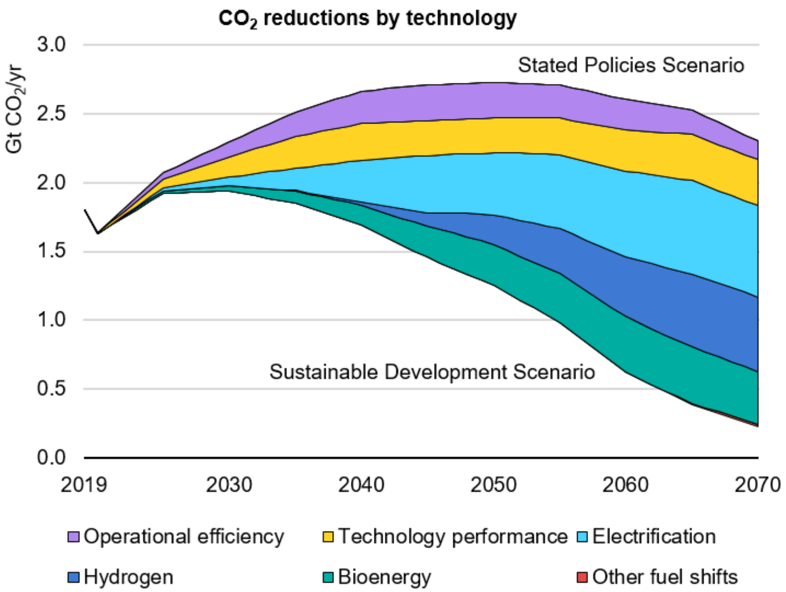
Share of vehicle sales in regions that have adopted fuel economy and/or CO_2 emissions standards

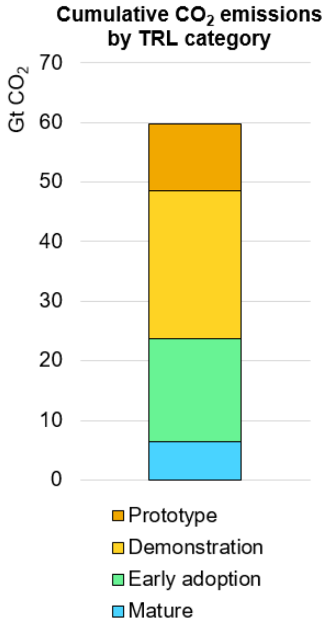


Vehicle efficiency and CO_2 emissions standards for heavy-duty vehicles are catching up with those for light-duty vehicles.

Decarbonising trucks will require a broad portfolio of strategies

Global CO_2 emissions from trucks by abatement measure (left) and technology readiness level (right) in the Sustainable Development Scenario versus the Stated Policies Scenario

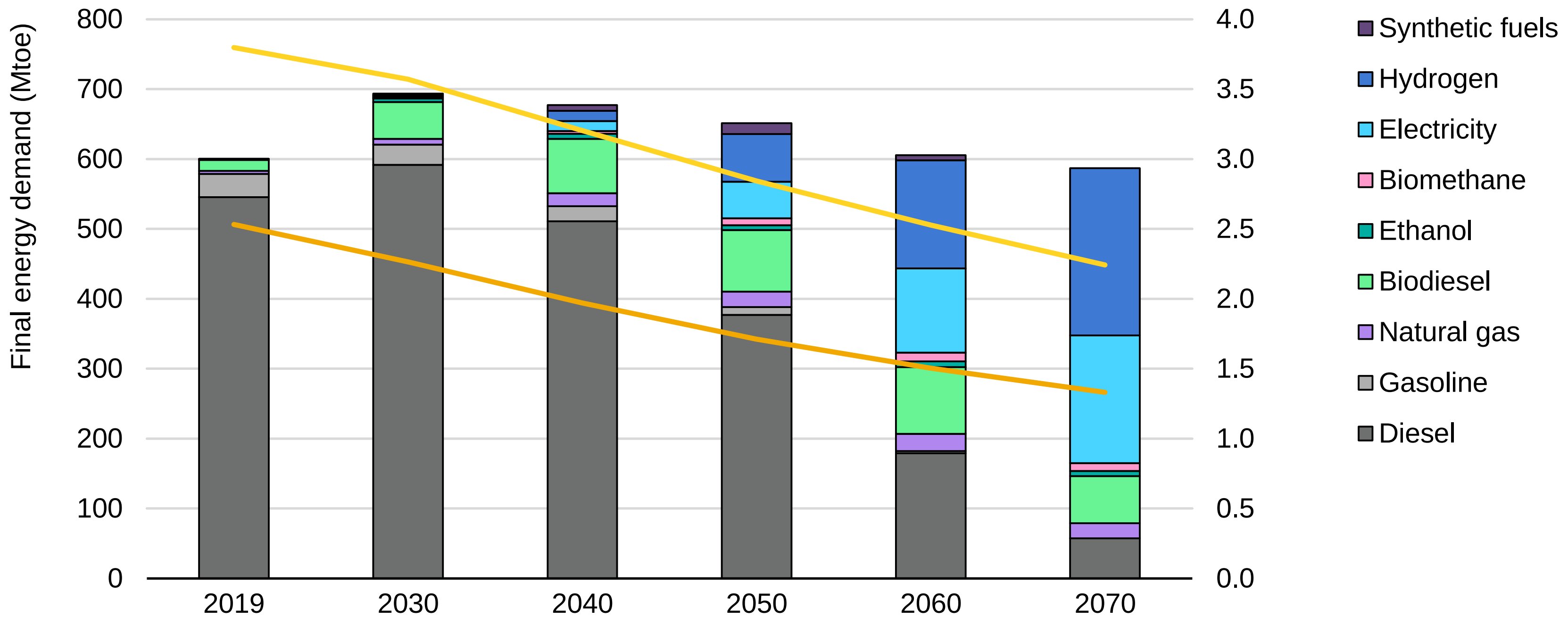




For heavy-duty trucks, operational and technical efficiency together contribute nearly 45%, electricity an additional 31%, and hydrogen and biofuels together almost 35% of cumulative CO_2 emission reductions in the Sustainable Development Scenario.

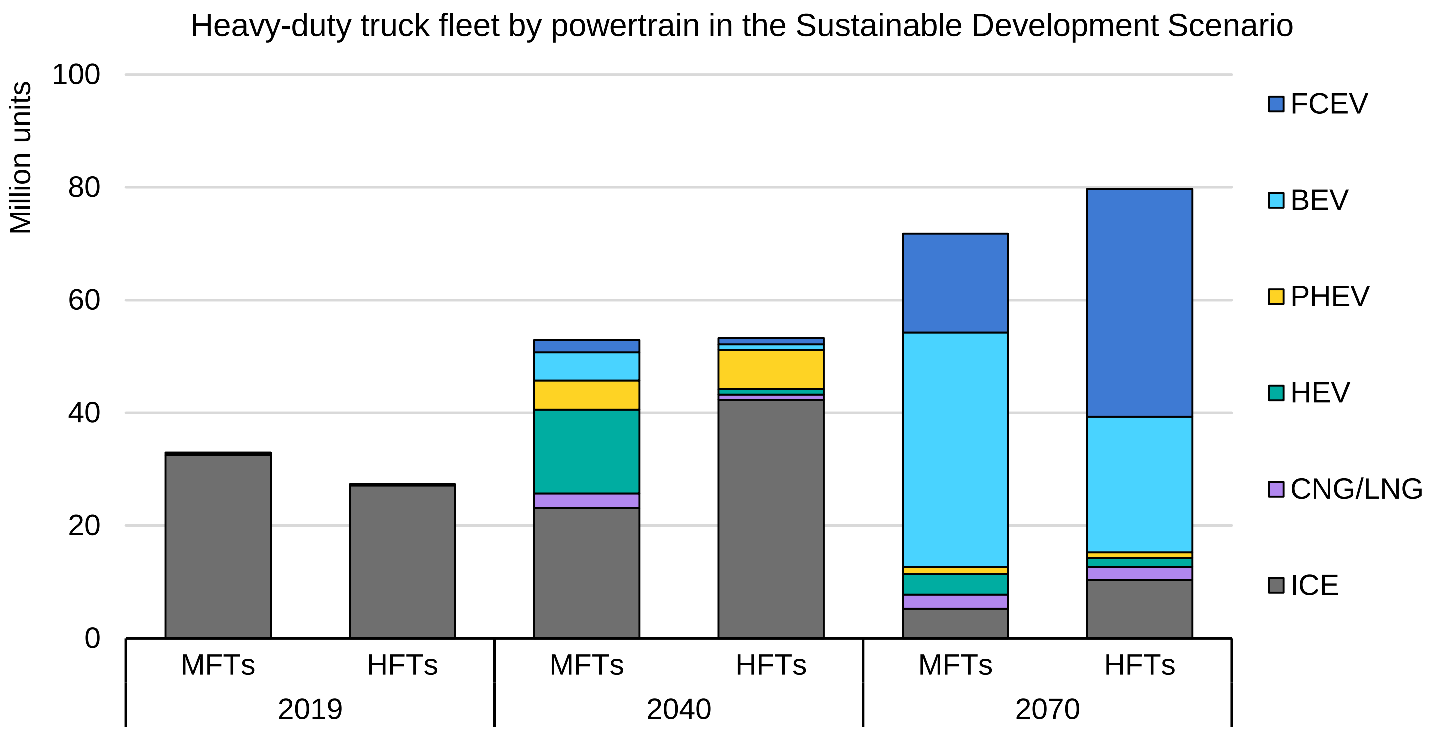
Low-carbon fuels reduce CO_2 emissions in trucking…

Global heavy-duty trucking energy demand and average vehicle efficiency in the Sustainable Development Scenario, 2019-70



The fuel mix diversifies first to liquid fuels, before ultimately shifting to electricity and hydrogen. Vehicle efficiency improvements by 40-45% as more trucks electrify or are equipped with fuel cells.

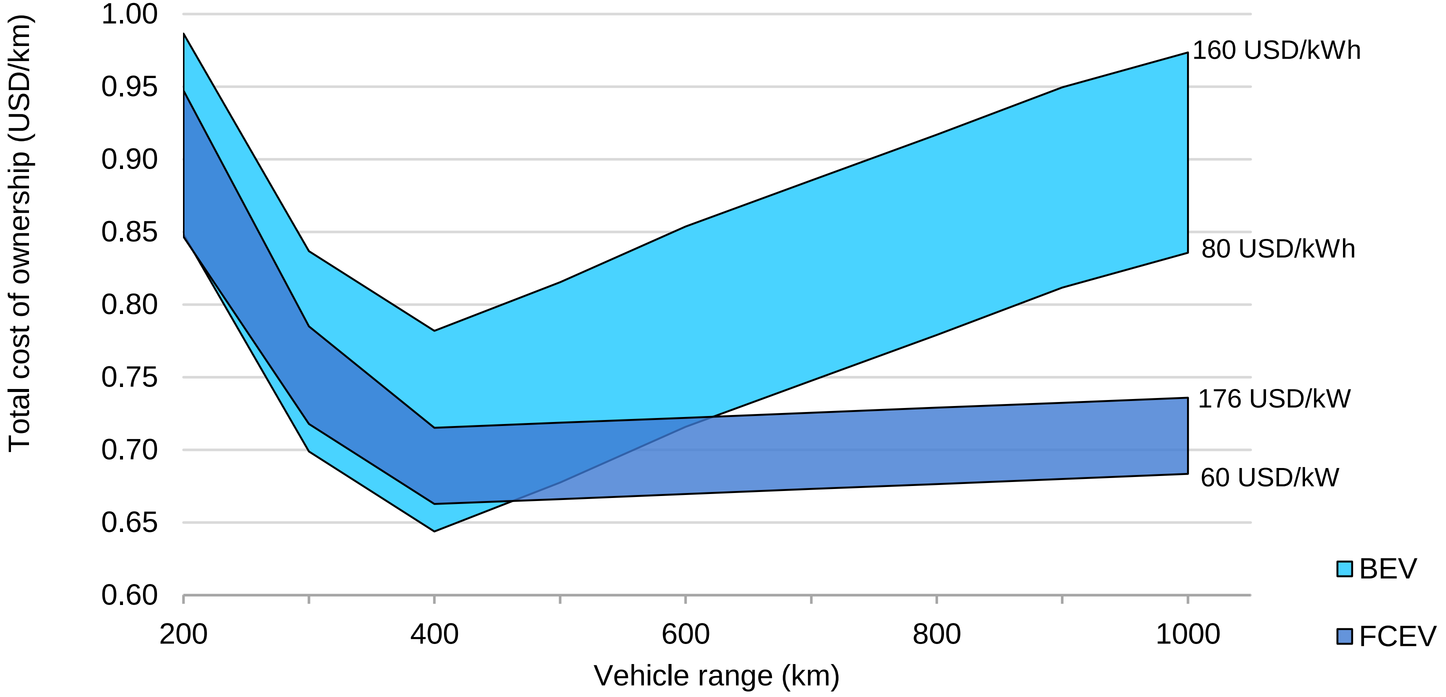
…and zero-emission "destination" powertrains offer hope for decarbonising



Nearly half of medium-freight trucks have hybrid or full electric powertrains by 2040, while most medium- and heavy-freight trucks operate with batteries or hydrogen fuel cells in 2070 in the Sustainable Development Scenario.

Batteries and fuel cells fulfill different niches in road freight

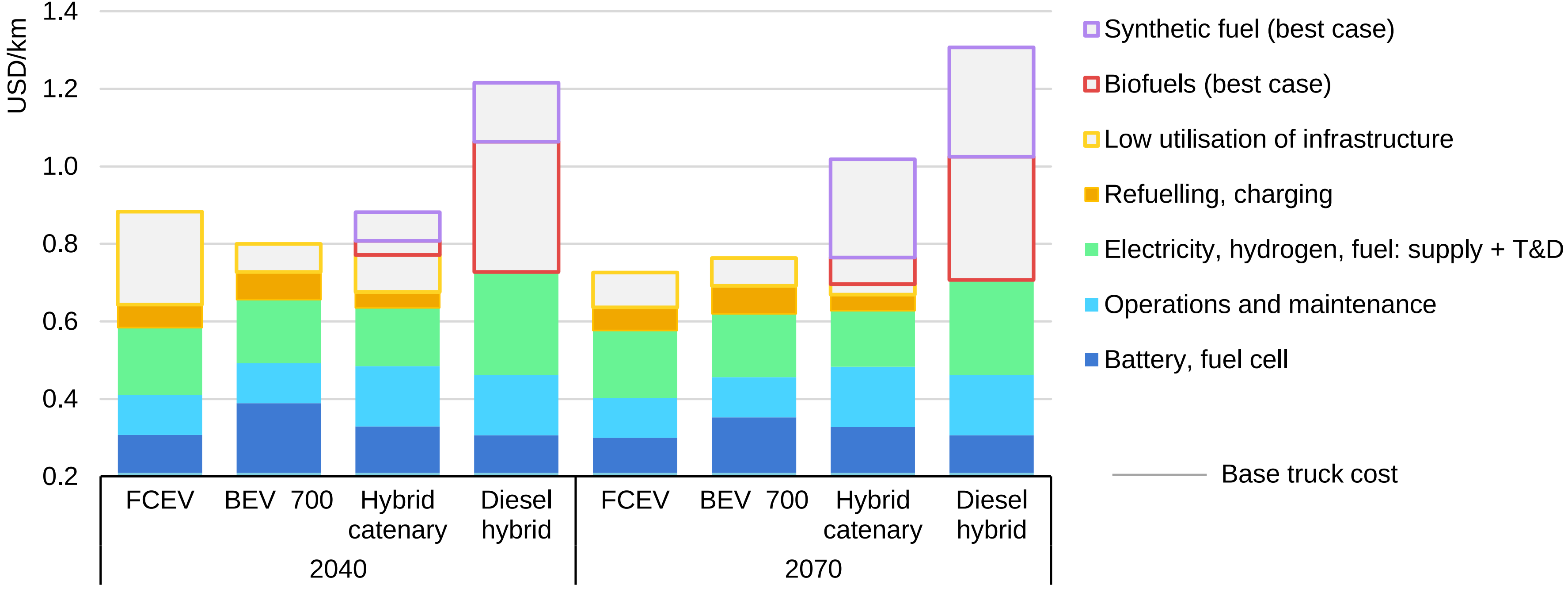
The effect of battery and fuel cell prices on total cost of ownership of heavy-duty trucks in long-haul operations



The prospects for competing powertrain options hinge on improvements in the cost and performance of batteries and fuel cells.

Long-term technology options for transport: electricity and hydrogen

Total cost of ownership of heavy-duty trucks by low-carbon fuel in the Sustainable Development Scenario, 2040 and 2070



Prospects for competing powertrain options hinge on the future costs and performance of batteries and fuel cells as well as accompanying infrastructure.

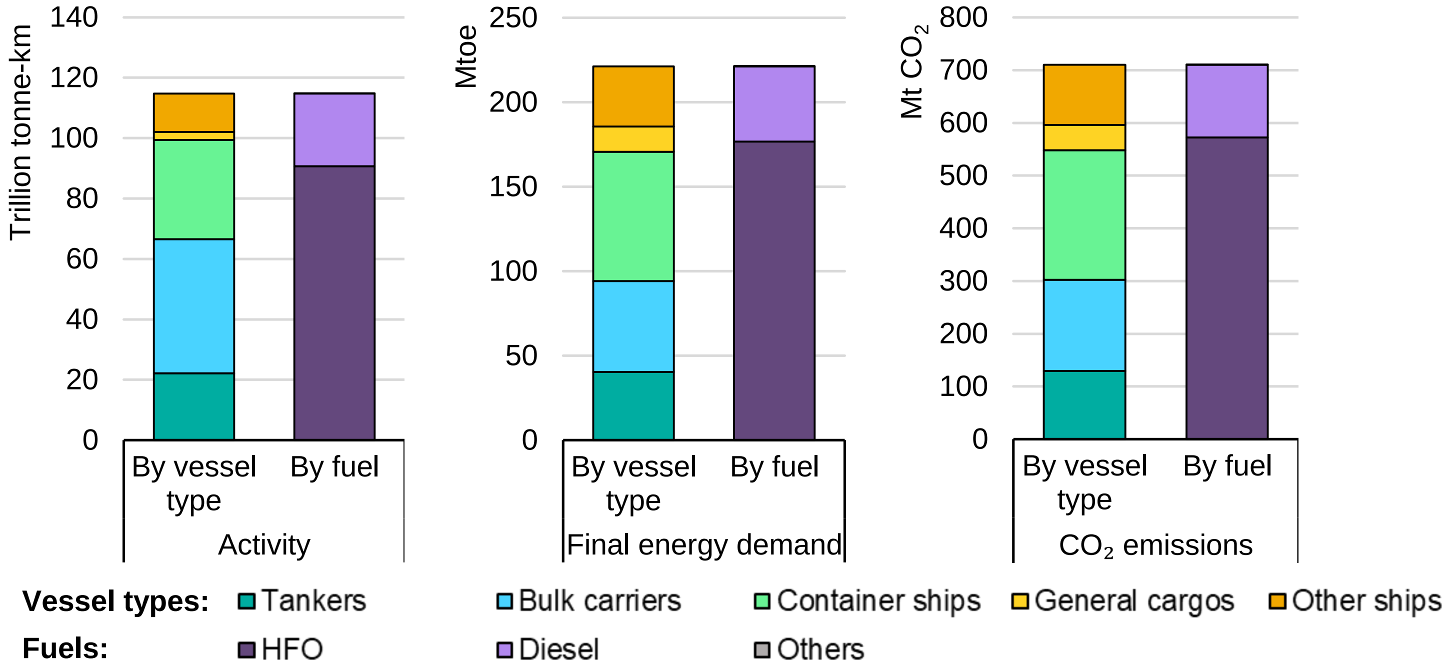
Uncertainties in the competition and complementarity of batteries and fuel cells

1. **Future trajectories of cost and performance** (energy and power density, durability, charging speed)
   of **batteries** and **fuel cells**
   - **Future progress in battery chemistries and production processes**
   - **Scale economies in fuel cell production**
2. **Future trajectories of cost and performance** of producing and delivering **electricity** and **hydrogen**.
   (Variable renewables like solar and wind, batteries and other technologies for energy storage, electolysers to make "green" hydrogen)
3. Operating and purchase costs will also be influenced by:
   - **The policy environment**
   - **Costs and utilisation rate of the infrastructure** (charging / hydrogen refuelling stations)
   - The **well-to-wheels efficiency** of competing pathways

Maritime shipping

International shipping carries three-quarters of the world's goods

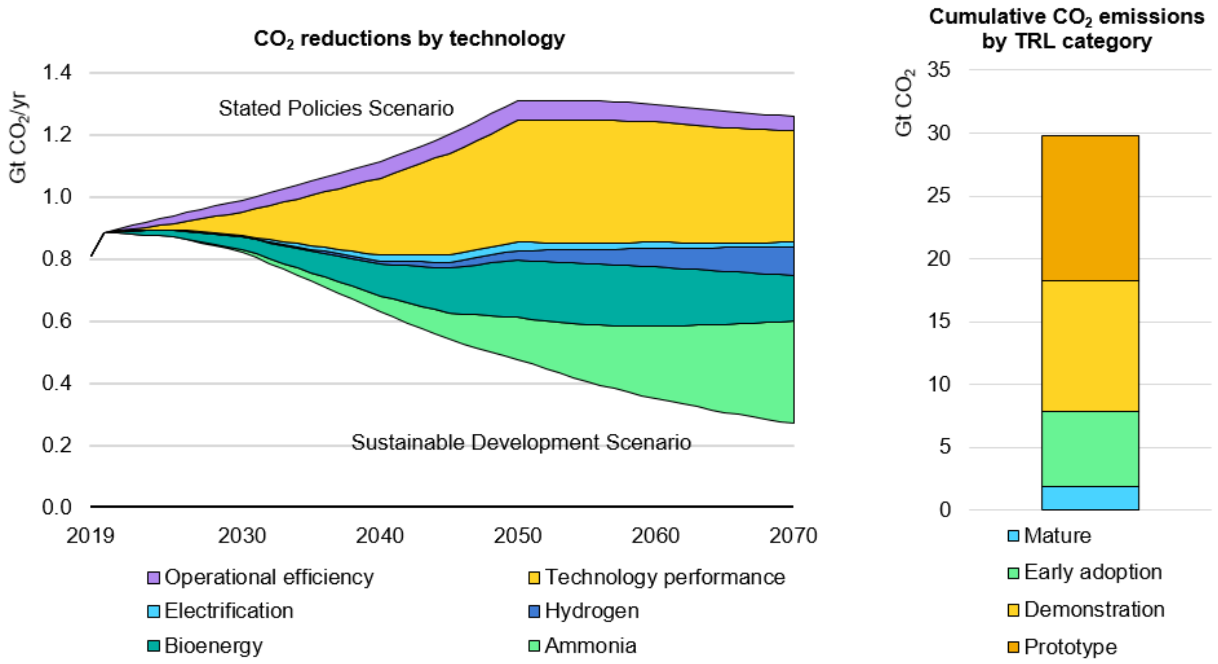
Global freight activity, energy consumption and CO_2 emissions in international maritime shipping by vessel type and fuel, 2019



Bulk carriers and container ships dominate in international shipping, together accounting for about 60% of total energy use in the sub-sector – almost entirely in the form of oil – and CO_2 emissions.

Reducing shipping emissions requires efficiency and alternative fuels

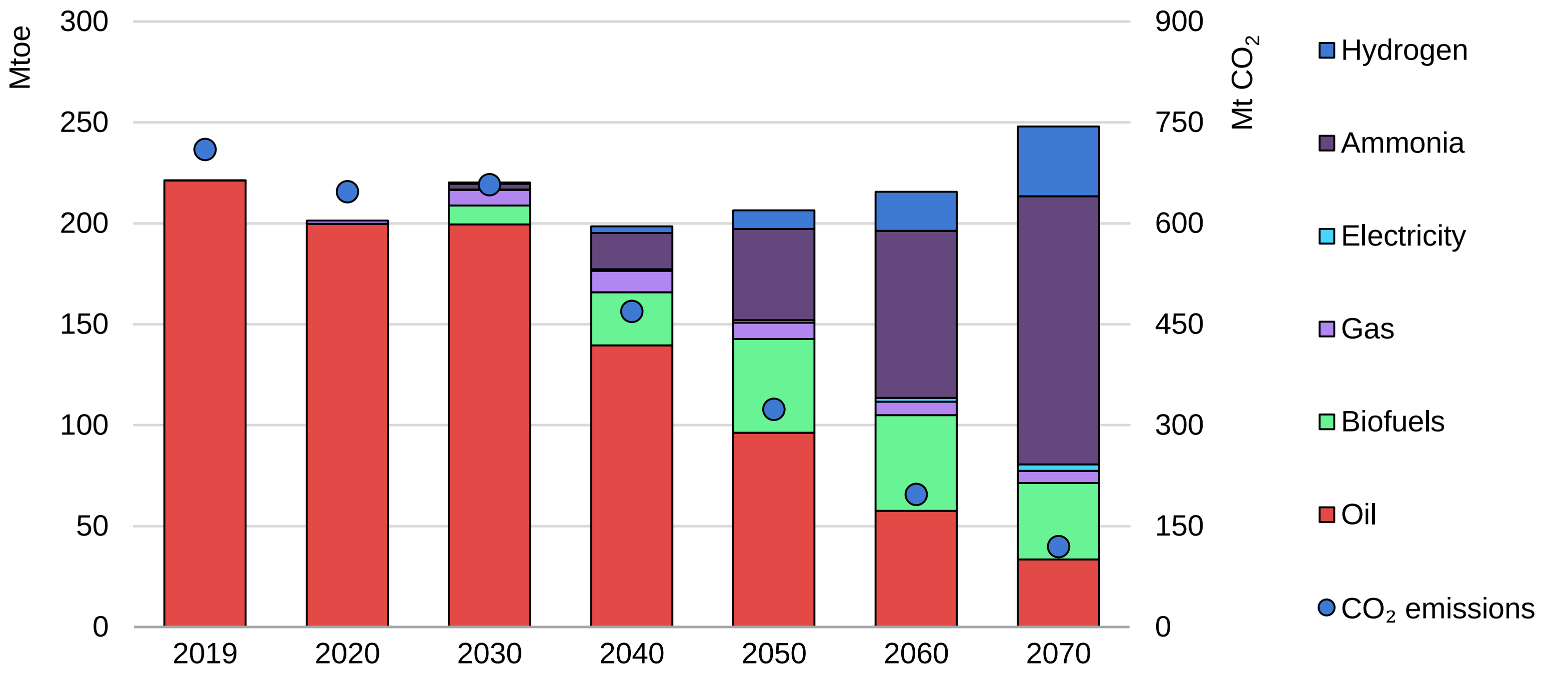
Global CO_2 emissions reductions in shipping in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-70



Biofuels and energy efficiency are the main contributors to shipping emission reductions in the Sustainable Development Scenario in the short term, while hydrogen and ammonia contribute more in the long term.

Ammonia, biofuels, and hydrogen replace oil in maritime shipping

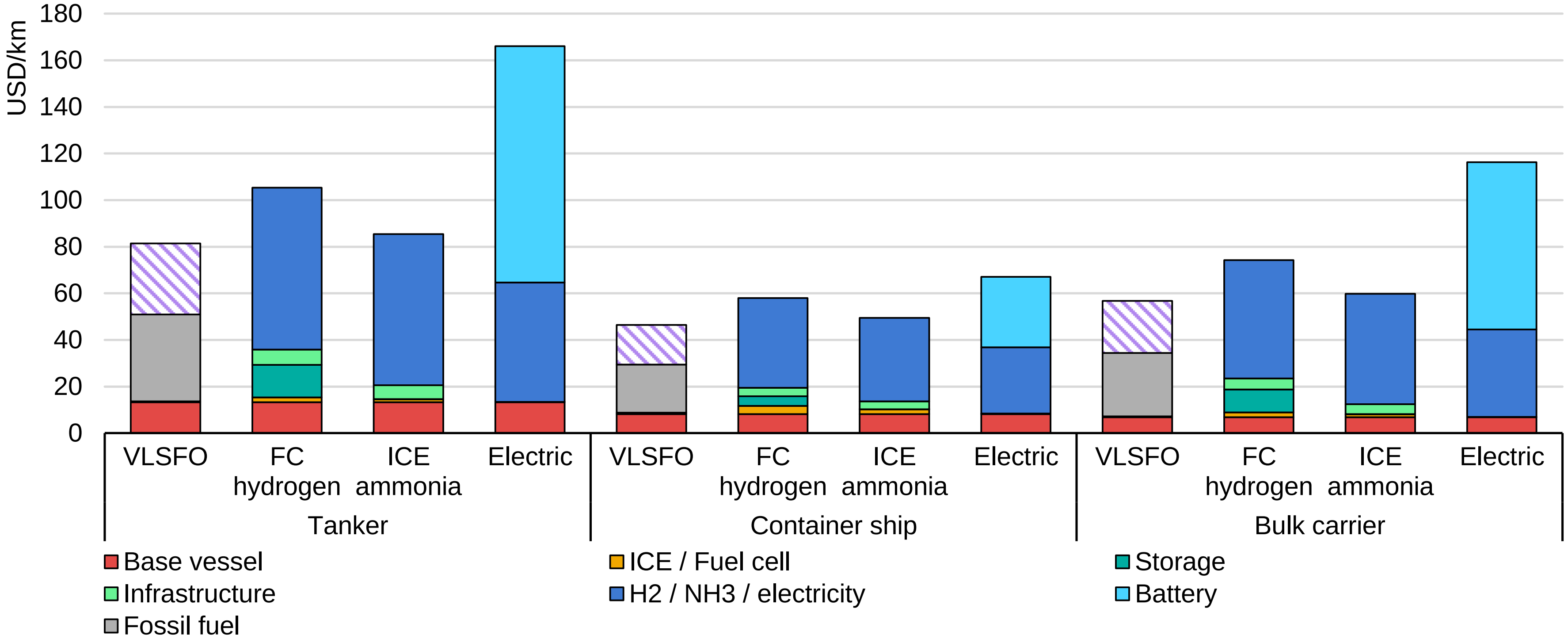
Global energy consumption and CO_2 emissions in international shipping in the Sustainable Development Scenario, 2019-70



Emissions from international shipping fall by more than four-fifths between 2019 and 2070 in the Sustainable Development Scenario, mainly due to switching to biofuels and hydrogen-based fuels.

All these alternative low-carbon fuels and powertrains are expensive

Total cost of ownership of hydrogen, ammonia and electric vessels by ship type, 2030

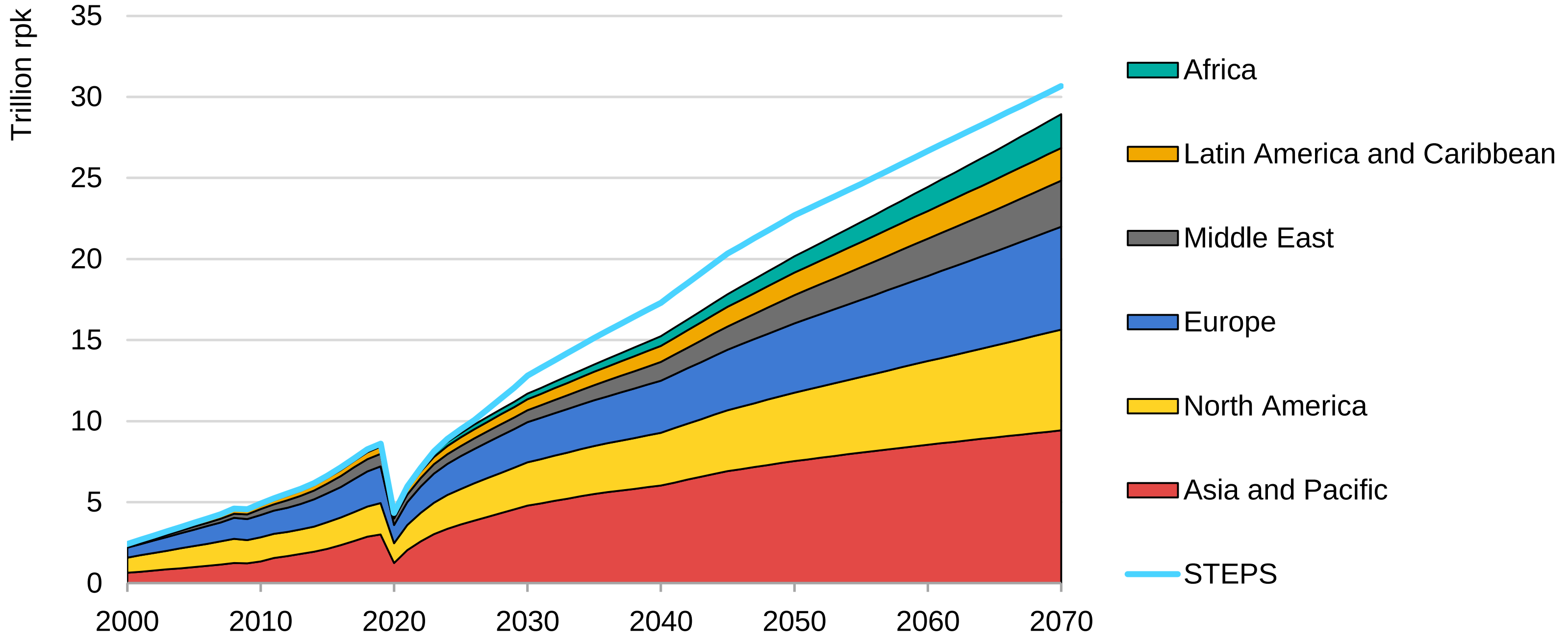


The high cost of storing hydrogen makes it less economical than ammonia. The economics and technical performance of electric vessels need to improve to become a competitive technology for long-distance shipping.

Aviation

Aviation activity is set to rebound by the mid-2020s

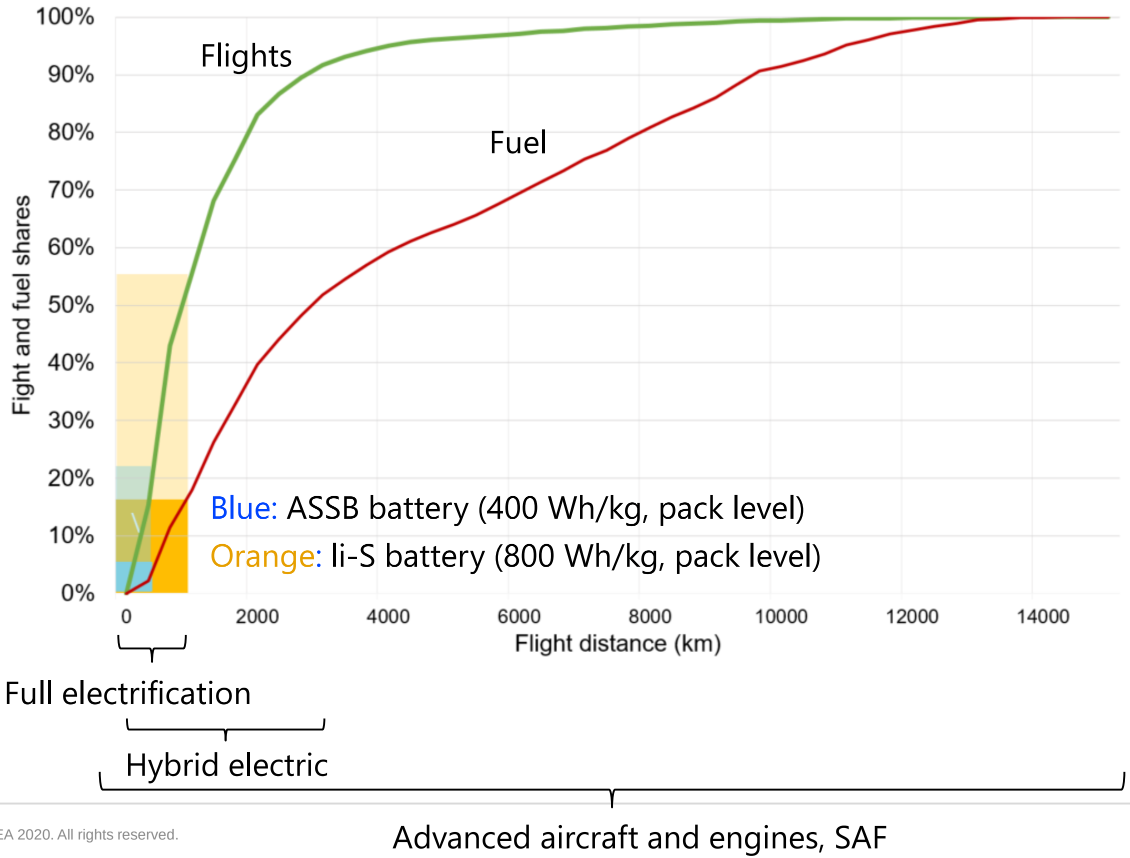
Passenger aviation activity by region in the Sustainable Development Scenario, 2019-70



Despite strong policy measures, including taxes that reduce overall demand, air passenger traffic increases by about 350% through to 2070 in the Sustainable Development Scenario.

Long-term efficiency and fuel opportunities depend on distance

Technology potential for CO_2 emissions reduction declines as distances increase



Example efficiency opportunities in operations and technology

Current generation

- Single engine or electric taxiing
- Cabin weight reduction
- Congestion management
- Optimised departures / approaches
- Reduced cruise inefficiency
- Increased engine / aero maintenance
- Increased use of composites

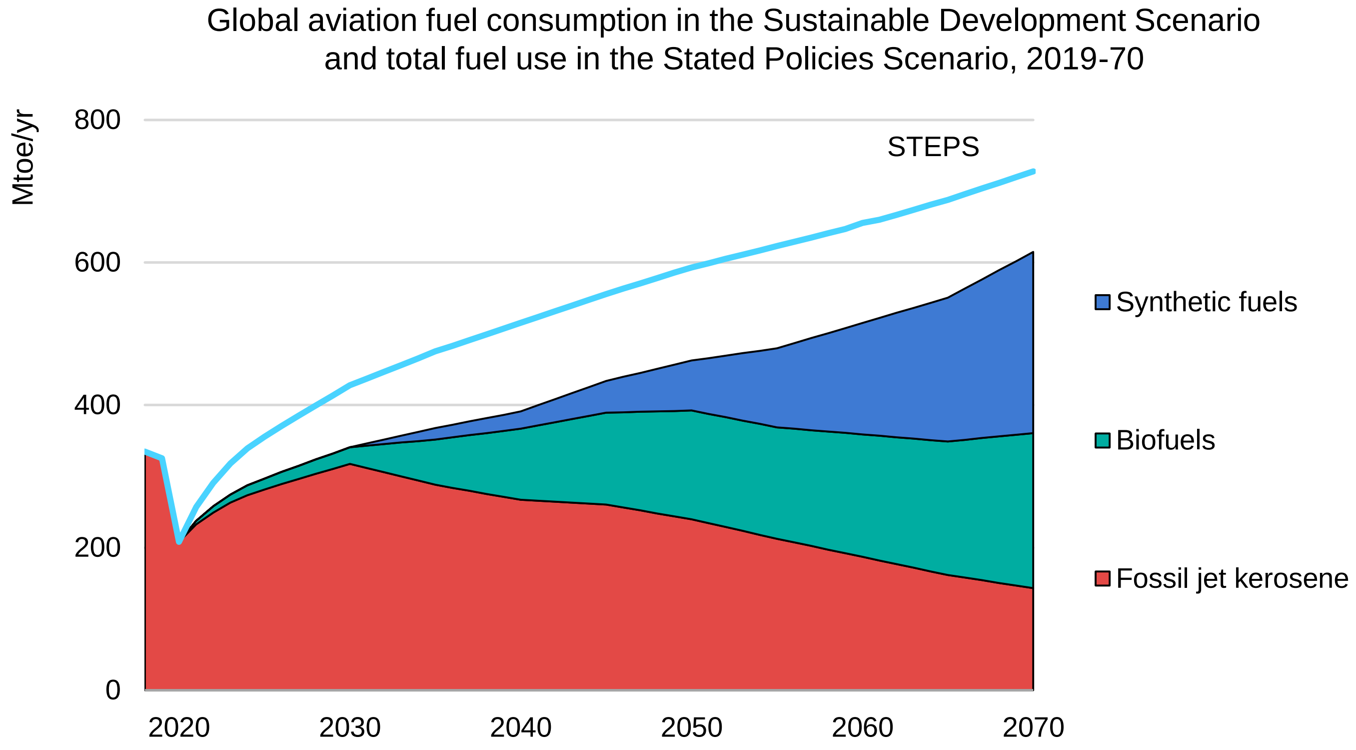
Next gen

- Ultra-high bypass ratio
- Double-bubble
- Open rotor

Disruptive (likely 2040 at earliest)

- Hybrid-electric aircraft (Boundary layer ingestion)
- Blended wing-body aircraft
- Full electric aircraft
- Hydrogen jet engine aircraft
- H2 fuel cell aircraft

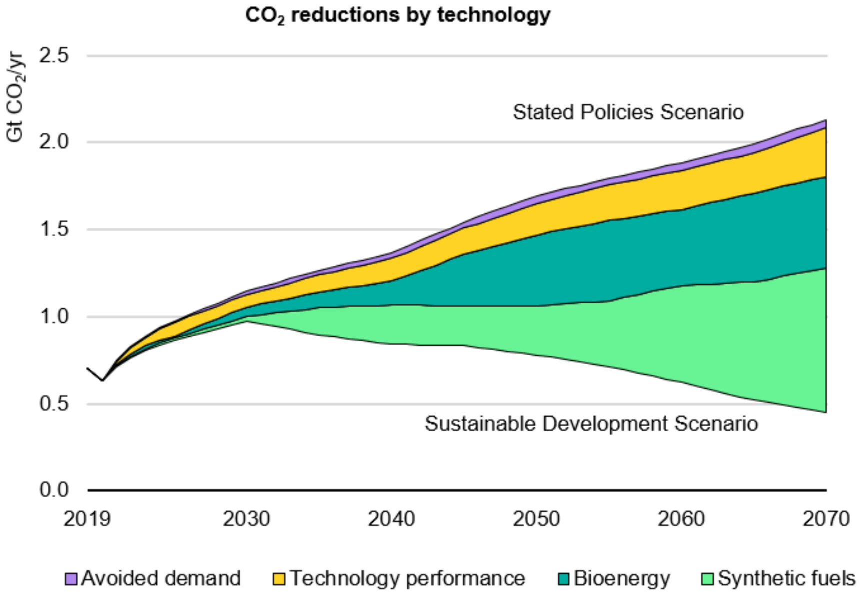
Sustainable Aviation Fuels are critical to reducing aviation emissions

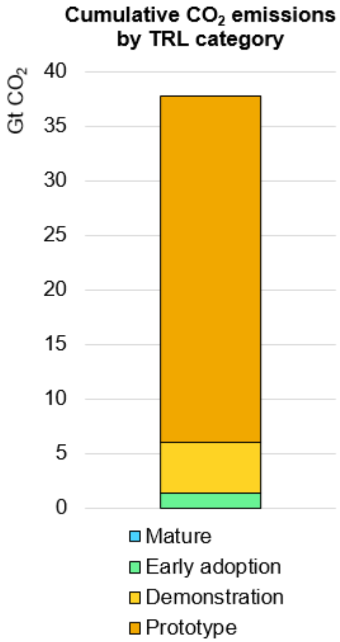


Rigorous policies to promote the development and adoption of sustainable aviation fuels play the leading role in reducing the climate impacts of aviation in the Sustainable Development Scenario.

Strong policies will be needed to reduce aviation emissions

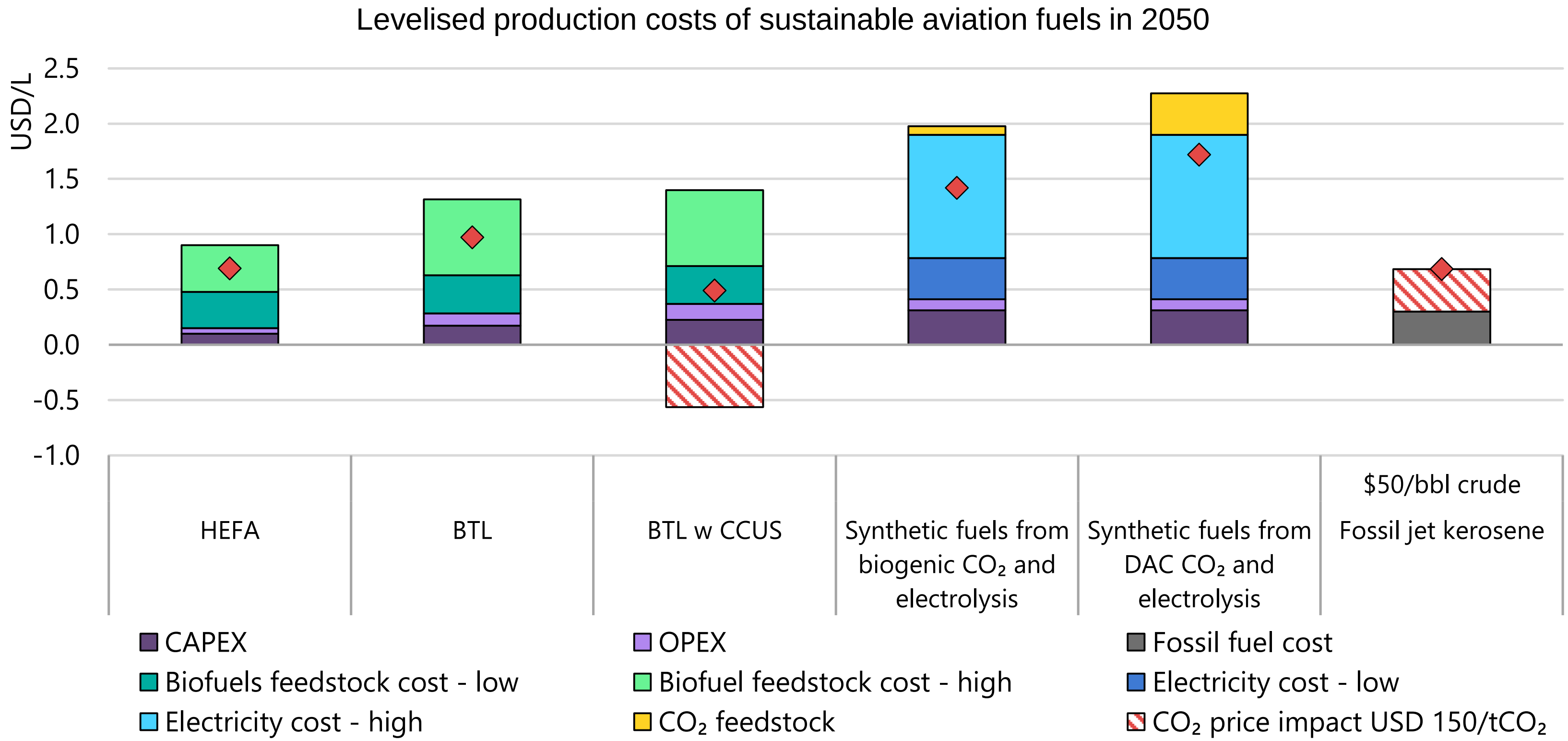
Global CO_2 emissions in aviation by abatement measure (left) and technology readiness level (right) in the Sustainable Development Scenario relative to the Stated Policies Scenario





Rigorous polices that promote sustainable aviation fuels, efficiency and shifts to alternative transport modes reduce emissions substantially in the Sustainable Development Scenario.

Policies will be needed to incentivise alternatives to fossil-derived jet fuel



With a carbon price of USD 150/tonne, sustainable aviation fuels begin to compete with oil-based jet kerosene, though policy support will need to account for the volatility and uncertainty of future feedstock costs and oil prices.