Climate policy in a world with fragmented international trade: evidence from JRC-GEM-E3

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The international trade system of the 2010s was a highly globalised one. Nonetheless, it is unclear whether this system will persist in the years to come. Increasing political uncertainties, rising trade tensions and changes in industrial policy raise the prospect of a shift towards a more fragmented global economy. As documented by the World Trade Organization (WTO), recent years saw the development of policies aimed at re-shoring production, the emergence of new challenges for the rules-based trade order as well as an increase in average tariff levels (WTO, 2024).

These changes in trade policy may affect traditional fossil fuel-related energy trade, but crucially also trade in clean energy technologies. Thus, this section of the report delves further into relevant developments in the trade landscape, and investigates whether the degree of trade openness influences how countries reach their climate targets and their transition towards a 1.5°C-compatible pathway.

1.1. The tariff landscape in 2025

The WTO finds that nearly 20% of worldwide imports were affected by trade measures (predominantly tariffs) by late 2025, a marked increase from the 12.6% at the end of 2024. However, 2025 also saw the introduction of more trade-facilitating measures than the preceding year, reflecting certain countries' efforts to maintain smooth cross-border trade in times of increasing protectionism (WTO, 2025). In fact, five new regional trade agreements entered into force in 2025 (WTO, 2026), and at the time of writing progress is being made in trade talks by large economies such as the EU, India and the Mercosur region.

Before January 2025, imports into the US coming from the EU were subject to an average trade-weighted, ad-valorem tariff of only 1.1%. By January 2026, this had increased to 10.6%. Most other regions equally faced an average tariff of below 5% pre-January 2025, which increased to at least 10% or more in the span of one year.

Clean energy technologies also feel the impact of both trade-restricting and trade-facilitating measures. Electric cars are one of the technologies identified as competitive and market-ready in Chapter 4, and this extends into trade policy. Many regions are ramping up their EV production capacities and are aiming to establish a competitive position on the global market. Within this context, tariffs may be viewed as an industrial policy tool or as a way to safeguard domestic industries against unfair market practices abroad.

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For example, many countries have a 0% Most-Favored Nation (MFN) tariff on electric cars,[2] but some emerging markets such as Indonesia, Thailand and Vietnam have tariffs of over 25%. A similar logic applies to MFN tariffs on solar panels,[3] where import tariffs are most often 0% while they may be high in some emerging markets (World Trade Organization Integrated Database, 2026).

At the same time, there are initiatives to actively reduce trade barriers for green technologies, such as the Agreement on Climate Change, Trade and Sustainability between New Zealand, Costa Rica, Iceland and Switzerland. This agreement liberalises, among other things, tariffs on solar panels, wind and hydraulic turbines and electric vehicles (i.e. reduces or eliminates tariffs for these products), to stimulate the development of these industries.

Box 1. Evidence on the importance of trade for green technology supply chains

JRC-GEM-E3, as a general equilibrium model, has an aggregate sectoral structure that does not capture the role of individual technologies within the energy transition. Other studies focusing on these specific key technologies find that trade disruptions can negatively impact energy and climate policy.

For example, (Gerarden *et al.*, 2026) found that US tariffs on solar panel imports were detrimental to climate objectives. Not only did tariffs drive up solar panel costs for consumers, but they also reduced total US employment, as there were more job losses in solar installation and related sectors than there were job gains in other manufacturing.

Several World Bank reports warn emerging markets against using similar protective measures for imports of green technologies (Montfaucon *et al.*, 2023; Rosenow, Espitia Rueda and Fernandes, 2024). One report finds that imports along the solar value chain and the downstream segments of other green value chains are particularly sensitive to the imposition of tariffs. Thus, trade protectionism could hinder the short-term diffusion of green technologies (Rosenow, Espitia Rueda and Fernandes, 2024).

Similarly, related to green hydrogen, (Seibold *et al.*, 2025) find that supply chain integration of energy-intensive industries can lead to cost savings. If the earlier stages of the supply chain (e.g. producing direct reduced iron) are located close to where green hydrogen is produced at a comparative advantage, this drives down production and transport costs. This implies the establishment of a few global production hubs where green hydrogen is produced cost-efficiently, and from where upstream products are shipped to different downstream production locations.

Also, instability and fragmentation in trade policy increase overall uncertainty in the global economy. This kind of economic uncertainty often leads to increased capital costs, which disproportionally affects green technologies (e.g. offshore wind), as they tend to be more capital-intensive compared to fossil fuel technologies.

Imports related to fuels and mining are often not as protected by tariffs as other sectors (e.g. manufacturing), given that countries may not have domestic subsitutes for imports of natural resources. Still, the average tariffs on US imports of fuels and mining increased from 0.5% pre-January 2025 (trade-weighted), to 6.5% by early 2026.[4] While the US does have fossil fuel reserves,

[2] Based on HS 870380 - Motor cars and other motor vehicles principally designed for the transport of <10 persons, incl. station wagons and racing cars, with only electric motor for propulsion (excl. vehicles for travelling on snow and other specially designed vehicles of subheading 870310).

[3] Based on HS 854143 - Photovoltaic cells assembled in modules or made up into panels.

[4] Calculations based on (UN Trade and Development (UNCTAD), 2026).

it is still heavily reliant on imports for certain critical minerals (U.S. Department of Energy (DOE), 2024).

1.2. The connectivity of international energy trade

Figure 1 visualises the global energy trade flows in 2017,[5] highlighting the extent to which regional interdependencies shape the current global energy system. Trade in fossil fuels is concentrated between resource-rich exporters and energy import-dependent economies.

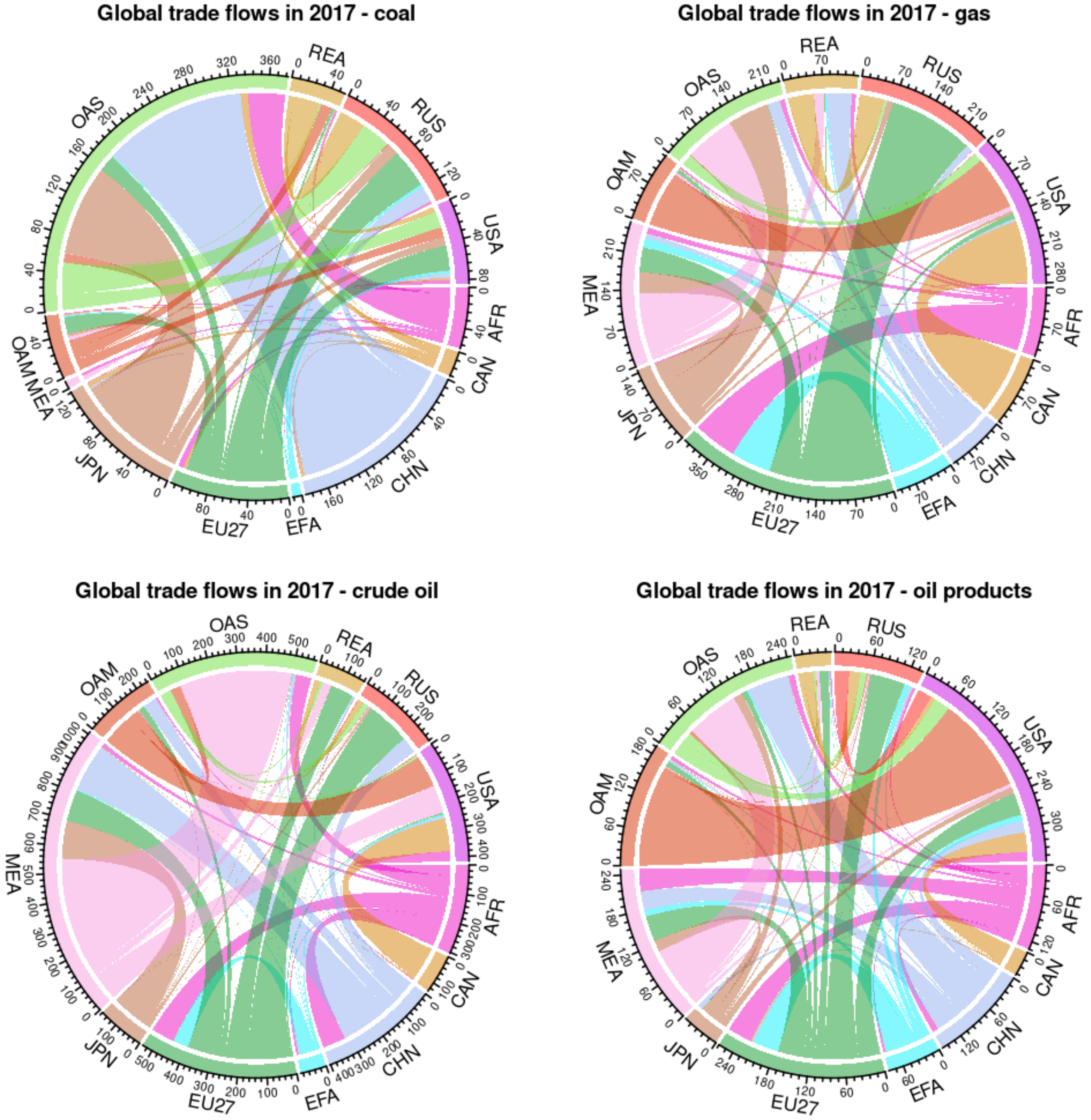
Additionally, patterns of trade regionalisation are evident depending on the type of energy carrier. For example, there is considerable regional trade in coal between different Asian countries, including coal exports from ‘other Asia’ (OAS) to Japan. When it comes to gas trade, regionalisation patterns are visible between the US, Canada and ‘other Americas’ (OAM), and between the EU, Russia and part of Asia. Trade in crude oil and oil products, however, is less regionalised.

This structure of trade in energy products has been shaped by many different factors, including historical and political relations between regions, transport costs, and quality considerations. The patterns visible in **Figure 1** underscore the importance of secure energy supply chains, as most countries lack the natural resources to meet their entire demand domestically.

It is noteworthy that since 2017 energy trade between the EU and Russia has changed substantially because of the sanctions on Russia after its invasion of Ukraine. After 2022, EU imports of Russian mineral fuels dropped rapidly to below 2.5 billion USD (Bruegel, 2026).

[5] 2017 serves as the base year in the JRC-GEM-E3 analysis.

Figure 1: Selected trade flows in 2017 – energy trade – billion USD 2017.



Source: Calculations based on GTAP-Power database (Chepeliev, 2020; Aguiar et al.*, 2022)*
Notes: Each of the flows represents the total trade between two regions (imports and exports), without specifying the direction of the flow. 'AFR': Africa, 'EFA': European Free Trade Association, 'MEA': Middle East, 'OAM': Other Americas, 'OAS': Other Asia, 'REA': Rest of Eurasia.

1.3. Globalisation vs. fragmentation in international trade

This article evaluates socio-economic climate policy impacts in two stylised trade policy settings: a globalised system with current levels of trade openness, and a fragmented system characterised by increased trade barriers and stronger push for domestic production. These are analysed in combination with the standard GECO climate policy scenarios, namely the Reference and the 1.5°C scenarios (see **Table 1**). Unless otherwise noted, results are reported as changes relative to the Reference with the globalised trade regime. Some figures present absolute values, but the globalised Reference remains the benchmark for comparison.

Box 2. Modelling the fragmentation of international trade

The standard GECO modelling with JRC-GEM-E3 is based on a representation of a globalised system of the world economy. JRC-GEM-E3 is based on GTAP-Power data for base year 2017 (Chepeliev, 2020; Aguiar *et al.*, 2022), a year in which trade openness was high. In standard modelling, as there are no explicit assumptions on changes in trade policy, the base year structure is implicitly maintained, meaning that the default GECO scenarios are based on a globalised version of the economy.

One exception is the changing trade relation for fossil gas between the EU and Russia after Russia's 2022 invasion of Ukraine. Changes in the structure of fossil gas trade are incorporated in the baseline based on data from (Bruegel Dataset, 2026).

The fragmented version of the global economy, however, adapts this structure by introducing higher import tariffs, increasing average baseline tariff levels by 25 percentage points between all global regions (excluding intra-EU trade) from 2025 onward. This modelling approach follows similar methodologies used in the literature (Fujimori *et al.*, 2017; Arriola *et al.*, 2020), providing a stylised representation of a world with reduced trade integration. It is not intended to mirror current real-world policy developments, but it is rather a modelling approach to create an alternative version of the globalised economy where countries are more self-sufficient and less reliant on trade.

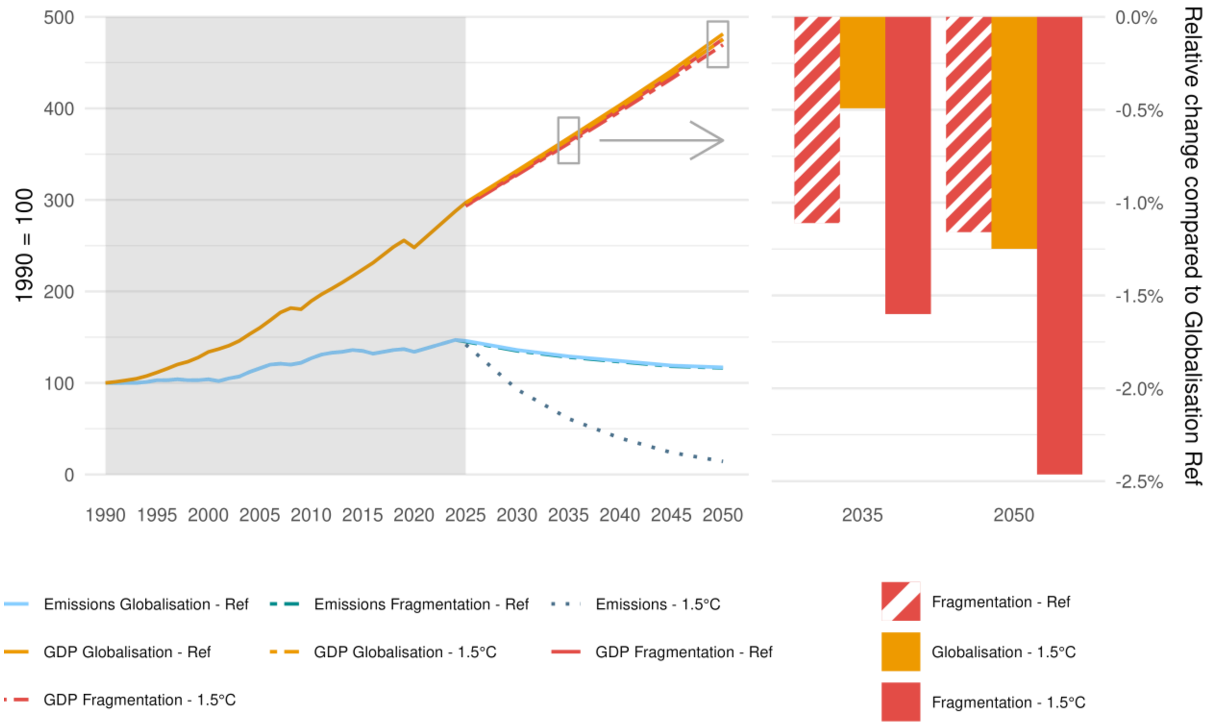
Table 1: Summary of the scenarios and references and their combinations.

International trade / Climate ambition	Globalisation	Fragmentation
Current policies (Ref)	Climate policies that have already been implemented into domestic legislation with current levels of global trade openness.	Climate policies that have already been implemented into domestic legislation in a world with more fragmented trade and more domestic production.
1.5°C	Temperature increase of 1.5°C by the end of the century with current levels of trade openness.	Temperature increase of 1.5°C by the end of the century in a world with more fragmented global trade.

Source: JRC-GEM-E3 scenarios.

1.4. Minimal interaction between climate and trade policy at global GDP level

Figure 2: Global GDP (excluding effects of climate change impacts) and global GHG emissions (including LULUCF), by scenario.



Source: JRC-GEM-E3

Notes: The GHG emissions in the 'Globalisation' and '1.5C' scenarios are based on results from POLES-JRC. By construction, GHG emission levels are identical in the globalised and fragmented 1.5°C scenarios. The GHG emissions in the 'Fragmentation' Reference are based on JRC-GEM-E3 modelling, using JRC-POLES as input, which captures the economic impact on GHG emissions of fragmentation.

Figure 2 compares global GDP and GHG emissions across the Reference and 1.5°C scenarios under both a globalised and a fragmented global economy. Overall, the GDP impacts of climate mitigation are similar under both trade regimes, and the absolute differences remain modest (left-hand panel). Compared with the globalised Reference (right-hand panel), the results indicate that climate mitigation and trade fragmentation interact only weakly in the fragmented 1.5°C scenario. Still, when fragmentation and mitigation occur together, the impact on GDP effectively doubles.

The picture is very different for GHG emissions. Emissions differ substantially between the Reference and the 1.5°C scenarios, with the left-hand panel showing the sharp reduction in emissions required to meet the 1.5°C target. Emission levels are identical in the globalised and fragmented 1.5°C scenarios by construction, as the carbon price adjusts endogenously to achieve the target.

Trade fragmentation on its own also affects economic outcomes. Moving from the globalised to the fragmented Reference scenario lowers global GDP by around 1.1% in both 2035 and 2050 (**Figure 2**, right-hand panel), as trade restrictions put downward pressure on global economic growth. However, the size of this effect differs across regions. Most regions experience relative GDP declines of 1-2%, while a smaller group sees reductions of up to 4%. These differences are related to countries' size and trade dependence, with larger and less trade-dependent economies being less affected by higher tariffs.[6]

Like GDP, GHG emissions decline when moving from globalisation to fragmentation in the Reference (-0.5% by 2050). However, this is largely the consequence of weakened economic activity, i.e. a negative output effect which lowers emissions. For example, some of the sectors that see the largest decline in output and GHG emissions are the transport sectors, particularly maritime transport. This is because of the reduction in trade, which leads to a strong reduction in international transport demand.

Importantly, slower economic growth because of fragmentation does not necessarily lead to structural decarbonisation. On the contrary, GHG emissions decline less than GDP because the global economy becomes more emission intensive. As trade barriers raise the cost of imports, some regions expand domestic production to partially substitute for foreign suppliers, even though these domestic industries may be less efficient and more emission intensive. Although the introduction of tariffs reduces overall output, the increase in emission intensity dominates this negative output effect in a deep decarbonization scenario. As a result, the global carbon price must be USD 75/tCO_2e[7] higher in the fragmented 1.5°C scenario in 2050 to achieve the same emissions level as in the globalized 1.5°C scenario.

Overall, fragmentation delivers only very limited GHG emission reductions, and does so in an economically inefficient way, demonstrating that trade policy is not a substitute for climate policy.

By contrast, the transition from the globalised reference to the globalised 1.5°C scenario also results in a GDP reduction by 2050 (-1.25%) but generates substantial GHG emissions reductions of 88%, reflecting structural changes such as fuel switching, efficiency improvements and investment in low-carbon energy systems. This underscores that coordinated climate action can deliver deep mitigation at comparatively low direct macroeconomic costs - noting that this does not include the economic benefits from reduced climate damages and other co-benefits such as reduced air pollution. Similarly, the Reference scenarios do not reflect the costs of inaction or adaptation, which have been shown to negatively impact GDP (Feyen *et al.*, 2020).

[6] These results are in line with similar analyses of tariff hikes, such as by the (Nordgren, Norell and Stålenheim, 2024; Kiel Institute for the World Economy, 2025; McKibbin and Noland, 2025).

[7] USD 2017.

Box 3. Exempting fossil fuels from trade restrictions

As a sensitivity test, an additional scenario explores the impact of exempting fossil fuels from the tariff hike in the fragmentation scenario. In this sensitivity scenario, tariffs between all regions (except intra-EU) are increased by 25 percentage points for all goods and services with the exception of trade in fossil fuels (see also **Figure 1**). This reflects the real possibility that governments are less likely to impose high tariffs on essential energy imports, especially in net-importing regions with few domestic fossil fuel resources. Because the energy transition will reduce the need for fossil fuel trade, there may be interactions between energy and trade policy in this area.

Exempting fossil fuels from the tariff hike does not have a strong impact on GDP if trade barriers are still applied to all other goods and services. In 2035 GDP is 0.05% higher with the fossil fuel exemption compared to when they are also covered by additional tariffs. This reflects how lower tariff coverage puts less downward pressure on GDP. However, in 2050, GDP is almost identical with and without the fossil fuel exemption. Especially in the 1.5°C scenario, the energy transition means that there is little fossil fuel trade, and it makes hardly a difference whether this is covered by tariffs or not. GHG emissions react similarly to GDP. As mentioned above, trade fragmentation means that a higher carbon price is necessary to reach a 1.5°C target. This effect is slightly exacerbated when fossil fuels are exempt from the tariff increase. This is because there are no tariffs providing a dampening effect on fossil fuel trade, while other industries are still relocating to potentially more emission-intensive domestic markets because of the remaining tariffs.

1.5. Climate and trade policy cause structural change

Fragmentation and mitigation both have the potential to reshape the structure of international trade. **Figure 3** illustrates changes in total global trade and its sectoral composition relative to 2017. In the globalised scenarios, manufactured goods – including both manufacturing and energy-intensive industry – remain the most traded products as the total volume of trade expands in 2035 and 2050. In the fragmented scenarios, however, trade volumes contract, reflecting the shift towards domestic production as well as the overall contraction of GDP.

Figure 3: Total global trade by sector in different scenarios, relative to base year 2017 (index 2017 = 100).

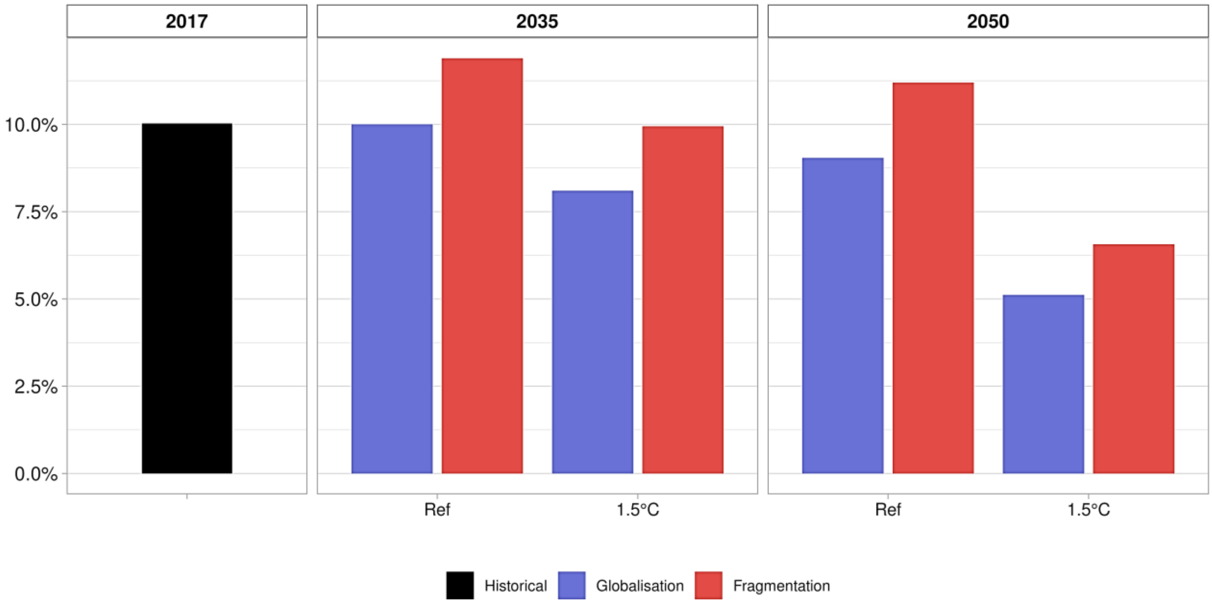
Source: JRC-GEM-E3

Figure 3 indicates that fossil fuel trade grows in absolute terms, albeit slightly, in both the globalisation and fragmentation Reference scenarios, while it decreases in the 1.5°C scenarios. In addition, **Figure 4** visualises the share of fossil fuels in global trade over time by singling out the global fossil fuel trade bars seen in **Figure 3**.

In the fragmented Reference scenario, the share of fossil fuels in global trade remains broadly stable, increasing only slightly from 10% in 2017 to 11% in 2050, reflecting the continued reliance on internationally traded energy resources. Notably, this does not mean that fossil fuel trade increases in absolute terms. Rather, fragmentation has a stronger negative effect on trade in other categories – particularly manufacturing – leading to a relative increase of fossil fuels in the global trade basket.

In the globalised 1.5°C scenario, the share of fossil fuels falls to around 5% by 2050 as the world decarbonises. In the fragmentated version of the global economy, the share declines more slowly, reaching around 7% in 2050. Overall, the results highlight how the levels of energy trade are more affected by climate policy, while levels of manufacturing trade respond more strongly to trade policy.

Figure 4: Share of fossil fuels in global trade across years and scenarios (based on trade in monetary terms).



Source : JRC-GEM-E3

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