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No more fossil fuel from 2035

A pre-study carried out within the Swedish Transport Administration's industry program Sustainable Shipping, operated by Lighthouse, published in April 2026

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SJÖFART

No more fossil fuel from 2035

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Summary

This report examines how maritime transport could transition to fossil-free operations by 2035 and long-term sustainability. That was grounded by a hypothetical global ban of fossil fuels, following a climate crisis in 2025. The pre-study analysed renewable fuel availability, technological options and changes in transport patterns, and combined system-level analysis with stakeholder insights to identify feasible transition pathways.

Shipping is currently almost entirely dependent on fossil fuels and faces structural challenges in decarbonisation, including long vessel lifetimes and limited suitability of battery-electric solutions for long-distance transport. While biofuels may enable short-term reductions, sustainable biomass is scarce and competed for across sectors. Hydrogen-based electrofuels offer long-term potential but require major expansion of renewable electricity and infrastructure. The transition will therefore likely depend on a combination of renewable fuels alongside significant efficiency improvements. It may also lead to changes in global trade patterns, including slower shipping, reduced transport demand and increased regionalisation of production.

A central element of the study was a stakeholder workshop using a World Café format, involving more than thirty participants from industry, authorities and research. The workshop explored challenges, opportunities, solutions, and initial roadmaps for the transition.

Key challenges identified include the rapid scaling up of renewable energy systems, infrastructure constraints, and the complexity of transforming multiple sectors simultaneously. Participants also highlighted geopolitical uncertainties, limited shipyard capacity for retrofitting, and the importance of behavioural change and reduced energy demand.

At the same time, the transition was seen as an opportunity to drive innovation in fuels, vessel technologies and logistics, and to strengthen supply chain resilience through greater efficiency and circularity. Strong international cooperation and coordinated governance were identified as critical enablers.

Proposed solutions included early and decisive policy measures such as carbon pricing and long-term regulatory frameworks, alongside technological developments such as improved ship design, operational optimisation, retrofitting, and new propulsion systems. Wind-assisted propulsion, batteries for short-distance shipping, and renewable fuels were highlighted as key components. Collaboration across the maritime value chain and increased societal acceptance of higher transport costs were also considered essential.

An initial roadmap was proposed to include strong incentives and regulatory frameworks at global, regional and national political and other decision-making levels to provide opportunities/directives to shipping stakeholders to initiate and sustain the transition.

Overall, fossil-free shipping by 2035 is highly challenging but potentially achievable with strong political commitment, rapid technological deployment and systemic change.

Sammanfattning

Denna rapport analyserar hur sjöfartssektorn skulle kunna ställa om till fossilfrihet till år 2035 och på sikt en hållbar framtid. Det grundar sig i ett hypotetiskt globalt förbud mot fossila bränslen efter en klimatrelaterad kris år 2025. Förstudien behandlade tillgången på förnybara bränslen, möjliga tekniska lösningar, förändringar i transportmönster, samt kombinerade systemanalys med insikter från intressenter för att identifiera möjliga omställningsvägar.

Sjöfarten är idag nästan helt beroende av fossila bränslen och står inför strukturella utmaningar i omställningen, såsom långa livslängder på fartyg och begränsade möjligheter att elektrifiera långväga transporter. Biobränslen kan bidra på kort sikt, men hållbar biomassa är begränsad och efterfrågas av flera sektorer. Vätgasbaserade elektrobränslen har stor långsiktig potential, men kräver en omfattande utbyggnad av förnybar el och infrastruktur. Omställningen kommer därför sannolikt att bygga på en kombination av olika förnybara bränslen och betydande energieffektiviseringar. Den kan även leda till förändrade handelsmönster, med långsammare transporter, minskad efterfrågan på transporter och ökad regionalisering av produktion.

En central del av studien var en intressentworkshop i World Café-format med över trettio deltagare från industri, myndigheter och forskning. Workshopen fokuserade på att identifiera utmaningar, möjligheter, lösningar och en initial färdplan för omställningen.

De viktigaste utmaningarna som identifierades var behovet av en snabb utbyggnad av förnybara energisystem, begränsningar i infrastruktur samt komplexiteten i att samtidigt ställa om flera sektorer. Deltagarna lyfte även geopolitiska osäkerheter, begränsad kapacitet i varv för ombyggnation av fartyg samt vikten av beteendeförändringar och minskad energianvändning.

Samtidigt identifierades flera möjligheter. Omställningen kan driva innovation inom förnybara bränslen, fartygsteknik och logistiklösningar, samt stärka försörjningskedjors robusthet genom ökad effektivitet och cirkularitet. Stark internationell samverkan och samordnad styrning lyftes fram som avgörande.

Föreslagna lösningar inkluderar tidiga och tydliga politiska beslut, såsom koldioxidprissättning och långsiktiga regelverk, i kombination med tekniska åtgärder som förbättrad fartygsdesign, optimerad drift, ombyggnation av befintliga fartyg samt utveckling av nya framdrivningssystem. Vindassistans, batterier för kortdistanssjöfart och förnybara bränslen framhölls som viktiga komponenter. Samverkan längs hela värdekedjan och ökad samhällelig acceptans för högre transportkostnader bedömdes också som centrala.

En initial färdplan föreslogs innehålla kraftiga incitament och regelverk på globala, regionala och nationella politiska och andra beslutsfattande nivåer för att ge möjligheter/direktiv till sjöfartens aktörer att påbörja och vidmakthålla omställningen.

Sammanfattningsvis är fossilfri sjöfart till 2035 är mycket utmanande men potentiellt möjlig, förutsatt stark politisk vilja, snabb teknikutveckling och omfattande systemförändringar.

Contents

The Challenge

Science is clear; anthropogenic climate change is threatening planet health leading to catastrophic consequences already today. The consequences are expected to become significantly worse. Yet we are acting as we have all the time in the world. What if we collectively realised that we don't?

The starting point for the project is that people are good and quick to adapt if they really want to or have to. One can draw a parallel to how quickly we went from great mobility in society (January 2020) to more or less total isolation (March 2020) in connection with the outbreak of Covid. Another example is the extremely rapid technological development in the 60s, which made a moon landing possible in 1969.

The background is a hypothetical situation where the world decides to ban the use of fossil fuels. Context: "The massive climate-related natural disaster that occurred in November 2025, with 5 million deaths and 140 million refugees, has made the world realize the catastrophic nature of continued burning of fossil fuels. In a unanimous decision in the UN, the radical and necessary decision is made to ban the burning of fossil fuels from 1 July 2035. The world now has 10 years to change." In such a scenario, several priorities need to be made and drastic measures implemented.

How will shipping be prioritised among other sectors and industries? How will shipping have to adapt to the available amount of fossil-free fuel? Which transports should be prioritised? Which technologies should be prioritised? Can we go directly to sustainable solutions, or do we have to have interim solutions that are fossil-free but not sustainable? Do we need to drastically reduce our exports and imports, or can the transition be carried out with retained transport work? Will it throw us back several decades or will it be the step into the future?

This pre-study is limited in scope to analyse how maritime transport can transition to fossil-free sustainable operations when (hypothetically) access to fossil fuels is cut off in the year 2035, and at the same time be one stepping stone towards sustainable shipping. The work has been done through discussions in the project group, analysis of fuel use, scenarios and transport patterns and through a world café type stakeholder meeting.

A sudden global ban on fossil fuels is in this study treated as a scenario. We do not assess the likelihood that such an event will occur in the near future. Rather, this event is a boundary condition and used as a framing for the analysis to highlight the urgency in the energy transition and to provide a strict deadline for the transition.

Despite extensive searches using databases Scopus and Web of Science, we have not identified any prior work that bears closer resemblance to this project. However, there are scenario-based approaches that share some resemblance with the one employed here. These can be described in relation to the Börjeson et al. (2006) typology, which include three scenario categories of particular relevance: what-if scenarios, explorative scenarios and normative transformative scenarios. In addition, Eriksson & Pargman (2018) describe so-called "counterfactual scenarios" which are relevant to relate to here, which are primarily characterized by describing an alternative course of history. The various categories are summarised in Table 1.

Table 1. Scenario categories and short descriptions.

Scenario category	Description
What-if scenarios	Responding to the question “What will happen?” on the condition of some specified near future events of great importance for future development occur.
Explorative scenarios	Responding to the question “what can happen?” to explore developments that are regarded as possible to happen. Compared to what-if scenarios explorative scenarios typically involve longer time horizons and are less focused on trying to *predict* the development making them more *explorative* as the name suggest.
Normative transformative scenarios	Responds to the question “How can the target be reached, when the prevailing structure blocks necessary changes?”. Here, there is a normative starting point regarding what is to be achieved.
Counterfactual scenarios	Describing an alternative course of history that diverges from actual events at a specific historical juncture, after which the factual and counterfactual trajectories separate.

A brief account of related studies based on these types is given below.

Regarding what-if scenarios, the similarity to the present study was found to be low both in terms of scope and method. While the approaches touched upon the field of fossil-free shipping the topics were more specific such as a risk analysis on the implementation and operation of green Hydrogen and its derivatives in ports (García Nielsen et al. 2025) or scenario simulation for the control and improvement of ship emissions in ports (Kao et al. 2022).

Regarding explorative scenarios, some approaches had greater similarities. Sharmina et al. (2017) provides “global decarbonisation scenarios [which] are interrogated to identify shifts in demand for energy commodities, shedding new light on how the low-carbon agenda may affect global trade in the coming decades”. Another example is Wei et al. (2026), who examine three scenarios representing different levels of ambition regarding the transition to hydrogen production, the use of hydrogen-based fuels, and associated transport demand. In fact, the list of scenario-based approaches within this domain that focus on decarbonisation is extensive. However, the differences in identified studies are typically substantial with respect to the system boundaries applied and the considerably longer timeframes for the changes to occur in those studies.

Regarding transformative normative scenarios there are several studies that consider how to accomplish fossil free shipping, including Walsh et al. (2017) who presents scenarios that, while focusing on the UK perspective, “… show that to develop successful marine mitigation policy, it is essential to consider the interdependencies between ship speed, level and pattern of demand for services, and the extent and rate of innovation in propulsion technology”. To this point the develop target-fulfilling scenarios aligned with the Paris 2 °C target. Another example is Sim et al. (2025) where backcasting is explicitly employed to develop strategic pathways towards net-zero emissions in global container shipping companies. Again, these studies typically, adopt longer time horizons which leads to fundamentally different assumptions regarding technological development and behavioural change, and the main areas typically differ.

Finally, although a few counterfactual scenarios exist within the field of fossil-free shipping, they tend to differ in scope, areas of focus, and overarching objectives. Examples include Svindland & Hjelle (2019) which does a "mode-comparative analysis of CO_2 efficiency is undertaken by constructing a counterfactual road transport alternative serving the same market" in their own words, in the context of short sea container transport. Recurringly, counterfactual scenarios are used as a reference point as in the case of Sandford & Malins (2025) who develops counterfactual scenario examining emissions if only fossil fuels had been used as compared to the more likely scenarios where, e.g., biofuels are incorporated as well.

1 The playing field

1.1 Energy use and competition for fuels

Global energy use remains heavily dependent on fossil fuels. Total global final energy demand amounts to approximately 180,000 TWh per year (around 650 EJ), with oil, coal and natural gas continuing to dominate the energy mix (IEA, 2024), see Figure 1.

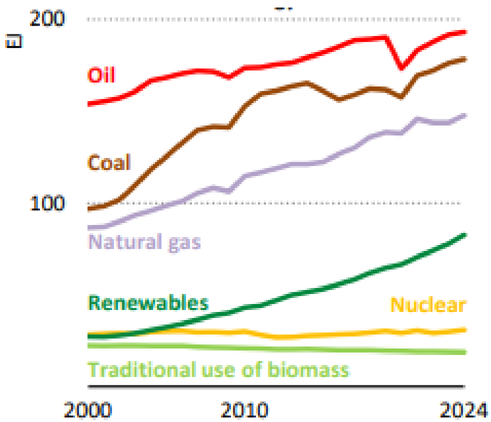

Figure 1. Total global energy demand by fuel (EJ per year). Source IEA (2024).

The transport sector is particularly reliant on oil. Global demand for oil was 100 million barrels per day (mb/d) in 2024 see Figure 2. Present forecast, not considering a fossil fuel ban in 2035, indicate an increased demand. Nearly all the growth in oil demand takes place in emerging market and developing economies, with some of the largest increases coming in India, Southeast Asia and Africa, and there is a continued decline in oil use in advanced economies.

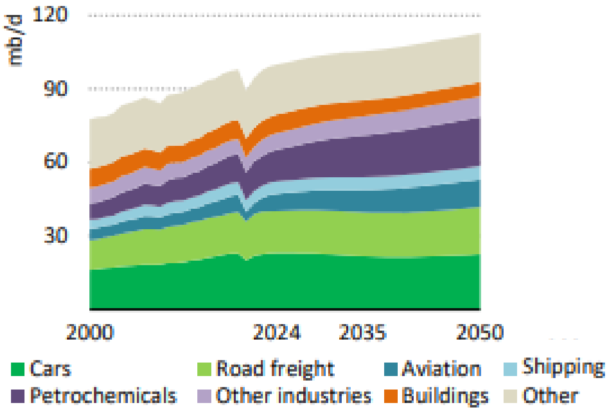

Figure 2. Global oil demand by sector. Source IEA (2024).

Within EU, competition for fuels is especially pronounced in three fossil fuel–dependent sectors: transport, energy industries, and other industries. As illustrated in Figure 3, transport is the largest source of greenhouse gas (GHG) emissions within the EU.

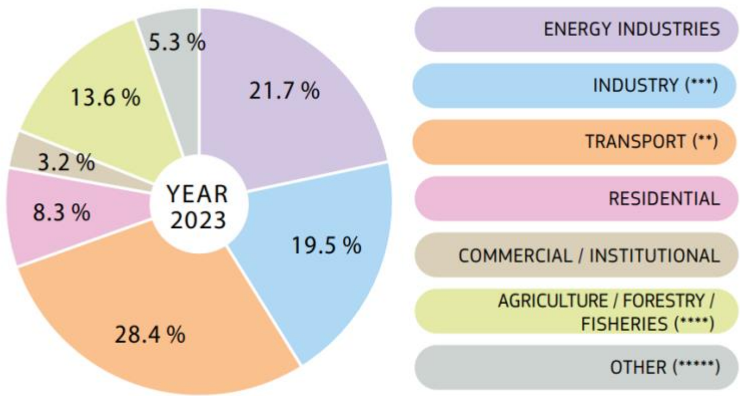

Figure 3. GHG emissions (*) EU-27 – by sector (million tonnes CO_2 equivalent) Source: European Commission (2025).

There is also significant competition for fuels within the transport sector itself. Rail is already largely electrified, and electrification is generally identified as the main tool for the road freight sector to meet set emission targets. Despite that the electrification is currently struggling, road freight transport has to accelerate the transition, with strong support by policy incentives and technological development. A high degree of electrification anticipated when fuels are no longer allowed to be combusted in 2035. The transition is facilitated by the relatively fast renewal of truck fleets with a commercial lifespan of a heavy truck of some 10-15 years.

In contrast, maritime and aviation sectors have limited potential for direct electrification due to energy density constraints and operational requirements. Consequently, their decarbonisation pathways rely primarily on energy efficiency measures and fossil-free fuels. Furthermore, ships and aircraft have long service lifetimes, typically 25–30 years, meaning that fleet renewal occurs slowly, which may delay large-scale transitions in these sectors.

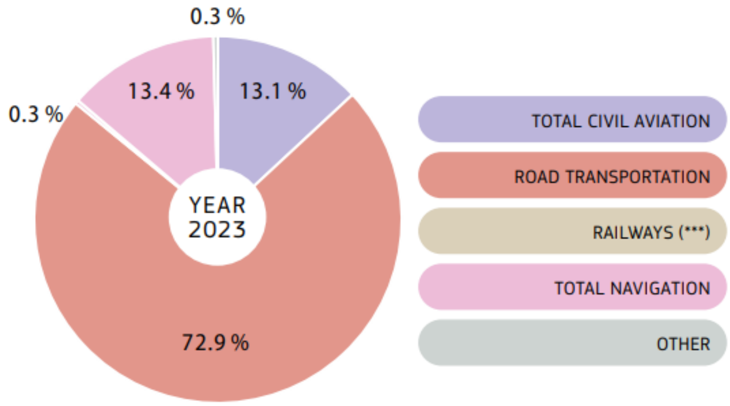

Figure 4. GHG emissions from transport EU-27 – by mode (shares %). Source: European Commission (2025).

1.1.1 Marine fuels

Global shipping energy use is typically estimated at around 10 EJ per year, (≈3,000 TWh), with values ranging from about 7 to 12 EJ depending on system boundaries and accounting methods; corresponding to approximately 200–300 million tonnes of fuel oil equivalent (Faber et al., 2020; IEA, 2024). Oil-based fuels – primarily heavy fuel oil (HFO), very low sulphur fuel oil (VLSFO) and MGO – dominate the sector. Approximately 99% of the world fleet currently operates on conventional fossil fuels (DNV, 2025). Although liquefied natural gas (LNG) has increased its share in recent years, it still represents a minor fraction of total marine energy use globally.

Within Europe, shipping energy demand amounts to roughly 320 TWh per year, which corresponds to around 27 million tonnes MGO equivalent (Styhre et al., 2025), In Sweden, annual bunkering volumes are on the order of 25–30 TWh (Styhre et al., 2024). These figures illustrate both the magnitude of maritime fuel demand and the strategic importance of shipping in any fossil-free transition pathway.

1.1.1.1 Near-term development of marine fuels (2025–2035)

Unless otherwise explicitly stated, the development pathways discussed below reflect trajectories aligned with current policy signals from the EU, IMO and other relevant institutions. They do not reflect the scenario of a full global ban on fossil fuels from 2035, which is the hypothetical scenario applied in this study.

Over the coming decade, the most plausible transition pathway is characterised by gradual diversification rather than immediate full substitution of fossil fuels. Three developments are particularly relevant:

- **Drop-in biofuels** such as hydrotreated vegetable oil (HVO), fatty acid methyl ester (FAME) blends, biomethane and bio-methanol, can provide incremental emissions reductions. Their main advantage is compatibility (partly or full) with existing engines and fuel logistics systems, thereby lowering technical and financial transition barriers. However, global sustainable biomass availability is limited, and biofuels face significant cross-sector competition from aviation, heavy-duty road transport and industrial feedstock applications (IRENA, 2023; ETC, 2021). While bio-methanol can be produced from biomass and may reach non-neglectable volumes, total sustainable supply remains limited in a global context.

- The expansion of LNG infrastructure in parts of the fleet creates a pathway for substituting fossil LNG with **liquefied biomethane** (LBG/LBM/bio-LNG). Where LNG engines are already installed switching to biomethane typically requires no onboard technical modifications, reducing transition friction. Swedish analyses indicate that liquefied biomethane production could reach up to approximately 30 TWh per year by the mid-2040s under favourable conditions, although only a share of this volume would realistically be available to shipping (Jivén, 2022). A plausible uptake for Swedish marine use is in the range of 4–6 TWh per year, depending on sectoral prioritisation and infrastructure development (Jivén, 2022).
- **Electrofuels** – such as e-methanol, e-methane and e-diesel – are expected to expand from a low base. Announced project pipelines in the Baltic Sea region indicate significant longer-term capacity. However, historical experience shows that only a fraction of announced projects materialises on schedule. Realistic production volumes by 2030 are therefore likely to be substantially lower than announced figures (Styhre, 2025).

In the near term, bio-based fuels are therefore expected to constitute a larger share of renewable marine fuels than electrofuels.

In parallel, energy efficiency improvements, including slow steaming, digital optimisation, wind-assisted propulsion and partial electrification of short-sea shipping; are expected to reduce total fuel demand. Demand reduction is critical, given the limited availability of renewable fuels in the near transition phase (IEA, 2023).

1.1.1.2 Long-term global renewable fuel potential (towards 2050)

Towards mid-century, the decisive factor becomes the scale of global renewable fuel production. Within 1.5°C-aligned transition scenarios, global modern bioenergy supply is projected to reach approximately 100–130 EJ per year by 2050 (IEA, 2023; IRENA, 2023). This figure encompasses all sectors and all bioenergy applications.

Shipping currently consumes around 12 EJ annually (IEA, 2024). Even assuming efficiency improvements that reduce future demand, a full substitution of global shipping with biofuels would likely require more than 10 EJ per year of sustainable bio-based fuels (IEA, 2024). This would represent a significant share of global available sustainable biomass and would intensify competition with aviation and industrial applications (ETC, 2021).

Consequently, most mainstream energy transition scenarios do not assume exclusive long-term reliance of biofuels in shipping. Instead, biofuels are typically projected to supply a limited share of maritime energy demand by 2050, often in the range of 10 %, while hydrogen-based electrofuels (such as methane, methanol and other hydrogen derivatives) are expected to scale progressively in long-term energy transition scenarios (IRENA, 2023).

Electrofuels offer a larger theoretical resource base, as their primary constraint is renewable electricity availability rather than biomass. However, large-scale deployment requires substantial expansion of renewable power generation, electrolysis capacity, CO_2 capture (for carbon-based e-fuels), and dedicated fuel infrastructure.

The long-term outlook therefore suggests a diversified fuel mix:

- Biofuels playing a significant but resource-constrained role.
- Electrofuels expanding as renewable electricity systems scale.
- Continuous efficiency improvements reducing overall demand.

1.1.2 Swedish and regional perspective

From a Swedish perspective, domestic renewable fuel production becomes strategically important in a scenario involving an abrupt fossil phase-out by 2035. Sweden has favourable structural conditions for several pathways: significant forest and agricultural residues for advanced biofuels and biomethane, large share of renewable electricity generation, and access to biogenic CO_2 streams suitable for e-fuel production.

Nevertheless, even optimistic domestic production scenarios indicate that renewable fuel volumes will remain limited relative to total transport demand. Sweden's long-term liquefied biomethane potential is estimated at up to approximately 30 TWh per year (Jivén, 2022). However, even if fully allocated to shipping, this would cover only a portion of national maritime fuel demand.

Regional electrofuel projects in the Baltic Sea region indicate substantial long-term potential. Nearly 300 hydrogen-related projects have been identified across the region with a hydrogen-derived energy output of approximately 338 TWh, corresponding to roughly 31 million tonnes of MGO equivalent (Styhre et al., 2025). However, realised volumes in the near term are expected to be considerably lower than aggregated project announcements suggest. This reflects typical implementation risks, including financing constraints, infrastructure bottlenecks, permitting and grid connection delays, and overall project maturation timelines (Styhre, 2025). Under a scenario involving an abrupt fossil phase-out by 2035, some constraints (particularly related to policy prioritisation, costs and permitting) could be alleviated. Nevertheless, capital mobilisation, supply chain limitations and system integration challenges would likely remain critical limiting factors.

Swedish shipping will remain integrated into a broader European and global renewable fuel market. Strategic allocation between sectors, aviation, industry, heavy road transport and shipping, will be unavoidable under an accelerated fossil phase-out scenario.

In summary, maritime fuel transition pathways must be evaluated within a context of constrained biomass resources, capital-intensive electrofuel expansion and strong cross-sectoral competition. The most credible pathway combines:

1. Structural demand reduction through efficiency improvements.
2. Targeted use of sustainably sourced biofuels.
3. Progressive scaling of hydrogen-based electrofuels within an increasingly renewable energy system.

This diversified approach reflects both resource constraints and systemic transition dynamics.

1.2 Product supply chains

Industry and trade are highly dependent on international trade, which is largely carried out by shipping. It is not unusual for the supply chains of rather simple products with a low value to include shipping across the globe repeatedly between manufacturing stages, as the example in Figure 5 shows.

Figure 5. Example of transport for a single dress. Source: BBC, 2017.

Seaborne trade has steadily increased since after Word War 2. Despite crises causing disruptions, the overall trend has been a steady increase in shipping. Even major global events, such as Covid-19, did not cause drastic reductions in shipping but merely shifted the upwards trend forward in time.

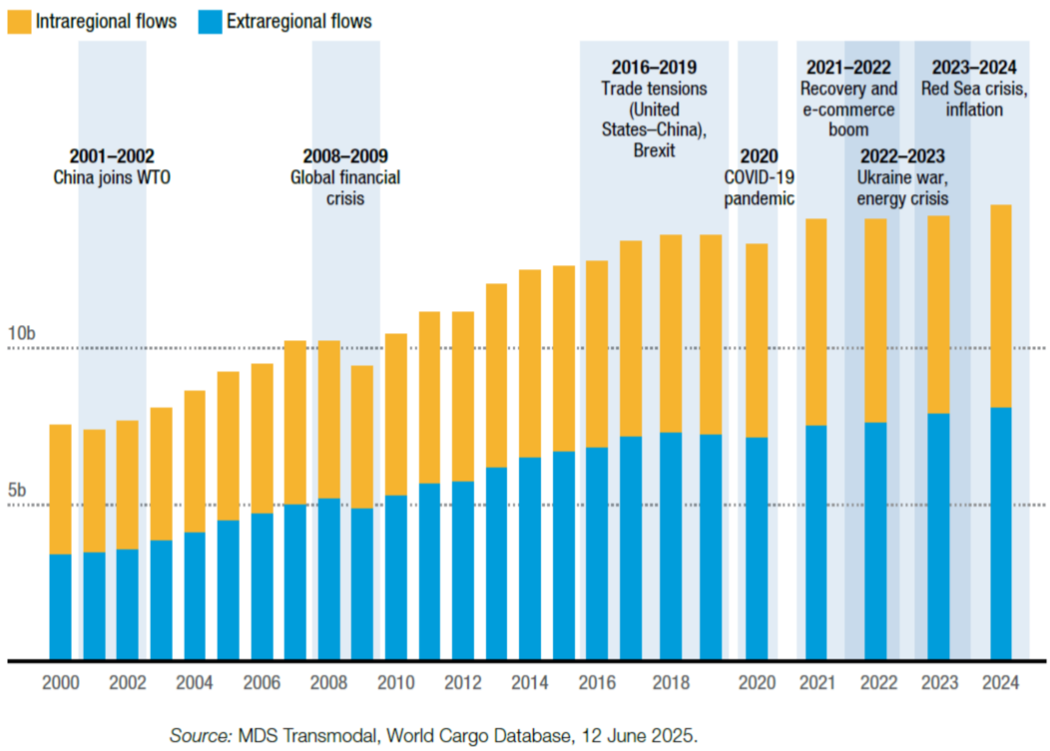

Figure 6. Intraregional and extraregional seaborne trade flows and disruptions (Billions of tons). Source: UNCTAD, 2025.

However, this is likely to change in the event of such drastic measures as in the current scenario of no fossil fuels at all from 2035. Transport costs will likely increase, and the characteristics of the transport services will change, for example by prolonging transport time, reducing frequency and shifting towards more energy efficient modes. This will impact different transport and customer segments differently. For example, the transport of fossil fuels will obviously disappear and be replaced by the transport of renewable fuels. Large tankers from oil rich areas might be replaced by smaller tankers with more regionally or locally sourced fuel or e-fuels from warm and sunny regions.

A full review of potential changes is out for scope for this pre-study, although we will give some overview of potential areas of changes as a background for the results from the workshop presented in chapter 3. This section first focuses how seaborne trade is likely to be affected in a short and a slightly longer time horizon by banning fossil fuels. After establishing the character of the future demand for long-distance freight transport, the analysis is turned towards potential modal shifts. As a consequence of being a pre-study, it should be noted that the text is speculative and based on the authors' prior knowledge and judgment, rather than on a forecast model, or a thorough literature analysis. A potential main study will require further scrutiny of how supply chains, logistics and in turn shipping can be affected by a full-scale transition away from fossil fuels.

1.2.1 Short-term changes in trade flows before the ban (2025–2035)

During the initial period until the ban comes into full effect in 2035, supply chains will gradually start to adapt. Forerunners will see this as an opportunity to be ahead of competitors, while other actors will try and postpone any changes as long as possible.

Global supply chains are relatively slow-moving systems based on competitive advantages for the different raw material origins and manufacturing steps in the supply chains, although they have evolved towards greater agility in response to the major disruptions in recent years. Supply chain managers have learnt a lot from the Covid-19 pandemic, Russia's war of aggression against Ukraine, droughts in Europe's rivers and in the Panama Canal, Houthi rebels' attacks near the Red Sea and increasingly strained trade relations. The transition period during the coming decade will also offer opportunities to successively adapt supply chain design to a situation with quite different production factor costs.

The magnitude of change depends on the hardship the population can or have to accept. When supply chains were strained during the pandemic, for instance, consumers might have failed to get pasta of their favourite brand, but there was no real shortage of pasta and plenty of other food available (Roos *et al.*, 2025). A similar situation is likely to occur, in which most consumers must compromise their exact product preferences but can still get fed and enjoy a comfortable life.

For industry, reducing international transport is a slow process due to the current industry structure. Factories in Europe have closed and the supply chains have become reliant on cheap transport from low wage countries, mostly in Asia. The recent disturbances, not least the highly variable tariffs with secondary effects when products find new markets, have incentivised a simplification of supply chains. Shipping moves an immense amount of raw material and consumer products, but the globalisation and fragmentation of supply chains implies that shipping also moves large amounts of components and sub-assemblies on their way to the next refinement step. This phenomenon is likely to shrink along with supply chain regionalisation, that is concentrating more steps within a continent aiming at relatively independent supply chains for each main economic region.

Nevertheless, moving production back to Europe, as well as to North America, is a slow process (Woxenius *et al.*, 2025). Factories would need to be built, staff recruited and trained, and necessary competences and equipment acquired. Challenges would be even tougher since presumably a significant share of the industry would be competing for the same resources and capacities in Europe, as many would be looking into these alternatives.

If materialised in a large scale, regionalisation will mostly affect deep sea container shipping as a large share, probably more than 50%, of the containers on the main trade routes carry intermediate products. Another likely consequence of regionalisation into all-European supply chains, as argued by Woxenius *et al.* (2025), is a shift towards short sea shipping, particularly towards the RoRo and RoPax segments.

1.2.2 Long-term changes in trade flows after the ban (after 2035)

When the burning ban on fossil fuels is in place, regionalisation is likely to continue. A central factor here is the willingness to pay for fuel. Shipping would be competing with other areas of society for a limited fuel supply. In general, the cost of transport, and in particular the cost of fuel, is only a small part of the selling price of a product. The competition for energy with other sectors will likely be decisive in how far the regionalisation trend will go. Given that shipping is an energy efficient mode of transport with the potential to utilise significant scale effects with large vessels, it is possible that the attractiveness of shipping even could increase.

There will still be examples of commodity refinement chains that are robust also in a constrained energy environment. One example is that access to clean and cheap energy in Iceland makes it a natural node in the production of aluminium. Moving bauxite there for the energy intensive refinement will still be motivated.

1.2.3 Modal shift

The different traffic modes obviously have different inherent capabilities, performance and suitability for matching different transport demands. Such a major shift in the conditions for both demand and supply of transport as created by a global ban on fossil fuels is thus highly likely to result in profound changes in the transport system that seeks to minimise cost, given the constraints of a limited fuel supply.

Passenger transport will also be affected as fuel cost is likely to go up. Looking isolated at passenger transport, the higher cost is likely to cause a reduction in demand. But at the same time, likely constraints in global air travel might cause local shipping to be an increasingly attractive option where perhaps local cruises will replace intercontinental air travel for holiday and weekend trips by air.

1.2.3.1 Within continents

The main modal shift is likely to be found within continents and involving sea, road and rail. Moving production back to Europe is likely to increase intra-European transport demand. Short sea shipping has the potential to play a role here, given an increased congestion on European roads and that incoming container flows from Aisa would be replaced by intra-European trailer flows. At the same time, a likely rapid electrification of road transport increases the attractiveness of road in a fossil free scenario. Rail is already electrified and it is likely to see a modal shift from the road sector, although rail is limited by capacity constraints on the network.

Replacing much of intra-EU air passenger transport with rail will be problematic in the short term and longer journeys will compete with rail freight for overnight rail capacity. In the long term it is likely with extensive construction programmes for interconnected high-speed lines that will free capacity for freight trains on existing tracks.

1.2.3.2 Between continents

Except for land transport through Eurasia, moving goods between continents is in practice divided between air freight and deep-sea shipping.

There will still be commodities and products which trade implies a very high willingness to pay for fast transport. Air freight is thus likely to have its place also in a post-fossil freight transport market, predominantly between continents. Intercontinental transport in 2024 accounted for 83% of air freight handled at EU airports (Eurostat, 2025). Nevertheless, the volumes are miniscule in comparison with shipping. If Frankfurt, the largest freight airport in the EU with its 2.0 Mtons handled in 2024 (Eurostat, 2025) should be ranked together with Swedish ports it would be sorted in at place 20 between Holmsund and Västerås (data from Sjöfartsverket, 2026). The total amount of air freight handled at EU airports, 14,3 Mtons, is less than the flow through Brofjorden. A substantial modal shift from air to sea would hence be dramatic for airlines and airports but ports and shipping lines would hardly notice. There might be a marginal market for faster vessels that can replace air freight for parts of the time sensitive cargo, but it will save rather little time with a very high bunker consumption.

If the common threat of global change and the agreement to prioritise lower carbon emissions also leads to a world with less geopolitical tensions, rail through Russia or more southern Eurasian corridors can capture parts of what is currently moved by air as it offers a compromise in between shipping and air freight on opposite ends of the scales of transport time, energy efficiency and costs. But the capacity will not be enough for replacing large shares of current container shipping on Europe-Asia routes.

The brief and admittedly partly speculative analysis is illustrated in Figure 7. Shipping will remain an important mode of transport between continents, largely caused by a lack of alternatives. Supply chain structures will change, but it is a slow process and the willingness to pay for transport might be higher than the incentives to move production. Within continents, the importance of short sea shipping will increase, largely driven by changes in supply chains and capacity constraints on road and rail.

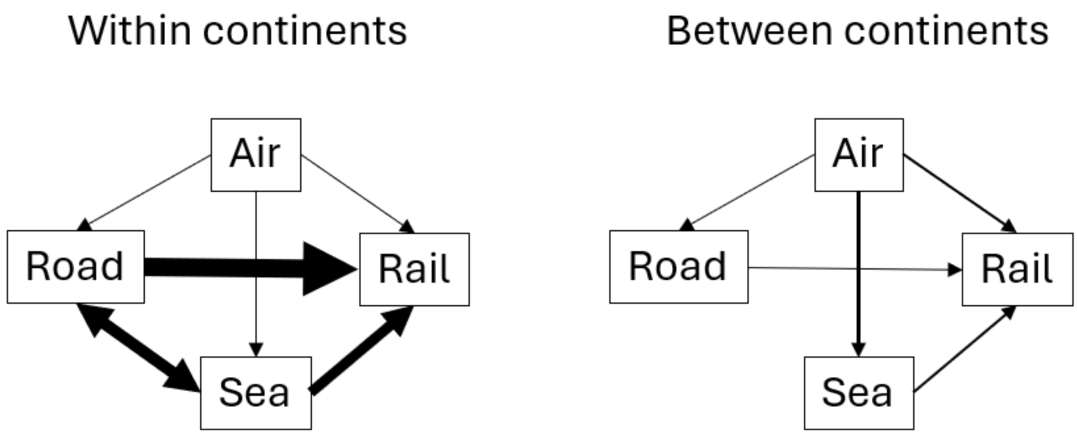

Figure 7. Potential modal shifts in a fossil-free transport market.

2 The method

2.1 Backcasting

To reach the pre-study aim, the project team agreed that a backcasting approach would likely be the most useful as it gives more freedom to form ideas and solutions than using other methods that extrapolates results and trends. Backcasting also have the benefit to allow creation of ideas and solutions to get to a future desired state/scenario/vision. As sustainability is in focus of the study, the pre-study group chose the ABCD-procedure that embeds backcasting and has been used in several other studies about planning for sustainable transport (Borén et al., 2017; Robèrt et al., 2017).

The ABCD-procedure is an application of the Framework for Strategic Sustainable Development – FSSD (Broman and Robèrt, 2017), which is designed to support planning and actions towards a sustainable future. It includes a five-level model that helps structuring and clarifying inter-relationships between phenomena of different character (Figure 8).

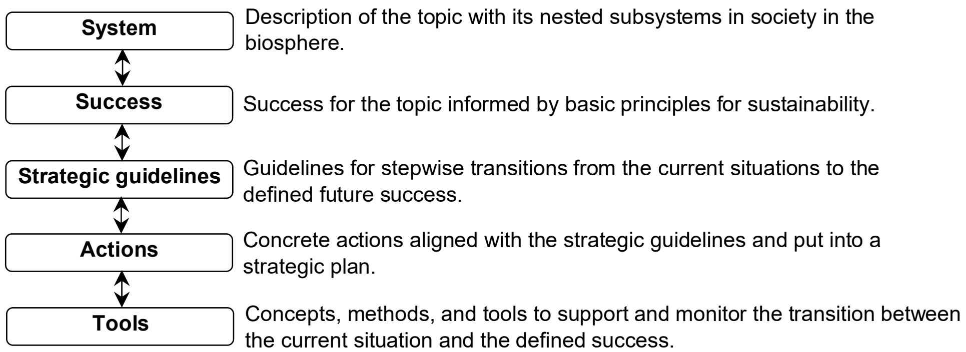

Figure 8: Levels of the FSSD. Source: Broman and Robèrt (2017).

The vision of success belongs to the second level and is framed by sustainability principles (SPs), another essential feature of the FSSD. The current version of the principled definition of sustainability of the FSSD comprises eight sustainability principles (Broman and Robèrt, 2017):

In a sustainable society, nature is not subject to systematically increasing ...

1. ... concentrations of substances extracted from the Earth's crust;

2. ... concentrations of substances produced by society;
3. ... degradation by physical means;

and people are not subject to structural obstacles to ...

4. ... health;
5. ... influence;
6. ... competence;
7. ... impartiality;
8. ... meaning making.

The FSSD also includes a funnel metaphor and the abovementioned operational planning procedure – ABCD (Broman and Robèrt, 2017), as illustrated in Figure 9.

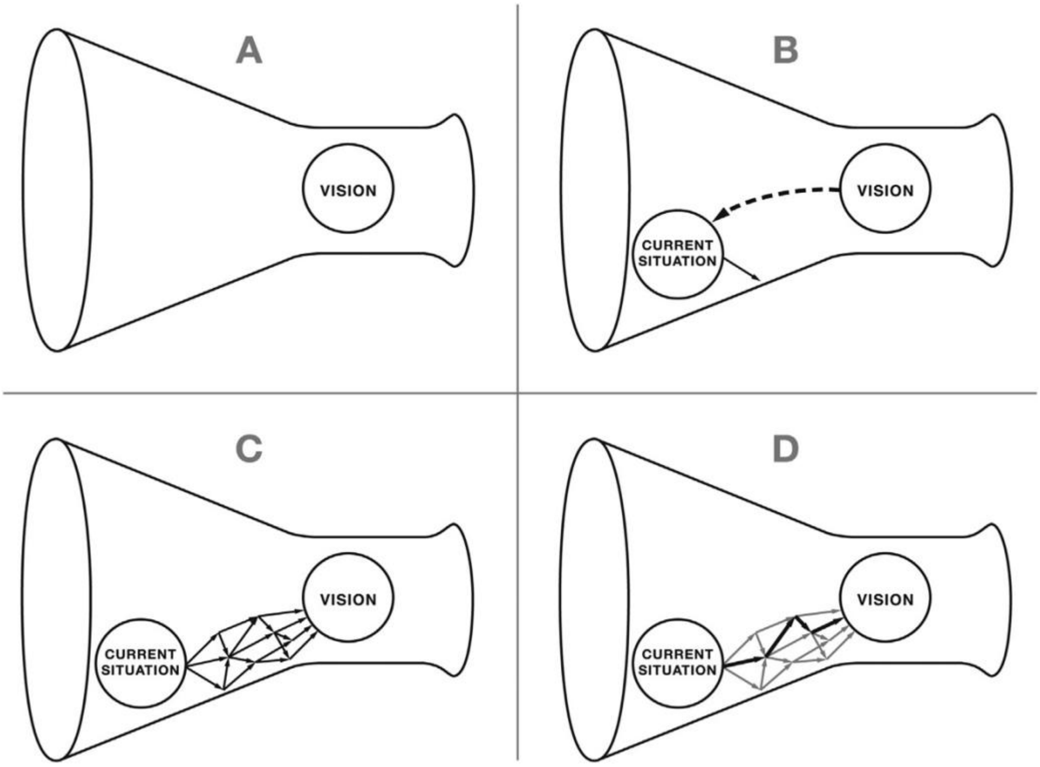

Figure 9: The funnel metaphor and the ABCD-procedure of the FSSD. Reprinted from Broman and Robèrt (2017, page 5), with permission from Elsevier.

As described by (Broman and Robèrt 2017), the inclining funnel wall in Figure 9 metaphorically describes the systematic character of the challenge and indicates the self-benefit of strategically working towards a sustainable vision (avoiding hitting the wall of the funnel while moving to the vision in the opening of the funnel), framed by the SPs. A sustainable vision is developed in 'A'. The current challenges and assets in relation to the vision are captured in 'B'. Possible steps towards the vision are invented in 'C', and these are prioritized into a strategic plan in 'D'.

2.2 Workshop design

The ABCD procedure is most effective when involving a high degree of stakeholder collaboration via workshop(s) to get a well anchored and rich results. The aim of this pre-study took the workshop design a bit further than the D-step to identify possible knowledge gaps when planning for a transition towards fossil free shipping by 2035. The workshop was therefore designed with the scenario of fossil free shipping by 2035 as a goal towards sustainable shipping in the A-step.

2.2.1 Participation

The workshop results depend largely on who participates. The project group found that it was important to have representation from the shipping industry (e.g. ship owners and designer, shipyards, harbours, suppliers, trade associations), authorities and agencies, and research. Over 100 stakeholders with different backgrounds and competencies were invited to the workshop. Most of them were already connected to the Lighthouse network, and the project group invited some more people to include different ages, gender, and complementary background and competence.

2.2.2 World Café setup

The pre-study group chose World Café (Brown and Isaacs, 2001) as the stakeholder collaboration model in the workshop to maximize chances to have as rich and agreed results as possible. In brief, World Café participants discuss issues around tables, where one person is a host. Participants then shift tables and discuss another level of the issues, while one person stays and acts as a table host for the coming group.

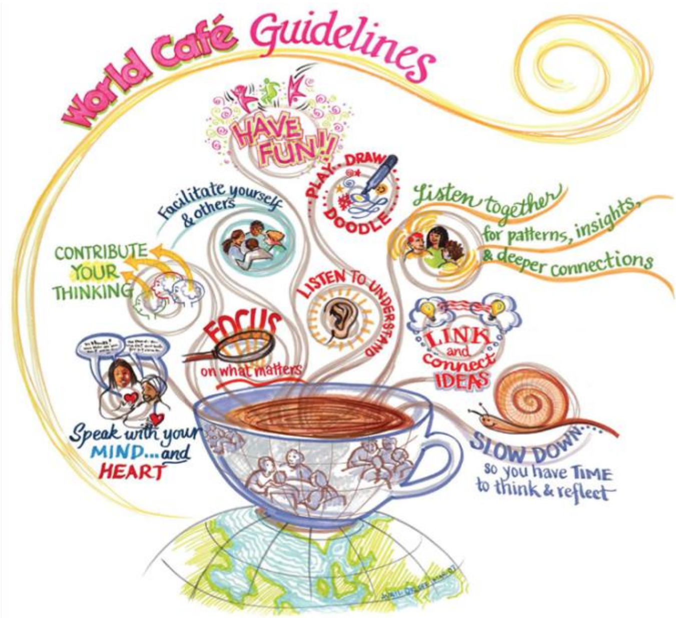

Figure 10: World Café guidelines illustrated by Avril Orloff 2007

Participation at each table was designed in advance to include different backgrounds and competencies. The language used in the workshop was Swedish as all participants were Swedish. The organisers were ready to host the workshop in English if that would have been preferred by anyone.

The discussions were guided by six questions that were designed with the ABCD-steps in mind and to enhance discussions and get prepared to answer the next question. As the A-step was covered by the scenario, the first two questions were about the B-step, followed by two questions about the C-step, and then two about the D-step. The guiding questions were:

1. What challenges and opportunities do you think there will be to arrive at fossil free shipping by 2035?
2. Assuming there are no fossil fuels by 2035, what will be the need for sea transport then?
3. What solutions could realize fossil free shipping by 2035?
4. On a scale of 1 (low) - 3 (high), what is the impact of the solutions to arrive at fossil free shipping by 2035?

5. Approximately how much can each solution contribute to arrive at fossil free shipping by 2035?
6. What could an initial plan for fossil free shipping by 2035 look like? Who needs to do what and when?
7. What more do we need to know more to be able to create a solid plan?

The shifts between tables happened between each step as the second guiding question in each step (question 2, 4, 6) was tightly connected to the previous.

Question 7 about knowledge gaps was discussed in plenum.

2.2.3 Harvest

Table hosts presented (in plenum) a summary of the results after each step and made them visible for the coming group. After the workshop, results from each presentation were photographed and transferred to a document (see appendix).

See appendix for further details regarding the workshops agenda, guiding questions, participants and results. A summary of results will follow in the next section.

3 The workshop observations

31 stakeholders attended the workshop, supported by 3 workshop hosts and 6 table hosts. 13 of the stakeholders were from the shipping industry (e.g. ship owners and designers, shipyards, harbours, suppliers, trade associations), 7 from authorities and agencies, and 11 from research related organisations. 8 females attended, and the age of about 40-60 was in majority among the participants.

Below is a summary of the discussion starting with the challenges (to reach the goal of fossil-free shipping by 2035), followed by opportunities this transition may offer. The transport demand by 2035 in this scenario was discussed follow by possible solutions (technical and other) and finally roadmaps to reach the aim were discussed.

3.1 Challenges

There were 49 challenges listed during the session. These were summarized and ranked 1-7 depending on frequency of appearance in the data:

1. Insufficient access to more energy, difficulties in ramping up electricity and renewable energy production and slow speed of energy systems transformation.

2. Instability in geopolitics, global oil distribution and dependency.

3. Need for life-style changes from consumption towards resource efficiency.
4. Lack of political incentives, and prioritisations to realise the transformation.
5. Unclear roles of the transport and shipping sectors in the transformation.
6. Lack of a system perspective, and not enough focus on resources and robustness.
7. Insufficient innovation capacity to find new technical solutions.

https://fatsil.org/aboriginal/native-shipping/

3.2 Opportunities

There were 51 opportunities listed during the session. These were summarized and ranked 1-7 depending on frequency appearance in the data:

1. Potential for increasing renewables in the energy systems and the electricity mix.
2. Reduced consumption, potential behaviour- and life-style changes.
3. Innovation of new technologies (e.g. energy efficiency measures, new ship solutions, digitalization) and new business opportunities.
4. Increased focus on circularity and robust systems.
5. Incentives, regulations, management, and support from political and commercial actors to support the transition, including resource allocation and re-distribution.
6. Increased market share as shipping benefits from being an energy efficient and cost-effective mode of transport.
7. Stronger international collaboration and global structures to support the transformation.

Photo by Nataliya Vaitkevich from Pexels:
https://www.pexels.com/photo/a-close-up-shot-of-letter-dice-6120219/

3.3 Need for transport

There were 44 changes in transport needs with a focus on shipping listed during the session. These were summarized and ranked 1-7 depending on frequency appearance in the data:

1. Regionalisation of production, fuels, and transport flows potentially reduces global shipping.
2. Significant reduction of fossil energy production and fossil intensive activities will likely change shipping patterns.

3. Changes in transport patterns due to the use of renewable energy , and route optimisation/efficiency.
4. More circular and sustainable end-user consumption and behaviours can decrease the need of transport at large.
5. New markets from the industry transition, and economies of scale for new fossil-free solutions will likely change shipping patterns.
6. Enhance system integration of existing solutions and improved use of existing infrastructure can save resources for shipping.

https://orbitshub.com/ship-turning-circles-explained/

3.4 Solutions

There were 93 solutions listed during the session. The solutions were aggregated into five main themes. If possible, the themes were labelled with assumed impact (1-3) and share (%) in the transition towards fossil free shipping. Impact and share of transition reflected the discussions at the workshop. These ratings are coarse and should be seen as an exercise in prioritising solutions to create a roadmap (in line with the next questions). The expected share represents the overall discussion at the workshop and should not be interpreted as that the other themes has no share in the transition.

Table 2: Solutions themed and ranked depending on assumed impact and share in the transition towards fossil free shipping by 2035

Theme	Expected impact (1-3)	Expected share (%)
Incentives and politics for the transition, e.g. long-term politic, high taxes on fossil fuels, global and regional ETS	2-3	50
Energy efficiency and optimisation, e.g. energy efficient propulsion, speed optimisation, digitalization, retrofitting	2-3	20
Renewable energy carriers for ship propulsion, e.g. bio- and e-fuels, drop-in fuels, wind assistance, batteries	2-3	30
Innovation, cooperation, and competence, e.g. multiple stakeholder collaborations, innovation support, skills development, knowledge dissemination	2	
Behaviour changes and acceptance, e.g. changes in consumption behaviours, willingness to pay for non-fossil transport, communication about benefits	2.5-3	

3.5 Initial roadmap

The workshop groups discussed how an initial roadmap towards fossil-free shipping by 2035 could look like, based on the solutions found in the previous workshop sessions. The findings were unsurprisingly similar to the solutions, and it was difficult to find a timeline for each measure, as well as who should do what. However, the following emerged:

https://i.pinimg.com/564x/58/21/1c/58211cd8fa9534ad834e5bbd7e768290.jpg

Strong, early and coordinated global, regional, and national **political decisions** for fossil-free shipping by 2035 are needed to form a foundation for:

- policies, laws, and regulations,
- powerful incentives for increased share of renewable energy carriers, early movers, energy and resource efficiency, reduction of GHG emissions via ETS, circular economy and less throwaway consumption.

These political decisions are expected to lay the foundation for an immediate ramp-up of:

⇒ production and distribution of renewable fuels, e-fuels, energy efficiency measures, energy storages onboard and in harbours by energy companies, alongside development and production of wind-powered propulsion,

⇒ capacity in shipyards for retrofitting of existing fleet, alongside new production of ships,

⇒ skills development for both companies and citizens and information campaigns by governmental and global institutions (e.g. IMO),

⇒ adjustments and adaptations of existing rules and regulations for shipping, harbours, production of ships and renewable energy,

⇒ strengthened collaborations between stakeholders (e.g. ship-owners, shipyards, harbours, energy carrier providers, public organisations, and global institutions) to pave the way for the transition, including collaborative risk management and compensations to groups, business, regions and countries negatively impacted by the transition.

4 Reflection on Workshop results

4.1 Methodological considerations

The backcasting approach and the use of the ABCD procedure was chosen by reasons mentioned in section 2.1. A more traditional forecasting approach would rather extrapolate trends into the future (e.g. sensitivity analysis) meanwhile backcasting would define interesting futures, analyse consequences and conditions for these futures to materialise (Dreborg, 1996). Additionally, the same researchers states that a forecasting perspective addresses dominant trends, likely futures, possible marginal adjustments, and how to adapt to trends, meanwhile a backcasting perspective addresses societal problem in need of solution, desirable futures, scope for human choice, strategic decisions, and retain freedom of action.

4.2 Participation

As described in section 2.2.1, we carefully selected who should be invited to the workshop. To avoid possible shortcomings in having a limited spectrum of competences and opinions, we made sure to invite as many as possible that could have an interest in the results and asked different stakeholders for additional people to invite. We were clear in the invitation about the focus of the workshop, which might have caused stakeholders who were sceptic to the scenario of fossil-free shipping by 2035 to not attend. That scenario was not meant to be challenged in the workshop but was anyhow partly discussed during the first round-table session about challenges and opportunities.

The intended mix of competencies from different disciplines in the sector, gender and age was quite well achieved (see section 2.2.1) as more than 1/3 were from the industry, more than 1/4 represented authorities and agencies, and almost 1/3 research related organisations. The shipping sector in general is dominated by males, so the share of females (1/4) in the workshop was in that perspective ok and represented the share of females who were invited.

4.3 Results

The discussions at the workshop gave important input to this pre-study and to the design of the main study (see chapter 6). The basic assumption (of a stop for fossil fuels by 2035) requires an open mindset and to think outside normal scenarios and prognoses. From this aspect, the workshop was successful and there were fruitful discussions on the topics listed above.

The workshop highlighted several challenges to reach the main objective of the pre-study. Of course, the increase in production of non-fossil fuels within the period is a major challenge, not least because of limitations in electricity production, but also changes in geopolitics and life-style changes were discussed. Other technical challenges involve the capacity and potential to develop new technologies and to rebuild ships where shipyards' capacity may be an issue. Several of the challenges were also framed as opportunities. A renewable energy system has obvious climate and environmental benefits. The change may lead to beneficial life-style changes and opportunities for new businesses.

On the influence on transport work produced by shipping, the workshop participants expected a decrease in transport due to (1) no transportation of fossil fuels, (2) regional production of renewable fuels, and (3) changes in consumption and production due to higher transport costs.

The solutions to reach the objective discussed at the workshop comprised both regulatory and technical suggestions. To put policy instruments to drive the transition in place swiftly was seen as fundamental. To ramp up the production of renewable fuels and to speed up the work on energy efficiency were also highlighted. Finally, the workshop participants created initial roadmaps that clearly pointed out that decisions for the transition have to be taken swiftly by global, regional and national politicians, accompanied by powerful incentives and regulations that supports the transition.

The results highlight that the present topics should be studied across several disciplines covering technology development, energy system analysis, transport economics, governance, and behaviour. Furthermore, although there were objections about the possibility to reach the objective, (e.g. regarding renewable fuel production capacity, shipyard capacity, and political competence) there were in general very constructive discussions at the workshop.

5 Further work

One purpose of this report is to discuss the design of a deeper analysis around the scenario of a complete fossil fuel ban. With a starting point in the outcome of the stakeholder workshop and our own analyses, we find several interesting ways forward for a deeper analysis. Several questions were found worthy to pursue, and the further analysis requires a combination of methods and approaches.

Keeping the basic assumption that a decision is made to ban the use of fossil fuel after ten years, globally and for all sectors, the following questions should be addressed:

- What does the world look like in ten years (under this assumption of a ban on the use of fossil fuels)?

This should be done as a set of scenarios.

- What does the path (or paths) look like to get to these futures?

Thus, the work can appropriately be addressed through backcasting. Gaining from the results in this report, there are several subtopics to explore, divided into technological transition, political transition and market transition. A technological transition will need to take place supported by appropriate incentives and regulations from a political side. At the same time, the transport market will transform and adapt to new cost levels and characteristics of maritime transport in a fossil free scenario. The focus of a future study is on shipping, but other sectors will also need to change with a transition from fossil fuels, resulting in competition for energy and complex interactions between sectors. This is of course a major task especially regarding electricity production and industry. In that work, we believe that a set of scenarios with different endpoints and basic assumptions will be fruitful to cover the large uncertainties as it is an overwhelming task to estimate all possible futures. Further, trajectories for key technologies and for fuel production should be constructed to highlight the need for policy measures, technological breakthroughs and business models.

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Appendix 1: Workshop Harvest

The workshop was in Swedish, and this appendix is therefore in Swedish to avoid any possible miss-intepretations in the translation of the results. Workshoppen genomfördes på svenska och därför är denna bilaga på svenska för att undvika eventuella feltolkningar i översättningen.

Resultaten redovisas nedan utefter svar på respektive ledande fråga 1-6. Svar på fråga 7 besvarades och diskuterades i Plenum (se kapitel 4).

Lösningar kategoriserades i ljusblått beträffande energieffektivisering och optimering, mörkgult: styrmedel och politik för omställning, mörkgrönt: nya energibärare för framdrift, ljusorange: beteendeförändring och acceptans, mörkgrått: innovation, samverkan och kompetens.

Resultat från Bord A

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Eltillgång	Momentum och framåtanda	Mindre/inga nöjeskryssningar
Ledtider kraftproduktion	Kärnkraft, vind, sol & vatten	Regionaliserad tillverkning av produkter, ex. bilar, byggmaterial, grus
Tidsperspektiv	Top-down beslut med hårda prioriteringar	Mindre/inga fossila energislag
Energibehov	Mindre biltrafik	Mindre/inga onödiga rutter genom ruttplanering
Slit- & slängsamhälle	Livsstilsförändringar	Mer av förnybar energi
Resursslöseri	Regionalisera (lokal tillverkning)	
Fokus scope 1-2 för växthusgasrapportering	Lära oss leva med naturen	
Global tillbakagång mot olja	Lära av historien - leva med låga utsläpp	
Ej systemperspektiv	Vi har lösningar	
Förändringsrädsla	Göra saker som håller	
Bekvämlighet	Cirkularitet	
Samhällstempo	Just in time med right	
Transportutveckling (volymer) måste ned	Bättre planerbarhet	
Demokrati	Lager på land	
Befolkningstillväxt		
Förväntan om materiel välfärd		
Inga lager		
Mer förnybart		

Beträffande genomslagskraft (fråga 4), så kunde inte gruppen enas.

3. Vilka lösningar finns för att nå fossilstopp 2035?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Energieffektivisering	12%	1. Beslut om Fossilstopp
Gröna korridorer	2%	2. Politik: • Tillståndsprocesser • Dyrare transporter => Ransonera konsumtion • Fördelningsmekanism som innefattar konsumtion • Styrmedel för bland annat gröna bränslen • Globalt stigande fossilbeskattning • Snabbt öka produktion av förnybart bränsle
Helhetsperspektiv vid införande		
Söka synergier för att lösa flera samhällsmål		
Inte bara klimat		
Ta bort moms på förnybart		
Stabil politik skapar förutsättningar	70%	
Styra om kapital		
Kostnadssätta samhällskostnader		3. Energianvändare (fartyg, hamnar): • Effektivisera • Skapa förutsättningar att använda förnybara energibärare i energiomvandlare
Styrmedel (kostnadsinternalisering)		
Nya affärsmöjligheter		
Affärsmodeller		
Hållbara trovärdiga visioner		
Biodrivmedel	30%	
Elektrobränsle		
Bränsleceller hålls varma		
Livsstilsförändring		
Cirkulära flöden		
Kompetensutveckling		
Blanda kompetenser		
Samverkan, samordning och samarbete (rederi, energibolag, hamnar)		

Resultat från bord B

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Tillgång energi	Öka Sjöfart	Mer regionala bränsleflöden
Systemtröghet	Förbättringspotential sjöfart generellt	Använd dagens infrastruktur
Rättvisa i effekter	Ransoneringar bränsle och resande	Högre marknadsandelar
	Hårdare styrmedel mot orättvisa i effekter	Mindre bränsleflöden för vägtransporter
	Bibehåll prioriteringar/regelverk för klimat	Konsumtionsmönster - väljer bort fossila transporter
	Retrofit	Cirkulära materialflöden
	Positiva effekter för medborgare	Internalisering av kostnader
	Kompensatoriska åtgärder	Medborgarnas uppbackning och acceptans
		Systemintegration i bränsleproduktion-distribution

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslags-kraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Långsiktiga åtagande för nya bränslen	2	30%	Beslut målbild 2035
Maximera hållbara uttag av biomassa cirkulär ekonomi	2,5		Snabba starka beslut
Kärnenergi	3		Korrigerad policy
Minskad fart => lägre bränsleförbrukning	2	10%	Kompensatoriska åtgärder
Kostnads- och riskfördelning mellan aktörer	2		Kompetensmatchning prio klimat
Optimerade operationer med digitalt stöd	3		Skapa acceptans
Kapacitet - större och fler fartyg	3		"Coronastöd" - trycka pengar
Retrofit	2,5	10%	Börja bygga nu
Energieffektivitet ombord	2		Lösa marknadsmisslyckanden
Kompetens och kunskap	2	50%	Kostnads- och riskfördelning
Höga skatter på fossila bränslen från 2026	3		

Resultat från bord C

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Ledtider på fartyg	Nya affärsmöjligheter	Inga/färre kryssningsfartyg
Samarbete mellan alla aktörer	Mycket teknik finns	Ersätta dagens flyg
Länder ekonomiskt beroende av olja	Digitalisering/AI	Prioritera "nyttiga" transporter
Finansiering nationellt och rika-fattiga länder	Energieffektivisering	Mer lokal produktion => transport av råmaterial (ex. koppar) och mindre av färdiga produkter
Minska konsumtion	"Kniven på strupen"/enade	Biobränslen mer lokalt/regionalt
Energitillgång	Andra länder inte beroende - möjlighet för vissa länder	Elektrobränslen från solrika länder, ex. mellanöstern
Systeminvesteringar	Kärnkraft?	Offentlig upphandling kan styra
Fördelning av energi (sektorer och länder)	Ransonering (konsumtion, transport, etc)	Fler mindre fartyg och jättestora oceangående
Alla kommer inte bli nöjda	"Marknaden" minskar transporterna	Flytande hubbar för omlastning
Geopolitik	Innovativ produktion, 3D-printing	Mindre närsjöfart => mer tåg
Tillgång kritiska mineraler	Ändrad priskänslighet för ny teknik - provar allt	Längre transporttid i vissa fall
Allt blir inte perfekt till 2035		Minskning eller ökning av sjötransporter?
		Minskad konsumtion = minskad produktion
		Fartyg för längre livslängd
		Mer standardiserade fartyg
		Fossilt i ett cirkulärt flöde => ej bränna. Ok?

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslagskraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Konsumtionsmönster - mindre slit & släng	3		Politiken (globalt, regionalt, nationellt):
Förbud mot fossila bränslen	3	50%	• Ekonomiska och regelmässiga incitament (på marknadsmässiga villkor):
Subventioner	2,5		○ förnybara bränslen
Riskdelning finansiering	2,5		○ early movers
Globala styrmedel	3		○ energieffektivisering
Betalningsvilja (generellt)	3		• Energieffektivisera och minska energianvändningen i samhället

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslags-kraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Ta risker (investeringar, prova nytt)	3		• Utveckla och använd rätt ramverk för omställningen
Politisk regionalisering, ex. MAGA	2		
Digitalisering och AI	2	5%	
Autonom sjöfart optimimeringoptimering	2		Oklart:
Reglerade rutter (vissa typer av fartyg)	2		Utbud <-> efterfrågan - vad kommer först? Efterfrågan ökar närmare 2035.
Mer lokala/regionala produktionssystem	2,5		Penningströmmar
Lågt hängande frukt kvar för sjöfart	3		Var kommer pengarna ifrån? Pensionsfonder m.fl.?
Intermodalt och integrering	2		
Samordna flöden	2		
Trafikledning, typ flyg	2		
Eco Drivning	1,5		
Energieffektiv sjöfart => mer sjöfart	2	20%	
Långsammare fartyg	2		
Ökad nyproduktion av fartyg	2		
Förutsättningar för innovation	2		
Samarbeten i branschen	2		
Jättestora shuttles globalt	1,5		
Förvalta det vi har/kan	3		
Mer råvaror till biobränsle	3		
Biodrivmedel	3	25%	
Batteridrift	2		
Seglande flotta	2		
Landström	1		
Kärnkraftsfartyg	1		

Resultat från bord D

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Produktion förnybara bränslen	Kärnkraft för produktion av e-bränslen	Färre fossila bränslen
Varvskapacitet	Kultur och beteende för mindre konsumtion	Mindre kryssning taxfree
Tillgång på el	Möjligheter för ny teknik och uppfinningar	Lite mindre råvaror
Andra sektorer - konflikter om bränslen	Mer hållbart samhälle	Mycket mindre flyg
	Tillbaka till energianvändning lika 2035	

Observera att den totala andelen på fråga 5 överstiger 100%. Detta är normaliserat i sammanfattningen (kapitel 3.4).

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslags-kraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Elektrifiering	2	20%	Globalt ekonomiskt styrmedel typ ETS ger finansiering till IMO + länder
Vindassistans	2	20%	Länder luckrar upp tillstånd för användning av förnybara bränslen och mineraler till omställningen
Elektrobränsle	2,5	15%	Informationskampanjer (IMO + länder)
Okänd	2	10%	En oplanerad katastrof händer
Utökad produktion hållbara biobränslen	2,5	15%	Kompetensutveckling om vägen till fossilstopp och risker - DNV mfl
Konsumentbeteende - köpa låg-fossil transporter	2,5	0%	Riskhantering
Transparens - motverka greenwashing	1	10%	Satsning på varv från resp. land
Finansiellt stöd till early movers	2	25%	
Åtgärder för att minska transportarbetet	2	0%	
Globalt ETS	3	45%	
Investeringspengar fossilt => fossilfritt	2,5	20%	
Energieffektivisering (teknik, operationellt & logistik)	3	20%	

Resultat från bord E

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Världsläget - gott samtalsklimat vs regionalisering	Produktionspotential för e-bränslen skapar transportbehov	Ny industri med sjöfart och bränslen ger ny marknad
Eget behov av egna fossilfria lösningar	Katastrofscenarier - behov av samverkan	Nya skalfördelar för alternativa lösningar
Ersätta stor del av dagens flotta	Eldrift och segel - men tar tid	Förändrat, men kanske inte minskat
	Nödlösning (kompensation) för ej omställda	Förändrade investeringsmönster från olja/gas till förnybart
	"Early mover" = fördel	
	Skala upp befintlig ekonomisk omfördelning och incitament	
	Låga transportkostnader kan ökas markant	

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslags-kraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	5. Ungefär hur stor andel kan respektive lösning bidra med för att uppnå fossilstopp 2035?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Samling kring och hålla i beslut - ledarskap, långsiktighet, samarbete	3		Se lösningar
Förenkla och korta ledtider i tillståndsprocesser	2		
Tidigarelägga mål 2050 - 2035 => ändra tidsaxel på befintliga styrmedel	2,5		
Regelverk som underlättar omställningen	3		
Cirkulär konsumtion	2,5		
Nya affärsmodeller för energiintegrering, ex. uppskalning, nya affärer, initiala stöd, FuelEU Maritime och andra krav	2		
Högre transportkostnader för att finansiera omställningen	2		
Förändrad produktionskedja för flexibla ledtider/anlöp	2		
Minskat transportbehov		5-20%	
Energieffektivisering av komponenter, digitalisering, logistik, fartygsutformning med befintlig teknik	3	30-50%	
Rampa upp produktion av förnybara bränslen globalt	2	10-30%	
Drop-in biobränslen	3		
Segel- och vindlösningar	2,5		
Nyttja biobränslen som fungerar i befintliga motorer	3		
Kärnkraft ombord på vissa fartyg	2		
Lag på att ha solceller på tak	2		

Resultat från bord F

1. Vilka utmaningar och möjligheter tror ni kommer finnas för att nå fossilstopp 2035?		2. Vilket transportbehov till sjöss kommer finnas 2035 utifrån att det inte finns några fossila bränslen?
Utmaningar	Möjligheter	
Bygga produktionskapacitet för bio- och e-bränslen	Minskat transportbehov (energi)	Minskade tanktransporter
Svårighet för vissa branscher, ex. stål och energi	Optimerade transportlösningar - logistik	Lite nya transportmönster
Behov av ny infrastruktur, ex gas, lagring	Innovation ger nya affärsmöjligheter	Mer regional sjöturism
Kulturförändring slutkunder		Elektrifiering av kortdistans sjöfart ihop med energieffektivisering
Behov av nya fartygstyper	Ökad självförsörjning	Mer lastbilstrailer och mindre förarbundet (RoRo)
Minskat inflytande oljeländer		Ökade råvarutransporter
Åsidosätta demokratiska principer, ex gruvdrift	Storskalig biobränsleproduktion	
Kapacitet och kompetens på varv	Ökat återbruk och återanvändning	
Ny maktbalans med nya bränslen kan ge nya skurkstater		

Beträffande andelar (fråga 5) så kunde inte Gruppen enas.

3. Vilka lösningar finns för att nå fossilstopp 2035?	4. Vad har lösningarna för genomslags-kraft för att uppnå fossilstopp 2035 på en skala 1(lågt) - 3(högt)?	6. Hur kan en initial plan mot fossilstopp 2035 se ut? Vem behöver göra vad och när?
Digitalisering - 3D-printning, virtuella resor, VR-teknik	2	1. Åtgärder för kunskap/beteende/acceptans: - Först mer i offentliga org. och sedan mer privata
Digitalisering och AI för effektivare energianvändning och logistik	3	
Kunskapsspridning kring Fossilstoppet	3	2. Teknikimplementering rampas upp med tiden
Beteendeförändring och acceptanslösningar - människor upplever att de får det bättre	3,5	3. Utveckla/anpassa regelverk: Utredning => tillämpning => vidareutveckling => implementering
Upphöra med subventioner av fossila bränslen	3	
Regelverk, ETS som gynnar omställningen	3,5	4. Finansiering ekonomi/risk/affär:
Snabba på produktion av fossilfria bränslen	3	Offentliga => marknad
Tekniska lösningar för vind- och eldrift, elektrifiering, sol	3	