MPP Aviation Transition Strategy FAQ

- What is MPP?
  - **The Mission Possible Partnership (MPP) is an alliance of climate leaders** focused on supercharging the decarbonisation of seven global industries representing 30% of emissions: aviation, shipping, trucking, steel, aluminium, cement/concrete, and chemicals. Without immediate action, these sectors alone are projected to exceed the world's remaining 1.5°C carbon budget by 2030 in a Business-As-Usual scenario.
  - **MPP comprises four core partners**: the Energy Transitions Commission, RMI, We Mean Business Coalition and the World Economic Forum.
  - **MPP brings together the world's most influential leaders across finance, policy, industry and business.** MPP is focused on activating the entire ecosystem of stakeholders across the entire value chain required to move global industries to net-zero.
  - **MPP is funded by** the Bezos Earth Fund, Bloomberg Philantropies, Breakthrough Energy, the Climateworks Foundation, the European Climate Foundation, and the Joseph and Marie Field Family Environmental Foundation.
- What is CST?
  - The Clean Skies for Tomorrow (CST) Coalition provides a crucial global mechanism for **top executives and public leaders, across and beyond the aviation value chain, to align on a transition to sustainable aviation fuels** as part of a meaningful and proactive pathway for the industry to achieve carbon-neutral flying.
  - **The Clean Skies for Tomorrow Coalition is led by the World Economic Forum in collaboration with RMI and the Energy Transitions Commission.** Learn more at www.weforum.org/cleanskies.
- What does MPP try to achieve with its Sector Transition Strategies?
  - The objectives of the MPP Sector Transition Strategies are:
    1. **To demonstrate industry-backed, 1.5°C-compliant pathways to net zero**, focusing on in-sector decarbonisation and galvanising industry buy-in across the value chain.
    2. **To be action-oriented with clear 2030 milestones**: By quantifying critical milestones for each sector in terms of its required final energy demand, upstream feedstock resources, and capital investments, MPP wants to lay the foundation for tangible, quantitative recommendations of ways to reach these milestones through collaboration among industry, policymakers, investors, and customers.
    3. **To be transparent and open**: MPP's long-term goal is to fully lay open the internal machinery of the Sector Transition Strategies, that is, to make its Python models open source and all data inputs open access. In addition, MPP is developing online web interfaces that bring the Sector Transition Strategy reports to life: individual users will be able to explore the results of the reports and to customize model input assumptions, study the impact of individual levers, and dive deeper into regional insights.
    4. **To break free from siloed thinking:** The transition of a sector to net zero cannot be planned in isolation since it involves interactions with the broader energy system, for instance, via competing demands for resources from multiple sectors. All MPP Sector Transition Strategies are based on similar assumptions about the availability and costs of technologies and resources like electricity, hydrogen, or sustainable biomass. By providing a harmonized, cross-sectoral perspective, we

intend to inform decision makers with a fair, comparable assessment of transition strategies for all seven sectors.

- How is net-zero defined?
    - The world needs to get to net-zero GHG emissions by 2050 to avoid the most harmful effects of climate change. Thereby, **“net zero” means priority in-sector decarbonisation, complemented by carbon dioxide removals (CDR).**
        - About **90%–95% of current emissions in each sector need to be reduced by in-sector measures.** This is in line with the Science Based Targets initiative, which prescribes “long-term deep decarbonization of 90%–95% across all scopes before 2050” as the single most important target for a net-zero world.
        - **The remaining 5%–10% of residual emissions that** cannot be reduced by in-sector decarbonisation **need to be neutralised by CDR**.
- How did MPP define the carbon budget for aviation?
    - The Intergovernmental Panel on Climate Change (IPCC) estimates the global **carbon budget to limit global warming to 1.5°C** above preindustrial levels with a probability of 50% to **about 500 Gt CO2** from the beginning of 2020.
    - Hard-to-abate sectors are limited in their decarbonisation speed, whereas other sectors like the power or automotive sector could switch to low-carbon technologies more quickly. In a preliminary assessment by the MPP, **roughly 50% of the 450 Gt CO2 has been allocated to the seven MPP sectors** (see more details in the main report).
    - Following this methodology and updating the global carbon budget from the beginning of 2020 to 2022, **global aviation has a 1.5°C carbon budget of about 18 Gt CO2** from 2022 onwards.
    - Given the variety of other potential sectoral allocation methods, this value should not be taken as the absolute truth but rather as an indicative figure for a 1.5°C carbon budget for global aviation.

- Which global supply constraint for sustainable biomass is MPP using and how is it allocating the available volumes to individual sectors?
    - The list of **sustainable biomass feedstock** considered in this Transition Strategy is based upon a previous CST report but **excludes all edible crops**. GHG reduction potentials of sustainable biomass are regionally different and estimations about supply potentials are subject to high uncertainty.
    - The **global limit for sustainable biomass** for this Transition Strategy Explorer is assumed to be **about 50 EJ in a Prudent scenario and up to about 110 EJ in a Maximum Potential scenario**. These indicative suggestions are based on a report of the Energy Transitions Commission.
    - **According to a prioritisation framework** developed by MPP, which analyses the merit order of biomass use for different biomass-demanding sectors, **the amount of biomass ending up in jet fuel should not exceed about 15 EJ.** Considering that the production of bio-jet fuel will always come with the production of byproducts, overall more sustainable biomass will be used in SAF production facilities.
- What are the trade-offs between PtL and biofuels?
    - **Power-to-Liquids (PtL) rely on large amounts of hydrogen and captured CO2 (both powered by renewable electricity).**
    - **Biofuels**, in contrast, are (and should only be) **produced from *sustainable* biomass feedstocks** that allows for a high GHG reduction compared to fossil jet fuel, even when including emissions from indirect land use change (ILUC). Such feedstocks are e.g., agricultural residues, forestry residues or municipal solid waste.

    - While **renewable electricity, hydrogen and CO2 captured from air are theoretically not limited**, the **globally available sustainable biomass is likely to be constraint to about 50-110 EJ (indicative range)**.
    - However, **biofuels** based on waste products offer co-benefits like avoided landfills, and are the only **market-ready SAF production** pathway right now. **PtL** is projected to enter the market **from 2025 on.**
    - No SAF type (PtL and biofuels) alone will be sufficient to meet ambitious 1.5°C-aligned milestones towards carbon-neutral flying. **It will always need a combination of both** – and other decarbonisation measures. Depending on the regional feedstock availability (e.g., low-cost renewable electricity vs. available sustainable biomass), individual regions in the world are likely to focus either more on PtL or on biofuel production.
- <u>What is the potential role of hydrogen aircraft in aviation?</u>
    - Both, Power-to-Liquids (PtL) as well as hydrogen are produced from renewable electricity. Compared to PtL, hydrogen cannot be blended into existing aircraft and the existing fuel infrastructure. Therefore, **hydrogen aircraft will need massive technological developments** (and corresponding RD&D investments), in particular to increase the energy density of hydrogen storage tanks and to set up hydrogen logistics and infrastructure.
    - **However, hydrogen aircraft could potentially be operated at lower total costs of ownership**, could potentially reduce the climate impact of flying more than SAFs, **and the fuel (hydrogen) can be produced more efficiently than PtL** (60-70% efficiency of H2 production vs 35-45% for PtL production).
    - **Fuel cell-based hydrogen aircraft** could be used **for short- and mid-haul flights**, **hydrogen combustion aircraft potentially for even longer ranges**, if the weight of hydrogen tanks can be reduced massively.
    - The **large-scale market entry** of hydrogen aircraft is expected for the late **2030s**, but retrofits of short-haul aircraft could already enable a first market entry as soon as 2025.
    - Until 2050, hydrogen aircraft could be responsible for **up to a third of the final energy demand** in global aviation.
- <u>What is the role of fuel efficiency measures in aviation?</u>
    - **Over the past decades, the aviation industry has made huge progress in making its aircraft and flight procedures more efficient**. Flying can be made more efficient by making airframes more aerodynamic and weigh less, by making turbines more fuel efficient and by optimizing flight procedures.
    - **Increasing the efficiency of flying reduces fuel costs**. As a result, the industry achieved average **yearly efficiency improvements of 1.0%** between 1970 and 2019, and it reached 1.5%/y between 2010 and 2019. Beyond those continued historical trends, the Aviation Transition Strategy assumes that **efficiency improvements could be increased to 2.0%/y by 2030** through additional efficiency gains.
    - **If these efficiency targets are achieved, the global aircraft fleet could be about 40% more fuel efficient in 2050 than in 2019.**
    - **Replacing the average aircraft with the most efficient aircraft currently in service would save about 16%–21% of fuel,** without introducing any new technologies to the market.
    - **Policy incentives are needed to support bridging the gap between the historical 1%–1.5%/y efficiency gains and the aspired 2%/y,** which will require massive research, development, and demonstration (RD&D) efforts from original equipment manufacturers (OEMs) and engine/parts suppliers.
    - There is evidence from historical data that times of high oil prices have been followed by a stronger focus on fuel efficiency gains. Similarly, **the prospect of future fuel price increases due to the introduction of SAFs will serve as a key driver for increased fuel efficiency measures.** Therefore, policies need to create certainty

about the switch from fossil jet fuel to SAFs in the future (through blending mandates, carbon pricing, emissions trading schemes, etc.) and corresponding increases in average fuel costs.