THE SUSTAINABILITY OPPORTUNITY FOR AEROSPACE

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THE BIGGEST LONG-TERM THREAT to the commercial aerospace industry right now isn't COVID-19 but the need for sustainability. True, the pandemic has led to a steep decline in demand for air travel. But that is a short-term issue. More broadly, the industry has set ambitious targets to reduce greenhouse gas emissions by 2050, and it is currently not on track to achieve them. As awareness grows about the environmental impact of air travel, and as consumer preferences and behaviors shift, the industry's profit pools are increasingly at risk.

A variety of new technologies and solutions are emerging to increase efficiency and reduce greenhouse gas emissions, and government regulations are increasing the requirements for efficiency and green operations. But these represent only incremental improvements. The industry needs to take more transformational measures, with airframe and engine OEMs, suppliers, and other companies throughout the value chain stepping in to coordinate the sustainability agenda.

This kind of collaborative effort will ensure that the industry has a say in its own future, rather than having that future shaped by regulatory fiat. Moreover, proactive coordination will lead to faster gains in reducing CO_2 emissions. Viewed in that light, we believe sustainability represents an opportunity for the aerospace industry.

Falling Short of Targets

Commercial aviation accounted for about 2% of global greenhouse gas emissions in 2019, but projections suggest that will rise to as much as 20% by 2050 without major intervention. The industry has set long-term decarbonization targets, including a 50% reduction in net emissions by 2050 compared with 2005 levels. But so far, progress against that goal has been limited.

Historically, commercial aviation has seen an increase in efficiency of about 1.5% per year, and that trend is likely to continue as new technologies are retrofitted onto aircraft currently in service. For example, high-bypass-ratio (HBPR) engines such as the LEAP design, which sends larger volumes of air around jet turbines and thus requires less fuel, are already in use. Similarly, aerodynamic structures such as winglets can improve the efficiency of airflow around a wing. However, the gains from these measures are likely to be overtaken by a steady growth in air traffic—once the pandemic ends and travel resumes—of 1% to 4% through 2050. That means the absolute amount of greenhouse gas emissions will continue to rise, causing the industry to miss its 2050 targets by a gap of 800 to 1,400 million tons of CO_2.

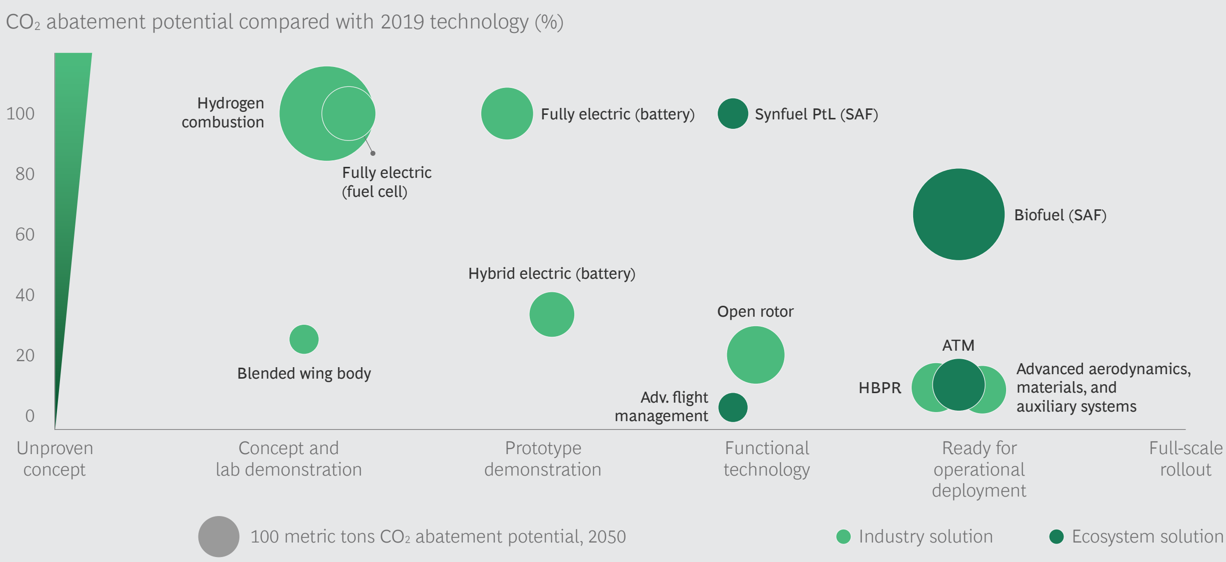
Advanced Technologies Bring Greater Uncertainty

Also in development are more advanced technologies that could lead to greater advances in efficiency and emissions reduction. But these vary widely in maturity and emissions abatement potential. (See Exhibit 1.) For example, open-rotor engines—consisting of two unducted, counter-rotating propellers powered by a turbine—can provide efficiency levels between those of jet engines and turboprops. Open rotors are a proven technology that could enter service by 2030, reducing CO_2 emissions by about 20% compared with existing engine designs.

Hybrid and fully electric engines, powered by batteries or hydrogen fuel cells, hold the potential for significant gains as well. But they are at an earlier stage of development and carry sizable uncertainties in terms of technical viability and the feasibility of deployment. These competing and highly disruptive technologies would both require large investments in ground infrastructure to increase power generation capacity, as well as in airport charging stations. Moreover, airlines would need to be persuaded that there is a viable economic case for switching from engines that burn fossil fuels.

Sustainable aviation fuels (SAFs), which are refined from nonpetroleum feedstocks, are among the most mature breakthrough technologies. Accelerating the adoption of SAFs presents a potential intermediate step for OEMs, since it would allow them to generate significant gains in emissions reduction with existing engine designs. But long-term deployment will likely be hindered by supply constraints—in terms of both feedstock availability and production capacity—limiting the impact of SAFs to approxi-

EXHIBIT 1 | New Technologies Show Varying Potential



Sources: International Council on Clean Transportation; International Civil Aviation Organization; company press releases; BCG analysis.
Note: ATM = air traffic management; HBPR = high-bypass-ratio engine; PtL = power-to-liquid fuel; SAF = sustainable aviation fuel.

mately half of the 2050 target gap in CO_2 emissions compared with current fuels. To supply enough of these fuels to achieve 50% adoption by 2050, production capacity would have to increase by a factor of 25, from 14 billion liters in 2025 to approximately 350 billion liters in 2050. This would require approximately $600 billion in capital expenditures.

Implications for Propulsion and Airframe OEMs

Given the variety of technologies in the works, propulsion OEMs must hedge their bets. These companies are likely to be conservative, adopting either HBPR designs in the short term (that is, by 2025) or open-rotor engines in the short to medium term (by 2030). And in addition to encouraging adoption of SAFs, they must also develop advanced and disruptive engine designs.

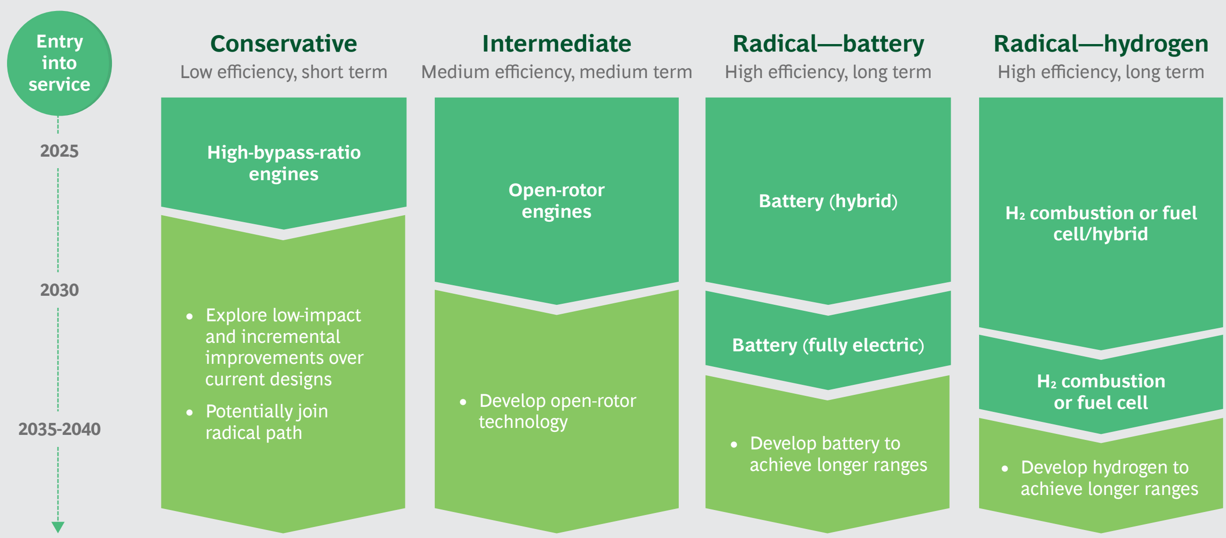
Airframe manufacturers will pursue longer-term strategies aimed at achieving higher efficiencies. These OEMs are likely to pursue either battery-powered engines (aiming for hybrid electric by 2030) or hydrogen combustion and fuel cells (aiming for hybrid combinations by 2035).

For both propulsion and airframe OEMs, the challenge is to determine how best to time their investments across the various technologies. (See Exhibit 2.) Compounding this challenge is the long-term nature of fleet replacement programs at airlines, which typically take 10 to 15 years. Airframe and propulsion OEMs therefore need to bet on technologies that will be ready for service by 2035. SAFs will play an important role in all scenarios.

Current Regulations Have Had Limited Impact

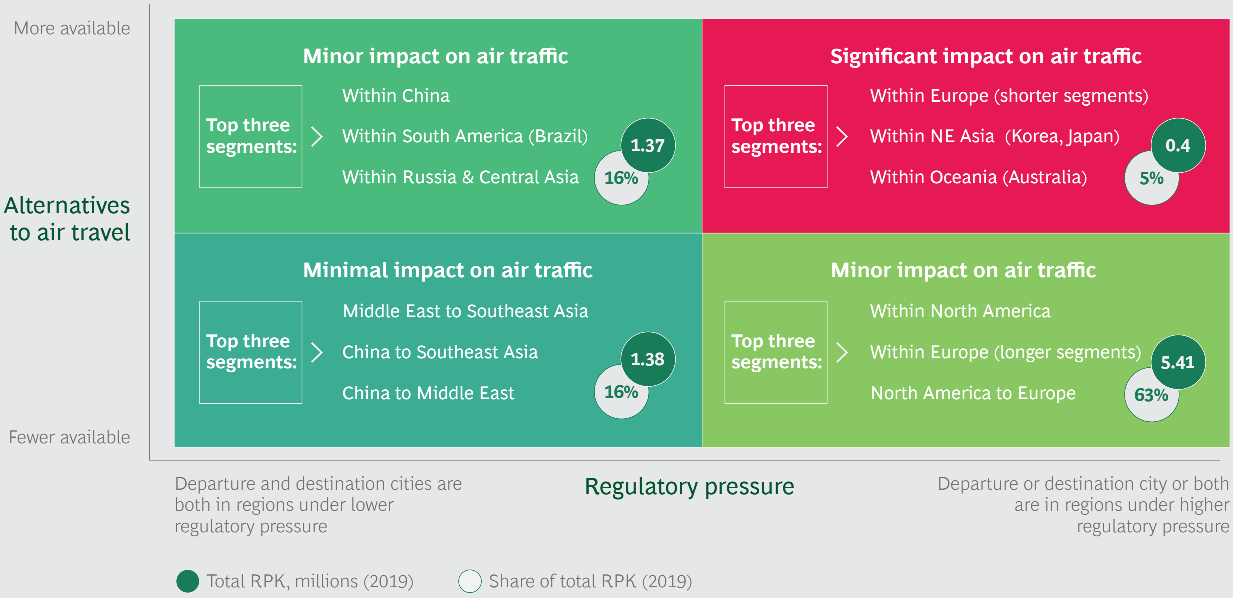
Regulations imposed by many national and regional governments on the aviation industry have so far had limited impact. Mandates compelling the use of costlier SAFs, for example, and mechanisms such as carbon taxes or cap-and-trade systems all increase airlines' operational costs, which get passed along in the form of higher ticket prices. This gives passengers an incentive to travel by other means (such as rail), and—according to the regulatory logic—air traffic therefore declines. But we found that, as of 2019, there were viable alternatives to air travel, such as a rail line connecting departure and destination cities, for only 20% of flights. Moreover, only about a quarter of those alternatives were in regions under high regulatory pressure, such as Europe. (See Exhibit 3.) Thus, we do not expect existing regulations to re-

Exhibit 2 | OEMs Must Time Their Investments Across Various Technologies



Source: BCG analysis.

EXHIBIT 3 | The Impact of Current Regulations on Air Traffic Has Been Very Limited



Source: BCG analysis.
Note: RPK = revenue passenger kilometers.

duce emissions by more than 250 million tons by 2050.

We believe that regulators need to move beyond the current focus on demand and create more positive incentives. In other sectors, regulatory mechanisms such as subsidies have helped promote change, with electric vehicles, for example, starting to replace those powered by internal combustion engines and renewable power generation replacing some fossil-fuel-based sources. In the aerospace sector, similar approaches could spur R&D investments and the adoption of new technologies.

Building the Foundation

In sum, there is no silver bullet that will ensure the industry meets its 2050 emissions targets—neither emerging technologies nor regulatory pressure. The targets will only be met if the entire industry collaborates and coordinates—not just airframe OEMs, engine manufacturers, and suppliers, but also energy companies, airports, regulators, and other stakeholders. Given the uncertain impact on emissions reductions of new technologies and regulations, companies need to focus on developing a climate-ready roadmap and becoming activists in the ecosystem.

First, companies need to figure out a path to success regardless of what the future holds in terms of new technologies and regulations. In particular, as they consider COVID-related restructuring initiatives over the next 12 to 18 months, they need to retain their emissions-related capabilities and investments. Leadership teams will clearly face tough choices regarding what to trim, but sustainability initiatives should not be on the list.

In addition, companies need to work with their suppliers to ensure that they are ready for new technologies. They should consider the full range of collaboration structures, including co-investing with other stakeholders, changing suppliers, and exploring vertical-integration opportunities.

Second, companies need to shape the overall sustainability agenda throughout the ecosystem, working with regulators to establish standards and frameworks. This kind of activist approach will give companies a seat at the table as new standards are established, allowing them to convert regulation into a source of competitive advantage.

And again, companies should encourage collaboration and coordination among stakeholders—for example, forming a consortium of fuel refiners, engine manufacturers, infrastructure developers, and regulators to consider how best to implement SAFs. An additional advantage of collaboration is that it can help companies identify new opportunities in adjacent business areas, such as battery manufacturing or the hydrogen value chain. Given that sustainability imperatives are growing in virtually all industries, this approach will allow organizations to expand beyond their current boundaries and potentially develop products and services that address broader decarbonization challenges.

The commercial aerospace industry is changing radically owing to emissions-reduction targets, changing consumer preferences, new technologies, evolving regulations, and other factors. Companies in the industry have a choice. They can be passive participants and be overtaken by the competition. Or they take a more proactive approach, building the right foundations today to seize the climate opportunity in the future.

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