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King Abdullah Petroleum Studies and Research Center

CO_2 Emissions Reduction Progress and Future Perspectives in Aviation

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About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia's energy sector and inform global policies through evidence-based advice and applied research.

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Key Points

Worldwide, the aviation sector has been geared toward achieving CO_2 emission targets and goals by considering the reduction in CO_2, even though aviation currently contributes only approximately 2–3% of total global emissions. Although aviation is one of the most challenging transport modes for which to find alternative energy sources, policymakers, researchers, and the industry have pledged to cut carbon emissions through net-zero and carbon-neutral initiatives. Furthermore, the aviation sector has shown significant growth worldwide, reaching 4.2 billion passengers and 56.6 million tonnes of freight for a total share of 12% of energy demand within the transport sector – 6% of the global total – in 2019. However, in 2020, the COVID-19 pandemic generated one of the most critical disruptive worldwide events in the sector and temporarily stopped aviation. In 2021, the aviation sector rebounded quite well. Then, in 2022, it had an uneven recovery due to the slow vaccine rollout and individual measures taken by each country. The COVID-19 pandemic caused a critical reduction in energy demand and CO_2 emissions, and it brought new challenges to be addressed in efforts to transition toward a sustainable future. Initiatives such as fossil-fuel-based and non-fossil-fuel-based solutions in aviation are currently receiving more attention in efforts to contribute to global climate change targets and ultimately decarbonize the industry. Although it is more difficult to find alternative fuels in aviation than in other transportation modes, aviation has witnessed significant technological advances in recent decades, reducing consumption and decreasing emissions. Additionally, operations planning and aircraft and engine developments have played key roles in the past. Gains in reducing CO_2 emissions in aviation seem negligible because of steady growth hiding the considerable achievements that make this sector a priority for policymakers, governmental entities, and authorities.

For some years, fossil fuels have continued to be the primary energy source in aviation. However, recent developments in low-carbon aviation fuels (LCAFs), sustainable aviation fuels (SAFs), hydrogen, and e-fuels have created alternatives with a promising future for reducing emissions.

The aviation sector has set ambitious targets and goals to mitigate CO_2 globally. These emission targets consider carbon-neutral growth (from 2020 onward) and a reduction in net aviation CO_2 emissions of 50% by 2050 relative to 2005 levels. Several promising areas for breakthrough aircraft technologies, air traffic control measures, and energy sources have been identified, but challenges, constraints, and barriers must be overcome to achieve these goals.

Aviation is expected to reach these future targets and goals for reducing CO_2 emissions worldwide by continuing to work on fuel-efficiency gains, weight reduction, engine efficiency, the deployment of new energy sources, and improvements in air control systems.

With the momentum toward soon achieving a sustainable transport mode, there is a need to address the main challenges that could impact or restrict the situation in the aviation sector in the foreseeable future.

Summary for Policymakers

CO_2 emissions from aviation are a priority for policymakers, researchers, entities, and governments worldwide. Traditional approaches to analyzing the aviation sector must be modified because aviation practices are no longer supply driven. In fact, the recent increase in environmental awareness worldwide has modified previous motorized-oriented approaches to be more energy efficient by investigating how the system is designed rather than considering the provision of infrastructure.

Technology could be one of the main pillars of reducing emissions, but the current aircraft technology dates from the 1960s, despite some adjustments that have been made in recent decades. Technology will be one of the main drivers of reducing CO_2 emissions, and it will be geared toward achieving certain targets and goals for aviation (i.e., carbon-neutral or net-zero targets). Even though technology is the key, it seems to be a long-term solution because developments are moving fairly slowly in comparison with changes in other transportation industries (e.g., hybrid and electric vehicles). Aviation technology seemingly does not enter the market very quickly because the existing duopoly between Boeing and Airbus, which consumes most of the fuel, has not incentivized new advances.

Aviation is expected to grow significantly in emerging economies (e.g., the Middle East, Indonesia, Vietnam, and Brazil) with double-digit annual growth rates. Therefore, technological changes will not be enough to absorb newly emerging CO_2 emissions since, in an optimistic scenario, technological improvements could account for approximately a 2% decrease. Technologies such as hydrogen- or electric-driven aircraft will have limitations and, for this reason, will serve only certain segments of the market. The expected introduction of those technologies will represent the replacement of 50% of hydrocarbons since the commercial range for hydrogen is on routes over 3,000 kilometers.

Operational changes will add a more systemic value in terms of energy efficiency. Therefore, in addition to technological improvements, it is essential to consider the optimization of routes that would result in greater energy efficiency. Even though the discussion tends to focus mainly on what will happen to airlines and aircraft operators, because those impacts are the most visible, other subsystems, such as airports, are also important. Airport locations could, in some cases, represent a large portion of emissions when people are traveling to a distant airport or in terms of logistics, distribution of fuel, and air navigation services. Those subsystems need energy, and that need will continue in the future regardless of whether hydrogen or SAF is being used. As a result, subsystems in the aviation sector should be considered because they could become more sustainable.

Aviation and other transport modes have been affected by more frequent occurrences of natural disasters (e.g., floods or fires). These events affect infrastructure and limit airport capacity because they can lead to airport closures or limit air traffic capacity. Additionally, health issues, such as the COVID-19 pandemic – the most significant disruptive event in aviation in recent years – limit aviation demand, as do responses to environmental emergencies in cities that struggle to curb levels of air pollution that limit air travel capacity. As a result, more health or emergency actions will create larger disruptions in aviation that will affect emissions and create a need for more advances in the short term.

From a multistakeholder perspective at the international level, even though ambitious targets and goals have been set that impact the aviation sector, every country is responsible for setting goals beyond those. The targets and ambitions seem to be too few and too late because they are based exclusively on within-sector measures based primarily on offsetting mechanisms and SAFs. As a result, instruments should be developed to facilitate access to funding and technology transfer so that all countries can respond

The industry is focused on the consumer perspective in developing its future. When consumers consider their CO_2 budget, the challenge is how they see the world and not how the industry sees it. Aviation relies heavily on technology, as do other sectors that are reducing CO_2 emissions as rapidly as possible. For this reason, the sector is partnering with leading technology developers.

In conclusion, the aviation sector has taken on an essential role in reducing CO_2 emissions globally. However, the current technology trends (e.g., hydrogen or electric) are either under development or growing at a lower rate than the aviation demand. Developing emerging economies will have a significant position in the future because the growth in their aviation sectors will be substantial. Therefore, measures to be applied in the aviation sector to reduce CO_2 emissions should involve subsystems (e.g., airport design, the fuel supply chain, and electric power for air navigation services) rather than focusing on the aircraft side. This concept has attracted attention to the use of existing technology, such as carbon capture, usage, and storage (CCUS), to decarbonize aviation. Even though the technology seems expensive, the cost could be considered negligible when taking into account positive externalities, such as trade, tourism, and wider benefits for the overall economy.

Background of the Workshop

On August 30, 2022, KAPSARC hosted a webinar on the progress of reducing CO_2 emissions in aviation and future perspectives. Over the past few years, the KAPSARC Transportation and Infrastructure team has been researching the future of energy demand in the aviation sector to provide past, current, and future perspectives on the growth and environmental contribution of this sector. Emissions from the aviation sector worldwide have contributed only 2–3% to the total, which has historically made the sector receive less attention from governments, policymakers, and air transport associations than other industries. However, in recent years, this sector has gained more policy attention, and the aviation sector has turned toward a more sustainable transport system. In addition, the onset of the COVID-19 pandemic increased the focus on how emissions can be reduced in the future, even if demand for aviation is expected to grow significantly in the coming years worldwide.

The aviation sector seeks to uphold and increase its past achievements, regardless of the increase in transportation demand. Current growth trends in the aviation sector are of the utmost importance because of CO_2-related emissions, even though these trends are concentrated unevenly across regions and countries. Therefore, the goals and targets for decarbonizing this sector are a critical concern for reshaping policies, current technologies, operations, and infrastructure to decrease the evolution of emissions in the coming years.

The previous concerns of the aviation sector have prompted the following three key themes that formed the basis for the workshop:

- The general context of the aviation sector.
- Technology, operations, infrastructure, and energy advancements to reduce CO_2 emissions in the aviation sector, including future perspectives
- Future outlook for CO_2 emissions emerging in the aviation sector.

The current progress of CO_2 emissions emerging in the aviation sector has pointed to measures to mitigate and decrease emissions globally. Fuel efficiency gains have accompanied the aviation sector growth experienced in recent decades worldwide. As a result, high-efficiency gains have contributed to a noticeable reduction in fuel consumption. At the same time, these gains seem negligible because the aviation growth rate has surpassed the efficiency gains. CO_2 emissions have brought new challenges to the aviation sector in terms of its growth and sustainability prospects due to greater dependency on fossil fuels. To this end, aviation is undergoing extensive efforts to decrease or mitigate CO_2 emissions.

Although the COVID-19 pandemic impacted aviation worldwide in unprecedented and unevenly distributed ways across countries and regions, it led to recommendations aimed at helping governments and policymakers reduce CO_2 emissions. Reducing CO_2 emissions would require clear pathways to be set for aviation sector infrastructure, operations, and technical components to support decisions, measures, and strategies in the short, medium, and long term. Even though the pathways for reducing CO_2 could focus on local or regional aviation, it is important to note that aviation is global. For this reason, it will be necessary to fully align countries' policies and measures with international ones.

International aviation associations, such as the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA), have played an important role in reducing CO_2 emissions by considering a combination of market measures and alternative fuels. However, most alternative fuels are not commercially available because there are fewer facilities for producing them and their costs are substantially higher than those of fossil-based fuels.

In conclusion, the aviation sector is transitioning to reducing its CO_2 emissions, but the reliance on traditional fossil fuels may be a major obstacle. Future perspectives on reducing CO_2 emissions in the aviation sector are promising, but the progress and expansion of these efforts will depend on mandates and regulations imposed at the country level.

General Context of the Aviation Sector

The aviation sector is a transport system with different subsystems (i.e., airlines, airports, aircraft, and air navigation services) that must be considered when discussing decarbonization strategies. Consequently, relations, interrelations, and interactions among the subsectors should be assessed because it is difficult to find alternative energy sources for aviation. Moreover, aviation transport (infrastructure and services) plays a vital role in the accessibility and mobility of people, services, and commodities (freight). Therefore, transport is a critical element in the economic performance of countries and regions worldwide. Several types of research have been conducted to analyze the links between economic development and transportation as well as the coupling effect and externalities (positive and negative).

The development of aviation has been aligned with transport planning methodologies. Transport planning methodologies started in the 1950s in the United States when the country started an important road development program, assuming more simplifications than exist today by considering the equilibrium between supply and demand through the *"predict and provide"* approach. Therefore, the planning was developed for the infrastructure side rather than the demand side. Some examples are larger highway developments, new ever larger airports, larger aircraft, and a business model characterized by point-to-point transport. Transport planning evolved to focus on people's movement, creating combinations of transport modes and people's engagement in activities. More recently, transport planning has considered other objectives (i.e., health and sustainability). Therefore, the previous emphasis on meeting people's needs for motorized transport has changed dramatically in recent years and encouraged the reallocation of road space, restraint of car use, and restriction of aircraft, among other measures.

Although the new planning objectives seemingly regress to a motorized transport-oriented approach because there is a stronger emphasis on optimizing infrastructure, energy is playing a much more critical role. As a result, we can say that we are migrating to "*energy-oriented*" models. In fact, developing new aircraft will redefine the aviation sector and could have a larger disruptive effect. As a result, the aviation sector is undergoing essential changes in the improvement in engines and the development of new materials to reduce aircraft weight that could generate turning points in infrastructure provision and improve fuel efficiency while reducing environmental impact.

In conclusion, aviation sector policymakers face multifaceted decisions regarding new objectives, indicators, and appraisal methodologies. Therefore, transport planning is being reassessed with a shift from "*predict and provide*" to "*envision, validate, and trust*".

Technological, Operational, and Infrastructure Advancements in the Aviation Sector: Current and Future Perspectives on Reducing CO_2 Emissions

Although technology could be the backbone of solving environmental concerns, there is a more skeptical view of this optimistic approach. When we observe the aviation system, we see that developments are moving fairly slowly. For instance, the automobile industry is changing extremely quickly with the development of battery electric vehicles. This shift has occurred nearly everywhere in the world, and the numbers of electric vehicles are increasing.

The aviation sector is much smaller, and new technologies do not enter the market very quickly because of the market structure of aircraft manufacturing. Given the duopoly between Boeing and Airbus for major aircraft, which consume most of the fuel, manufacturers have little incentive to bring in state-of-the-art technologies because such changes are fairly risky. Therefore, manufacturers are extremely cautious, and the basic aircraft designs currently in production are concepts from the 1960s to the 1980s. Only a few updates to engines and aerodynamics and small structural changes have been implemented. That is why only a small improvement to the air transport system fleet has occurred; optimistically, it may be 1.5–2% per year, but some markets have grown extremely quickly. In emerging markets, such as the Middle East, Indonesia, Vietnam, and Brazil, aviation is growing at a pace of almost double digits annually, whereas global average annual growth rates vary from 4 to 5%. Therefore, the 2% improvement with existing technology is simply not enough.

Regarding other technologies, researchers and the industry are considering hydrogen-powered aircraft. Hydrogen technology is very impressive, and the move to hydrogen-driven aircraft can be performed in a commercially competitive way, but only in certain segments of the air transport system. Hydrogen aircraft will probably have range issues due to tanks of hydrogen being integrated into the fuselage. The larger these tanks are, the more commercially usable floor space is taken away. Therefore, there is a direct trade-off between the number of seats and the range of the aircraft. Some researchers have reported that the maximum commercially sensible range is nearly 3,000 kilometers. Since 50% of energy consumption globally is on routes over 3,000 kilometers, we can probably replace only 50% of hydrocarbons on short hauls when the transition to hydrogen happens.

When we consider the climate change action timeline, the aviation industry, especially in Europe, is under much pressure from politicians and society to reduce emissions. Hydrogen aircraft will probably not enter into service until 2035 or 2040; thus, this change needs another 15 to 20 years. Therefore, the impact of hydrogen aircraft will be significant after 2050 for probably half of the energy consumption in aviation. As a result, we will continue to need hydrocarbon fuels in the future. This suggests that regardless of whether hydrogen aircraft are successful, SAFs will be required in the future. Producing aviation fuels from renewable energy sources is a fascinating topic.

As previously mentioned, technology improvements will probably continue at rate of 1 to 2% in the short term, which will not be enough. Therefore, operational improvements involve working on airports. Tests on taxiing have been conducted, but there could be additional smart moves in building new airports. For instance, at the new airport in Turkey (Istanbul), aircraft need 15 to 20 minutes of taxiing, but if the airport were redesigned, this time would be saved. Additionally, for air navigation services in Europe, the estimated savings range between 2 and 5%. In other countries, such as China, Indonesia, Saudi Arabia, and Brazil, military aviation is quite important, and aircraft need to make short flights around the country. Therefore, a few improvements are possible, and those aspects should not be neglected. Many initiatives are underway, especially in designing new airports in high-growth countries, such as Saudi Arabia, Vietnam, China, India, and other countries that are still building many new airports. Europe and the United States are not building airports; thus, changes in navigation services will definitely reduce CO_2 emissions in those regions.

The infrastructure side is not always the main point to consider. The discussion tends to focus on what will happen to airlines and aircraft operators because those are the areas of the most visible impact. Nevertheless, one important point is airport activities since a flight cannot happen without the contributions of other sectors of the transport industry. Airports can play a significant role in reducing carbon emissions throughout the entire travel value chain, not just in the flight per se but also door-to-door. Reaching the airport can, in some cases, represent a large amount of emissions, which has a direct relation to the functioning of airports. For instance, the Airports Council International (ACI) has developed interesting insights into how airports can be improved. In addition, the logistics of fuel supply need to be considered in the backstage aspects of airline operations because these operations will remain regardless of whether hydrogen or SAFs are deployed. For instance, some airports do not receive a constant fuel supply by ducts. Therefore, the sustainability of aviation fuel, hydrogen, or SAFs needs to be tracked, which will also add to emissions in the sector. Additionally, aeronautical infrastructure for the safe movement of aircraft (i.e., radar, VORs, and other systems) needs energy; changes in this infrastructure may lead to potential gains that make it more sustainable.

Another point to consider is how the environment responds based on the effects of humans on the environment. This is very important because natural and environmental events that were formerly rare are happening more frequently. Those events (e.g., floods and fires) affect the infrastructure by limiting airport capacity because they can lead to the closure of airports or limit air traffic capacity. In the future, more emergency actions will limit demand that is not related to health issues such as the COVID-19 pandemic but is related to emergency response, similar to many cities' efforts to curb air pollution by restraining the use of cars.

The ambitions and goals set for the industry will impact the international sector. The ICAO ambitions may sound too few and too late, but they ensure a multistakeholder perspective, and these ambitions can be realized. In this international framework, every nation is responsible for setting further goals. On the one hand, this will allow countries to adapt to their different contexts; on the other hand, it sets a minimum ambition for the world. In addition, the long-term aspirational goal (LTAG) is based exclusively on within-sector measures and is related to SAFs. Additionally, the 41st assembly of the ICAO is expected to set minimum standards from which each country can work. The expectation is that there should be a 39% to 87% decrease in CO_2 emission by 2050. The limits are significant, and each country's context is very different. Therefore, these ambitions also set instruments to facilitate access to funding and technology transfer so that all countries can respond in some way.

From the policy side, the ICAO sets standards and recommends practices that will be important in enabling the uptake of technologies that are related not only to aircraft but also to SAFs. In conclusion, a multistakeholder perspective is vital in setting this vision. Aviation will not be more sustainable if we consider only the airline side.

Current and Future Perspectives of the Industry to Reduce CO_2 Emissions

The third era of aviation is coming, and there are many reasons for that. The industry wonders how quickly this will happen. Much will happen on the technology side, but customer expectations are also important for the industry. Certain parts of the world (i.e., Scandinavia, Northern Europe, and Western Europe) are increasingly focused on sustainability. Among all stakeholders, the customer is the most important. To develop the industry for the next 5, 10, and 15 years, the industry must listen to expectations, and it is clear that younger generations are extremely focused on sustainability.

Although aviation accounts for 2.5% of the total emissions worldwide, flying within Norway accounts for 1.5%. The Wideroe company represents only 0.4%, and we are very comfortable with that. Customers are increasingly encouraged to examine their personal CO_2 budget, and the challenge is the way they see the world rather than the way the industry sees the world. New technology will be the preferred way of moving, and it could expand even further when we consider how other industries are reducing CO_2 emissions as quickly as they can.

If the industry wants to grow in the future, it must reduce emissions. This will take time, and it will be a challenge. Therefore, we are positive about how this may expand the market, while other discussions in Norway are about expanding other transport modes, such as the railway, with quite polluting construction approaches. The industry can do this because it operates many short flights 15 to 20 minutes long. We believe that new technology will come first to our segment so that we can use it early, and we want to play the role of a test bed for new technology.

For this reason, we are working with leading technology developers (i.e., Airbus, Boeing, Embraer, and Rolls Royce – engine manufacturers) to understand how to use this new technology in the industry. This includes all-electric alternatives, and we are investigating other alternative fuels. In the future, passengers will be look to technology. We can travel most sustainably from where a person is to where he or she wants to go. Then, we need to examine the rest of the chain and collaborate with the ecosystem to make that happen. The industry does not expect this goal to be easy to achieve, but we believe that we can use the technology sooner, and our country is already committed to similar initiatives (e.g., 80% of all new cars sold last month were EVs). Therefore, we think the market will be very receptive to new technology. Our company expects to enter such technologies into service before 2030.

Future Perspectives on CO_2 Emissions Reduction

In terms of transportation modes, aviation is probably the only one that has rebounded very quickly from the pandemic. Overall, total aviation demand will be approximately 25% higher in 2050 than it is today, with very little fuel substitution in the base case. When we examine all sectors and policy elements, we find that it is not a two-degree world, and it is probably more like 2.4 degrees. What will aviation look like in a less than two-degree world? There are many perspectives on technology and where things can be improved, but we do see some fuel switching to these lower-carbon cases, which are insignificant, and there is some electricity in the mix.

In a real green scenario, which is less than two degrees, aviation demand overall begins to flatten and then decreases, and there is not enough fuel substitution to allow the sector to grow in the same way that it does in our base case. Present-day perspectives on technology are important. For instance, the prospects of flying long-haul with hydrogen jets are probably nonexistent, and an electric aircraft would not travel very far. What if the technology cannot deliver? What if we reach a plateau and engines cannot be improved at more than a marginal rate? We have SAFs that are deliverable, highlighting physical risks from infrastructure and energy transition.

Conclusion

The workshop aimed to support a discussion on current and future measures intended to decrease CO_2 emissions in the aviation sector by considering different and broader points of view. These can be summarized as follows:

Countries play an important role in adopting measures intended to decrease CO_2 emissions, not only in the aviation sector but also in other agreements and the Kyoto Protocol or the Paris Agreement. Industrialized countries must do more about carbon abatement. In emerging economies, aviation is quite important; therefore, the benefits are a significant concern if aviation is to be capped.

Global blending mandates could be positive when opening new business possibilities because two of the main markets (i.e., the United States and Europe) are transitioning to blending mandates, subsidies, and carbon credits. There is a new business opportunity to move in this optimistic direction to decarbonize aviation.

We should not be overly optimistic about SAFs. Even though this direction is good, and aviation could benefit from it, it is not enough, and it represents only a 2 to 3% change globally. Moreover, aviation should take two or three other steps before considering alternatives. For instance, we can investigate the use of high-speed rail (HSR). Some countries such as Norway are unsuitable for HSR, but in China, Korea, Japan, and Europe, it is beneficial, especially for trips of up to three hours, and it is very convenient. Therefore, we should consider alternative modes. Additionally, short-haul flights could be electric or hydrogen driven.

There are different markets, and it is important to distinguish and differentiate future prospects. Hydrogen can be a solution, but there are certain places or segments where it is not, and SAFs may be the only alternative. Different airlines from different parts of the world have different perspectives. Currently, an increasing number of airlines are focused on sustainability compared to previous years, not only in Europe but also in the United States. They are considering CO_2 emissions reductions, so airlines will very soon push these initiatives through themselves because of customer demand.

Future aviation demand until 2050 will come mainly from high-growth emerging economies, and Europe and North America will have little growth. Considering that emerging economies will grow in the future, the main concern is how decarbonization technology will be applied in terms of their ability to afford it and either the impact on the government budget or passing it on to customers. Having a zero-emission airplane by 2030 will already be too late for the climate challenge, so aviation needs to include practical solutions by supporting technology that already exists, such as CCUS. Technology for aviation is expensive, but carbon reductions could also be realized outside the sector, as applied through the EU Emissions Trading System (EU ETS), which has connected electricity generation, markets, and aviation. From the economic point of view, it is promising because CO_2 reductions will be able to be made at the lowest cost in comparison to technology costs, and positive externalities, such as trade, tourism, and wider economic benefits, will impact the overall economy.

The aviation industry is focused on what consumers truly want, and for this reason, how to allocate efforts to the trading scheme and technology should be considered. For instance, in the car industry, some countries are incentivizing the trend through EV markets, whereas some conventional car industries do not do so because they are focused on other concerns.

Forecasting aviation and its outlook calls for action. We can use the forecast to do things within that forecast or that future that we envision, even if we have limitations. Therefore, it is expected that customers will seek another way forward, as they have done in the car sector. It is also very important to consider that we cannot examine any sector individually. For example, we cannot just consider aviation and say that it needs to curb emissions, and that will be the solution. Instead, we need to think about the additionality of emissions. For instance, not flying may involve more emissions from using cars, even if they are electric, and if the electricity comes from a dirty source of energy, then additional emissions are involved. Therefore, we need to take a systemic view of aviation and analyze the entire global system.

The aviation sector needs the right type of challenge and innovation. For instance, 50 years ago, low-cost carriers (LCCs) created a large disruption event, and the expected future growth will probably be concentrated on this market. Therefore, innovation in aviation will be completely different from what we know thus far, as markets that have not been important because of the duopoly between Airbus and Boeing are becoming more visible.

In the future, there will be many uncertainties regarding technology, operations, customers, and infrastructure, but we will need to consider measures at the country or regional level to determine how they can be applied to reduce CO_2 emissions. Stakeholders may be concerned if they must follow the same arc as that in Europe or perhaps in other countries.

Since aviation is a global industry, when something happens in one region, it will have a snowball effect and will be implemented elsewhere. In countries where sustainability is not the main issue or priority, they will not create a profitable business by considering only the domestic markets. In conclusion, airlines in countries where sustainability is not an issue will connect in the US or Europe, where customers who are more sensitive will drive them to take action.

Airlines have a natural incentive to operate more efficient aircraft because they are simply cheaper, reducing fuel consumption, especially in the current environment of high oil prices. However, these responses to every environmental concern do not yet differ . In addition, European airlines probably use the environment as an argument, for instance, in traffic rights negotiations, when they argue that the government allows traffic rights only when they follow environmental and social rules. That is an issue to keep in mind when countries interested in establishing a foothold in Europe must carefully consider these regulations in Europe or in other parts of the world. Therefore, if European governments establish certain environmental requirements in traffic negotiations or create prerequisites for entry into these markets, the benefits of applying environmental rules that are not too expensive overall for obtaining additional market access will likely be much higher.

Regarding other proposals from the European Commission for applying a blending mandate, airlines should be required to refuel at EU airports since practices such as tankering are no longer allowed. Even though it is the right of European countries to do so, European airlines would probably pay additional fees to meet local requirements.

About the Workshop

KAPSARC hosted a workshop with guest participants from academia, research centers, and the aviation industry. The speakers addressed the challenges of CO_2 emissions reduction progress and future achievement of targets and goals for the aviation industry, including technological, operational, infrastructure, and industry perspectives. They aimed to provide insights into the different challenges that aviation worldwide is facing to become a more sustainable transport mode.

List of participants

This webinar was held with participants from academia, the aviation industry, market researchers, and researchers:

- **Fahad M. Alturki –** Vice President of Knowledge & Analysis, KAPSARC
- **Wouter Dewulf –** Academic Director, Master in Maritime and Air Transport Management, University of Antwerp, Belgium
- **Wolfgang Grimme –** Project Manager, German Aerospace Center (DLR), Cologne, Germany
- **Andres Felipe Guzman –** Research Fellow, Transportation and Infrastructure, KAPSARC, Saudi Arabia
- **Edgar Jimenez Perez –** Lecturer in Air Transport Management, Centre for Air Transport Management, Cranfield University, United Kingdom
- **Andreas Kollbye –** Chief Executive Officer, Wideroe Zero Airline, Norway
- **Paul McConnell –** Executive Director, Climate and Sustainability, S&P Global Commodity Insights, United Kingdom
- **Moderator: Anvita Arora –** Program Director, Transportation and Infrastructure, KAPSARC, Saudi Arabia

Notes

About the Team

Anvita Arora

Anvita is Program Director for Transportation and Infrastructure at KAPSARC. Previously, she was the CEO of Innovative Transport Solutions. Anvita holds a Ph.D. from the Indian Institute of Technology Delhi, India.

Andres Felipe Guzman

Andres Felipe is a Fellow at KAPSARC, working on the future of aviation energy demand. He has previously worked as a professor, researcher, and consultant. His research interests include assessing the economic impact of transport policies/ economics, the macroeconomic impact of transport policies, and energy-related decisions.

Abdulrahman Alwosheel

Abdulrahman is a research associate at KAPSARC. He worked as a lecturer at the College of Engineering at Muhammed Ibn Saud University and as a traffic engineer at the Riyadh Metro project. His interests are transport demand, choice modeling, transport economics, and energy demand modeling.

About the Project

The KAPSARC Aviation Model project objective is to analyze the main drivers of energy demand in the aviation sector and assess energy concerns by considering the current and future use of fossil-based and non-fossil-based fuels. Aviation is a key transport mode worldwide because it provides essential travel routes and generates economic growth in many related sectors. Therefore, a better understanding of aviation in countries such as Saudi Arabia is necessary to illustrate how aviation policy decisions are framed so that they can continue to be a catalyst for such countries' development. This project explores current and future aviation and energy demand scenarios to generate policy-relevant insights. Issues related to aviation performance, energy demand, and consumption create a need to develop better management tools and methodologies for data, models, and technologies.

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