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EUROPEAN UNION

# Shifting Away from a Fossil Fuel- Intensive Airline Industry in the European Union:

Interventions, Feasibility, and  
Global Responsibility Analyses  
and Recommendations for the  
European Commission

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**Table of Contents:**

- I. Executive Summary**
- II. Introduction**
- III. Analysis**
  - A. Specific Measures**
    - 1. Current Policy Proposals**
    - 2. Aircraft Architecture**
    - 3. Alternative Fuel Sources**
    - 4. Air Traffic Infrastructure**
    - 5. Addressing Airlines**
    - 6. Train Networks and Feasibility of Switching**
  - B. Likelihood of Compliance**
  - C. Global Impact and Leading by example**
    - 1. Aid to Developing Countries**
    - 2. Accounting for Unforeseen Consequences**
      - a. Electric Cars**
      - b. Accounting for “Hidden” Emissions**
- IV. Recommendations**
  - A. Shifts in Technology**
  - B. Infrastructure Modernization**
  - C. Business Regulation**
  - D. High Speed Rail**
  - E. Aid to Developing Countries**
  - F. Accounting for Unforeseen Consequences**
- V. Conclusion**
- VI. Acknowledgements**
- VII. Bibliography**

## Executive Summary:

In this report, our Policy Team presents several options for the European Union to implement initiatives to decrease greenhouse gas emissions from the airline industry and investigates the feasibility of switching to other modes of transportation. We begin with an introduction to the impact of airline industry emissions, and the motivation behind our research question considering the significance of these emissions in the European Union. The first section of analysis focuses on possible interventions available that could be used to reduce emissions by either altering the airline industry's infrastructure, incentivising the development and usage of less greenhouse gas intensive air travel technology and behavior, or decentering air travel in relation to ground-based transportation. The second section analyzes the probability of EU states accepting the interventions given geopolitics, access to resources, concerns of competition in the airline industry, and France's ban on short haul flights. The third section of analysis details the EU's global responsibility to provide aid to developing countries and to account for outsourced emissions as part of the EU's total emissions. In the recommendations section, we synthesize the most feasible actions going forward relative to each prior section of analysis.

## Introduction:

This policy paper aims to address one of the most significant sources of greenhouse gas emissions in the European Union and around the world, the airline industry. It's crucial to target transportation emissions because they can be altered with new technology and policies. The impact of the transportation industry in the E.U. is clear with 26% of the total greenhouse gas emissions in the EU-27 member states coming from the transport segment in 2017, and 4% specifically from aviation (MDPI). It is even more alarming that the levels of greenhouse gases have continued to rise in recent years. In 2018, there was a 27.6% increase from 2013 levels, with 144 million tonnes of carbon dioxide emitted from EU Aviation (euagenda). In addition, the increase in greenhouse gas emissions is not limited to one country. From 2012 to 2018, there was an increase in aviation greenhouse gas emissions for almost all member states. The largest increases occurred in Hungary (+157%), Lithuania (+91%) and Bulgaria (+77%) the highest levels overall were in Germany, then France, Italy, Poland, and Spain.

Although carbon dioxide is known to be the most impactful greenhouse gas emitted from aircraft, there are several other particulates that contribute to the worsening situation of the atmosphere's chemistry. Radiative forcing is a combination of emissions from carbon dioxide, NO<sub>x</sub> (sum of tropospheric O<sub>3</sub>, methane, and decrease in ozone), emissions of water, formation of persistent linear contrails, aviation-induced cloudiness, emission of sulphate particles, and emission of soot particles.<sup>1</sup> What makes aviation stand out from other areas of the transportation industry is the fact that these emissions are directly deposited into the atmosphere 8-12 kilometers high. The resulting pollution and increased global warming effects have catastrophic implications for the future of the world. Soots and sulphates from aircraft emissions, for example, pose a risk to human health as they accumulate in the atmosphere.

Not only is there a direct impact from pollution to human health, but the effects of climate change have the potential to span several critical sectors such as agriculture. Potential impacts of climate change include sea level rise devastating major cities and coastlines around the world, extreme weather, declining human health, increasing frequency of natural disasters, and threat to food security as biodiversity is lost.

It is a critical time for the European Union to take the opportunity at hand with the green deal to introduce policies that can most effectively ameliorate the existing environmental damage, and be the first to take the necessary steps to a safer and healthier future for the global population. The target areas for policy are numerous, but the path of least opposition from member states must be taken in order to promote full compliance.

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<sup>1</sup> David S. Lee et al., "Aviation and Global Climate Change in the 21st Century," *Atmospheric Environment* 43, no. 22-23 (July 2009): pp. 3520-3537, <https://doi.org/10.1016/j.atmosenv.2009.04.024>.

## Analysis:

### Specific Measures

#### Current Policy Proposals

Current proposals for addressing the carbon footprint of the air industry seek to maintain standards of air travel while making it more efficient and carbon neutral. These efforts are centered around the European Commission's "Fit for 55" package. This proposal calls for a 55% reduction in the airline industry's carbon emissions by 2030.<sup>2</sup> The primary objective is to increase the usage of sustainable aviation fuels (SAF) across EU airports. These include advanced biofuels and synthetic aviation fuels. If this regulation was implemented, the required share of SAF supplied in 2025 would be 2%, ramping up to 5% in 2030, and 63% by 2050. Within this framework, additional obligations or incentives would include requirements of minimum SAF usage by individual airlines, penalties for noncompliance by fuel suppliers and airlines, and mandatory audits on airline practices by currency existing EU agencies.<sup>3</sup>

In addition, the Fit for 55 package includes regulations to prevent the practice of fuel tankering. This is where aircraft refuel with more fuel than needed for the immediate flight, so as to avoid paying higher fuel costs at a destination airport. This increases the per-unit emissions of the flight, as additional energy/fuel is needed to lift the increased weight of extra fuel. Thus, the Fit for 55 regulations mandates that the yearly quantity of aviation fuel uplifted at any EU airport is at least 90% of the fuel required. In addition, this increases competition between EU airlines, as operators based in states with low fuel costs can currently exploit these cheap fuel prices via tankering between destinations.

#### Aircraft Architecture

Looking to technology provides insight for additions that can be made to these existing policies. With so many possibilities for modifications that could be made, it is critical to consider which are the most efficient and cause minimal environmental damage. When considering possible technological mandates, there are three main areas ideal for modifications to the architecture of aircraft. This includes reducing basic aircraft weight, improving aircraft aerodynamics to reduce drag, and improving specific engine efficiency to reduce fuel burn per

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<sup>2</sup> "RefuelEU Aviation — Sustainable Aviation Fuels," European Parliament. October 21, 2021. <https://www.europarl.europa.eu/legislative-train/api/stages/report/current/theme/a-european-green-deal/file/refueleu-aviation>.

<sup>3</sup> "Regulation of the European Parliament and of the Council on Ensuring a Level Playing Field for Sustainable Air Transport," European Commission. August 14, 2021. [https://ec.europa.eu/info/sites/default/files/refueleu\\_aviation\\_-\\_sustainable\\_aviation\\_fuels.pdf](https://ec.europa.eu/info/sites/default/files/refueleu_aviation_-_sustainable_aviation_fuels.pdf).

unit thrust.<sup>4</sup> Outside of redesigning aircraft, there is potential to switch fuel sources to options that release minimal greenhouse gases as prioritized in the “Fit for 55” package.

Shifting the design of airlines becomes a complex issue since the turnover for updating planes can be relatively long. The product life cycles can range from 30 to 50 years.<sup>5</sup> As a result, it’s important to make well-thought out decisions when it comes to updating aircraft since the decision will be long-lasting. With this depth of impact also comes the potential to provide for long-lasting decreases in emissions.

Weight reduction can be accomplished through the introduction of light-weight alloys and composite materials.<sup>6</sup> The advantages of taking a more technologically focused approach to redesigning the airline industry is that companies tend to be more receptive to updating their equipment and increasing efficiency since it usually comes with financial benefits.

Drag reduction is another possibility for modification. Friction drag in particular is promising for improving with cutting-edge designs such as the blended-wing-body airframe layout which minimizes aircraft surfaces that do not directly contribute to lift.<sup>7</sup> With making these modifications to aircraft, airlines will need to consider what passenger preferences will be. A critical component of running an airline is hospitality, and with some designs, there is a possibility of losing some aspects of the experience such as windows.

Engine design can go in many directions whether that be alterations to materials, coatings, combustion-techniques, sensors, and cooling techniques, alternative propulsion or open-rotor engines.<sup>8</sup>

Overall, technology improvements in architectural design of aircraft are promising. Assuming all new aircraft would incorporate these features, over 5 years, a reduction of 6% could be observed in carbon dioxide emissions.<sup>9</sup>

### **Alternative Fuel Sources**

The current conventional jet-fuel is mineral kerosene, but examples of alternatives include liquefied hydrogen, methane, methanol, ethanol, bio-diesel (methyl esters) from processing plant-oils and animal-fats, nuclear power, synthetic paraffinic kerosene created by feedstocks of biomass natural gas or coal or hydroprocessing of plant-oils and animal-fats (HEFA)).<sup>10</sup> While there are many alternative fuels, some come with considerable drawbacks such as considerable land use or other harmful emissions.

Biofuels are known for having potentially harmful effects on the environment. Many require a large area of land that further puts stress on the environment as land is converted and carbon sinks such as trees may be further decreased. They could also increase nitrous oxide (a

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<sup>4</sup> Matt Grote, Ian Williams, and John Preston, “Direct Carbon Dioxide Emissions from Civil Aircraft,” *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

<sup>5</sup> Ibid.

<sup>6</sup> Ibid.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> Ibid.

<sup>10</sup>Ibid.

greenhouse gas) emissions.<sup>11</sup> Algae is an example of a biofuel that may have a beneficial impact on the environment. They have high energy and oil-yields while also absorbing carbon dioxide.<sup>12</sup> Since the metabolism of algae requires carbon dioxide, it helps to extract carbon dioxide from the environment, which is a benefit on its own, in addition to providing a cleaner source of energy.

Another popular alternative fuel source is hydrogen. Literature has an overwhelmingly positive outlook on the use of hydrogen for powering aircraft efficiently. It comes with many advantages as it is easy to extract for use and has no directly negative effects on the environment. Unlike kerosene, hydrogen does not release toxic gases such as NO<sub>x</sub> or SO<sub>x</sub> when combined with oxygen.<sup>13</sup> Apart from avoiding emissions of harmful pollutants, hydrogen power holds much technological promise as it is applicable on an industrial scale and can be easily attained. Hydrogen is one of the most prevalent elements on Earth, making it easier to obtain and minimizes energy expenditure when collecting it. It can easily be extracted from water or biomass and stored in either solid, liquid, or gas form.<sup>14</sup> This flexibility gives it a major advantage over other forms of fuel which may require specific and difficult conditions to be kept to preserve it. It can produce 2.75 times more energy than hydrocarbons and can either be used to replace kerosene fuel or in cells to replace jet engines.<sup>15</sup> These fuel cells convert chemical fuel into heat and electricity that can be used as an alternative form of power. Implementation would require normal aircraft to be electrically operated with modern electric motors and accumulators would be charged with energy obtained by burning hydrogen.<sup>16</sup> Today's hydrogen aircraft are built for using liquid hydrogen fuel, but with the turnover time for replacing and updating planes, modern electric motors and accumulators could be incorporated into modern aircraft.

Some disadvantages of using hydrogen power include inefficiency on the industrial scale compared to nuclear fuel and storage. Hydrogen is notably heavy and might require an influx of energy to be exerted for its transport. For example, Toyota reports having an efficiency of 5.7% by holding 5.7 kg of gaseous hydrogen in a 100 kg tank.<sup>17</sup> Despite these drawbacks, hydrogen may be a viable option for shifting fuel sources of aircraft.

Other concerns with alternative fuel sources include costs, lack of fuel production and delivery infrastructure, requirement for larger fuel-tanks and larger fuselage volumes, subsequent increased weight and drag, low energy densities, and safety concerns.<sup>18</sup> Safety concerns come

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<sup>11</sup>Matt Grote, Ian Williams, and John Preston, "Direct Carbon Dioxide Emissions from Civil Aircraft," *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

<sup>12</sup> Ibid.

<sup>13</sup> Relly Victoria Petrescu et al., "Hydrogen for Aircraft Power and Propulsion," *International Journal of Hydrogen Energy* 45, no. 41 (August 21, 2020): pp. 20740-20764, <https://doi.org/10.1016/j.ijhydene.2020.05.253>.

<sup>14</sup> Relly Victoria Petrescu et al., "Hydrogen for Aircraft Power and Propulsion," *International Journal of Hydrogen Energy* 45, no. 41 (August 21, 2020): pp. 20740-20764, <https://doi.org/10.1016/j.ijhydene.2020.05.253>.

<sup>15</sup> Ibid.

<sup>16</sup> Ibid.

<sup>17</sup> Germain Jaillier, Mathieu Bouchard, and David Rancourt, "Performance Analysis of a Hydrogen Fuel-Cell Powered General Aviation Aircraft," n.d.

<sup>18</sup> Ibid.

with any adjustment to a new fuel source, including those from the public about how this will apply to their travel.

Another key note to make is that as fuel efficiency increases, it becomes difficult to minimize the increase in NO<sub>x</sub> formation.<sup>19</sup> NO<sub>x</sub> is composed of other greenhouse gases although they don't include carbon dioxide. NO<sub>x</sub> is defined by three component terms: production of tropospheric O<sub>3</sub> (positive RF); a longer-term reduction in ambient methane (CH<sub>4</sub>) (negative RF), and a further longer-term small decrease in O<sub>3</sub> (negative RF).<sup>20</sup> One risk of nitrous oxide is its potential to form tropospheric ozone and acid rain.<sup>21</sup> Although ozone high in the atmosphere is critical for shielding the earth from aggressive ultraviolet rays, ozone in the troposphere can be detrimental to human health. In fact, there is a specific standard listed by the United States' Environmental Protection Agency that should not be passed. The standard is currently set at .053 parts per million.<sup>22</sup> Potential adverse effects of acid rain from nitrous oxide is also a serious issue since entire ecosystems can be destroyed by an altered pH, which will eventually lead to direct effects on the economy as well.

Sulfur oxides are another serious pollutant that contribute to both harmful health and environmental effects if released into the atmosphere by kerosene. This includes adding particulate matter to the air that damages the lungs when inhaled or damaging foliage and decreasing growth of trees.<sup>23</sup>

### **Air Traffic Infrastructure**

Along with improvements to the technology of the flights themselves, critical initiatives to decrease the environmental burden of air travel focus on modernizing air traffic management (ATM) infrastructure.<sup>24</sup> This will enable emissions reduction by allowing aircraft to fly environmentally optimal routes, with minimal waste. Current estimates state that at least 6.2 million metric tons of CO<sub>2</sub> emissions could be saved by 2050 if immediate investments are made in ATM infrastructure. These initiatives are outlined in the Single European Sky (SES) program.<sup>25</sup> Air traffic management inefficiency can increase flight distances by an average of 9-10% based on studies of the European route network.<sup>26</sup> Clearly there is a necessity to decrease emissions from traveling unnecessary distances associated with management inefficiency. One

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<sup>19</sup> Germain Jaillier, Mathieu Bouchard, and David Rancourt, "Performance Analysis of a Hydrogen Fuel-Cell Powered General Aviation Aircraft," n.d.

<sup>20</sup> David S. Lee et al., "Aviation and Global Climate Change in the 21st Century," *Atmospheric Environment* 43, no. 22-23 (July 2009): pp. 3520-3537, <https://doi.org/10.1016/j.atmosenv.2009.04.024>.

<sup>21</sup> "Nitrogen Oxides (NO<sub>x</sub>): Why and How They Are Controlled," Nitrogen Oxides (NO<sub>x</sub>): Why and how they are controlled § (1999).

<sup>22</sup> Ibid.

<sup>23</sup> "Sulfur Dioxide (SO<sub>2</sub>) Pollution," EPA (Environmental Protection Agency), accessed November 12, 2021, <https://www.epa.gov/so2-pollution/sulfur-dioxide-basics>.

<sup>24</sup> "Aviation Sustainability Briefing," Eurocontrol. October 2021.

<https://www.eurocontrol.int/sites/default/files/2021-10/eurocontrol-aviation-sustainability-briefing-edition-4.pdf>.

<sup>25</sup> "'Now or Never' For Single European Sky," International Air Transport Association. April 20, 2021.

<https://www.iata.org/en/pressroom/pr/2021-04-20-02/>.

<sup>26</sup> Matt Grote, Ian Williams, and John Preston, "Direct Carbon Dioxide Emissions from Civil Aircraft," *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

specific issue, a lack of airport capacity, leads to an average of 160 kg of carbon dioxide emissions for each minute spent flying in a holding-pattern awaiting a landing spot.<sup>27</sup>

Two primary goals are to expand capacity and increase flexibility of route management. Expanding the capacity of flights an ATM center can handle will reduce the wasteful consumption of airspace and fuel when planes are either idling on the ground or flying holding patterns as they wait to land.<sup>28</sup> Furthermore, greater flexibility of route management and decreased heterogeneity in airspace rates will allow planes to fly the shortest feasible routes possible, thus reducing overall fuel consumption.<sup>29</sup>

In addition, the above-mentioned technological developments will require additional modernization to allow ATM to better allocate airspace for more technologically advanced aircraft.<sup>30</sup> For instance, super-high altitude aircraft, operating above FL600, will need special care in planning their ascent and descent while being cognizant of traffic below, which will strain conventional air traffic management resources.

Another modification that can be made to operational procedures for aircraft is with adjusting requirements for separation while in the air. Unnecessary long distance requirements could be another factor contributing to longer routes that increase emissions. Studies show that a reduction in the vertical separation minimum reduces fuel-use.<sup>31</sup> Not only does reducing fuel use benefit the environment, but also potentially the airline itself as it is spending less money on fuel for a given route. This could be a favorable and well-accepted policy change.

### **Addressing Airlines**

Beyond improving airline infrastructure, it is key that policy interventions incentivize the development and usage of carbon neutral or less carbon intensive air travel technology and airline behavior. The straightforward approach would be through a tax scheme scaled to per-unit carbon emissions of a flight. Currently, both business and cargo flights are exempt from aviation fuel tax proposals.<sup>32</sup>

However, such tax schemes have faced pushback from both industry groups and climate activists. Airlines For Europe, an industry trade group, has stated that tax-based climate policy is counterproductive, as even if these taxes are reinvested in decarbonization projects, they divert investment and innovation capacity in low-carbon technology; they recommend subsidizing the

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<sup>27</sup>Matt Grote, Ian Williams, and John Preston, "Direct Carbon Dioxide Emissions from Civil Aircraft," *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

<sup>28</sup> "The Funding of Air Navigation Services," Eurocontrol, Central Route Charges Office, October 21, 2021. <https://www.eurocontrol.int/sites/default/files/2021-10/eurocontrol-think-paper-14-future-system-route-charges.pdf>.

<sup>29</sup>Ibid.

<sup>30</sup>Tatjana Bolić and Paul Ravenhill, "SESAR: The Past, Present, and Future of European Air Traffic Management Research," *Engineering* 7, no. 4 (2021): 448-451. doi: 10.1016/j.eng.2020.08.023.

<sup>31</sup> Matt Grote, Ian Williams, and John Preston, "Direct Carbon Dioxide Emissions from Civil Aircraft," *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

<sup>32</sup> "Corporate jets to escape EU's 'green' aviation fuel tax," *The Irish Times*. July 13, 2021. <https://www.irishtimes.com/business/transport-and-tourism/corporate-jets-to-escape-eu-s-green-aviation-fuel-tax-1.4618545>.

development of such technology.<sup>33</sup> However, climate activists point out that these types of subsidies for air travel sets the wrong precedent, as they nevertheless fund carbon-generating activities.<sup>34</sup>

In considering the equity questions raised by reducing airline demand, it is important to address the fact that rural communities are often more dependent on air transportation for connection and business than urban ones.<sup>35</sup> Recently, the job of distributing health care goods to rural communities in the EU has been borne by air transport.<sup>36</sup> Conversely, flying is one of the most carbon-intensive activities individuals from the developed world can participate in. For example, a San Francisco to London flight emits an equivalent 5.5 metric tons of CO<sub>2</sub> per person, compared to the annual equivalent per person emissions of just 4.8 metric tons.<sup>37</sup> Moreover, only 1% of the world's population contributes to 50% of flight emissions.

### **Train Networks and Feasibility of Switching**

Long-term measures for mitigating the adverse environmental effects of airlines will require decreasing the use of air travel as a substitute for ground-based transportation, such as buses or rail. Trains tend to generate less carbon dioxide on a per-passenger basis compared to planes.<sup>38</sup>

In this sense, the EU represents a promising region for further investment into low-carbon transportation modalities, given the existing interconnected rail and ferry network.<sup>39</sup> In considering the potential of rail transportation to be a feasible alternative to short or medium distance air travel, two questions must be addressed: does high-speed rail effectively substitute for air travel, and is it accessible by passengers and across different regions?

Research has found that the development of HSR networks has reduced demand for air transport along certain routes.<sup>40</sup> However, the lower unit capacity of HSR compared to air travel means that mandated phaseouts of short-haul routes will need to be gradual, to allow for a smooth transition. In addition, better estimates are needed to quantify the potential changes in supply and demand for air travel as HSR is phased in, alongside understanding how these

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<sup>33</sup> "A4E's Position on the European Green Deal," Airlines For Europe. October 15, 2020.

<https://a4e.eu/publications/a4es-position-on-the-european-green-deal/>.

<sup>34</sup> Ciara Nugent, "Airlines' Emissions Halved During the Pandemic. Can the Industry Preserve Some of Those Gains as Travel Rebounds?" Time. May 17, 2021. <https://time.com/6048871/pandemic-airlines-carbon-emissions/>.

<sup>35</sup> "Aviation Benefits Report," International Civil Aviation Organization. 2019.

<https://www.icao.int/sustainability/Documents/AVIATION-BENEFITS-2019-web.pdf>.

<sup>36</sup> Isabel García Muñoz, "Green deal for aviation: EU needs to start building a greener, more socially and economically robust future for aviation, argues Isabel García Muñoz," The Parliament. December 22, 2020. <https://www.theparliamentmagazine.eu/news/article/a-green-deal-for-aviation-but-one-with-a-red-heart>.

<sup>37</sup> Nugent, "Airlines' Emissions Halved During the Pandemic," Time.

<sup>38</sup> Dichter, Alex, Kimberly Henderson, Robin Riedel, and Daniel Riefer. "How airlines can chart a path to zero-carbon flying." *McKinsey & Company: Chicago, IL, USA* (2020).

<sup>39</sup> "Sustainable Transport Across Europe," Heinrich Böll Stiftung. 2021.

[https://eu.boell.org/sites/default/files/2021-01/EUMobilityAtlas2021\\_FoldingMap\\_FINAL\\_26Jan.pdf?dimension1=euma2021](https://eu.boell.org/sites/default/files/2021-01/EUMobilityAtlas2021_FoldingMap_FINAL_26Jan.pdf?dimension1=euma2021).

<sup>40</sup> Nicolò Avogadro *et al.* "Replacing short-medium haul intra-European flights with high-speed rail: Impact on CO<sub>2</sub> emissions and regional accessibility." *Transport Policy* 114 (2021): 25-39. doi:10.1016/j.tranpol.2021.08.014.

changes will differ between locales throughout the EU.<sup>41</sup> Note that evaluation of the impacts of banning short or medium distance routes is often based on both travel time increases and cost/service changes, which are hard to quantify *a priori*.

It is also important to consider the potential externalities of increased rail travel. Empirical analysis demonstrates that the development of capacity light rail systems *within* cities has led to less congestion, travel time, and pollution, thus mitigating the negative externalities of car usage.<sup>42</sup> However, it remains to be seen whether the expansion of intercity and continental rail needed to substitute for high-capacity European air routes can be undertaken with minimal adverse effects, e.g. being built upon an environmentally-conscious power infrastructure.

The history of the railway industry is also a factor to consider when reconstructing its organization. The railway sector was formerly monopolistic and experienced stifling competition from other modes in the late 20th century and state-controlled railways were under pressure to.<sup>43</sup> This may be due to government subsidies given to other modes during this time. This paper, “European Railway Deregulation: An Overview of Market Organization and Capacity Allocation”, advised reintroducing vertical separation to foster competition and improve efficiency and quality of the railway sector.<sup>44</sup> This seems to be a logical conclusion given that if there is a reason to appeal to passengers for the sake of beating competition, better services will be provided which will encourage passengers to take trains more.

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<sup>41</sup>Nicolò Avogadro *et al.* “Replacing short-medium haul intra-European flights with high-speed rail: Impact on CO<sub>2</sub> emissions and regional accessibility.” *Transport Policy* 114 (2021): 25-39. doi:10.1016/j.tranpol.2021.08.014.

<sup>42</sup> Xavier Fageda, “Do light rail systems reduce traffic externalities? Empirical evidence from mid-size European cities.” *Transportation Research Part D: Transport and Environment* 92 (2021) 102731. doi:10.1016/j.trd.2021.102731.

<sup>43</sup> Abderrahman Ait Ali and Jonas Eliasson, “European Railway Deregulation: An Overview of Market Organization and Capacity Allocation,” *Transportmetrica A: Transport Science*, 2021, pp. 1-25, <https://doi.org/10.1080/23249935.2021.1885521>.

<sup>44</sup> *Ibid.*

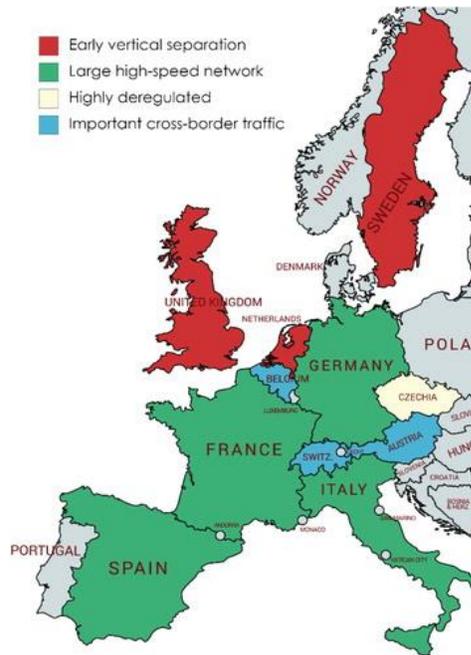


Figure 1: Map of European Railways and prominent features.<sup>45</sup>

Another important note to make with existing transportation firms in the European Union is that there are subsidies provided by Europe’s Public Service Obligation air services to increase air travel access to remote areas. One study found that the outcome of these subsidized services on accessibility are highly variable with only 15% of services appearing to yield accessibility sufficient to justify the corresponding subsidies.<sup>46</sup> This low profitability suggests there is opportunity for a new type of subsidy to provide modes of transportation that connect to rural regions. Railway may be the best option since it would most likely be more cost effective and cause less environmental damage. Criteria for existing air travel subsidies include that there were existing air services before liberalization, a threshold minimum of 10 enplanements per day but not to an extent that it is economically viable on its own.<sup>47</sup> Providing railway subsidies would support the European Commission’s existing initiatives to decrease emissions.

<sup>45</sup> Abderrahman Ait Ali and Jonas Eliasson, “European Railway Deregulation: An Overview of Market Organization and Capacity Allocation,” *Transportmetrica A: Transport Science*, 2021, pp. 1-25, <https://doi.org/10.1080/23249935.2021.1885521>.

<sup>46</sup> Falko Mueller, “Accessibility for Money? an Evaluation of Subsidized Air Transport Services in Europe and the United States,” *Transport Policy* 106 (June 2021): pp. 153-164, <https://doi.org/10.1016/j.tranpol.2021.03.023>.

<sup>47</sup> Falko Mueller, “Accessibility for Money? an Evaluation of Subsidized Air Transport Services in Europe and the United States,” *Transport Policy* 106 (June 2021): pp. 153-164, <https://doi.org/10.1016/j.tranpol.2021.03.023>.

## Likelihood of Compliance

For the EU's Green Deal to succeed in reducing emissions across the European bloc, its framework must take into account the unique set of challenges faced by each individual country. The EU's "Fit for 55" policies aim to reach a 55 percent greenhouse gas reduction target by 2030. They should make air travel relatively more expensive compared to lower carbon rail travel over time by mandating more expensive sustainable aviation fuels and by expanding the scope of aviation subject to EU carbon taxation. These policies will result in very different burdens for different EU Member states depending on their geography, access to sustainable fuel resources, and infrastructure. One-size-fits-all emissions reductions schemes are likely to fail and stoke political backlash. This section analyzes the unique set of challenges facing each country that should be taken into account in ensuring the success of Fit for 55 programs aimed at lowering aviation emissions.

### Sustainable Aviation Fuel

The "Fit for 55" ReFuelEU Aviation proposal imposes increasingly stringent requirements over time on the amount of sustainable aviation fuel that must be blended into jet fuel at EU airports, including a minimum share of synthetic fuel. These requirements are uniform across the EU, even though EU countries differ significantly in their access to quality sources of sustainable aviation fuel and will need varying levels of support to reach the target of 63 percent market share by 2050 from the current share of less than 1 percent today.<sup>48</sup> Currently, sustainable aviation fuel is expensive to produce and has variable quality depending on whether it derives from cooking oil, feedstock, and municipal waste. This leads to significant inequities between EU Member states depending on their access to the technology and raw materials needed to produce sustainable aviation fuel efficiently.<sup>49</sup> For instance, since Greece and Malta have very limited access to sustainable aviation fuel resources while Germany's resources are substantial, the ReFuelEU requirements will impose a greater burden on the Member states that face more transition barriers and are least able to afford it. One way to address these inequities while also achieving the Fit for 55 goals would be to prescribe faster and more ambitious targets for Member states with the greatest capacity. An alternative approach would be to provide subsidies to those Member states that face the greatest challenges to enable them to invest in the necessary technology and access appropriate raw materials.

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<sup>48</sup> Siddarth Vikram Phillip and Ben Elgin, "Airlines Rush Toward Sustainable Fuel But Supplies Are Limited," Bloomberg.com (Bloomberg), accessed December 5, 2021, <https://www.bloomberg.com/news/articles/2021-11-10/airlines-rush-toward-sustainable-fuel-but-supplies-are-limited>

<sup>49</sup> Sean Goulding Carroll, "EU Planning Staggered Increase in Use of Green Jet Fuel," www.euractiv.com (EURACTIV.com, March 16, 2021), <https://www.euractiv.com/section/alternative-renewable-fuels/news/eu-planning-staggered-increase-in-use-of-green-jet-fuel/>.

## **Redistribution to Rail Travel**

By increasing the scope of aviation that is subject to EU carbon taxation and increasing sustainability requirements on aviation fuel over time, the Fit for 55 policies are designed to redistribute travel from aviation to lower carbon rail over time. But these one-size-fits-all taxes and requirements do not take into account that different Member States have different capacities for rail to substitute for air travel, in part reflecting the topography of different countries.<sup>50</sup> In building a railway, engineers must discern how to navigate certain natural barriers with technology and structural alterations, which makes increasing rail infrastructure more expensive and complex in countries with large natural barriers such as mountain ranges and extensive coastlines.<sup>51</sup> Moreover, there are some localities with significant obstacles to railway travel that may not be able to substitute short-haul flights with railways at all, such that their citizens will have no alternative to rising prices for flights and shipping.<sup>52</sup> Even in geographies with a broad network of railways, there will still be considerable challenges in achieving the same coverage and accessibility by rail as is currently available by air.<sup>53</sup> Different EU countries use varying electrification and signaling systems, and the integration of railway systems with varied gauges is difficult.<sup>54</sup> The inequity in railway viability as well as the lack of standardization in infrastructure must be addressed if rail travel is to become a major component of reducing aviation emissions.

## **Why Hasn't a Tax Been Implemented?**

A consideration of what has been implemented by EU members in the past is informative as to the feasibility of future Green Deal initiatives for each state. Currently no European states tax jet fuel in domestic flights, despite having legal authority to do so, although Germany and Sweden have debated doing so.<sup>55</sup> The most frequently expressed concern about taxing jet fuel for domestic flights is the potential loss of competitiveness. The EU Green Deal strives to tax aviation fuel across the EU, but EU airlines are concerned that they will face a competitive disadvantage if foreign airlines don't adopt the same tax. Thus, for the EU to successfully sustain the expansion of taxation to aviation, coordination with countries outside of the EU is necessary.<sup>56</sup>

It is also worth mentioning that taxing kerosene and jet fuel across the EU would require unanimous approval, which is less attainable with the strain of COVID on the economies and

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<sup>50</sup> Jean-Paul Rodrigue, *Geography of Transport Systems* (ROUTLEDGE, 2020), 130-133.

<sup>51</sup> Ibid.

<sup>52</sup> Ludger Sippel et al., *Comprehensive Analysis of the Existing Cross-Border Rail Transport Connections and Missing Links on the Internal EU Borders Annex 3: Fact-Sheets of Each Cross-Border Rail Connection* (Luxembourg: Publications Office, 2018), 33-40.

<sup>53</sup> Ibid.

<sup>54</sup> Ibid.

<sup>55</sup> Sam Morgan, "Taxing Jet-Fuel Still on the Radar, despite Aviation's Virus Woes," [www.euractiv.com](http://www.euractiv.com) (EURACTIV.com, June 22, 2020),

<https://www.euractiv.com/section/aviation/news/taxing-jet-fuel-still-on-the-radar-despite-aviations-virus-woes/>.

<sup>56</sup> Henry Bewicke et al., "How a Jet Fuel Tax Would Impact European Airlines," *Simple Flying*, December 1, 2019, <https://simpleflying.com/eu-jet-fuel-tax/>.

political systems of the smaller states. Air travel has already been hit by the pandemic. On top of this, a 33 cent per liter aviation fuel tax is likely to increase airline ticket prices by 10 percent, which is projected to reduce air travel by 11%.<sup>57</sup> Thus, each EU Member state will have to weigh the 11% reduction in travel and the associated emissions against the potential backlash. In order to get every country on board, the EU will have to determine how they can use the revenues from the new tax to aid the most disadvantaged citizens, effectively creating a safety net in proportion to the risk.

### **Past Policies to Replace Air Travel with Rail**

It is instructive to study previous European efforts to replace air travel with lower carbon rail as the EU moves forward on its “Fit for 55” transportation policies. In April 2021, France banned all flights equivalent to train rides up to 2 hours and 30 minutes in length, down from a more controversial proposal to ban flights equivalent to all train rides up to 4 hours.<sup>58</sup> This ban was not applicable to hubs with connecting flights, so it omitted many short haul flights. Moreover, many pointed to the limited effect on carbon emissions given that short-haul flights only account for 4% of European aircraft emissions whereas long-haul flights account for 52%.<sup>59</sup> In addition, some critics pointed out that decarbonizing aviation would need to start with testing on short-haul flights so that banning short haul flights may actually hinder the development of green fuel technologies.<sup>60</sup>

On the other hand, the short haul flight ban is viewed favorably by other EU countries including Austria, Germany, and Spain. In fact, Germany’s Green Party aims to ban short-haul flights by 2030. And the EU as a whole is striving to offer carbon neutral alternatives to these short-haul flights with an emphasis on the development of high-speed rail. Countries like Italy and Norway have emphasized the importance of building up alternative transportation options for short-haul travel before banning short haul flights.<sup>61</sup> If railways are the only viable option, there is a risk they could charge more and reduce the quality of their service, unless there is a regulated, coordinated approach.<sup>62</sup>

More broadly, it will be important to expand and improve alternative modes of lower carbon travel as a substitute for air travel. The lack of alternatives for long haul travel highlights the importance of investing in research and development on more sustainable solutions.

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<sup>57</sup>Henry Bewicke et al., “How a Jet Fuel Tax Would Impact European Airlines,” Simple Flying, December 1, 2019, <https://simpleflying.com/eu-jet-fuel-tax/>.

<sup>58</sup> Ilaria Grasso Macola, the Airport Technology team, and Ilaria Grasso Macola, “France Bans Short-Haul Flights: Industry Reacts,” Airport Technology, April 14, 2021, <https://www.airport-technology.com/features/france-bans-short-haul-flight-industry-reacts/>.

<sup>59</sup> Ibid.

<sup>60</sup> Ibid.

<sup>61</sup> Benjamin Walther, “Germany, Spain, or the Entire EU? Who's next to Ban Short-Haul Flights after France?,” Information Design, July 14, 2021, <https://www.id1.de/2021/05/21/germany-spain-or-the-entire-eu-whos-next-to-ban-short-haul-flights-after-france/>.

<sup>62</sup> Mari Eccles, “Short-Haul Flights under Fire,” POLITICO (POLITICO, October 15, 2021), <https://www.politico.eu/article/travel-short-haul-flights-europe-under-fire-climate-change-cop26/>.

# Global Impact and Leading by Example

## Aid to Developing Countries

This section will place the European Union in a global context, especially regarding the continent's responsibility to developing nations. These nations require aid to recover from climate crises, safeguard against future ones, and transition to more environmentally friendly practices. As the European Union works to decarbonize within its borders, it must look globally as well—and not just in the context of airline travel. The climate crisis is a global issue, and global cooperation is necessary to combat it. To help those hit hardest by climate change and ensure that all countries move in a sustainable direction, the European Union must act in a leadership capacity and bolster nations who require more assistance. After all, much of the developing world needs to address basic necessities—such as economic stability in the face of climate change—before it can contribute to the decarbonization of the airline industry.

Firstly, the European Union owes climate aid to developing countries. Not only does the EU have a moral obligation to assist poorer countries; in multiple regards, many EU powers are responsible for these nations' vulnerability to climate change. For example, colonialism and other forms of domination and intrusion by (now) EU powers have exacerbated both poverty and dependency on non-renewable energy.<sup>63</sup> Centuries of colonialism stripped countries of material wealth, political autonomy, and educational opportunities; therefore, poverty and instability are enduring legacies of these hegemonies. "Poverty, low levels of education and limited human, institutional, economic, technical and financial capacity" make poorer countries less equipped to fend off climate change's adverse effects.<sup>64</sup> Consequently, when natural disasters--stemming from climate changes--decimate poorer countries, it is much harder for them to rebuild at all (much less "sustainably"), and such destruction to "farms, schools, small businesses and homes" makes destitute conditions even worse.<sup>65</sup> For example, loss of farms may damage farmer income and food availability, while loss of schools restricts educational opportunities, making it difficult for citizens to pursue higher-paying jobs and for governments to combat climate change through research and innovation. For example, rising ocean temperatures catastrophically hurt food production in Ethiopia and Somalia about ten years ago, and citizens in these countries starved.<sup>66</sup> Therefore, the EU's complicity in the climate change vulnerability of developing countries cannot be ignored.

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<sup>63</sup> Greiner, Patrick Trent. "How Colonialism's Legacy Makes It Harder for Countries to Escape Poverty and Fossil Fuels Today." *The Conversation*, June 28, 2021.

<https://theconversation.com/how-colonialisms-legacy-makes-it-harder-for-countries-to-escape-poverty-and-fossil-fuels-today-159807>.

<sup>64</sup> Deutscher, Eckhard. *Development Co-Operation Report 2010*. OECD ILibrary. Paris: OECD, 2010.

<https://doi.org/10.1787/dcr-2010-en>.

<sup>65</sup> Dasgupta, Ani. "Will Recent Extreme Weather Spur More Climate Finance from Wealthy Nations?" World Resources Institute, August 3, 2021. <https://www.wri.org/insights/extreme-weather-climate-finance-wealthy-nations>.

<sup>66</sup> Dasgupta, Ani. "Will Recent Extreme Weather Spur More Climate Finance from Wealthy Nations?" World Resources Institute, August 3, 2021. <https://www.wri.org/insights/extreme-weather-climate-finance-wealthy-nations>.

(The extent to which certain EU powers have benefited from colonialism is difficult to quantify. However, some measure of variation can be drawn from the logic that degree of colonialism corresponds with degree of wealth extracted from colonized countries. Therefore, the wealth of EU powers with a history of colonialism—such as France, Germany, and the Netherlands—can be partially attributed to that colonial history. By making the amount of aid each EU power is required to provide to developing countries dependent on national wealth, the largest beneficiaries of colonialism would likely end up providing the most compensation. Albeit imperfect, making mandatory aid proportional to national wealth would help justly distribute responsibility for colonialism among EU members.)

Not only is the EU complicit from a colonial perspective; the emissions of the EU and other developed countries are primarily responsible for the climate crisis and its disproportionate impact on poorer countries.<sup>67</sup> Therefore, recent "decreasing focus on the poorest countries...[and] adaptation" and consequently fewer grants and more loans for climate support is particularly problematic.<sup>68</sup> The EU should not be able to profit from the detrimental effects of its own carbon emissions on developing countries through interest from loans.<sup>69</sup> An analogous situation would be one person destroying another's home and then charging him rent on tools to rebuild it. Developing countries also struggle to repay these loans, which can plunge them further into poverty.<sup>70</sup> The European Investment Bank wants to offer loans, yet these typically go to "projects promoting mitigation" in wealthier nations; essentially, EU financial institutions view mitigation projects as more lucrative.<sup>71</sup> As of 2019, adaptation initiatives get \$22 billion annually, compared to \$436 billion for mitigation.<sup>72</sup>

First, financial gain should not be the primary focus of climate aid; exploiting climate crises in developing countries is a climate brand of colonialism, especially egregious given the residual effects of historical colonialism. Second, even if EU banks are not convinced by these moral issues, they should consider how adaptation initiatives can lay the groundwork for mitigation projects down the road--"financing adaptation offers significant [indirect] returns in sustainable development and poverty eradication...which are also a condition for some mitigation efforts to really take off."<sup>73</sup> This "poverty eradication" would also have reverberating

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<sup>67</sup> Faber, Floris, and Mattias Söderberg. "Developing Countries Deserve Fair and Transparent Climate Support from the EU ." [www.euractiv.com](https://www.euractiv.com). EURACTIV.com, September 4, 2020. <https://www.euractiv.com/section/climate-fund/opinion/developing-countries-deserve-fair-and-transparent-climate-support-from-the-eu/>.

<sup>68</sup> Ibid.

<sup>69</sup> Ibid.

<sup>70</sup> El Gharib, Sarah. "Rich Countries Have a 'Responsibility' to Fund Climate Efforts. Here's Why." Global Citizen, June 1, 2021. <https://www.globalcitizen.org/en/content/international-climate-finance-explainer/>.

<sup>71</sup> Faber, Floris, and Mattias Söderberg. "Developing Countries Deserve Fair and Transparent Climate Support from the EU ." [www.euractiv.com](https://www.euractiv.com). EURACTIV.com, September 4, 2020. <https://www.euractiv.com/section/climate-fund/opinion/developing-countries-deserve-fair-and-transparent-climate-support-from-the-eu/>.

<sup>72</sup> Yeo, Sophie. "Where Climate Cash Is Flowing and Why It's Not Enough." Nature News. Nature Publishing Group, September 17, 2019. <https://www.nature.com/articles/d41586-019-02712-3>.

<sup>73</sup> Ciommo, Mariella, and Pamela Eunice Ahairwe. "The EU Budget and External Climate Financing: The State of Play." European Centre for Development Policy Management. Open Society European Policy Institute, May 2021.

positive effects in developing countries, improving education, living conditions, and ability to rebuild after climate disasters. Third, EU funding for developing countries can end up in the hands of governmental officials unequipped or unwilling to spend it judiciously and effectively.<sup>74</sup> Therefore, receiving aid does not always culminate in effective change. The EU must offer grants--not loans--to support adaptation, ensuring that funds go to legitimate projects.

From an economic perspective, developing countries are particularly vulnerable to both climate change *and* the potential effects of the European New Deal. Many developing countries "rely heavily on climate-sensitive sectors," such as "agriculture, forestry, fisheries, water sources management, human health, nature conservation, energy, and infrastructure."<sup>75</sup> Climate change is disproportionately destructive to such industries. Therefore, workers might require assistance to "adjust their livelihoods."<sup>76</sup> The EU Green New Deal could be economically devastating for other countries that depend on gas and oil exports, and the EU must help these nations cultivate new export strategies in advance of the New Deal's implementation.<sup>77</sup> In conclusion, the EU must be cognizant of 1) countries that depend on "climate-sensitive" industries and 2) countries that depend on fossil fuels.

### **Accounting for Unforeseen Consequences**

When attempting to reduce negative environmental impacts in different sectors of the economy such as the airline industry, creating a framework through which to judge alternative goals is crucial. The European Union's focus on climate change in the passage of the European Green Deal places a primacy on direct emissions, as lowering greenhouse gas emissions is one of the preeminent goals of the European Green Deal. Thus, procedures of accounting for costs in Europe's technological systems will have far-reaching implications throughout those systems' supply chains, for the European Union is a powerful market driver with the ability to influence industries across the globe. The United Nations Framework Convention on Climate Change (UNFCCC) guidelines, as well as several European directives, account for the EU's carbon dioxide, methane, and other greenhouse gas emissions<sup>78</sup>, and are the primary determinants of European technological calculations. These restrictions, however, establish a future framework in which technological solutions fix technological problems, maintaining that any two solutions are essentially equivalent, as long as the concentration of carbon dioxide in the atmosphere decreases. This framework for weighing energy options ignores ecological concerns associated

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<https://ecdpm.org/wp-content/uploads/EU-Budget-External-Climate-Financing-State-Play-ECDDPM-Briefing-Note-13-2-2021.pdf>.

<sup>74</sup> Youngs, Richard. "The EU's Indirect and Defensive Approach to Climate Security." Carnegie Europe, July 12, 2021. <https://carnegieeurope.eu/2021/07/12/eu-s-indirect-and-defensive-approach-to-climate-security-pub-84874>.

<sup>75</sup> Deutscher, Eckhard. *Development Co-Operation Report 2010*. OECD ILibrary. Paris: OECD, 2010. <https://doi.org/10.1787/dcr-2010-en>.

<sup>76</sup> El Gharib, Sarah. "Rich Countries Have a 'Responsibility' to Fund Climate Efforts. Here's Why." Global Citizen, June 1, 2021. <https://www.globalcitizen.org/en/content/international-climate-finance-explainer/>.

<sup>77</sup> Leonard, Mark, Jean Pisani-Ferry, Jeremy Shapiro, Simone Tagliapietra, and Guntram B. Wolff. "The EU Can't Separate Climate Policy from Foreign Policy." Bruegel, March 5, 2021. <https://www.bruegel.org/2021/03/the-eu-cant-separate-climate-policy-from-foreign-policy/>.

<sup>78</sup> European Environmental Agency, "Accounting," 11.

with drilling for oil,<sup>79</sup> threats to indigenous communities from certain types of resource extraction,<sup>80</sup> and the political ramifications of a societal dependence on certain energy resources.<sup>81</sup> Intrinsically, these policies assume that, *aside* from greenhouse gas emissions, different energy systems are value-neutral, able to be exchanged for any other form of energy without significant trade-offs. The purpose of this section is to explore the global implications of current policy on the proliferation of certain technologies, and to evaluate the concomitant costs and benefits.

### **Electric Cars**

The UNFCCC policy on accounting for renewable energy projects has the potential to dictate energy policy across the union, as the European Green Deal contains financial incentives aimed at promoting certain types of development among member states.<sup>82</sup> In accounting for energy emissions, the EU uses territorial emissions assessments, meaning that the EU assigns greenhouse gas responsibility to the countries in which that energy was generated, and that emissions are the central metric by which climate success is based<sup>83</sup> This means that European Union assessments do not take into account non carbon-based ecological impacts in source countries of technologies, such as mining for various mineral resources in nations in the global south. Mining for lithium and cobalt, fundamental components of electric car batteries, has the potential to wreak environmental and social damage on source countries.<sup>84</sup> These consequences range from natural ecosystem destruction in Chile<sup>85</sup> to the attempted acquisition of U.S indigenous land<sup>86</sup> to child labor in the Democratic Republic of the Congo.<sup>87</sup> As demand for electric cars rises, mining companies go to greater lengths to supply adequate amounts of precious metals.<sup>88</sup>

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<sup>79</sup> U.S. Fish and Wildlife Service, “Oil and Gas.”

<sup>80</sup> Podmore, “Oil and Gas Drilling Threaten.”

<sup>81</sup> Campbell, “Biopolitics of Security,” 944-45.

<sup>82</sup> Harvey et al., “What is the European Green Deal.”

<sup>83</sup> UNFCCC, “GHG Accounting,” 4

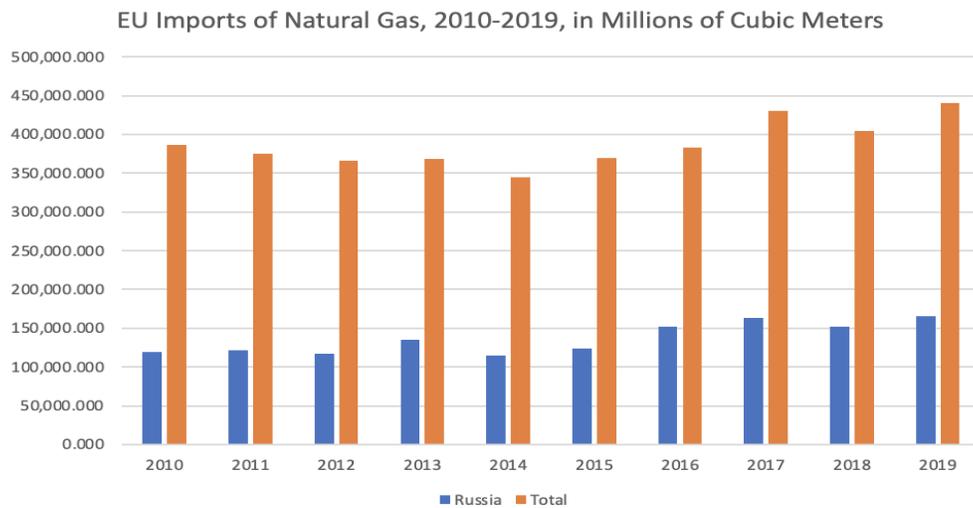
<sup>84</sup> Balch, “The Curse of ‘White Oil.’”

<sup>85</sup> Gutiérrez et al, “Chilean Atacama Site.”

<sup>86</sup> Siegler, “Biden Promised Electric Cars.”

<sup>87</sup> Sanderson, “Congo, Child Labor and Your Car.”

<sup>88</sup> Penn et al., “The Lithium Gold Rush.”



*(Note: Data in graph courtesy of Eurostat)*

### **Accounting for “Hidden” Emissions**

In recent years, satellite technology has allowed outside observers unprecedented insight into previously unknown sources of CO<sub>2</sub> emissions, especially those sources resulting from methane leaks.<sup>89</sup> Recently, ahead of the finalization of the Nord Stream 2 pipeline connecting Germany and Russia,<sup>90</sup> a major methane leak was discovered in Russia by satellites measuring changes in atmospheric composition.<sup>91</sup> These satellite-revealed leaks are not counted by current, official measures of methane emissions, since the methane leaked never reached the market. Trade with Russia constitutes a large percentage of the European Union’s total methane imports, having increased from 31.0% in 2010 to 37.7% in 2019. In fact, due to high rates of leakage and the potency of methane across the board, burning natural gas can have comparable impact to burning coal.<sup>92</sup> Thus, as the Nord Stream 2 pipeline moves forward, and as European countries look to natural gas to relieve them from a fuel-deficient winter, the role of natural gas in European energy must be seriously considered by lawmakers.

<sup>89</sup> Ravikumar et al., “Are Optical Gas Imaging Technologies Effective?”

<sup>90</sup> Donahue et al., “Nord Stream 2.”

<sup>91</sup> Mufson et al., “Russia Allows Leaks.”

<sup>92</sup> Oreskes, “A Green Bridge to Hell.”

# **Our Recommendations:**

## **Shifts in Technology**

Although there are several options that could be implemented realistically including alternative fuel sources (hydrogen, algae, synthetic kerosene), architectural redesign (weight reduction, drag reduction, engine redesign), subsidies to the railway industry to reach rural areas, and increasing efficiency in operational procedures, there are factors to consider that may limit the success of these approaches. First of all, it appears that traffic-growth rates will outpace emission reduction-rates.<sup>93</sup> There is an increase in demand for travel as a result of an increase in low cost carriers that might detract from the efforts to reduce emissions. If there is more travel, the magnitude of emissions will increase despite increasing efficiency of energy use for individual aircraft. However, with fuel-efficiency and aircraft-architecture changes, 100% biofuel-use, and fully integrated global ATM system, 60-95% reduction in CO2 emissions could be achieved over a 40 year time period according to.<sup>94</sup> Other obstacles may include the timeline for implementation since it may be decades until a reduction in emissions is observed in the industry in order to completely phase out current models of aircraft. In particular, certification issues severely limit decarbonization routes for aviation.<sup>95</sup>

Given these limitations, the most impactful technological shifts would come in the form of a combination of those outlined. Ideally, an incentive for airlines to increase fuel efficiency with updated infrastructure, make improvements to the ATM system, and introduce alternative fuel sources including either hydrogen, algae, or synthetic kerosene would bring the European Union closer to its goals for decreasing emissions in a way that is least disruptive to existing industries outside the airline industry. This would increase the likelihood of receiving wide support from member states to make these switches.

Another important note to make is that increasing efficiency also comes with financial benefits for airlines and airports as they are able to be more profitable with less delays from poor ATM and consequently spend less on wasted fuel. This approach would be likely to gain the support from the industry for this financial benefit.

## **Infrastructure Modernization**

Overall, the modernization of ATM infrastructure can be accomplished by allowing member states to optimize control of navigation services across shared airspaces, and to develop and certify high-automation workflows. In addition, the introduction of economic regulation

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<sup>93</sup> Matt Grote, Ian Williams, and John Preston, "Direct Carbon Dioxide Emissions from Civil Aircraft," *Atmospheric Environment* (Pergamon, June 20, 2014), <https://www.sciencedirect.com/science/article/pii/S1352231014004889>.

<sup>94</sup> Ibid.

<sup>95</sup> Nathan Gray et al., "Decarbonising Ships, Planes and Trucks: An Analysis of Suitable Low-Carbon Fuels for the Maritime, Aviation and Haulage Sectors," *Advances in Applied Energy* 1 (February 23, 2021): p. 100008, <https://doi.org/10.1016/j.adapen.2021.100008>.

which will reduce airspace rate heterogeneity in a cost-effective manner is key, being cognizant of the fiscal burden upon member states to maintain ATM infrastructure.

These reforms will best be carried out if the European Commission works to implement the Single European Sky program, which has stalled due to inaction by EU member states and navigation service providers. In implementing SES, care must be taken to prevent a direct increase in gross air traffic, as well as in creating an EU-wide regulatory agency to direct these reforms. For this initiative to deliver on its goals, it is likely that many additional national and commercial actors will need some measure of external coordination and incentive schemes.

### **Business Regulation**

The direct approach to addressing the environmental externalities of air travel would be through a tax scheme scaled to per-unit carbon emissions of a flight. Care must be taken to ensure that this tax burden is distributed evenly, and especially across business and cargo flights, both of which are exempt from current aviation fuel tax proposals. Furthermore, a key component of equitable measures to modernize the sky will be to ensure the economic and capacity burden is distributed with respect to the necessity of air travel to different communities.

The most forceful way to address the environmental cost of air travel would be to divest from air travel altogether, which will require sustained investment in alternative transportation modalities and short or medium term behavioral interventions to reduce demand for flights.

### **High Speed Rail**

Long-term measures for mitigating the adverse environmental effects of airlines will require disincentivizing the usage of air travel as a substitute for ground-based transportation, such as buses or rail. In this sense, the EU represents a promising region for further investment into such low-carbon transportation modalities, given the existing interconnected rail and ferry network.

When expanding High Speed Rail networks, it is key that mandated phaseouts of short-haul routes will need to be conducted gradually, so that railway companies and policy makers can appropriately react to this shift through rescheduling and investments in the vehicle fleet. Moreover, while this shift is possible at a commercial and technological level, policy interventions are required to ensure continuity and regional equity of access to transportation.

### **Aid to Developing Countries**

Given the substantial barriers faced by developing countries, there are a few policy ideas the EU should consider. First, the majority of aid must be in the form of grants, not loans, to prevent the perpetuation of (and profiting from) poverty.<sup>96</sup> The EU could still utilize loans from the European Investment Bank, but the lucrateness of projects should not result in funding

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<sup>96</sup> Faber, Floris, and Mattias Söderberg. "Developing Countries Deserve Fair and Transparent Climate Support from the EU." [www.euractiv.com](https://www.euractiv.com/section/climate-fund/opinion/developing-countries-deserve-fair-and-transparent-climate-support-from-the-eu/). EURACTIV.com, September 4, 2020.  
<https://www.euractiv.com/section/climate-fund/opinion/developing-countries-deserve-fair-and-transparent-climate-support-from-the-eu/>.

priority. A potential consideration is to match all given loans with grants. Therefore, foreign investors are satisfied, but developing countries receive more grant money than they will owe in loan interest, providing a net benefit.

Second, in addition to grants, the EU should set a minimum percentage of aid that goes to adaptation initiatives, which have peripheral benefits for the receiving community.<sup>97</sup> These projects are often not as attractive to private investors, so it is paramount for the public sector to help fill that void.<sup>98</sup> An additional option is to subsidize private investments in adaptation initiatives.

Third, considering occasional mishandling of aid, the EU must ensure that all contributions are spent properly, effectively, and judiciously.<sup>99</sup> The EU must guarantee "that funds go to quality projects that give marginalized groups a voice and do not lead to unintended or harmful consequences" and check that "donors coordinate and harmonize their adaptation efforts at the country level."<sup>100</sup> The EU could make aid conditional upon the recipient's agreement to periodically report back to an EU representative about how the money has been spent and how the environmental projects are going. In addition to fostering accountability, this representative could serve as a point person for any questions or issues that may arise—potential help includes "[providing] technical assistance to boost...expertise and improve...feasibility in attracting potential financing."<sup>101</sup> This support and guidance could help environmental projects run more smoothly and with greater efficiency.

Lastly, to minimize the economic effects of the Green New Deal, the EU should help countries dependent on climate-sector or fossil fuel industries foster economic diversity.<sup>102</sup> A potential option to help "hydrocarbon-dependent" countries is supporting "renewable energy and green hydrogen that could in the future be exported to Europe."<sup>103</sup> Such initiatives would both

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<sup>97</sup> Di Ciommo, Mariella, and Pamella Eunice Ahairwe. "The EU Budget and External Climate Financing: The State of Play." European Centre for Development Policy Management. Open Society European Policy Institute, May 2021.

<https://ecdpm.org/wp-content/uploads/EU-Budget-External-Climate-Financing-State-Play-ECDPM-Briefing-Note-13-2-2021.pdf>.

<sup>98</sup> Ibid.

<sup>99</sup> Youngs, Richard. "The EU's Indirect and Defensive Approach to Climate Security." Carnegie Europe, July 12, 2021. <https://carnegieeurope.eu/2021/07/12/eu-s-indirect-and-defensive-approach-to-climate-security-pub-84874>.

<sup>100</sup> El Gharib, Sarah. "Rich Countries Have a 'Responsibility' to Fund Climate Efforts. Here's Why." Global Citizen, June 1, 2021. <https://www.globalcitizen.org/en/content/international-climate-finance-explainer/>; Deutscher, Eckhard. *Development Co-Operation Report 2010*. OECD ILibrary. Paris: OECD, 2010. <https://doi.org/10.1787/dcr-2010-en>.

<sup>101</sup> Di Ciommo, Mariella, and Pamella Eunice Ahairwe. "The EU Budget and External Climate Financing: The State of Play." European Centre for Development Policy Management. Open Society European Policy Institute, May 2021. <https://ecdpm.org/wp-content/uploads/EU-Budget-External-Climate-Financing-State-Play-ECDPM-Briefing-Note-13-2-2021.pdf>.

<sup>102</sup> Deutscher, Eckhard. *Development Co-Operation Report 2010*. OECD ILibrary. Paris: OECD, 2010. <https://doi.org/10.1787/dcr-2010-en>; Leonard, Mark, Jean Pisani-Ferry, Jeremy Shapiro, Simone Tagliapietra, and Guntram B. Wolff. "The EU Can't Separate Climate Policy from Foreign Policy." Bruegel, March 5, 2021. <https://www.bruegel.org/2021/03/the-eu-cant-separate-climate-policy-from-foreign-policy/>.

<sup>103</sup> Abnett, Kate. "EU Climate Change Plans Will Ripple through Foreign Policy, Researchers Say." Reuters. Thomson Reuters, February 3, 2021.

safeguard against economic collapse and ensure a market for future exports. EU members could also form partnerships with developing countries to act as climate mentors on these initiatives.<sup>104</sup> Additionally, the EU should consider funding trade school classes for people employed in these industries to ensure they have a useful skill set in a safe, backup profession. Therefore, if climate or European policies jeopardize their current jobs, they have a means to maintain financial security. For example, trade school classes could focus on jobs which—given the looming climate change and efforts to combat it—have high expected growth rates. Many of these jobs are concentrated in renewable energy sectors, such as “wind turbine service technicians” and “solar photovoltaic installers.”<sup>105</sup> Although trade school classes would not produce scientists or engineers, they could supply a steady stream of skilled workers adept at the technical maintenance of clean energy infrastructure.

### **Accounting for Unforeseen Consequences**

As the European Union crafts incentives for certain kinds of technologies, it must ensure that those incentives do not encourage ecologically-destructive practices in other countries. For these purposes, the European Union should adopt a cradle-to-grave emissions accounting program focused on accounting for externalities associated with the provision of certain fossil fuels, like natural gas and oil. This emissions program could be modeled off of existing cradle-to-grave emissions accounting, such as the “Product Life Cycle Accounting and Reporting Standard” currently employed for businesses under the GHG protocols.<sup>106</sup> Furthermore, the European Union should look to restrict the sourcing of certain fossil fuels and other energy products, considering the ecological harms and indigenous and local implications of sourcing those materials. As a highly influential player in global resource markets, it is incumbent upon the European Union to ensure responsible sourcing for its raw materials. To that end, the entire lifespan of European goods must be considered, with considerations of both reported and unreported emissions at the forefront of analysis. Furthermore, a process of vetting must be developed that ensures the protection of indigenous rights and ecological safety when obtaining raw materials for European use. As climate is a global issue, if Europe simply outsources its emissions to other places, net improvements in climate will not be made. As the European Union seeks to incorporate more energy from natural gas in response to winter fuel shortages, it must also consider the implications of permanent natural gas infrastructure on its climate objectives.

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Shifts in Technology	Infrastructure Modernization	Business Regulation	High Speed Rail	Aid to Developing Countries	Accounting for Unforeseen Consequences
<ul style="list-style-type: none"> <li>- Alternative fuel sources (hydrogen, algae, synthetic kerosene)</li> <li>-Architectural redesign (weight reduction -Drag reduction, engine redesign)</li> <li>-Subsidies to the railway industry to reach rural areas, and increasing efficiency in operational procedures</li> </ul>	<ul style="list-style-type: none"> <li>-Allow member states to optimize control of navigation services across shared airspaces</li> <li>-Develop and certify high-automation workflows</li> </ul>	<ul style="list-style-type: none"> <li>-Tax scheme scaled to per-unit carbon emissions of a flight</li> <li>-Divest from air travel</li> <li>- Investment in alternative transportation</li> </ul>	<ul style="list-style-type: none"> <li>-Disincentivizing the usage of air travel as a substitute for ground-based transportation</li> <li>-Gradual mandated phaseouts of short-haul routes</li> </ul>	<ul style="list-style-type: none"> <li>-Majority of aid in form of Grants</li> <li>-Loans from the European Investment Bank</li> <li>-Minimum percentage of aid that goes to adaptation initiatives</li> <li>-Subsidize private investments in adaptation initiatives</li> <li>-Help countries diversify their economies</li> <li>-Funding trade school classes</li> </ul>	<ul style="list-style-type: none"> <li>-Consider emissions throughout the development process</li> <li>-Consider the implications of permanent natural gas infrastructure on its climate objectives</li> <li>-Develop processes for vetting the flow of resources to Europe that maintain respect for global welfare</li> <li>-Account for emissions of infrastructure in a cradle-to-grave way, informed by construction and development costs</li> </ul>

**Figure 3: Table format summary of our recommendations**

## Conclusion:

The European Union is at an ideal position to take initiative and make these policy changes not only for its own benefit, but to set an example on a global scale. Other countries will be more inclined to take similar actions after witnessing the successful implementation of fuel-efficiency and aircraft-architecture changes, 100% biofuel-use, fully integrated global ATM system, infrastructure modernization, business regulation, expanding high speed rail, and providing grants to developing countries, all while being cognizant of potentially ecologically-destructive practices in other countries. The European Union's priority for lowering greenhouse gas emissions is clear with the existence of its current policies, and we hope that our policy paper provides insight for additions that can be made to help reach its targets.

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