OCTOBER 2017
R: 17-10-A

REPORT

RAISING THE BAR: NRDC'S 2017 AVIATION BIOFUELS SCORECARD

ACKNOWLEDGMENTS

NRDC thanks the Packard Foundation for the generous contributions that made this report possible.

NRDC acknowledges the role of Patrick Mazza, MROC (Independent consultant) in preparing this report.

The author of this report would also like to thank the following individuals for their contributions toward reviewing an early draft. Their review does not constitute an endorsement of the findings:

James Beard (Policy Specialist - Energy & Climate Change, WWF-UK)

Dr. Robert Malina (Professor of Environmental Economics, MIT Laboratory for Aviation and the Environment)

NRDC Acting Chief Communications Officer: Michelle Egan
NRDC Deputy Directors of Communications: Lisa Goffredi and Jenny Powers
NRDC Senior Editor, Policy Publications: Mary Annaïse Heglar
NRDC Policy Publications Editor: Tim Lau

Design and Production: www.suerossi.com

Table of Contents

Executive Summary **4**

Introduction: Assuring Aviation Biofuel Sustainability Through Third-Party Certification **8**

2017 Aviation Biofuel Scorecard Survey Results **10**

1: Airlines Rank in Four Groups 10

2: Key Findings 10

3: Additional Findings 15

Conclusions and Recommendations **21**

Appendix A: NRDC 2017 Aviation Biofuel Scorecard Survey **23**

Appendix B: Scoring Methodology **26**

Appendix C: Glossary of Acronyms **28**

Endnotes **30**

Executive Summary

THIRD-PARTY CERTIFICATION IS CRUCIAL FOR GROWING A TRULY SUSTAINABLE AVIATION BIOFUELS INDUSTRY.

With the 2016 Paris Accord, the world is coming together around the need to deeply reduce the greenhouse gases (GHGs) that are driving dangerous climate change. Despite the Trump administration's June 2017 announcement that the United States will withdraw from the accord, and despite the fact that GHG reduction pledges under the accord are insufficient to meet global warming limits set out in the accord, the agreement still represents a vital step toward meeting the critical challenge of climate disruption.[1] But the Paris Accord only covers national actions, so international transportation modes, aviation and marine shipping, are left off the table.

The aviation industry's share of anthropogenic carbon dioxide emissions (those produced by human activities) is now at 2 percent. If business continues as usual, it will grow to 3 percent by 2050. To avoid that outcome, the industry is taking steps to reduce GHG emissions, including adopting low-carbon fuels that assure significant net GHG reductions. To be considered truly sustainable, production of these fuels must also limit adverse impacts on food security, land, water, air, wildlife, and ecosystems and protect local communities, while also providing socioeconomic benefits.

A process managed by the International Civil Aviation Organization (ICAO) has developed a framework for the aviation sector ratified in October 2016. After many years of negotiation, the ICAO 39th Assembly adopted the Carbon Offsetting Scheme for International Aviation (CORSIA), which is intended to meet the International Air Transport Association's (IATA) broadly supported goal for carbon-neutral growth. The industry itself has come together through the Sustainable Aviation Fuel Users Group (SAFUG) to promote low-carbon fuels produced under strict standards for environmental and social sustainability. Airline leaders understand their social license for growth is contingent on reducing aviation GHGs as well as the potential environmental and social impacts associated with the development of new aviation biofuels.

Sustainability certification based on third-party audits is crucial to ensure well-rounded performance. Recognized certification systems include the Roundtable on Sustainable Biomaterials (RSB), Bonsucro, the Roundtable on Responsible Soy (RTRS), and the International Sustainability and Carbon Certification (ISCC). However, not all certification standards are equal. Some of the key indicators of a credible certification standard include balanced governance; multi-stakeholder participation; transparency; rigorous, consistent, and performance-based requirements that address environmental and social aspects of production; accreditation of auditors; and on-site annual audits to confirm that standard requirements are met by producers. The RSB is the only standard in the marketplace today that fully meets these fundamental thresholds. It is also the only standard that attempts to tackle the complex issue of indirect land use change (ILUC), which can be caused by increasing feedstock demand. The RSB Low ILUC Risk module allows certified producers to earn additional credit for documenting low-ILUC risks for feedstocks. Thus, we consider it the gold standard of sustainability certification.

Since 2013, NRDC's *Aviation Biofuel Scorecard* has aimed to encourage airline leadership to support the adoption of truly sustainable biofuel through third-party certification standards. Now in its fourth year, the *Scorecard* is the premier global measure of airlines' progress toward this goal.

Airlines can leverage their significant purchasing power to promote sustainable practices throughout the biofuel supply chain. They can send clear market signals that production must comply with sustainability standards that are independently audited through credible certification programs, in order to incentivize operators to proactively include this in their planning and operations.

For our 2017 *Scorecard*, NRDC surveyed 38 airline companies. We included all 29 airlines surveyed for the 2016 *Scorecard*, all of which have indicated a commitment to adopting aviation biofuels. We also included two new airlines that have made biofuels announcements, an air freight carrier that has reported significant biofuel use in its ground fleet, and six airlines that round out the world's top 20 by network capacity. We received responses from 17 companies, which is 2 fewer than the number responding to the 2016 survey. Therefore, the list of nonrespondents grew this year to 21, up from 9 in 2016, largely because we surveyed more companies.

As we did last year, we grouped the responding airlines into three categories, reflecting points earned for commitments to biofuels and supply chain implementation:

- Leading Airlines, 20 to 38 points (the maximum possible)
- Advancing Airlines, 10 to below 20 points
- Basic Airlines, below 10 points

Three Leading Airlines, at the tip of the spear for sustainable aviation biofuel commercialization, scored close together, ranging from 23 to 24.5 points. A middle group of 10 Advancing Airlines, scoring 10.2 to 19.2 reported a range of commitments to sustainable aviation

biofuel development. A cluster of 4 Basic Airlines, scoring 4.5 to 6 points, have also made commitments in this field, but at a lower level. We will describe important distinguishing factors among the three categories later in this report.

To reflect a growing maturity in aviation biofuels development, our 2017 survey and *Scorecard* raised the bar for leadership. We gave more credit to actual usage and amounts of certified sustainable biofuels in airline operations, and sought more detail on usage and purchase commitments and supply chain development. We also gave credit for a commitment to use specific third-party certification systems, such as the RSB. NRDC encourages airlines to purchase only biofuel certified by a recognized third-party standard, with strong preference for RSB.

Our findings suggest an aviation biofuel market that appears to be maturing, judging from increases in contracting and fuel purchases and several other important industry milestones. However, as discussed later, British Airways and Air France/KLM pulled back from firm commitments due to supply chain challenges, raising concerns. The next several years will show whether new technologies can be commercialized to produce affordable fuel at scale. That test will determine the level to which airlines can meet their 2020 IATA carbon-neutral goals with sustainably produced aviation biofuels.

We placed the surveyed airlines into four categories. They are listed in the following box:

TABLE 1: 2017 SCORECARD CATEGORY RESULTS

CATEGORY	AIRLINE COMPANIES*	SCORE
Leading Airlines —strongest range of commitments and supply chain implementation. (scoring category: 20–38)	• Air France/KLM Royal Dutch Airlines • Jet Blue • United Airlines	23–24.5
Advancing Airlines—range of fuel purchase commitments and actions.(scoring category: 10–to under 20)	• British Airlines • Cathay Pacific Airways • GOL • Japan Air Lines • Lufthansa • Qantas Airways • SAS • South African Airways • Virgin Atlantic Airways • Virgin Australia Airlines	10.2–19.2
Basic Airlines —basic level of fuel purchase commitments and actions.(scoring category: 1–to under 10)	• Air New Zealand • Alaska Airlines • Finnair • Thomson Airways	4.5–6
Nonresponsive Airlines	• AeroMexico • American Airlines • All Nippon Airways • Avianca Taca • Air Canada • Air China • Cargolux • easyJet • Emirates • Etihad Airways • FedEx • GulfAir • LATAM • Lion Air • Qatar Airways • Ryanair • Singapore Airlines • Southwest • Turkish Air • UPS • Westjet	0

*Airlines given alphabetically by cluster

KEY FINDINGS

A small group of companies are leading the aviation industry toward commercialization of sustainable aviation fuels. Notably, JetBlue jumped from the Basic category in last year's survey to join the Leading Airlines with the September 2016 announcement that it would purchase 33 million gallons of blended jet fuel made from hydro-processed esters and fatty acids (HEFA). This is the largest airline biofuel commitment to date to purchase jet fuel made from HEFA. It is also one of the largest commitments for any form of sustainable aviation fuel.[2] JetBlue, Air France/KLM Royal Dutch Airlines, and United Airlines have committed to using RSB-certified fuel.

Seven airline companies moved down in rank this year. In 2016, British Airways, Cathay Pacific Airways, SAS, and South African Airways were Leading Airlines. This year they are Advancing. Alaska Airlines, Thomson, and Air New Zealand moved from Advancing to Basic. This partly reflects the change in methodology that raises the leadership bar. It also reflects industry supply chain setbacks and some reversals of commitments not to use fuels derived from coal and natural gas.

More airlines reported having certified fuel contracts in place. Six airlines reported firm contracts under RSB certification. These include JetBlue and Virgin Atlantic, which did not have contracts last year. Lufthansa, a new survey entrant this year, has a contract under ISCC certification.

More airlines are implementing their commitments, purchasing and flying on certified fuel. This year, five airlines reported purchases that we could score, up from two in the 2016 survey. United Airlines may soon have commercial-scale deliveries of RSB-certified fuel to its Los Angeles International Airport hub, which would bring the total to six. As of this writing, though, a final certification decision had not yet been made.

Advancing and Basic Airlines have important distinguishing characteristics. Eight Advancing Airlines have commitments to purchase certified sustainable fuel. Five of them have firm contracts in place to do so. Basic Airlines lack such commitments. Four Advancing Airlines received certified fuel this year, while no Basic Airline did.

The number of supply chain investments has dropped. Seven supply chain investments were reported for the 18 months prior to the survey, compared with 11 reported in the 2016 survey. Due to an overlap in time frame, some investments in 2016 were also reported and counted again in the 2017 results.

Two airlines that reported commitments for biofuel use in 2016 pulled back in 2017, setting back supply chain development efforts:

- In 2016, British Airways had a firm commitment to purchase 59 million liters of aviation biofuel by 2017, representing around 2 percent of demand at London's Heathrow airport. Unfortunately, the deal with the supplier, Solena, collapsed, so the airline reported no firm commitments this year.
- In 2016, Air France/KLM had established targets through 2020. However, cost challenges and producer setbacks caused the airline to withdraw these targets.

ADDITIONAL FINDINGS

A commitment to high sustainability standards continues. All but one of our 17 respondents are members of SAFUG, which sets forth a series of sustainability commitments and is a member of the RSB. RSB added one new member in 2017, with Japan Air Lines joining South African Airways and JetBlue. Ten airlines have explicitly committed to using the RSB for third-party certification, and one will use ISCC.

The airline biofuel workforce held steady. In 2017, airlines reported 26.75 full-time-equivalent employees working directly on biofuels, compared with 2016's 24.83 to 26.83.

Four airlines have made commitments to avoid using liquid fuels derived from coal or fossil natural gas where possible. SAS, Qantas Airways, Virgin Australia, and JetBlue confirmed their commitments. Unfortunately, though, Air France/KLM and Air New Zealand reversed theirs this year. These reversals raise serious concerns as fossil fuel–derived jet fuels are not consistent with the industry's GHG emissions reduction goals.

Airlines are increasingly addressing ILUC emissions risks from biofuels. Demands for biofuel feedstock can cause ILUC impacts such as large carbon releases from soil disturbance and forest clearing. We asked airlines whether they were developing measures to evaluate and avoid ILUC. Thirteen answered affirmatively, compared with nine last year. We evaluated their answers and credited six, up from four last year. Moving forward, airlines should back up their measures to evaluate and avoid ILUC with independent certification through credible approaches such as the Low ILUC Risk module launched by the RSB in 2015.

All but one of the respondent airlines report public policy engagements to promote sustainable fuels. NRDC urges that all public policy advocacy by airlines include strong endorsements of high sustainability standards certified by third parties.

Airlines consider biofuel an important tool to meet climate goals. This year, airlines expressed more optimism about the capacity of biofuel to help meet goals for post-2020 carbon-neutral growth through sustainable fuels, more efficient airplanes, and improved air traffic management. However, all respondents also see carbon offsets as necessary to achieve that goal, and all airlines except one are considering them.

RECOMMENDATIONS

The commercial aviation industry is leading the development of low-carbon, sustainably produced fuel supplies. These efforts deserve credit. By strengthening their sustainability commitments, airlines can further contribute to the growth of more-sustainable fuel supplies throughout the transportation sector.

To promote truly low-carbon, certified-sustainable aviation biofuels that can help the industry meet its climate targets, NRDC makes the following recommendations:

1. Airlines should publicly commit to sourcing only aviation biofuels that have been RSB-certified—specifying volume, percentage, and time line—and communicate this to fuel and feedstock producers.
2. Airlines that have not yet publicly committed to using sustainable aviation biofuel should do so—specifying, volume, percentage, and time line where possible.
3. Airlines that do not yet have a firm contract for the purchase of RSB-certified biofuels should explore and secure a delivery contract at the earliest opportunity.
4. Airlines should publicly disclose aviation biofuel volumes, GHG emissions, and sustainability certification.
5. To meet the industry's GHG emission reduction goals, SAFUG and IATA should firmly commit to the RSB certification framework.
6. Airlines should back up their measures to evaluate and avoid indirect land use change (ILUC) with independent certification through credible approaches such as the Low iLUC Risk module launched by the RSB in 2015.
7. When airport delivery systems allow, all airlines should establish a clear policy that prohibits the purchase of fuels from coal and fossil natural gas.
8. Airlines should limit their use of forest-derived biomass feedstocks to those that will demonstrably reduce carbon emissions in the near term (relative to fossil fuels) and will not threaten natural forest ecosystems. Examples include sawdust and waste wood from sawmills that would otherwise quickly decompose. Aviation biofuels should not be sourced from whole trees and other large-diameter wood, which are known to be high-carbon feedstocks.
9. Any biofuel crediting under the CORSIA system should be based on validated life-cycle carbon performance. The methodology should also include ILUC factors (unless ILUC mitigation measures are applied and certified) as well as sustainability requirements consistent with the RSB.

Introduction: Assuring Aviation Biofuel Sustainability Through Third-Party Certification

With the 2016 Paris Accord the world is beginning to come together around the need to drastically reduce climate-heating greenhouse gases (GHGs).[3] Despite the announced intent of the Trump administration to withdraw the United States from the accord, and despite the fact that GHG reduction pledges under the accord are insufficient to meet global warming limits set out in the pact, the agreement still represents a vital step toward mitigating dangerous climate change.[4]

Since the agreement only covers national actions, it takes international transportation modes, like aviation and marine shipping, off the table. That leaves a lot of emissions in the air. The aviation industry's share of carbon dioxide produced by human activities, now at 2 percent, will grow to 3 percent by 2050 without proactive steps. That 50% increase would be the fastest percentage growth of any transportation sector.[5] To avoid that outcome and maintain a social license for growth in the face of increasing public concern over climate disruption, the industry is taking steps to reduce GHG emissions.

Through the International Air Transport Association, the aviation industry has committed to carbon-neutral growth starting in 2020, and to reducing emissions 50 percent from 2005 levels by 2050.[6] Airlines are approaching this from four angles: more-efficient aircraft, improved airspace management, a carbon market mechanism, and low-carbon fuels from non-fossil-fuel sources. In October 2016, the International Civil Aviation Organization (ICAO) ratified a framework for the aviation sector. After many years of negotiation, the Carbon Offsetting Scheme for International Aviation (CORSIA) was adopted by the ICAO 39th Assembly. It is intended to meet the IATA's 2020 goal, which is broadly supported by the airline industry.

Because it is impractical to change fueling infrastructure or jet engines, airlines are promoting development of "drop-in" fuels, which can be switched into existing systems seamlessly. These replacement fuels must match the quality, performance, and energy density of fossil fuel, almost all of which today is petroleum.

Sustainability concerns are top considerations for airline companies. Full life-cycle analysis must assure significant net GHG reductions compared with fuels from fossil sources. New fuels must also limit adverse impacts on food security, land, water, air, wildlife, ecosystems, and local communities—while providing socioeconomic benefits for the latter. The industry itself has come together through the Sustainable Aviation Fuel Users Group (SAFUG) to promote low-carbon fuels produced under strict standards for environmental and social sustainability. SAFUG represents 28 airlines that account for 33 percent of the world's commercial aviation fuel demand. We surveyed all SAFUG members, of which 17 responded

Sustainability certification based on third-party audits is crucial to assure performance. Recognized systems include the Roundtable on Sustainable Biomaterials (RSB), Bonsucro, the Roundtable on Responsible Soy, and the International Sustainability and Carbon Certification (ISCC). RSB is the only certification framework that meets important thresholds for rigor, transparency, and governance (see "Roundtable on Sustainable Biomaterials Framework," below). RSB's Low ILUC Risk module allows certified producers to gain additional credit for documenting low ILUC risks.[7] It is, therefore, widely regarded as the gold standard of certifications. SAFUG has adopted RSB principles as its model standard. NRDC encourages airlines to leverage their market power by purchasing only biofuel certified by a recognized third-party standard, with strong preference for RSB, as reflected in the weighted scoring of our survey.

The 2016 *Scorecard* recognized the Roundtable on Sustainable Palm Oil (RSPO). However, we have significant concerns with the RSPO standard. Serious and unmitigated on-the-ground impacts continue in palm oil–producing countries, including violation of community land rights, conversion of biologically diverse natural forests to palm plantations, destruction of critical habitat for endangered and vulnerable species, and carbon emissions from the disturbance of peatlands. Therefore, we do not support the use of palm oil for fuel, and we opted to exclude it from the 2017 survey and Scorecard.

This report aims to encourage airline leadership to adopt truly sustainable biofuel through third-party certification standards. Now in its fourth year, the *Scorecard* is the premier global measure of airlines' progress toward this goal.

Airline companies can play a critical role in driving adoption of sustainable practices throughout their supply chains. Biofuel operators are making long-term design, employment, and operational decisions to optimize production, and many are now focusing on aviation as a key market. Clear and time-bound commitments to sourcing sustainable biofuels—including requiring that production comply with third-party, independently audited sustainability standards—will incentivize operators to proactively include this in their planning and operations.

Some in the aviation industry have expressed concerns that biofuels for the ground transportation sector are not held to the same high standard as those in the aviation sector, and that this will disadvantage new aviation biofuels. However, all biofuel should be held to high sustainability standards. As a potentially large biofuel consumer, airlines are setting a standard for the biofuel industry as a whole. NRDC encourages other transportation sectors that are looking to adopt biofuels to follow suit.

ROUNDTABLE ON SUSTAINABLE BIOMATERIALS (RSB) FRAMEWORK

The RSB's comprehensive sustainability framework consists of 12 principles:[8]

1. Biofuel operations shall follow all applicable laws and regulations.
2. Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative impact statement and management process and an economic viability analysis.
3. Biofuels shall contribute to climate change mitigation by significantly reducing life-cycle greenhouse gas emissions as compared with fossil fuels.
4. Biofuel operations shall not violate human rights or labor rights and shall promote decent work and the well-being of workers.
5. In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural, and indigenous people and communities.
6. Biofuel operations shall ensure the human right to adequate food and improve food security in food-insecure regions.
7. Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and other conservation values.
8. Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.
9. Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources and respect prior formal or customary water rights.
10. Air pollution from biofuel operations shall be minimized along the whole supply chain.
11. The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance and minimize the risk of damages to the environment and people.
12. Biofuel operations shall respect land rights and land use rights.

2017 Aviation Biofuel Scorecard survey results

1: AIRLINES RANK IN FOUR GROUPS

For our 2017 *Scorecard*, NRDC surveyed 38 airlines. We included all 29 companies surveyed for the 2016 *Scorecard*, all of which have indicated a commitment to adopting aviation biofuels. We added two new airlines that made such commitments in 2017, Air Canada and Westjet. In addition, to build a broader base for the survey, we added China Eastern Airlines, China Southern Airlines, Delta, easyJet, Ryanair, and Turkish Air. This allowed our survey to reflect the world's top 20 airlines by network capacity.[9] We also invited UPS, which operates an air freight fleet and has made a major ground fleet biofuel commitment.

We sent our survey to all of these airlines and followed up with respondents, as needed, for additional information. After the initial request, we also followed up with nonrespondents to encourage their participation in the survey. Unfortunately, none of the airlines that were added this year opted to participate. Several 2016 respondents, including Etihad Airways, AeroMexico, and Singapore Airlines, also declined to participate in this year's survey. One airline, Lufthansa, that was nonresponsive last year, joined the 2017 survey. We received responses from 17 companies, 2 fewer than in 2016. While the list of nonrespondents grew this year to 21, up from 9 in 2016, this was largely because we surveyed more companies.

As with last year, we grouped airlines responding to the survey into three categories:

- Leading Airlines, scoring 20 to 38 points (the maximum possible)
- Advancing Airlines, scoring 10 to under 20 points
- Basic airlines, scoring under 10 points

Three Leading Airlines—at the tip of the spear for sustainable aviation biofuel commercialization—scored close together, ranging from 23 to 24.5 points. The 10 Advancing Airlines, scoring 10.2 to 19.2 points, report a range of commitments to sustainable aviation biofuel development. The four Basic Airlines, scoring 4.5 to 6 points, have also made commitments in this field, but at a lower level. Later in this report, we will detail the important distinguishing factors among the three categories.

This year we changed our methodology to reflect a growing maturity in aviation biofuels development. We gave more credit to actual usage and amounts of certified biofuels in airline operations, and we sought more detail on usage and purchase commitments as well as supply chain development. Our scoring methodology is described in Appendix B.

2017 Scorecard Results

Leading Airlines demonstrated the strongest commitments and actions to implement sustainable aviation fuel supply chains, including commitments to transparency and disclosure. Three airlines qualified for this category.

Advancing Airlines showed a broad range of commitments and actions to implement sustainable aviation fuel supply chains. They did not achieve the highest rank, but all 10 can be considered genuine trendsetters.

Basic Airlines have made fundamental commitments to sustainable aviation biofuels. At this point, these four companies still need to follow through with purchase commitments for certified sustainable fuels.

In 2016 we considered creating a Gold category for airlines that achieved 90 percent of total possible points. However, since no airline reached that threshold, there is no Gold category this year.

2: KEY FINDINGS

The Leading Airlines have made the strongest efforts to implement commercial sustainable aviation biofuel supply chains. Notably, JetBlue jumped from Basic in last year's report to Leading this year. In September 2016, it announced the largest commitment by any airline to date to purchase jet fuel made from hydro-processed esters and fatty acids (HEFA); this was also one of the largest commitments for any form of sustainable aviation fuel.[10] Air France/KLM made a certified fuel purchase and supply chain investment and continued with a strong set of commitments in most scoring categories. All Leading Airlines have committed to using RSB-certified fuel.

Seven airline companies moved down in rank this year. This partly reflects the change in methodology that raises the leadership bar; it also reflects industry supply chain setbacks and some airlines' reversed commitments not to use fuels derived from coal and natural gas (discussed below). In 2016, British Airways, Cathay Pacific Airways, SAS, and South African Airways were Leading. Now they are Advancing. Alaska Airlines, Thomson, and Air New Zealand moved from Advancing to Basic.

More airlines reported having contracts in place to purchase certified sustainable fuel. Six airlines reported firm contracts under RSB certification, including JetBlue and Virgin Atlantic, which did not have such commitments last year. Lufthansa, a new survey entrant this year, reported an ISCC-certified contract. South African Airways was the only airline that reported a contract last year but did not have one this year. The airline

TABLE 1: 2017 SCORECARD CATEGORY RESULTS		
CATEGORY	**AIRLINE COMPANIES***	**SCORE**
Leading Airlines —strongest range of commitments and supply chain implementation. (scoring category: 20–38)	• Air France/KLM Royal Dutch Airlines • Jet Blue • United Airlines	23–24.5
Advancing Airlines—range of fuel purchase commitments and actions.(scoring category: 10–to under 20)	• British Airlines • Cathay Pacific Airways • GOL • Japan Air Lines • Lufthansa • Qantas Airways • SAS • South African Airways • Virgin Atlantic Airways • Virgin Australia Airlines	10.2–19.2
Basic Airlines —basic level of fuel purchase commitments and actions.(scoring category: 1–to under 10)	• Air New Zealand • Alaska Airlines • Finnair • Thomson Airways	4.5–6
Nonresponsive Airlines	• AeroMexico • American Airlines • All Nippon Airways • Avianca Taca • Air Canada • Air China • Cargolux • easyJet • Emirates • Etihad Airways • FedEx • GulfAir • LATAM • Lion Air • Qatar Airways • Ryanair • Singapore Airlines • Southwest • Turkish Air • UPS • Westjet	0

*Airlines given alphabetically by cluster

had accepted delivery of biofuel from a test tobacco crop in 2016. It does, however, have substantial commitments to continue developing that supply chain.

More airlines are implementing their commitments, purchasing and flying on certified fuel. This year, five airlines earned points for purchases, up from just two last year, Air France/KLM and SAS. This year, those two were joined by Cathay Pacific Airways, South African Airways, and Lufthansa. United Airlines may soon have commercial-scale deliveries of RSB-certified fuel to its Los Angeles International Airport hub (bringing the total to six), but a final certification decision had not yet been made at the time of this writing.

Advancing and Basic Airlines have important distinguishing characteristics. Eight Advancing Airlines have committed to purchasing certified fuel. Five of them have firm contracts to do so. Basic Airlines lack such commitments. Four Advancing Airlines received certified fuel this year, while no Basic Airline did.

Supply chain investments dropped. Seven supply chain investments tied to a certification framework were reported for the 18-month survey period, compared with 11 in the 2016 survey. Due to the time frame—which covered the 18 months up to the cutoff date of November 21, 2016—there is some overlap between 2017 and 2016 results. Two Leading Airlines currently have investments,

as do four Advancing and one Basic. Three dropped off this year, including British Airways. The airline's investment in Solena was discontinued due to various commercial challenges as well as lack of government support mechanisms.[11] Air France/KLM made a small investment, but it was not related to a certification framework. Jet Blue and Virgin Atlantic were new to the 2017 list of airlines making supply chain investments. Etihad, which confirmed an investment in the 2016 survey, did not respond this year.

Two airlines that reported firm commitments to biofuel use in 2016 had to pull back in 2017, reflecting supply chain difficulties.

- In 2016, British Airways had a firm commitment to purchase 59 million liters of aviation biofuel by 2017, representing around 2 percent of Heathrow demand. But its supply deal with Solena collapsed, and the airline reported no firm commitments this year. However, the airline does state, "We have a firm board commitment to invest in new projects, subject to a number of conditions being met. The total volume should exceed [59 million tons] as we are pursuing more than one project." In September 2017, British Airways announced a partnership with Velocys to prepare a business case for a waste-to-fuel project.[12]
- In 2016, Air France/KLM aimed for a 1 percent biofuel share of overall fleet fuel use, if economically viable. The airline established targets of 2.4 million liters in 2015, 3.5 million liters in 2016, 35.5 million liters in 2017, and 118-355 million liters in 2020. However, in the 2017 survey, the airline stated, "KLM could not source any new sustainable biofuels in 2015, because there was a worldwide lack of sustainable feedstock (RSB-certified). Also planned production facilities in Europe and United States encountered setbacks and were not able to start biojet fuel production until the first quarter of 2016. In 2015 and 2016 sustainable biofuels are hardly available against the conditions we need: Customers are not willing to pay high premiums for sustainable biofuels." The airline, however, does have a firm contract in place for delivery of around 5 million liters from SkyNRG as it becomes available. SkyNRG is dedicated to developing supply chains linking aviation biofuel producers with airlines.

Because we broadened the survey list, the number of nonresponsive airlines grew to 21, compared with last year's 9. A number of these nonresponsive airlines have announced engagements in aviation biofuels development. But without transparent certification commitments, we cannot rate their sustainability performance. Transparency is crucial for maintaining public good will and the social license to grow the aviation biofuels sector cited by many aviation industry leaders.

AIRPORT FUEL DELIVERIES

Los Angeles International Airport: United Airlines earned its ranking as a Leading Airline largely because of its advanced development of the supply chain to its hub at Los Angeles International Airport (LAX). On March 11, 2016, United became the first U.S. airline to begin commercial-scale use of aviation biofuels. First deliveries were by truck, but now biofuel is blended into the hydrant delivery system. Fuels are made from waste oils at AltAir's hydro-processing facility in Paramount, California, and United has agreed to purchase 57 million liters of it over a three-year period.[13] As noted earlier, this fuel may soon be certified to the RSB standard, but final certification had not yet been awarded at the time of this writing.

United has also committed to purchasing at least 341 million liters per year over the next 10 years from Fulcrum BioEnergy, with deliveries to LAX expected to begin in 2019. In 2015 the airline announced a $30 million investment in Fulcrum—the largest publicly disclosed supply chain investment by any airline to date. Fulcrum's planned facility near Reno, Nevada, is slated to produce fuel from municipal solid waste.

Seattle–Tacoma International Airport: The Port of Seattle, Boeing, and Alaska Airlines cosponsored a study to identify the best infrastructure pathways to deliver up to 190 million liters of aviation biofuel annually to Seattle–Tacoma International Airport. Delivered in January 2017, the study explored a range of options, from a small volume over 12 to 18 months to a large volume over 2 to 10 years. Alaska Airlines aims to have a commercial supply available at one of its hub airports by 2020. The study examined delivery by pipeline, rail, barge, and truck, as well as storage, blending, testing, and delivery by the airport hydrant system; it also assessed costs at various stages. The study found that the best short-term option is a receiving and blending facility at the airport tank farm, while the optimal long-term option is blending at refineries in Anacortes, Washington, the current regional source of jet fuel.[14] In July 2017, SkyNRG, the Carbon War Room, and the Port of Seattle followed up with a report by the Rocky Mountain Institute on potential funding mechanisms to close the cost gap between aviation biofuel and conventional jet fuel.[15]

Stockholm Arlanda Airport: The Fly Green Fund—organized by SkyNRG in partnership with Swedavia, SAS, Air France/KLM, and European Flight Service—began deliveries of RSB-certified biofuels to Stockholm Arlanda Airport in late December 2016. The partnership brings sustainable aviation fuels to Nordic countries by enlisting corporate customers to purchase fuel. Swedavia, the owner and operator of Sweden's major airport network, will be the fund's first corporate customer to use blends with sustainable certified fuels on all its company business flights.[16] Deliveries to Oslo's airport began in January 2016 and were reported in last year's *Scorecard*. These deliveries, however, came under criticism from Greenpeace because the fuel was shipped from California. The airport defended the shipments, saying that their transport represented only a fraction of the GHGs that would be released by the equivalent amount of conventional jet fuel.[17]

THE TABLES BELOW SUMMARIZE RESPONSES TO THE 2017 SURVEY. LEADING AIRLINES ARE MARKED GREEN, ADVANCING AIRLINES PURPLE, AND BASIC AIRLINES BLUE.

TABLE 2: AIRLINE COMMITMENTS TO PURCHASE CERTIFIED FUEL

	Commitment to use certified fuel	Certified fuel contract	Firm targets	Certified fuel delivered in past year	Supply chain investment
Air France/KLM	Yes—RSB	Yes—RSB	No	Yes	No
Jet Blue	Yes—RSB	Yes—RSB	Yes	No	Yes
United Airlines	Yes—RSB	No	Yes	No	Yes
British Airways	Yes—RSB	Yes—RSB	No	No	No
Cathay Pacific Airways	Yes—RSB	Yes—RSB	No	Yes	No
SAS	Yes—RSB	Yes—RSB	Yes	Yes	No
South African Airways	Yes—RSB	No	Yes	Yes	Yes
Virgin Atlantic Airways	Yes—RSB	Yes—RSB	No	No	Yes
GOL	Yes—RSB	No	Yes	No	Yes
Japan Airlines	Yes—RSB	No	Yes	No	No
Lufthansa	Yes—ISCC	Yes—ISCC	No	Yes	No
Qantas	No	No	No	No	No
Virgin Australia Airlines	No	No*	Yes**	No	Yes
Alaska Airlines	No	No	No	No	No
Air New Zealand	No	No*	No	No	No
Finnair	No	No	No	No	Yes
Thomson Airways	No	No	No	No	No

*Virgin Australia and Air New Zealand do not have a firm contract but are currently in a Request For Information process seeking 200 million liters of sustainable aviation fuel made in their home countries over a 10-year period beginning in 2020.
**Because Virgin Australia does not have a certification system in place for its firm targets, it did not earn points for this.

TABLE 3: CERTIFIED FUEL DELIVERED IN PAST YEAR

	AMOUNT	CERTIFICATION SYSTEM
Air France/KLM	145,000 liters from ITAKA and Amyris	RSB and ISCC
SAS	~150,000 liters	RSB
Cathay Pacific Airways	60,000 liters	RSB and Bonsucro
South African Airways	35,000 liters	RSB
Lufthansa	12,000 liters	ISCC

TABLE 4: AIRLINES' FIRM TARGETS FOR AVIATION BIOFUEL USE			
AIRLINE	**YEAR**	**VOLUME**	**PERCENTAGE†**
JetBlue	2019	374.8 million liters over 10 years	1.2 percent
United Airlines	2016	Fulcrum: at least 341 million liters per year over 10 years AltAir: 57 million liters over 3 years	Fulcrum: 2.8 percent of current mainline fuel use AltAir: 0.2 percent
GOL	2020	50.4 million liters	~10 percent of a local airport uplift
Japan Air Lines	2020	None	None
SAS	2020	None	>1 percent
South African Airways*	2023	500 million liters*	50 percent of current Johannesburg uplift
Virgin Australia**	2020	100 million liters	5 percent

†Percentages are neat biofuel, not blends.
* South African Airways reported a 50-million-liter goal in 2016 and a 500-million-liter goal in 2017. When we inquired, an airline spokesperson explained that the latter was always the goal and the 2016 figure was a reporting error.
**Because Virgin Australia does not have a certification system in place, we could not award points for these targets. They are given here for informational purposes.

TABLE 5: AIRLINE COMMITMENTS TO MONITORING AND DISCLOSURE			
	Does your airline publicly disclose the total volume of aviation biofuels it uses in a year (whether or not it has used biofuels in the past year)?	**Does your airline monitor the full life-cycle greenhouse gas emissions of biofuels it uses employing third-party life-cycle analysis?**	**Are these full life-cycle greenhouse gas emission figures disclosed publicly now?**
Air France/KLM	Yes	Yes	Yes
JetBlue Airways	Yes	Yes	No
United Airlines	Yes	Yes	Yes
British Airways	Yes	Yes	Yes
Cathay Pacific Airways	Yes	No	No
GOL	Yes	No	Yes
Japan Airlines	Yes	Yes	No
Lufthansa	Yes	No	No
Qantas Airways	Yes	Yes	Yes
SAS	Yes	No	No
South African Airways	Yes	No	No
Virgin Atlantic	Yes	Yes	Yes
Virgin Australia Airlines	Yes	Yes	Yes
Alaska Airlines	Yes	No	No
Air New Zealand	No	No	No
Finnair	Yes	Yes	Yes
Thomson Airways	Yes	No	No

FUEL SUPPLY CHAIN DEVELOPMENT

JetBlue: In September 2016, JetBlue announced the largest commitment by any airline to purchase jet fuel made from HEFA, as well as one of the largest commitments for any form of sustainable aviation fuel. Beginning in 2019, the airline will take nearly 375 million liters over 10 years at its hub at New York's John F. Kennedy International Airport. That represents 1.2 percent of fleet usage and around 6 percent of uptake at the airport. It will be blended as a 30 percent mix with petroleum jet fuel. The fuels will be sourced from natural oils that do not compete with food supply. Philadelphia-based SG Preston will produce the fuel at its plant in Lawrence County, Ohio. Based on life-cycle analysis, the airline projects fuel GHG reductions of at least 50 percent compared with conventional jet fuel.[18]

Virgin Atlantic: This year, Virgin Atlantic reported a supply chain investment for the first time. The investment was in LanzaTech, a company that is innovating a technology to convert waste carbon monoxide from steel plants into ethanol via proprietary microorganisms. The airline and company have been partnering since 2011 on applying the process to jet fuel. In September 2016, they jointly announced production of 5,677 liters upgraded from LanzaTech ethanol via the alcohol-to-jet process in collaboration with Pacific Northwest National Laboratory. Virgin Atlantic says the new fuel could reduce carbon emissions up to 65 percent compared with standard jet petroleum.[19]

South African Airways: As was also reported in 2016, South African Airways has made a supply chain investment in cultivation of a nicotine-free tobacco feedstock. The Solaris tobacco, developed by Italian company Sunchem, could provide South African farmers with a substitute for regular tobacco, as health concerns are reducing demand. The feedstock has gained RSB approval, and airline support for development continues. South African Airways made tobacco oils into jet fuel at AltAir's hydro-processing facility in California. On July 15, 2016, a 30 percent blend of that fuel was used for two test flights from Johannesburg to Cape Town. Around 300 passengers flew on one flight by the airline and another by its subsidiary, Mango.

3: ADDITIONAL FINDINGS

A commitment to high sustainability standards continues. All but one of the 17 survey respondents are SAFUG members, which is largely consistent with last year. SAFUG members sign on to the following sustainability commitments:[21]

- Jet fuel feedstock source development should not jeopardize food or water supplies or biodiversity.
- Total GHG emissions from feedstock growth, harvesting, processing, and end use should be significantly reduced, compared with the emissions associated with fossil fuels.
- In developing economies, projects should improve socioeconomic conditions for small-scale sustenance farmers and avoid involuntary displacement of local populations.
- High-conservation-value areas and native ecosystems should not be cleared to make way for jet fuel feedstock source development.[22]

Conservation commitments: The last commitment listed above allowed SAFUG members to earn an additional point in response to our survey question "Has your airline made a commitment not to use feedstocks from high-conservation-value areas and clearance of native ecosystems?" Finnair was the only non-SAFUG member, but it has also made this commitment. Thus, 100 percent of 2017 survey respondents answered affirmatively to this key sustainability question.

Certification commitments: In selecting certification systems, SAFUG members are pledged to use "criteria . . . consistent with and complementary to emerging internationally recognized standards such as those being developed by the Roundtable on Sustainable Biomaterials."[23] SAFUG is a member of the RSB. For the 2017 *Scorecard*, the number of responding airlines that are RSB members grew by one from last year, as Japan Air Lines joined South African Airways and JetBlue. Most of our respondents have explicitly committed to using RSB for third-party certification. The exceptions are Virgin Australia, Qantas, Finnair, Alaska Airlines, Thomson, and Air New Zealand. Lufthansa has committed to using ISCC as its third-party certifier.

The airline biofuel workforce stays steady. For the second year in a row, the 2017 *Scorecard* awarded points for staff devoted to biofuel adoption. Among our findings:

- The aviation biofuel workforce has held steady, with airlines reporting 26.75 full-time-equivalent workers, compared with last year's 24.83 to 26.83.
- With one exception, all respondent airlines have assigned staff to biofuel adoption.
- Thirteen have at least one full-time-equivalent employee, a growth of three from last year.
- Standouts were Air France/KLM at four employees and United and Lufthansa at three each.

Four airlines have committed to eliminating liquid fuels derived from coal or fossil natural gas. Some alternative aviation fuel initiatives include coal and natural gas feedstocks as a hedge against oil price volatility and supply shocks. Jet fuel derived from coal through the Fisher–Tropsch process, an approved ASTM pathway, has been delivered at South Africa's Johannesburg Airport. Jet fuels derived from unconventional sources including tar sands and oil shale are already widespread throughout conventional fuel supply chains.

Coal-derived fuel produces far higher GHG emissions than petroleum.[24] Natural gas–based liquids may provide a small GHG emissions decrease at best but could well increase emissions.[25] Fossil fuels are also associated with significant negative environmental impacts, including land disturbance and water pollution. Aviation biofuels that meet the sustainability requirements of the RSB and other credible certification standards are environmentally preferable to fossil fuel alternatives.

This was the second year the *Scorecard* investigated whether airlines had publicly committed to eliminating fuels made from coal or natural gas when airport fueling systems allow other options. SAS, Qantas Airways, Virgin Australia, and JetBlue answered affirmatively. NRDC applauds this crucial commitment of these four airlines and urges the industry to adopt it generally.

Air France/KLM and Air New Zealand, which responded affirmatively last year, reversed their stance this year. We sought clarification but did not receive an answer from Air New Zealand. Air France/KLM responded that "we are not buying these type of fuels, but in certain parts of the world such as South Africa, these fuels might be in the airport hydrant system, thus we automatically fly on it."

We are concerned about these reversals. When fuels based on coal and natural gas are blended into an airport hydrant system, it may present real difficulties for airlines wishing to avoid them. However, while airlines may not be able to control the fuels they receive, their commitment not to use them when possible sends a message to airports. Airlines should exert their influence with airport operators to discourage these fuels. Fossil-derived jet fuels are not consistent with the industry's GHG emission reduction goals.

AIRLINES ADDRESS INDIRECT LAND USE CHANGE

For the second year in a row, our survey asked airlines whether they were developing measures to evaluate and avoid ILUC. Thirteen answered affirmatively, compared with nine last year. We evaluated their answers and credited six, up from four in 2016. Those were Air France/KLM, British Airways, Cathay Pacific Airways, Qantas Airways, United Airlines, and Virgin Atlantic. These airlines have adopted strategies explicitly based on using waste feedstocks. Use of wastes and residues do not typically replace an existing market demand, but in some cases they may already be used for other commercial purposes. In these cases they pose a low, but not insignificant, risk of ILUC. Moving forward, airlines should back up their measures to evaluate and avoid ILUC with independent certification through credible approaches such as the Low ILUC Risk module launched by the RSB in 2015. This approach is based on the Low Indirect Impact Biofuels (LIIB) methodology jointly developed by Ecofys, École polytechnique fédérale de Lausanne (EPFL), and the World Wildlife Fund (WWF).[27]

Intent to use the RSB Low ILUC Risk module earned credit in this year's report. ILUC impacts occur outside of the direct scope of the biofuel supply chain and are therefore not routinely evaluated. However, an addition of the RSB Low ILUC Risk module will certify *direct* measures taken by biofuel producers to mitigate the risk of *indirect* land use change impacts for specific feedstocks. Producers can earn this credit from the RSB by documenting use of wastes and residues as feedstocks, increased yields, or employment of degraded and/or unused land.

Other airlines reported participation in bodies such as RSB, SAFUG, and ICAO's Alternative Fuels Task Force. We could not credit these as sufficient in themselves to avert ILUC risk. Other airlines reported that they made demands on their suppliers or required information from them. But there was no clear internal decision-making mechanism or verification process to ensure the information was acted on or that the airline's demands were met. Therefore, because ILUC is such a high-risk issue, we found these answers insufficient to earn credit.

NASA FINDS BIOFUELS REDUCE AVIATION PARTICLE EMISSIONS

Particle emissions from jet engines provide a surface on which ice crystals can form, producing contrails. Though still under study, contrails are understood to impact how the atmosphere accumulates solar energy. A March 2017 NASA study found that a 50/50 blend of aviation fuel and camelina oil–based biofuel reduced particle emissions by 50 to 70 percent. Researchers flew between 300 feet and 20 miles behind the test aircraft, a DC-8 flying at up to 40,000 feet, to explore contrail formation. NASA aviation emissions researcher Bruce Anderson noted, "Soot emissions are a major driver of contrail properties and their formation." Cutting particle emissions "should directly translate into reduced ice crystal concentrations in contrails, which in turn should help minimize their impact on Earth's environment."[26]

BIOFUEL SUSTAINABILITY CHALLENGES

Throughout this report, the backdrop is the substantial challenge of producing truly sustainable biofuels. At the root of the challenge is the fact that generating biomass for energy requires a large land base. That impinges on a range of issues around resource use, habitat loss, ecosystem function, and competing demands on land.

With the growth of first-generation biofuels over the past several decades, these issues have come to the fore. A significant portion of the U.S. corn crop is used to make ethanol fuel, and biodiesel demands oilseed crops. A wide range of estimates have been made regarding impacts on food prices. But whatever the impact, public concern has pushed food security into the spotlight. The impact on people at the lower end of the economic spectrum is a particular focus.

Cultivating and transporting biofuel feedstocks entails significant energy use and requires agricultural inputs, such as fertilizers, that emit highly potent GHGs. This has raised questions over whether biofuels actually reduce GHG emissions, compared with their fossil fuel equivalents. This is why life-cycle analysis is required to verify biofuel GHG performance. Related concerns are water use, which can be substantial, habitat loss, and air and water pollution from agricultural operations.

Land use change has emerged as a pinnacle challenge in bringing sustainable biofuels to market. When natural ecosystems such as grasslands and forests are converted to croplands, large stores of soil and plant carbon are released into the atmosphere. It is relatively simple to measure GHG emissions from direct land use changes to create biofuel feedstock cropland. However, demands for biofuel feedstock can also cause indirect land use change (ILUC) impacts. ILUC occurs when new market demand for a feedstock causes development of other lands to meet existing feedstock demands. For example, creating new demand for palm oil to produce palm oil–derived fuel can prompt tropical forest clearing for new palm plantations to meet demands for palm oil used in food markets. Calculating ILUC effects involves use of agricultural, forestry, and economic models to develop best estimates of the net GHG emission impacts.

ILUC has become a key biofuel sustainability measure since the concern emerged around a decade ago. ILUC emissions are factored into the U.S. Renewable Fuel Standard, which sets life-cycle GHG emissions standards for credit under the standard. California's Low Carbon Fuel Standard also mandates ILUC calculations. Computer-based scenario modeling on which these calculations rest can produce widely varied results depending on initial assumptions.[29]

SAFUG GLOBAL PRINCIPLES FOR ADDRESSING INDIRECT LAND USE CHANGE IN GOVERNMENT POLICY

1. To promote a readily available supply of [biofuels], government policies should only incentivize the development and use of fuels that meet strong sustainability criteria, which actively protect against ILUC and other social and environmental risks.
2. Any feedstock has the potential to have deleterious impacts on the environment, including ILUC, depending on where the production is set up and the performance of the farming practices. As the feedstock type in itself does not necessarily determine the sustainability profile of a fuel, the emphasis should be first and foremost on the independently certified sustainability profile of the fuel in question and not simply the feedstock type.
3. Because of the potential negative impact, Indirect Land Use Change (ILUC) must be addressed in government policies promoting the production of sustainable fuels, and decision makers should consider mechanisms to lower the contribution of high ILUC risk biofuels and create incentives for sustainable fuels that have been certified as low risk of ILUC.
4. Any legislation addressing ILUC should consider the possibility of project-level mitigation approaches, including, but not limited to, the Low Indirect Impact Biofuels (LIIB) methodology currently under development by Ecofys, École polytechnique fédérale de Lausanne, and the World Wildlife Fund (WWF). We encourage government leaders and policymakers to support the development and adoption of such standards as one practical and cost-effective way to stimulate production of sustainable fuels that have low risk of ILUC, as well as to look for the right opportunities to incorporate such methodology into existing certification protocols. Given the evolving understanding of ILUC, any legislation addressing ILUC should include sufficient flexibility for future solutions and should not unreasonably hinder the progress of existing sustainable fuel development efforts.
5. Some feedstock types, e.g. residual municipal waste, waste liquids and gases, have no negative ILUC impacts. However, regulatory schemes that privilege certain crop-derived feedstocks without sustainability criteria, including ILUC, could cause negative environmental outcomes and should be discouraged.
6. Consequently, any regulatory scheme to address ILUC and other sustainability measures should be applied equitably and consistently to all feedstocks and processes, regardless of end use and country of origin.[31]

AIRLINES ADVOCATE FOR PUBLIC POLICY

All the respondents to our survey, with one exception, reported policy engagement to advance the development of sustainable aviation fuels. We opted not to score this question, as it can be difficult to ascertain all potential downstream implications of any given policy. Instead, we highlight here those engagements that take into account a full range of sustainability requirements, including land use and social equity. We also discuss cases in which those considerations are narrower in scope, and cases where it is less clear if they were included at all.

The following reflect broader sustainability commitments:

- Air France/KLM, British Airways, and Thomson work with Flightpath 2020, a project launched in June 2011 by the European Commission to bring 2.37 billion liters of aviation biofuel to the European market by 2020. One of Flightpath 2020's key commitments is to "work together with the full supply chain to further develop worldwide accepted sustainability certification frameworks."[32] This is in line with NRDC's advocacy of third-party certification covering the range of sustainability concerns.
- GOL leads the Brazilian Biojetfuel Platform and regional platforms in the states of Minas Gerais, Pernambuco, Rio Grande do Sul, Paraná, and Mato Grosso. The airline is also working with the RSB to promote smallholder agriculture.
- South African Airways is advocating fuel development policies with its government and supporting the RSB.
- Virgin Atlantic is working with its partner, LanzaTech, which makes fuel out of waste gases from steel plants. While not a biofeedstock source, as a waste-derived biofuel the LanzaTech product avoids sustainability issues associated with ILUC and land use impacts more broadly (e.g., impacts on soil and critical habitat). Virgin Atlantic is working to get the fuel qualified for credit under the European Renewable Energy directive.

The following reflect policy engagements that focus primarily on carbon emissions:

- United Airlines chairs the Airlines for America's Environment Council, which tracks and develops industry positions on environmental issues. The airline is also working to provide a per-gallon credit for aviation biofuels under the California Low Carbon Fuel Standard (LCFS). This would provide further support for biofuels delivery at its hub at Los Angeles International Airport. The standard measures carbon but lacks other sustainability criteria. NRDC supports their inclusion under the LCFS, which currently covers fuels used for on-road vehicles.
- Several airlines reported work on CORSIA, including United Airlines, Cathay Pacific Airways, JetBlue, British Airways, Virgin Australia, Air New Zealand, and Qantas Airways. In particular, Qantas cites work on carbon life-cycle assessment methodology for crediting alternative fuels under CORSIA. It is crucial that a full range of sustainability certification standards beyond carbon emissions be applied to these fuels.
- Lufthansa is working on the practical aspects of European Union Emissions Trading System recognition of aviation biokerosene.

Full consideration of sustainability issues was less clear in the following policy engagements:

- British Airways is working for sustainable aviation fuel policy incentives through the UK Transport Energy Task Force. The airline ascribed the collapse of a plan for Solena to make aviation biofuels to serve Heathrow International Airport to a lack of such policy incentives.[33]
- Australia's Virgin Australia and Qantas Airways are working with state and federal governments on policy incentives to advance commercialization of sustainable aviation fuels. Qantas reported, "As a result of this engagement the Queensland Government has announced a BioFutures Investment Fund to facilitate an advanced biofuels industry for the State. This follows extensive engagement by Qantas with the Queensland Government and the Premier's BioFutures Cabinet Committee around the need for an incentivizing framework to attract project developers and investment in advanced biofuel projects in Queensland."
- Air New Zealand is supporting the New Zealand Crown Research Institute SCION in the development of a Sustainable Biofuels Roadmap for New Zealand.
- Alaska Airlines reported advocacy of federal support for wood-based aviation biofuels. NRDC's concerns about this pathway are covered in the "First Flight on Wood-Based Fuel" text box.

Biofuels' carbon emissions profile, while crucial, is not the only concern that biofuels policies must address. NRDC urges that all public policy advocacy by airlines include strong recommendations for the inclusion of stringent sustainability standards certified by third-party frameworks.

FIRST FLIGHT ON WOOD-BASED BIOFUEL

On November 14, 2016, Alaska Airlines flew the first commercial flight using wood-based biofuel. Reportedly made from mill residuals and from post-logging forest residuals that are typically burned or left to decay, the alcohol-to-jet-fuel was produced by Gevo and recently approved for aviation use by ASTM. Gevo's fuel is based on fermentation of sugars into isobutanol, which is then upgraded to jet fuel. A total of 3,785 liters were mixed in a 20 percent blend with standard aviation fuel. The flight traveled from Seattle–Tacoma International Airport to Reagan National in Washington, D.C.[34]

Our 2016 Scorecard detailed the complex and controversial issues surrounding forest-derived biomass. We noted that its use—particularly whole trees and other large-diameter material—can potentially increase GHG emissions compared with fossil fuels and negatively impact forests. A growing body of peer-reviewed scientific evidence shows, for example, that burning wood from whole trees to produce electricity can increase carbon emissions relative to fossil fuels for many decades—creating a "carbon debt" lasting 35 to 100 years. That's far beyond the time frame of existing international climate policy commitments. Standing trees also absorb massive quantities of carbon dioxide out of the atmosphere each year, making them one of our best assets in the fight against climate change. Put simply, cutting and burning trees for bioenergy not only emits a lot of carbon dioxide, but erodes our forests' ability to mitigate global warming.

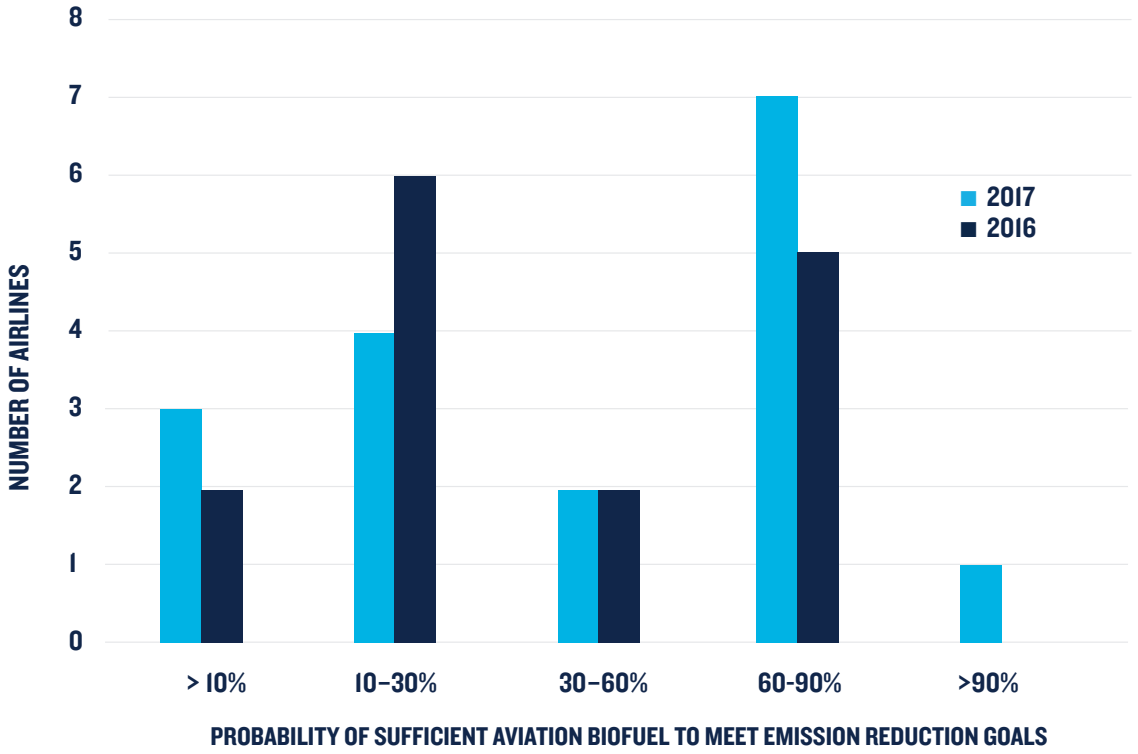
For biofuels to be a viable tool against climate change, carbon benefits must be realized within short time frames relevant to climate policy and action. Only a few categories of forest-derived biomass could meet these criteria. True wood waste, such as sawdust or chips from sawmills that would otherwise quickly decompose and release carbon anyway, could be a lower-carbon source, but their quantities are limited. Once these lower-carbon supplies are exhausted, ongoing demand would likely incentivize additional logging of higher-carbon feedstocks (forest thinning of whole trees) and could negatively impact sensitive forest ecosystems.

AIRLINES ASSESS INDUSTRY SCALE-UP POTENTIAL

For the second year in a row, our survey asked airlines for their confidential assessments of whether aviation biofuel production will grow in time to meet the industry goal for carbon-neutral growth by 2020. We received 15 responses to the question, as depicted in the chart below, and found slightly greater optimism this year. Seven airlines rated the probability of meeting emission reduction goals at 30 percent or less, compared with eight airlines last year.

Eight airlines rated the probability at 60 percent or more, compared with five airlines last year.

However, all respondents believe offsets—credits for GHG reductions against emissions made elsewhere—will be needed to meet 2020 GHG-neutral growth goals. Sixteen airlines responded to the question of whether they were considering offsets, with 15 saying they were. This indicates that while airlines are hopeful about a combination of



biofuels, more-efficient airliners, and more-effective airspace management, they do not view these measures as the complete answer. In 2016, 13 of 16 respondents said their airline was considering offsets. The year since has seen the ICAO agreement on CORSIA, which seems to be influencing airlines' attitudes toward offsets. The agreement is reviewed in the "Regulatory Changes" text box, below.

REGULATORY CHANGES

After many years of negotiation, the ICAO 39th Assembly adopted CORSIA in October 2016. The system aims to meet the IATA goal of carbon-neutral growth after 2020.[36] Starting in 2021, the total amount of carbon dioxide above 2020 levels will be distributed among airlines according to a formula intended to meet the concerns of airlines in developing nations with substantial aviation growth while minimizing market distortion. CORSIA requires airlines operating between two participating nations to purchase offset credits that meet eligibility criteria for every metric ton of carbon dioxide above 2020 levels. Biofuels that assure GHG reductions compared with conventional jet fuel can help airlines reduce offsetting requirements.

States' participation in CORSIA is voluntary from 2021 to 2026. After 2026, compliance becomes mandatory for states that meet certain criteria. As of June 29, 2017, 71 countries had voluntarily signed on, representing more than 87.7 percent of international aviation activity.[37]

The Stockholm Environmental Institute finds that carbon credits with high confidence of environmental integrity and positive sustainable development impacts could offset 3,000 megatons of GHG emissions from 2020 to 2035, meeting 70 to 90 percent of ICAO's projected goal for emissions reductions over that period. The study also projects that sustainably certified aviation biofuels can cut 100 to 300 megatons of GHGs in that time frame.[38] The degree to which aviation biofuels can compete in a system with low-cost offsets is still to be determined. IATA projects that more-efficient airliners will make a significant contribution with new aircraft designs after 2020 reducing fuel use 27 to 40 percent.[39] In terms of improved airspace and operations management, the Civil Air Navigation Services Organization and Boeing put global air traffic management inefficiency at 6 to 8 percent as of 2005. They have set an inspirational goal of up to a 98 percent increase in efficiency by 2050.[40]

When the CORSIA adoption was announced, Lou Leonard, World Wildlife Fund's senior vice president of climate and energy in the United States, said the agreement was "far from the finish line in curbing carbon pollution from international aviation. This is the starting block . . . Unless we accelerate our pace, emissions from international aviation will take too much of our remaining carbon budget and will restrict our ability to reach the Paris Accord's global temperature goals."[41]

The European Commission has proposed placing a higher priority on aviation fuels in its Renewable Energy Directive (RED), which aims to increase renewable energy to make up 27 percent of EU energy use by 2030.[42] The 2030 target is a 3.6 percent share of overall EU energy use for advanced biofuels that are made from nonfood feedstock and reduce GHGs at least 70 percent. The advanced biofuels goal was set partly to allay ILUC concerns surrounding food-based biofuels, which will take a declining share of RED commitments. To provide increased incentives specifically to aviation biofuels, these will be credited at 1.2 times their energy content in meeting goals. This is aimed at leveling the playing field relative to ground transportation biofuels, which are less costly than aviation biofuels due to quality and energy density requirements. The proposal must now go to the European Parliament and Council. Approval before 2018 is not expected.[43]

Conclusions and Recommendations

The world is moving to tackle the towering challenge of global climate change, as evidenced by the 2016 Paris Accord. The aviation industry has engaged the issue with the 2016 CORSIA agreement and by taking continued steps to develop low-carbon, sustainable fuels. Rapid growth in global aviation makes such steps imperative. If business continues as usual, aviation will increase its share of anthropogenic carbon dioxide emissions from today's 2 percent to 3 percent by 2050. Aviation's social license for growth is contingent on continued progress to hold GHG emissions in check and reduce them.

Industry leaders, to their credit, understand the importance of incorporating the broad range of sustainability concerns into their efforts to advance aviation biofuels. Deep reductions in carbon emissions must be verified by third-party life-cycle analysis. Also, fuel production must limit adverse impacts on food security, land, water, air, wildlife, and ecosystems. At the same time, production must protect local communities while also providing socioeconomic benefits. Third-party sustainability certification through a recognized global framework assures that these criteria will be met.

NRDC encourages airlines to purchase only biofuels certified by a recognized third-party standard and strongly recommends the RSB framework as the most complete and likely to address these sustainability risks. This year's results show progress in this area. Six airlines reported firm contracts under RSB certification in place, as opposed to four last year, with JetBlue and Virgin Atlantic as additions. Lufthansa reported a contract under ISCC certification. Five airlines reported certified fuel purchases, in contrast to two in the 2016 survey. A sixth company, United Airlines, began to use commercial-scale aviation biofuel at its Los Angeles International Airport hub. RSB certification is pending.

This year also saw some setbacks. Two airlines reporting firm commitments for biofuel in 2016, British Airways and Air France/KLM, pulled back in 2017, suggesting supply chain development challenges. Ultimately, airlines' ability to meet the aviation industry's 2020 carbon-neutral growth goal with aviation biofuels is contingent on developing supply chains that can produce truly sustainable and affordable fuel at scale.

The 2017 survey and *Scorecard* also show that commitment to high sustainability certification standards continues. Sixteen respondent airlines are SAFUG members, and SAFUG is a member of the RSB. The list of respondent airlines that are direct members of the RSB grew by one from last year. Four airlines stand out in their commitments to eliminating liquid fuels derived from coal or fossil natural gas. SAS, Qantas Airways, Virgin Australia, and JetBlue answered affirmatively when asked about having made a public commitment to this goal. However, Air France/KLM and Air New Zealand, which responded affirmatively last year, reversed their answers this year. This reversal raises serious concerns as fossil-derived jet fuels are not consistent with the industry's GHG emission reduction goals.

We asked airlines whether they were developing measures to evaluate and avoid ILUC. Thirteen said yes, compared with nine last year. We evaluated their answers and were able to credit six, compared to four last year. Moving forward, we strongly urge airlines to back up their measures to evaluate and avoid ILUC with independent certification through credible approaches such as the RSB Low ILUC Risk module.

To achieve growth in truly low-carbon, certified-sustainable aviation biofuels that can meet industry climate targets, NRDC recommends the following:

1. Airlines should publicly commit to sourcing only RSB-certified aviation biofuels. They should communicate this to fuel and feedstock producers.
2. Airlines that have not yet publicly committed to using sustainable aviation biofuel should do so—specifying volume, percentage, and time line where possible.
3. Airlines that do not yet have a firm contract for delivery of RSB-certified biofuels should explore and secure a delivery contract at the earliest opportunity.
4. Airlines should publicly disclose aviation biofuel volumes, annual GHG emissions, and sustainability certification.
5. To meet the industry's GHG emission reduction goals, SAFUG and the IATA should firmly commit to the RSB certification framework.
6. Airlines should back up their measures to evaluate and avoid ILUC with independent certification through credible approaches such as the Low ILUC Risk module launched by the RSB in 2015
7. All airlines should establish a clear policy that prohibits the purchase of fuels from coal and fossil natural gas where airport delivery systems allow them to make that choice.
8. Airlines should limit their use of forest-derived biomass feedstocks to those that will demonstrably reduce carbon emissions in the near term (relative to fossil fuels) and will not threaten natural forest ecosystems. Examples include sawdust and waste wood from sawmills that would otherwise quickly decompose. Aviation biofuels should not be sourced from whole trees and other large-diameter wood, which are known to be high-carbon feedstocks.
8. Any biofuel crediting under the CORSIA system should be based on validated life-cycle carbon performance. The methodology should also include ILUC factors (unless ILUC mitigation measures are applied and certified) and include sustainability requirements consistent with the RSB standard.

Appendix A: NRDC 2017 Aviation Biofuel Scorecard Survey

IDENTITY

1. What is the name of your airline?

2. What is your name?

3. What is your position?

4. What is your e-mail address?

5. What is your phone number?

MEMBERSHIP

6. Is your airline a member of the Sustainable Aviation Fuel Users Group? YES/NO

7. Is your airline a member of any of these recognized sustainability certification systems:*

- Roundtable on Sustainable Biomaterials (RSB)—through direct membership
- Roundtable on Sustainable Biomaterials (RSB)—through SAFUG membership
- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)

*Since NRDC does not support the use of palm oil to make jet fuel, we have not included the Roundtable on Sustainable Palm Oil standard in the survey this year.

PUBLIC COMMITMENTS

8. Has your airline made a public commitment to use aviation biofuels certified as sustainable by any of the following recognized systems?

- Roundtable on Sustainable Biomaterials (RSB)*
- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)

*Here we are seeking an explicit commitment to use RSB certification. Since SAFUG calls for a system that is "consistent with and complementary to emerging internationally recognized standards such as those being developed by the Roundtable on Sustainable Biomaterials," SAFUG membership alone does not automatically score credit for this question.

9. If yes to above and you have set firm usage targets, please specify:

- Date _____
- Volume target in liters_____
- Percentage of total use_____

10. Has your airline made a public commitment to not use fuels made from coal or natural gas when the airport fuel supply provides other options? YES/NO

AVIATION BIOFUEL CONTRACTS

11. Does your airline have a firm contract in place for delivery of aviation biofuels certified as sustainable by any of these recognized systems? (Please specify system or systems.)

- Roundtable on Sustainable Biomaterials (RSB)
- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)

12. If so, please specify:

- Deliveries to commence by _____
- Volume to be delivered, in liters:_____

AVIATION BIOFUEL VOLUMES DELIVERED

13. If any aviation biofuel certified under a recognized system was delivered to your airline in the past year, please provide the volume in liters: _____

14. If so, by what certification systems?

- Roundtable on Sustainable Biomaterials (RSB)
- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)

TRANSPARENCY AND DISCLOSURE

15. Does your airline publicly disclose the total volume of aviation biofuels it uses in a year (whether or not it has used biofuels in the past year)? YES/NO

16. Does your airline monitor the full life-cycle greenhouse gas emissions of biofuels it uses employing third-party life-cycle analysis? YES/NO

17. Are these full life-cycle greenhouse gas emission figures disclosed publicly now? YES/NO

18. Are there any additional issues that you would like to highlight, or information that you would like to share, related to your company's commitments to use aviation biofuels and validate their sustainability?

LAND USE

19. Is your airline developing measures to evaluate and avoid indirect land use change through the use of waste products as feedstocks or through the adoption of the RSB Low Indirect Impact Biofuel (LIIB) module?* YES/NO

*RSB certification to the global standard alone is not sufficient to gain points for this question unless the additional voluntary RSB LIIB module has also been applied.

20. If yes, please describe these measures.

21. Has your airline made a commitment not to use feedstocks from high-conservation-value areas and clearance of native ecosystems?* YES/NO

*SAFUG members should check YES due to their commitment to the SAFUG Pledge.

AIRLINE STAFF DEDICATED TO AVIATION BIOFUELS

22. Estimate the full-time employee equivalent of all staff time devoted to aviation biofuel adoption.

SUPPLY CHAIN DEVELOPMENT

23. In the past 18 months has your airline made a publicly announced investment in aviation biofuels supply chain development, including research & development, and commercial development of sustainability-certified feedstocks and/or biorefineries? YES/NO

24. If so how much?

25. If a commercial investment, please specify the recognized system under which the product is certified or will be seeking certification:

- Roundtable on Sustainable Biomaterials (RSB)
- Bonsucro
- International Sustainability and Carbon Certification (ISCC)
- Roundtable on Responsible Soy (RTRS)

26. Is your airline engaged in public policy advocacy to further development and adoption of sustainable aviation biofuels? YES/NO

27. If so, please describe your engagement.

INDUSTRY STATUS

These questions will be used not to score your individual airline, but to help us assess the progress of your airline industry as a whole in meeting sustainability commitments. Individual airline responses will be held in confidence and not reported publicly, but instead aggregated as an industry-wide evaluation.

28. Rate the probability that aviation biofuels production will scale to levels that allow your airline industry to reach 2020 GHG-neutral growth goals in conjunction with more efficient fleets and improved airspace management:

1. Highly likely: >90 percent probability
2. Somewhat likely: 60 to 90 percent
3. Potentially likely: 30 to 60 percent
4. Low likelihood: 10 to 30 percent
5. Probably won't happen: <10 percent

29. Rate the difficulty of scaling sustainable feedstocks and aviation biofuels production to reach 2020 GHG-neutral growth in your home region:

1. On course to meet goal
2. Challenging but likely to happen
3. Unlikely and so will have to access fuels from beyond region

30. Do you believe airlines can meet 2020 GHG-neutral growth goals without purchasing GHG offsets? YES/NO

31. Is your airline considering offsets as a means to achieve GHG-neutrality goals? YES/NO

Appendix B: Scoring Methodology

Airlines achieve Leading, Advancing, and Basic status based on the sum of their scores across all criteria. A top score of 38 points was possible. Three airlines scored in the 20-to-38-point scoring category and were rated as Leading, 10 scored in the 10-to-under 20-point scoring category and were rated as Advancing, and four scored in the under-10-point scoring category and were rated as Basic. Strong statistical clusters emerged in the categories, as the actual scores indicate. The questions reflected a wide range of issues, so airlines could have different strengths and weaknesses but end up in the same category.

In a change from last year, we did not disclose individual scores to the airlines in advance of the release of the final *Scorecard*.

Membership/Public Commitments

We awarded 1 point for membership in the Sustainable Aviation Fuel Users Group and additional credit for membership in recognized sustainability certification systems. Throughout the scoring, we assigned points based on evaluations of the depth and coverage of the various systems.

- Support of the Roundtable on Sustainable Biomaterials through SAFUG membership earned 1.5 points. For the first time this year, we gave an additional 0.5 point for actual airline membership in the RSB.
- Bonsucro membership earned 1 point.
- For membership in the International Sustainability or the Carbon Certification and Roundtable on Responsible Soy (RTRS), we gave 0.5 point each.
- We did not credit double membership, but credited the system with the highest point score.

Since NRDC does not support the use of palm oil to make jet fuel, we did not include the Roundtable on Sustainable Palm Oil standard in the survey this year.

This year, credit could be earned for an explicit commitment to use a specific certification system. RSB drew 2 points, Bonsucro 1 point, ISCC, and RTRS 0.5 point each. Again, when respondents indicated use of more than one system, we credited the one with the highest score.

For airlines giving firm usage targets, we gave:

- Date: 1 point for 2020 or after; 2 points for a date before
- Volume: 1 point if a target is already set; 2 if the target exceeds 11 million liters
- Percentage of total use: 1 point for 5 percent or under; 2 points for more than 5 percent

In practical terms, airlines could have earned up to 4 points for firm usage targets in 2016. This year they could earn up to 6.

We awarded 1 point for an affirmative answer to the question "Has your airline made a public commitment to not use fuels made from coal or natural gas when the airport fuel supply provides other options?"

Aviation Biofuel Contracts

Last year airlines could earn up to 3 points for having an RSB contract, 2 for Bonsucro, and 1 for other systems. This year we reduced credit for the existence of a contract and added points for date and volume, part of our methodology change to reflect the field's increasing maturity. Thus airlines could earn a maximum of 5.5 points in this section.

We asked whether the airlines have a firm contract in place for delivery of aviation biofuels certified by recognized systems. RSB earned 2 points, Bonsucro 1.5, and ISCC and RTRS 0.5 each. If multiple systems were cited, we scored the one with the highest credit.

For deliveries commencing before 2020, we gave 2 points, and we gave 1 point for 2020 or after. Volumes up to 11 million liters gained 1 point, while more than 11 million earned 1.5 points.

Aviation Biofuel Volumes Delivered

Last year we asked whether any biofuel was sourced in the previous year and what percentage was certified sustainable.

At the top of the scale, 100 percent RSB sourcing drew 7 points in the 2016 *Scorecard*. This year airlines could still earn 7 points in this section, but we gave less credit by certification system alone and emphasized volumes of certified fuel delivered. We asked whether any aviation biofuel certified under a recognized system was delivered in the past year and awarded the following credit:

- Under 1.8 million liters: 2 points
- 1.8 to 3.7 million liters: 3 points
- 3.7 to 10.99 million liters: 4 points
- 11 million liters and more: 5 points

Our certification system scoring was RSB: 2 points, Bonsucro: 1 point, and ISCC and RTRS: 0.5 point each. If multiple systems were cited, we scored the one with the highest credit.

Transparency and Disclosure

We provided 1 point for disclosure of the total volume of aviation biofuels an airline uses in a year. We gave 2 points if the airline monitors the full life-cycle greenhouse gas emissions of the biofuels it uses employing third-party life-cycle analysis, and we awarded 1 additional point if those emissions figures are disclosed publicly now.

Land Use

We asked airlines whether they are addressing ILUC and then evaluated their answers. Measures deemed sufficient to avoid ILUC risk gained 2 points. We credited an additional 1 point if the airline has made a commitment not to use feedstocks from high-conservation-value areas or from clearance of native ecosystems. SAFUG members were credited due to their commitment to the SAFUG Pledge.

Airline Staff Dedicated to Aviation Biofuels

We credited each full-time employee equivalent with 0.5 point, up to a maximum of 1.5 points.

Supply Chain Development

Last year we gave credit according to certification system alone. A maximum of 3 points was possible. This year we asked for more detail, awarding up to 5 points in total. We provided 1 point if the airline answered that in the past 18 months it had made a publicly announced investment in aviation biofuels supply chain development, including research and development, and commercial development of sustainability-certified feedstocks and/or biorefineries. A declared investment under $1 million (U.S.) gained 1 point, and an investment larger than that earned 2 points. Credit was given by certification system: RSB: 2 points, Bonsucro: 1 point, and ISCC and RTRS: 0.5 point each. If multiple systems were cited, we scored the one with the highest credit.

We eliminated credit for participation in stakeholder processes, as these were more a factor in earlier development of aviation biofuels than they are now.

Public Policy Engagement

We reported selected public policy engagements but did not score them.

Appendix C: Glossary of Acronyms

ASTM: Proper name of the group formerly known as the American Society for Testing and Materials

CORSIA: Carbon Offsetting Scheme for International Aviation

EPA: Environmental Protection Administration

EU: European Union

EU ETS: European Union Emissions Trading System

FTE: Full-time employee

GHG: Greenhouse gas

HEFA: Hydro-processed esters and fatty acids

ICAO: International Civil Aviation Organization

ILUC: Indirect land use change

ISCC: International Sustainability and Carbon Certification

LIIB: Low indirect impact biofuels

NRDC: Natural Resources Defense Council

RSB: Roundtable on Sustainable Biomaterials

SAFUG: Sustainable Aviation Fuel Users Group

Endnotes

1. United Nations Environment Programme (hereinafter UNEP), *The Emissions Gap Report 2015*, November 2015, uneplive.unep.org/media/docs/theme/13/EGR_2015_301115_lores.pdf.
2. Jet Blue, "JetBlue Announces One of the Largest Renewable Jet Fuel Purchase Agreements in Aviation History," press release, September 19, 2016, otp.investis.com/clients/us/jetblue_airways/usn/usnews-story.aspx?cid=981&newsid=39427.
3. United Nations Framework Convention on Climate Change, "The Paris Agreement," unfccc.int/paris_agreement/items/9485.php (accessed August 30, 2017).
4. UNEP, *The Emissions Gap Report 2015*.
5. U.S. Government Accountability Office, "Aviation and Climate Change: Aircraft Emissions Expected to Grow, but Technological and Operational Improvements and Governmental Policies Can Help Control Emissions," report to Congressional Committees GAO-09-554, U.S Governmental Accountability Office, June 2009, www.gao.gov/assets/300/290594.pdf.
6. Ibid.
7. Roundtable on Sustainable Biomaterials (hereinafter RSB), "RSB Low iLUC Risk Biomass Criteria and Compliance Indicators," June 1, 2015, www.rsb.org/wp-content/uploads/2017/02/RSB-STD-04-001-ver0.3RSBLowiLUCCriteriaIndicators.pdf.
8. RSB, *RSB Principles & Criteria for the Sustainable Production of Biomass, Biofuels and Biomaterials,* November 2016, rsb.org/wp-content/uploads/2017/04/RSB-STD-01-001_Principles_and_Criteria-DIGITAL.pdf
9. Poppy Morello, "What Are the World's Top 20 Airlines? December 2014 Network Update," Routes Online, December 1, 2014, www.routesonline.com/news/29/breaking-news/245818/what-are-the-worlds-top-20-airlines-december-2014-network-update/. "Network capacity" can refer to available seat miles or revenue passenger miles (or kilometer equivalent). NRDC was unable to gain clarification from Routes Online on the precise definition used here.
10. Jet Blue. "JetBlue Announces One of the Largest Renewable Jet Fuel Purchase Agreements."
11. GreenAir Online, "Low Oil Price and Current Lack of Government Support Stalls British Airways' Waste to Jet Biofuel Project," November 26, 2015, www.greenaironline.com/news.php?viewStory=2163.
12. Biofuels International, "Partnership Aims to Bring Waste-to-Jet Fuel Plants to UK," September 19, 2017, biofuels-news.com/display_news/12896/partnership_aims_to_bring_wastetojet_fuel_plants_to_uk/.
13. United Airlines, "United Airlines Makes History with Launch of Regularly Scheduled Flights Using Sustainable Biofuel," press release, March 11, 2016, newsroom.united.com/2016-03-11-United-Airlines-Makes-History-with-Launch-of-Regularly-Scheduled-Flights-Using-Sustainable-Biofuel. Dan Carey, "United Airlines Describes Effort to Introduce Aviation Biofuels," AINonline, November 1, 2016, www.ainonline.com/aviation-news/air-transport/2016-11-01/united-airlines-describes-effort-introduce-aviation-biofuels.
14. Port of Seattle, "Report: Infrastructure Options for Biofuel Delivery to Sea-Tac," *Biomass Magazine*, January 16, 2017, biomassmagazine.com/articles/14115/.
15. Nick Steel, "Seattle-Tacoma International Airport Moves a Step Closer to Funding Aviation Biofuels," SkyNRG, July 19, 2017, www.prweb.com/releases/2017/07/prweb14517280.htm.
16. SkyNRG, "Fly Green Fund, Swedavia Supply Biojet to Swedish Airport," *Biomass Magazine*, January 3, 2017, biomassmagazine.com/articles/14068/.
17. Alister Doyle, "Oslo Airport Imports Biofuels from California, Greens Doubt Benefit," Reuters, June 14, 2017, uk.reuters.com/article/us-environment-biofuels/oslo-airport-imports-biofuels-from-california-greens-doubt-benefit-idUKKBN195259.
18. Jet Blue, "JetBlue Announces One of the Largest Renewable Jet Fuel Purchase Agreements in Aviation History."
19. James Ayre, "Virgin Atlantic & LanzaTech Announce Jet Fuel Made from Steel Mill Waste," Clean Technica, September 15, 2016, www.cleantechnica.com/2016/09/15/virgin-atlantic-lanzatech-announce-jet-fuel-made-steel-mill-waste/.
20. Dan McCue, "South Africa Witnesses First Tobacco-Fueled Commercial Flight," Renewable Energy *Magazine, July 20, 2016,* www.renewableenergymagazine.com/biofuels/south-africa-witnesses-first-tobaccofueled-commercial-flight-20160721.
21. Sustainable Aviation Fuel Users Group (hereinafter SAFUG), "Our Commitment to Sustainable Options," www.safug.org/assets/docs/pledge_102010.pdf, (accessed August 17, 2017).
22. HCV Resource Network, "What Are High Conservation Values?" www.hcvnetwork.org/about-hcvf (accessed August 10, 2017). The HCV Resource Network defines high conservation values as "biological, ecological, social or cultural values which are outstandingly significant or critically important at the national, regional or global level," based on a definition first made by the Forest Stewardship Council.
23. Ibid.
24. Russell W. Stratton, Hsin Min Wong, and James I. Hileman, "Life Cycle Greenhouse Gas Emissions from Alternative Jet Fuels," Partner Project 28, Version 1.2, Partnership for AiR Transportation Noise and Emissions Reduction, June 2010, web.mit.edu/aeroastro/partner/reports/proj28/partner-proj28-2010-001.pdf.

25. Simon Mui et al., "GHG Emission Factors for High Carbon Intensity Crude Oils," Version 2, Natural Resources Defense Council, September 2010, www.nrdc.org/sites/default/files/ene_10070101a.pdf.

26. Mary Grady, "NASA Confirms Biofuels Cut Jet Pollution," AVweb, March 21, 2017, www.avweb.com/avwebflash/news/NASA-Confirms-Biofuels-Cut-Jet-Pollution-228675-1.html.

27. RSB, "RSB Low iLUC Risk Biomass Criteria."

28. David Diaz et al., *Evaluation of Avoided Grassland Conversion and Cropland Conversion to Grassland as Potential Carbon Offset Project Types*, The Climate Trust, 2014, climatetrust.org/wp-content/uploads/2014/07/Evaluation-of-Avoided-Grassland-Conversion-and-Cropland-Conversion-to-Grassland-as-Potential-Carbon-Offset-Project-Types-.pdf.

29. Chris Malins, Stephanie Searle, and Anil Baral, "A Guide for the Perplexed to the Indirect Effects of Biofuel Production," International Council on Clean Transportation, September 4, 2009, www.theicct.org/guide-perplexed-indirect-effects-biofuels-production.

30. Ecofys, "Low Indirect Impact Biofuel Certification Module," www.ecofys.com/en/project/low-indirect-impact-biofuel-methodology/ (accessed August 30, 2017).

31. The Members and Affiliates of SAFUG, "Global Policy Statement Indirect Land Use Change (ILUC)," April 2013, www.safug.org/assets/docs/iluc-global-proposition.pdf.

32. International Civil Aviation Organization (hereinafter ICAO), "European Advanced Biofuels Flightpath," ICAO Environment, www.icao.int/environmental-protection/GFAAF/Pages/Project.aspx?ProjectID=9 (accessed March 31, 2017).

33. GreenAir Online, "Low Oil Price and Current Lack of Government Support."

34. Alaska Airlines, "Alaska Flies First Commercial Flight with New Biofuel Made from Forest Residuals," Alaska Airlines Blog, November 14, 2016, blog.alaskaair.com/alaska-airlines/news/nara-flight/.

35. Andrea Colnes et al., "Biomass Supply and Carbon Accounting for Southeastern Forests," Biomass Energy Resource Center, Forest Guild, and Spatial Informatics Group, February 2012, www.biomasscenter.org/images/stories/SE_Carbon_Study_FINAL_2-6-12.pdf. Joshua Clark, *Impacts of Thinning on Carbon Stores in the PNW: A Plot Level Analysis*, Oregon State University, College of Forestry, May 25, 2011, www.nrdc.org/sites/default/files/ene_13041704a.pdf. Stephen R. Mitchell, Mark E. Harmon, and Kari B. O'Connell, "Carbon Debt and Carbon Sequestration Parity in Forest Bioenergy Production," *Global Change Biology Bioenergy* 4, no. 6 (November 2012): 818-827, onlinelibrary.wiley.com/doi/10.1111/j.1757-1707.2012.01173.x/full . Anna Repo et al., "Sustainability of Forest Bioenergy in Europe: Land-Use-Related Carbon Dioxide Emissions of Forest Harvest Residues," *Global Change Biology Bioenergy* 7, no. 4 (July 2015): 877-887, onlinelibrary.wiley.com/doi/10.1111/gcbb.12179/full . Anna L. Stephenson and David J. C. MacKay, "Life Cycle Impacts of Biomass Electricity in 2020: Scenarios for Assessing the Greenhouse Gas Impacts and Energy Input Requirements of Using North American Woody Biomass for Electricity Generation in the UK," U.K. Department of Energy and Climate Change, July 2014, www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/%20BEAC_Report_290814.pdf. Michael T. Ter-Mikaelian et al., "Carbon Debt Repayment or Carbon Sequestration Parity? Lessons from a Forest Bioenergy Case Study in Ontario, Canada," *Global Change Biology Bioenergy* 7, no. 4 (July 2015): 704-716, onlinelibrary.wiley.com/woll/doi/10.1111/gcbb.12198/full. Thomas Walker et al., "Biomass Sustainability and Carbon Policy Study," Manomet Center for Conservation Sciences, June 2010, www.mass.gov/eea/docs/doer/renewables/biomass/manomet-biomass-report-full-hirez.pdf.

36. International Air Transport Association (IATA), "Airlines Hail Historic ICAO Agreement," press release No. 56, October 6, 2016, www.iata.org/pressroom/pr/Pages/2016-10-06-02.aspx. ICAO, "Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)," ICAO Environment, www.icao.int/environmental-protection/Pages/market-based-measures.aspx (accessed August 10, 2017).

37. ICAO, "Carbon Offsetting and Reduction Scheme."

38. Rob Bailis, Derik Broekhoff, and Carrie M. Lee, "Supply and Sustainability of Carbon Offsets and Alternative Fuels for International Aviation," Stockholm Environmental Institute, working paper 2016-3, June 2016, www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-03-ICAO-aviation-offsets-biofuels.pdf.

39. IATA, *IATA Technology Roadmap*, 4th edition, section 2, June 2013, www.iata.org/whatwedo/environment/Documents/technology-roadmap-2013.pdf.

40. Boeing and Civil Air Navigation Services Organization (CANSO), "Accelerating Air Traffic Management Efficiency: A Call to Industry," February 2012, section 4, www.faa.gov/nextgen/media/newsletter/Accelerating%20ATM%20Call%20to%20Industry.pdf.

41. World Wildlife Fund, "New Deal Secures Path to Clamp Down on Aviation Emissions," press release, October 6, 2016, www.worldwildlife.org/press-releases/new-deal-secures-path-to-clamp-down-on-aviation-emissions.

42. Christopher Surgenor, ed., "Advanced Biofuels for Transportation Set to Benefit Under Proposals to Revise EU Policy on Transport Fuels," GreenAir Online, December 2, 2016, www.greenaironline.com/news.php?viewStory=2312.

43. Ibid.