RNG Poised To Propel Green Transition in Maritime and Aviation Sectors

This article is Part 2 in a series on how renewable natural gas — RNG, also called biomethane — can help unlock environmental and economic benefits across the global economy.[i]

Guidehouse, The Coalition for Renewable Natural Gas

Why Are the Maritime and Aviation Sectors Rethinking Their Fuel Mix?

Increasingly the focus of environmental discourse has turned to addressing "difficult-to-decarbonize" sectors. Such sectors are not exclusively niches or outliers; including economic activity from long-haul trucking to heat-intensive manufacturing, “difficult-to-decarbonize” encompasses human activities for which electrification does not provide an immediate, practical, or economically feasible decarbonization solution. The global aviation and maritime industries fall firmly into this difficult-to-decarbonize space.

The maritime and aviation sectors each accounted for approximately 2% of global greenhouse gas (GHG) emissions in 2021.[ii] However, as other sectors more amenable to electrification and low-carbon fuels decarbonize, the proportion of GHG emissions from maritime and aviation is forecast to balloon by 2050 to 17% and 21%, respectively.[iii] Some of the numerous challenges to reducing emissions in these sectors are listed below.[iv]

Maritime Sector Decarbonization Challenges:

- Fuels used in sector are currently almost entirely petroleum-based.
- Uncertainty as to how the prices of competing low-carbon fuels will evolve, including natural gas, ammonia, renewable methanol (e-methanol), renewable methane (e-methane) and biofuels.
- Electrification options (i.e., batteries) limited to short-distance coastal shipping.
- Market chicken-and-egg: without clear alternative fuel supply, fleets don’t convert, limiting new fuel development.[v]

Aviation Sector Decarbonization Challenges:

- Fuels used in sector are overwhelmingly petroleum-based.
- Aviation fuels need to have a high energy density to make their weight, and the space they take up on board, manageable.
- Safety standards and testing requirement for aviation fuels and/or aircraft design changes are needed to enable shift to lower energy density fuels.
- Limited supply of sustainable aviation fuel (SAF) from bio-based sources.
- Electrification options (i.e., batteries) limited to small, short haul flights.

Both sectors are feeling considerable regulatory and societal pressure to accelerate emissions reductions. [vi]

	In the aviation sector, policies of note include net zero targets, blending mandates for SAF, tax credits and grants to accelerate SAF production, and phasing out Emission Trading Scheme allowances. The International Airline Trade Association (IATA) has estimated that 65% of the emissions reductions the sector needs to get to net zero will have to come from switching to SAF.[vii] In the U.S., the Inflation Reduction Act (IRA) provides $1.25 per gallon of SAF that meets certain emissions criteria and has also allocated a competitive grants program to SAF.
	Measures in the maritime sector mostly center around carbon intensity reduction targets, requiring zero-emission fuels and subsidizing green hydrogen production that can itself be used as a fuel, or used to produce other fuels that may be better suited for transportation (ammonia, etc.). The U.S.’s proposed carbon intensity targets, requiring 100% zero-emissions fuels from 2040, are more ambitious than similar proposals in other parts of the world.

The maritime and aviation sectors are coordinating their response to this shifting regulatory environment at a global level through the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICOA), respectively.[viii]

How Can RNG Help the Marine and Aviation Sectors Reduce Their Emissions?

RNG is a key piece of the decarbonization puzzle for the maritime and aviation sectors, because of its:

- Flexibility: RNG can be used as a feedstock for producing low-carbon fuels (such as SAF) or as a low-carbon fuel itself.
- Ready Availability: Anaerobic digestion, used to produce RNG, is an established, scalable technology and the bio-wastes it uses as a feedstock are readily available globally.
- Sustainability: RNG offers a far broader range of sustainability benefits than GHG emission reduction alone. Environmental benefits of digestate, a byproduct of the anaerobic digestion process, include restoration of degraded soil and water eutrophication reduction. The CO2 captured in the process can also be upgraded to 99.9% purity for use in the food and beverage sector for carbonating drinks and for manufacturing packaging,[ix] and in other sectors for metal fabrication, in fire suppression equipment and to stimulate plant growth in greenhouses.[x] The dispersed nature of RNG production also supports greater energy supply resiliency and is a driver for job creation in rural and urban communities.[xi]

Specific examples of how RNG is already, or will soon be, reducing emissions in the maritime and aviation sectors include:

<u>Maritime Sector:</u>

- The maritime freight industry has invested heavily in the use of liquified natural gas as a lower-emissions alternative to diesel fuel.[xii] To further reduce emissions, liquified RNG has successfully been blended with traditional natural gas up to a ratio of approximately 10% by two consortia in the Netherlands: shipper CMA CGM Group and energy giant Shell, and shipper Furetank and LNG-supplier Titan LNG.[xiii]
- Methanol is another fuel the maritime sector is considering using to reduce its emissions. Though lower-carbon intensity than oil, most methanol is still fossil fuel derived. Using RNG in methanol production can drastically cut the GHG emissions associated with maritime methanol use. The ferry operator Stena Line was an early adopter of installing dual-fuel engines capable of using methanol while Maersk, the container shipping giant, ordered 19 methanol-ready ships in 2022.[xiv]. Additionally, OCI Global, the world's biggest producer of green methanol, plans to double annual production capacity at its Texas plant to 400,000 tons per year.[xv]

<u>Aviation Sector:</u>

- A type of Sustainable Aviation Fuel, known as Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK) can be produced by reforming RNG and has been approved for use when blended up to 50% with petroleum-derived jet fuel[xvi].
- U.S.-based SkyNRG Americas is developing a production facility in the Pacific Northwest that will also use RNG as one of the feedstocks to supply Boeing, among others, with SAF.[xvii]
- An alternative approach to increasing the bio-derived content of aviation fuels is the methanol-to-jet pathway. Being developed by Nacero (Texas) and ExxonMobil (Singapore) amongst others[xviii], this pathway can use RNG and a broad range of other bio-based feedstocks to reduce GHG emissions associated with aviation.

Case Study: SAF Use in the Aviation Sector and the Role of RNG

Today, airlines are investing in SAF to reduce operational emissions. One prominent example is U.S. aviation giant United Airlines, which has been procuring supplies of the low-carbon fuel for domestic and international flights since 2016.

The SAF used by United Airlines cuts GHG emissions by 85% compared to conventional jet fuel, based on the full lifecycle of the fuel including production, transportation and use. It's these lifecycle benefits that have also prompted international competitors, including Air France-KLM and SAS, among others — to view SAF as the lynchpin of their decarbonization plans.

While United's SAF interest is part of a widespread trend, the fuel today represents just a pinch of most airlines' fuel mixes — in 2022 United used roughly 3 million gallons of SAF, or slightly less than 0.1% of its total jet consumption.[xix]

The relative infancy of the SAF supply chain — where supply (SAF production) and demand (airports) are often geographically dispersed — is one reason the use of SAF still remains limited. To overcome this basic logistical hurdle, United has been using a “book-and-claim” procurement system. Under book-and-claim (variations of which are a mainstay of renewable energy markets), United pays a premium for SAF, which is then blended into total airport fuel supplies along with conventional jet fuel; in return for purchasing the SAF, the airline earns environmental "credits" which can be separately traded. The alternative — storing United’s SAF separately and delivering it via fueling trucks — would be more complex, environmentally onerous, and potentially impractical in some busy airports. The continued availability of book-and-claim procurement for SAF could prove vital to United’s and other airlines' abilities to decarbonize their fleets in coming years.

United Airlines has purchased SAF from World Energy to supply its Los Angeles operations (since 2016) and Neste to supply its Amsterdam (since 2022) and San Francisco (since 2023) operations.[xx] Both these SAF producers refine bio- or waste-derived oils to produce SAF — the most common route to SAF production in the U.S.[xxi]

However, the availability of waste oils is expected to become increasingly constrained by finite supply in the face of growing demand for SAF. RNG offers many advantages over waste oils as a SAF feedstock, including growing availability, decreasing costs, and compatibility with efficient methods of creating components that can blend with conventional jet fuels. To take advantage of the benefits that RNG offers, SkyNRG is developing a facility in Washington State that will use RNG and green hydrogen as feedstocks for SAF. With a production goal of 30 million gallons of SAF by 2027, and offtake agreements already in place with Boeing, this will be the first, large scale commercial demonstration of RNG for decarbonizing the aviation sector.[xxii]

Last Words

RNG is a flexible, ubiquitous, and sustainable fuel that can be part of the complement of low-carbon fuels and technologies the maritime and aviation sectors need in their green transition. RNG has an important role to play in diversifying the technologies and feedstocks that can support these sectors’ energy transitions. The examples provided in this article demonstrate how RNG can support hard-to-decarbonize sectors, as both a feedstock for low-carbon fuels and as a low-carbon fuel in its own right.

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[i] RNG, also known as biomethane, is a commercially available, low carbon fuel derived from the decay of bio-based wastes in anaerobic environments. RNG is chemically identical to, and can be used interchangeably with, conventional

natural gas. RNG is currently mostly utilized in transportation end uses, but it has the potential to reduce GHG emissions in other sectors, as well.

[ii] See International Energy Agency overviews of the maritime and aviation sectors

[iii] https://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf

[iv] https://www.dnv.com/energy-transition-outlook/download.html

[v] Market chicken and egg: RMI, Jumpstarting Decarbonization of the Maritime Shipping Sector

[vi] See International Energy Agency overviews of the maritime and aviation sectors

[vii] https://www.iata.org/en/programs/environment/flynetzero/

[viii] IMO (https://www.imo.org/) and ICOA (https://www.icao.int/Pages/default.aspx)

[ix] Article on the benefits of installing carbon capture equipment to anaerobic digestion facilities (https://www.privilege.finance/news/2021/03/16/capturing-carbon-in-anaerobic-digestion/). Note, without upgrading CO2 from AD is circa 75-98% pure (https://pubs.acs.org/doi/10.1021/acs.est.1c02894).

[x] International Energy Agency, "Putting CO2 to Use."

[xi] https://www.europeanbiogas.eu/wp-content/uploads/2023/02/20230213_Guidehouse_EBA_Report.pdf

[xii] https://www.freightwaves.com/news/thousands-of-ships-could-use-lng-as-fuel-is-that-a-good-thing#

[xiii] https://safety4sea.com/wp-content/uploads/2022/10/Sea-LNG-Role-of-bio-LNG-in-shipping-industry-decarbonisation-2022_10.pdf

[xiv] https://fathom.world/how-to-make-green-methanol-for-shipping/

[xv] OCI Global doubles capacity as shipping industry seeks green methanol | Reuters

[xvi] https://www.energy.gov/sites/prod/files/2020/09/f78/beto-sust-aviation-fuel-sep-2020.pdf

[xvii] https://skynrg.com/producing-saf/skynrg-pacific-northwest/

[xviii] Nacero reference - https://www.greencarcongress.com/2023/04/20230401-nacero.html and Exxon mobile reference - https://www.exxonmobilchemical.com/en/resources/library/library-detail/101116/exxonmobil_sustainable_aviation_fuel_production_en

[xix] Bloomberg, How United and Other US Airlines Lost Momentum on Sustainable Jet Fuel

[xx] https://www.prnewswire.com/news-releases/united-airlines-to-lead-industry-switch-to-sustainable-aviation-fuel-with-global-corporations-customers-301267616.html and https://www.neste.com/releases-and-news/renewable-solutions/neste-supply-sustainable-aviation-fuel-united-airlines-flights-departing-san-francisco-international

[xxi] https://www.greenbiz.com/article/us-unprepared-sustainable-jet-fuel-future

[xxii] https://skynrg.com/producing-saf/skynrg-pacific-northwest/