

Research and principles for a long-term climate goal for aviation

*Dan Rutherford, Ph.D.
Director, Marine and Aviation*

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**ICCT research on global
aviation emissions**

International Council on Clean Transportation

- Goal of the ICCT is to dramatically reduce conventional pollutant and greenhouse gas emissions from all transportation sources in order to improve air quality and human health, and mitigate climate change.
- Promotes best practices and comprehensive solutions to:
 - Improve vehicle emissions and efficiency
 - Increase fuel quality and sustainability of alternative fuels
 - Reduce pollution from the in-use fleet, and
 - Curtail emissions from international goods movement.
- The Council is made up of leading regulators and experts from around the world.



CO₂ emissions from commercial aviation, 2018

- Transparent, bottom-up global aviation inventory released in Sept.
- Allocated CO₂ to countries, regions, and markets by airport of departure for all passenger flights

Source	Use
OAG	Operations data for 39 million commercial flights
Great Circle Mapper	Long/lat for airports database
ICAO Data+, US BTS	Passenger and freight load factors
PIANO 5	Fuel burn estimates by flight
IATA	Passenger vs. freight fuel burn allocation
U.S., China, Japan, IATA emissions data	Model validation

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CO₂ emissions from commercial aviation, 2018

Authors: Brandon Graver, Ph.D., Kevin Zhang, Dan Rutherford, Ph.D.

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SUMMARY

Greenhouse gas emissions from commercial aviation are rapidly increasing, as is interest among fliers in reducing their carbon footprints. Under a business-as-usual trajectory, the United Nations' International Civil Aviation Organization (ICAO) expects aviation emissions to roughly triple by 2050, at which time aircraft might account for 25% of the global carbon budget.

Although ICAO and the International Air Transport Association (IATA) publish annual summary statistics of aircraft operations and economics, respectively, relatively little data is available about fuel burn, fuel efficiency, and carbon emissions at the regional and national levels. Policymakers cannot determine the precise amount of carbon emissions associated with flights departing from individual countries, nor can they distinguish the proportion of emissions from passenger-and-freight and all-freight operations, or from domestic and international flights.

To better understand carbon emissions associated with commercial aviation, this paper develops a bottom-up, global aviation CO₂ inventory for calendar year 2018.

Using historical data from OAG Aviation Worldwide Limited, national governments, international agencies, and the PIANO aircraft emissions modelling software, this paper details a global, transparent, and geographically allocated CO₂ inventory for commercial aviation. Our estimates of total global carbon emissions, and the operations estimated in this study in terms of revenue passenger kilometers (RPKs) and freight tonne kilometers (FTKs), agree well with aggregate industry estimates.

Nearly 39 million flights from 2018 were analyzed, and 38 million of these were flown by passenger aircraft. Total CO₂ emissions from all commercial operations, including passenger movement, belly freight, and dedicated freight, totaled 918 million metric tons (MMT) in 2018. That is 2.4% of global CO₂ emissions from fossil fuel use and a 32% increase over the past five years. Further, this emissions growth rate is 70% higher than assumed under current ICAO projections.

The data shows that passenger transport accounted for 747 MMT, or 81%, of total emissions from commercial aviation in 2018. Globally, two-thirds of all flights were domestic, and these accounted for approximately one-third of global RPKs and 40% of global passenger

transport-related CO₂ emissions. On a national level, flights departing airports in the United States and its territories emitted almost one-quarter (24%) of global passenger transport-related CO₂, and two-thirds of those emissions came from domestic flights. The top five countries for passenger aviation-related carbon emissions were rounded out by China, the United Kingdom, Japan, and Germany. CO₂ emissions from aviation were distributed unequally across nations; less developed countries that contain half of the world's population accounted for only 10% of all emissions.

This paper also apportions 2018 emissions by aircraft class and stage length. Passenger movement in narrowbody aircraft was linked to 43% of aviation CO₂, and passenger emissions were roughly equally divided between short-, medium-, and long-haul operations. The carbon intensity of flights averaged between 75 and 95 grams (g) of CO₂ per RPK, rising to almost 160 g CO₂/RPK for regional flights less than 500 kilometers.

BACKGROUND

Greenhouse gas emissions from commercial aviation are rapidly increasing. If the global aviation sector were treated as a nation, it would have been

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Key results

CO₂ EMISSIONS FROM COMMERCIAL AVIATION, 2018

To better understand the carbon emissions associated with commercial aviation, this study developed a bottom-up, global aviation CO₂ inventory for calendar year 2018.

918 million metric tons (MMT) CO₂ from passenger and freight transport

32% increase since 2013, using IATA values

38 million passenger flights (67% domestic / 33% international)

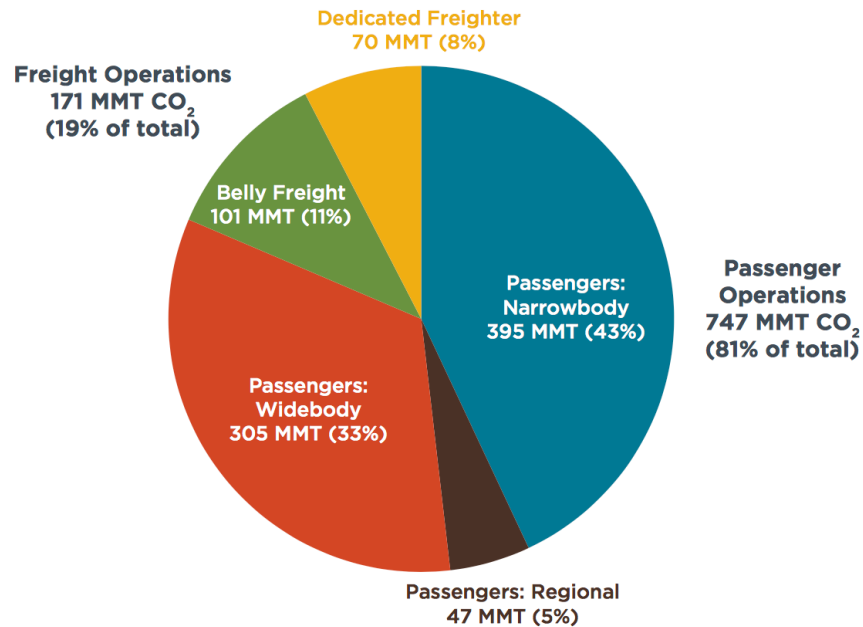





Figure 1. CO₂ emissions in 2018 by operations and aircraft class

TOP CO₂ EMITTERS

(based on country of departure)

-  **United States**
182 MMT
24% of global total
69% from domestic operations
-  **European Union**
142 MMT
19% of global total
47% from in-bloc operations
-  **China**
95 MMT
13% of global total
69% from domestic operations

Breakdown of 2018 aviation CO₂ by country and route group

Table 3. CO₂ emissions from passenger transport in 2018 – top 10 departure countries

Rank	Departure country	Operations	CO ₂ [MMT]	% of Total CO ₂	RPKs (billions)	% of Total RPKs
1	United States ^a	Domestic	126	17	1,328	16
		International	56.1	7.4	650	7.6
		Total	182	24	1,976	23
2	China ^b	Domestic	65.9	8.8	781	9.2
		International	29.0	3.9	361	4.2
		Total	94.9	13	1,142	13
3	United Kingdom ^c	Domestic	1.51	0.2	12.0	0.2
		International	28.3	3.8	328	3.9
		Total	29.8	4.0	350	4.1
4	Japan	Domestic	9.41	1.2	95.5	1.1
		International	14.0	1.9	172	2.0
		Total	23.4	3.1	267	3.1
5	Germany	Domestic	1.53	0.2	12.4	0.1
		International	20.7	2.8	235	2.8
		Total	22.2	3.0	247	2.9
6	United Arab Emirates	Domestic	<0.01	<0.1	<0.01	<0.1
		International	21.1	2.8	233	2.7
		Total	21.1	2.8	233	2.7
7	India	Domestic	10.8	1.4	125	1.5
		International	8.60	1.2	109	1.3
		Total	19.4	2.6	234	2.8
8	France ^d	Domestic	4.53	0.6	48.9	0.6
		International	14.7	2.0	172	2.0
		Total	19.2	2.6	221	2.6
10	Australia ^a	Domestic	6.65	0.9	76.3	0.9
		International	12.3	1.7	144	1.7
		Total	19.0	2.5	220	2.6
10	Spain	Domestic	2.88	0.4	28.9	0.3
		International	15.6	2.1	203	2.4
		Total	18.5	2.5	232	2.7
Rest of the World			298	40	3,381	40
Total			747	100	8,503	100

Table 2. CO₂ emissions and carbon intensity from passenger transport in 2018, by regional route group

Rank	Route Group (Not directional specific)	CO ₂ [MMT]	% of Total CO ₂	RPKs (billions)	% of Total RPKs	Carbon Intensity [g CO ₂ /RPK]
1	Intra-Asia/Pacific	186	25	2,173	26	86
2	Intra-North America	136	18	1,425	17	96
3	Intra-Europe	103	14	1,189	14	86
4	Europe ↔ North America	50.0	6.7	597	7.0	84
5	Asia/Pacific ↔ Europe	43.4	5.8	523	6.1	83
6	Asia/Pacific ↔ North America	38.7	5.2	459	5.4	84
7	Asia/Pacific ↔ Middle East	33.5	4.5	388	4.6	86
8	Intra-Latin America/Caribbean	29.1	3.9	303	3.6	96
9	Europe ↔ Middle East	25.1	3.4	291	3.4	86
10	Latin America/Caribbean ↔ North America	23.4	3.1	290	3.4	81
11	Europe ↔ Latin America/Caribbean	21.1	2.8	259	3.1	81
12	Africa ↔ Europe	16.5	2.2	197	2.3	84
13	Intra-Middle East	9.18	1.2	79.0	0.9	116
14	Middle East ↔ North America	8.84	1.2	98.8	1.2	89
15	Intra-Africa	8.62	1.2	72.6	0.9	119
16	Africa ↔ Middle East	7.75	1.0	84.8	1.0	91
17	Africa ↔ Asia/Pacific	2.73	0.4	30.0	0.4	91
18	Africa ↔ North America	1.90	0.3	19.4	0.2	98
19	Asia/Pacific ↔ Latin America/Caribbean	0.91	0.1	10.2	0.1	89
20	Latin America/Caribbean ↔ Middle East	0.79	0.1	8.29	0.1	96
21	Africa ↔ Latin America/Caribbean	0.46	0.1	4.73	0.1	97
Total		747	100	8,503	100	88

Carbon intensity of flying doubles under 500 km

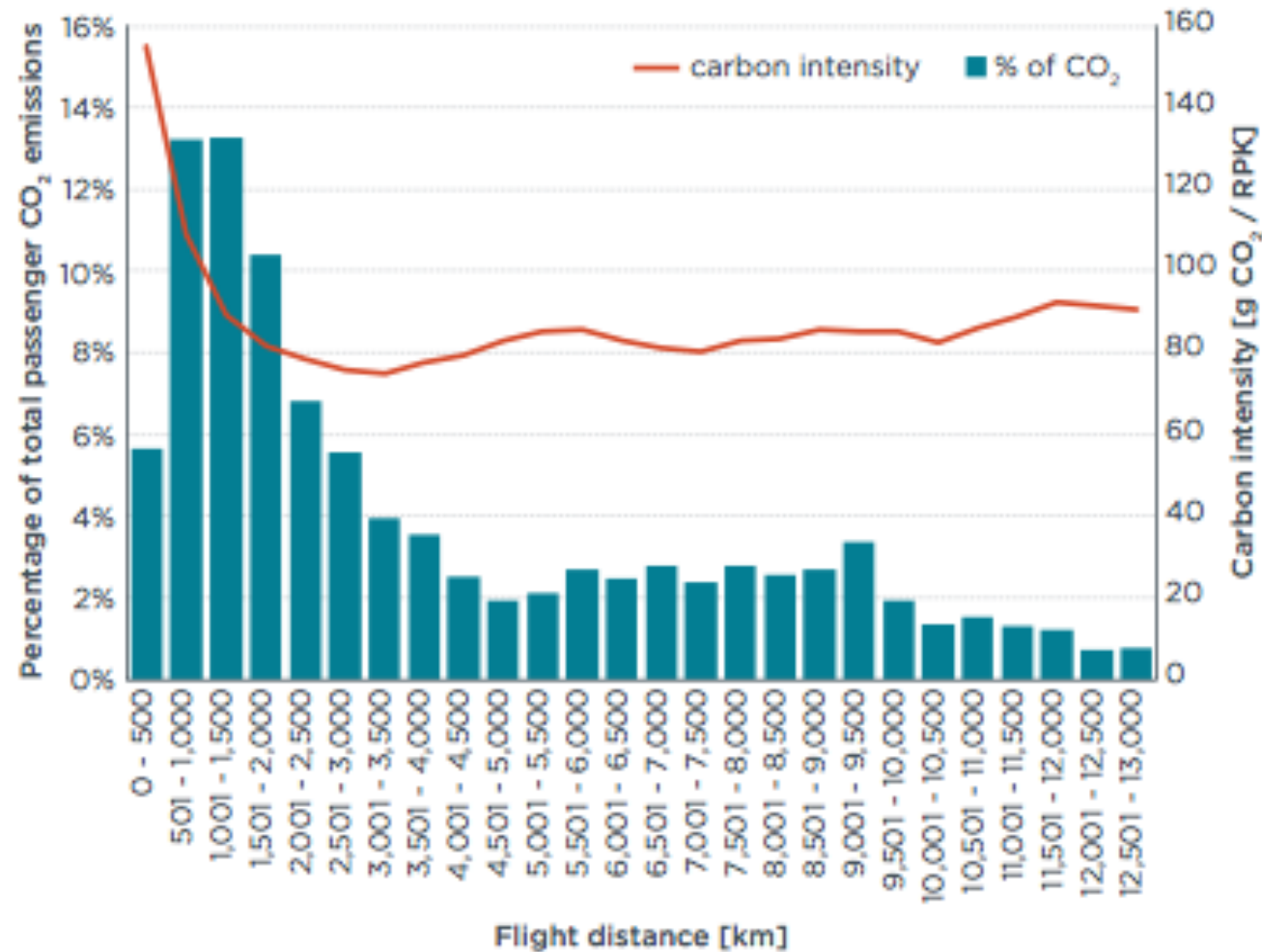


Figure 3. Share of passenger CO₂ emissions and carbon intensity in 2018, by stage length.

Passenger aviation CO₂ distribution today...

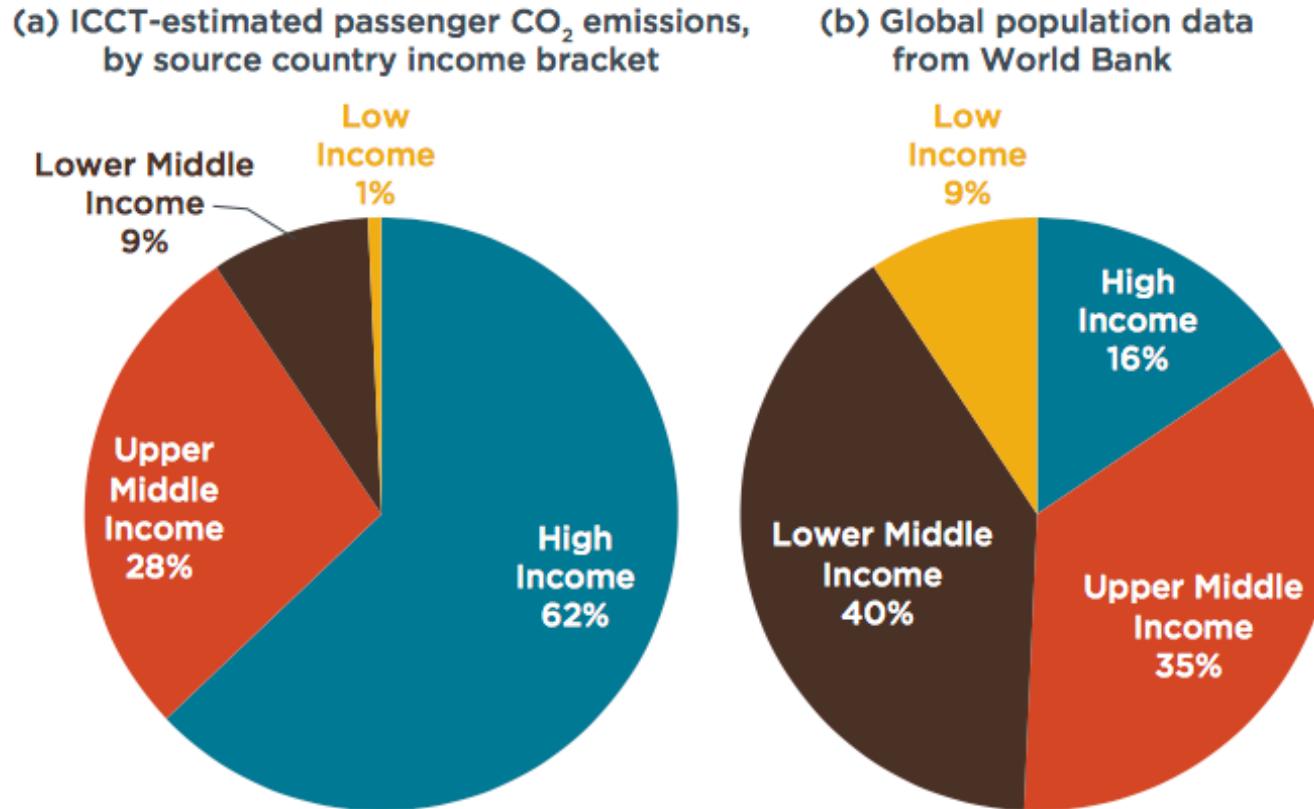
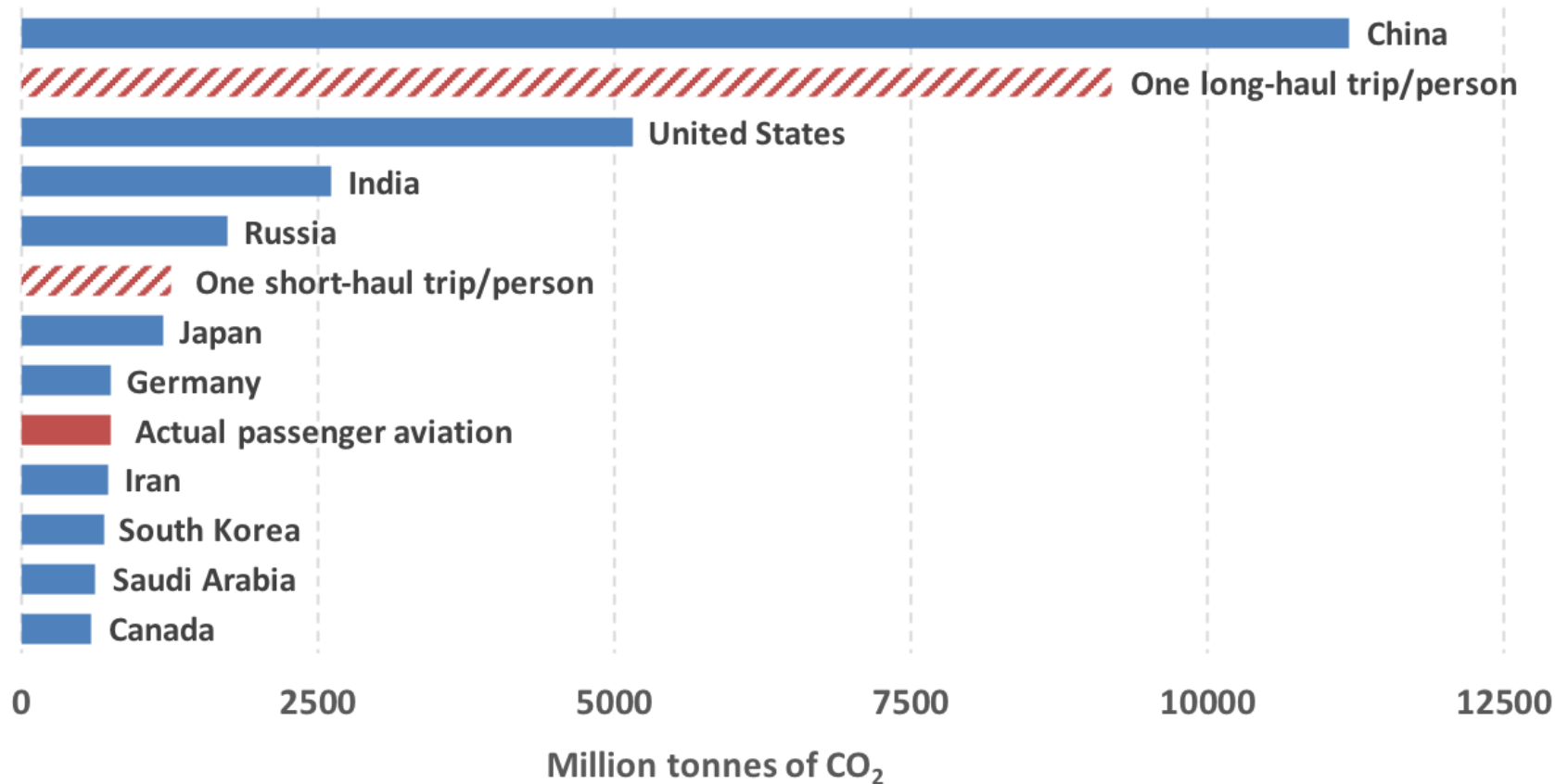


Figure 2. CO₂ emissions from passenger aviation operations and total population in 2018, by country income bracket (United Nations, 2019; World Bank, 2019)

... and growth in a hypothetical future

Actual and estimated CO₂ emissions from passenger aviation
versus the top ten emitting countries, 2018



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**ICSA principles for an
ICAO long-term climate
goal**

International Coalition for Sustainable Aviation



The International Coalition for Sustainable Aviation (ICSA) provides environmental NGOs with observer access to the UN's International Civil Aviation Organization (ICAO). ICSA members have actively participated in ICAO's technical work and political negotiations regarding environmental protection since 1998.

ICSA's Enhanced Climate Mitigation Targets and Levers

■ Targets

1. Well-to-wake GHG emissions not to exceed 2020 levels in 2035.
2. Well-to-wake GHG emissions reduced at least 50% from 2005 levels by 2050.

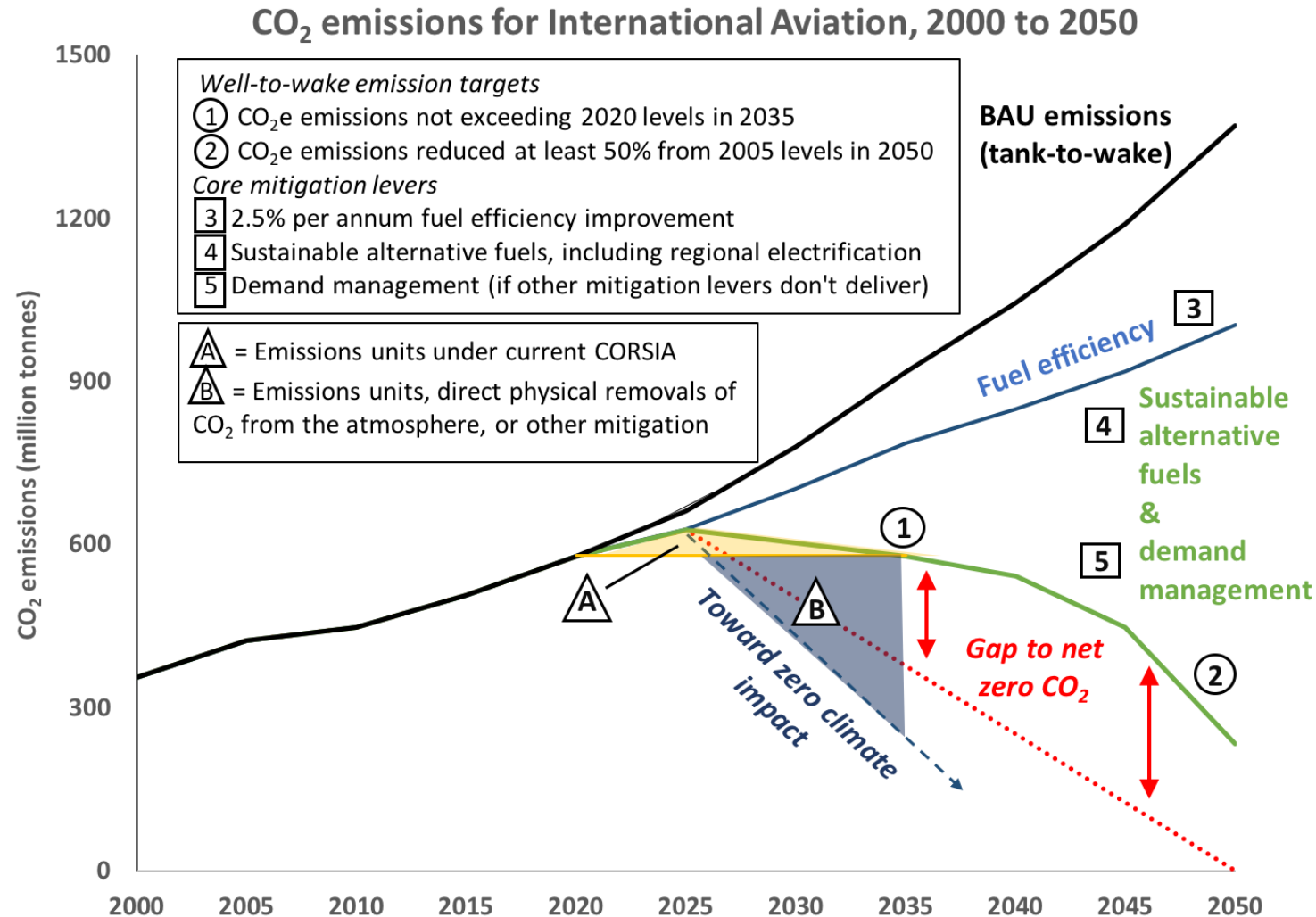
■ Levers

1. Fleetwide fuel efficiency improvements of 2.5% per annum from 2020 to 2050.
2. Use of certified sustainable alternative fuels (SAF) that deliver substantial emission reductions on a lifecycle basis and are not double counted
3. Demand management, to the extent that fuel efficiency and SAF are insufficient to meet the 2035 and 2050 goals.

■ Other issues raised

- Need to account for and control non-CO₂ climate impacts
- Likely importance of direct investments in atmospheric CO₂ removals

Potential emission pathways for international aviation



Recommended tangible next steps

- For governments

1. Adopt, strive, and advocate for targets in line with these principles
2. Commit to developing, and subsequently adopt, a long-term goal no later than at ICAO's 41st Assembly

- For industry

1. Update the ATAG climate change mitigation strategy
2. Advocate for aviation policy measures consistent with a 1.5 degree C future and that don't detract from other sectors
3. Adopt, without delay, national and regional measures to stop runaway emissions growth

Thank you!

Dan Rutherford, Ph.D.

Director, Marine and Aviation

International Council on Clean Transportation

dan@theicct.org

www.theicct.org

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