SAFE LANDING: Aviation Workers Demand Industry to Reject Dangerous Growth

Safe Landing

Finlay Asher

Hamburg Aerospace Lecture Series

Online, 4 May 2023

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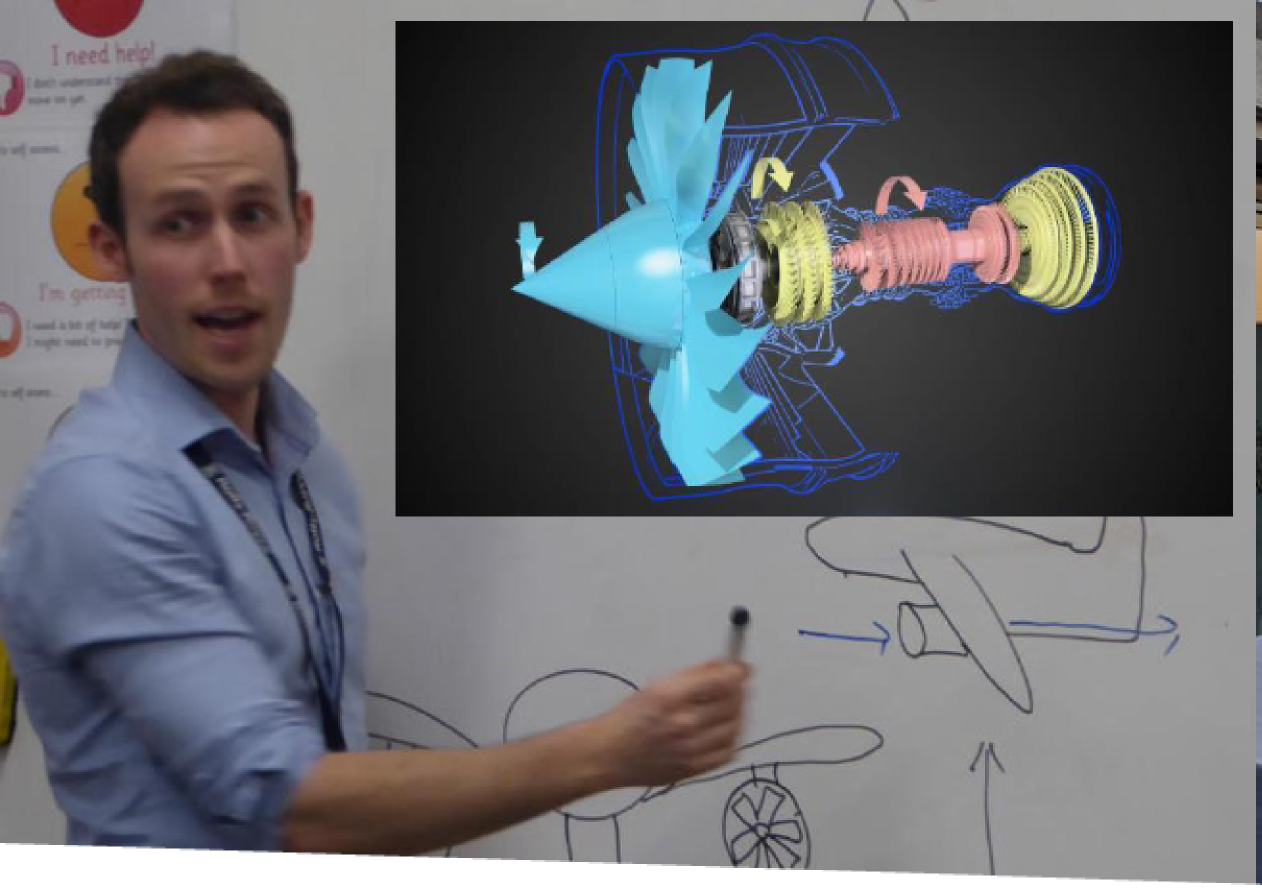
DISCLAIMER:

Don’t trust anything I say!

- Our group presents alternative positions to the status quo.
- Please challenge anything – seek out other sources of information and form your own view.
- Ask questions – during the talk, or later by emailing: info@safe-landing.org

AGENDA

- My background
- My organisation: Safe Landing
- Issues with aviation decarbonisation plans
- Our alternative positive vision of the future
- How can we collectively achieve this?



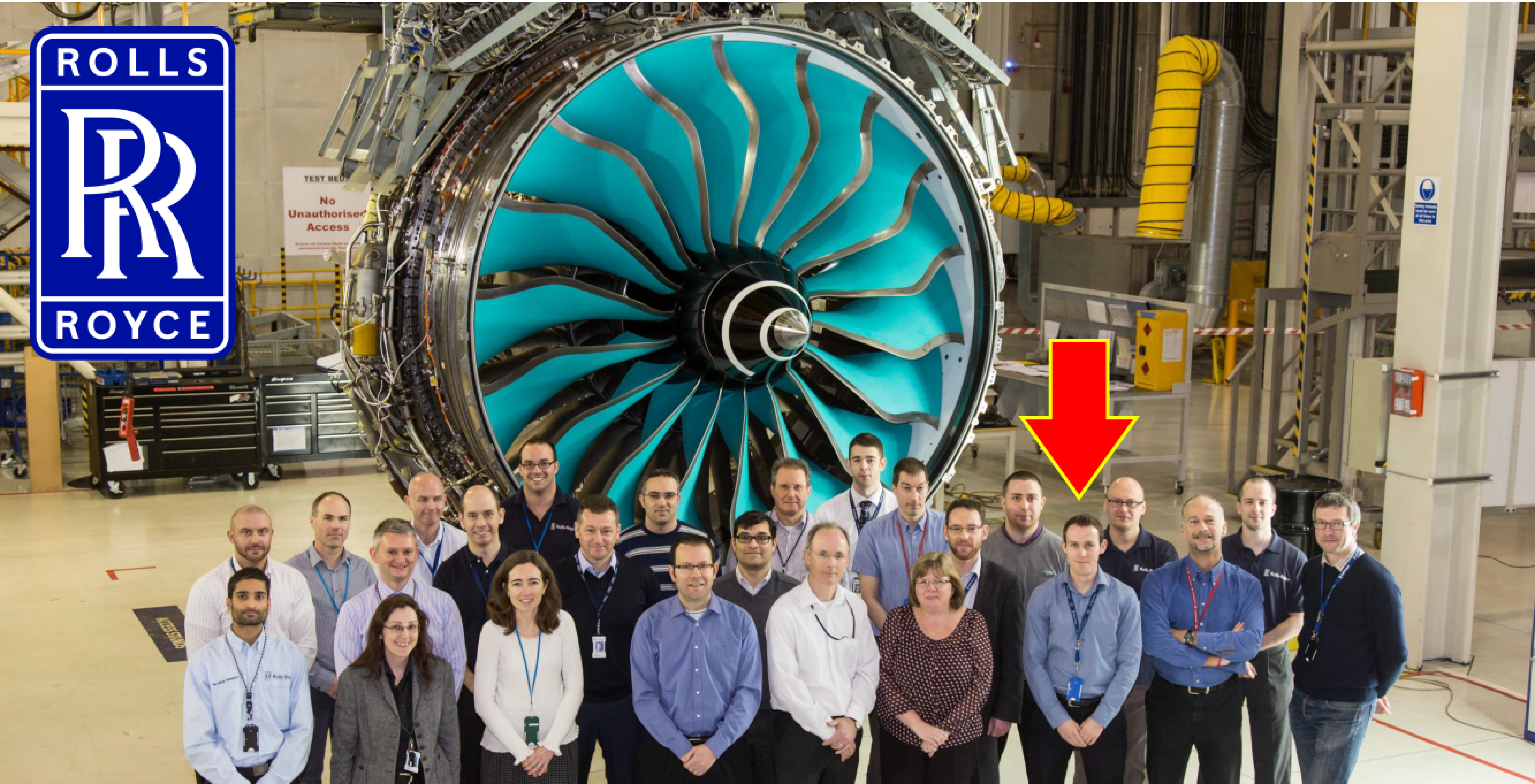
Finlay Asher

- Mechanical / Aerospace Engineer
- Co-founder of Safe Landing (aviation workers)
- 8 Years @ Rolls-Royce: Future Aircraft Engine Design

Safe Landing

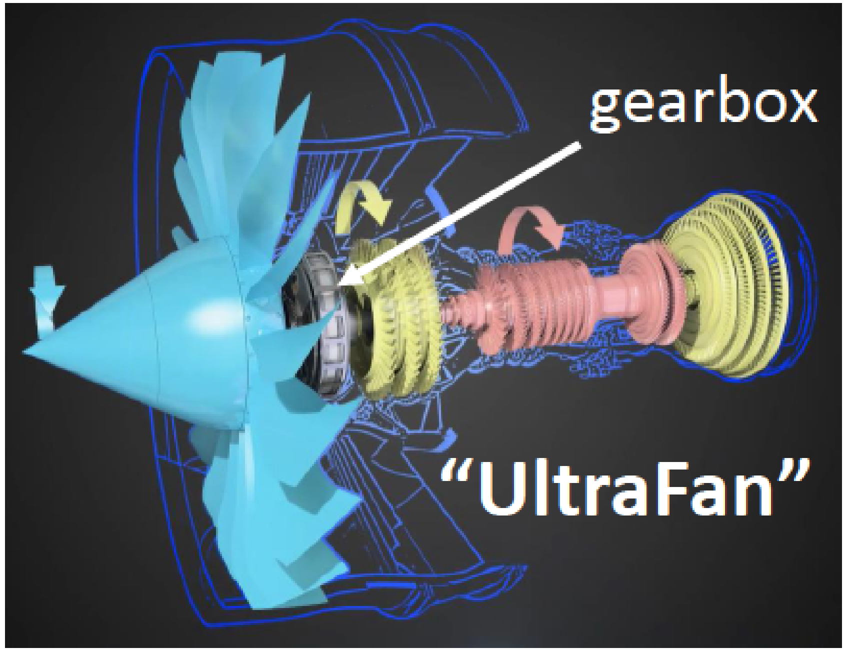
My Background: 8 years at Rolls-Royce

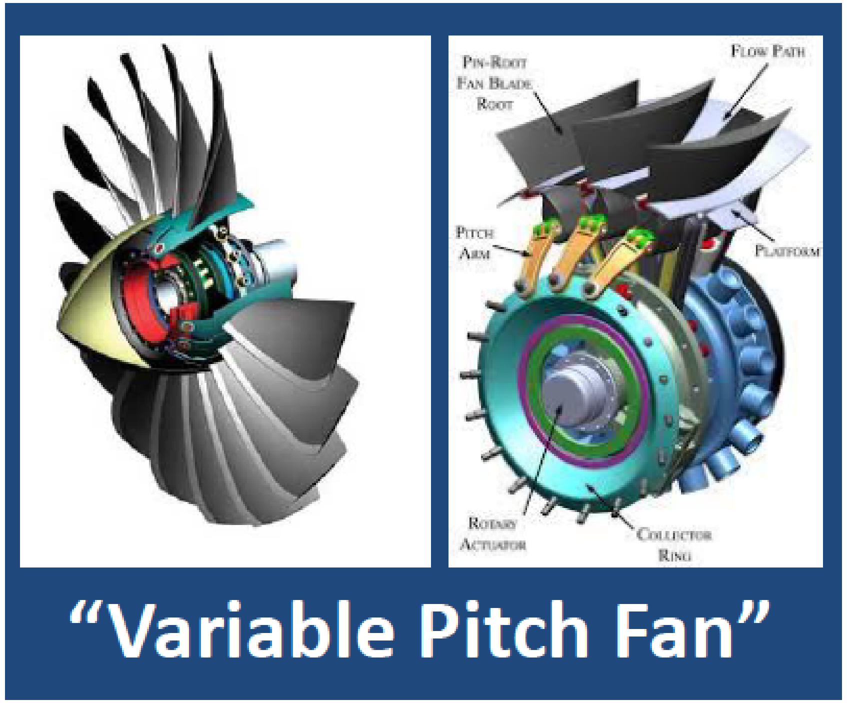
My Background: 8 years at Rolls-Royce



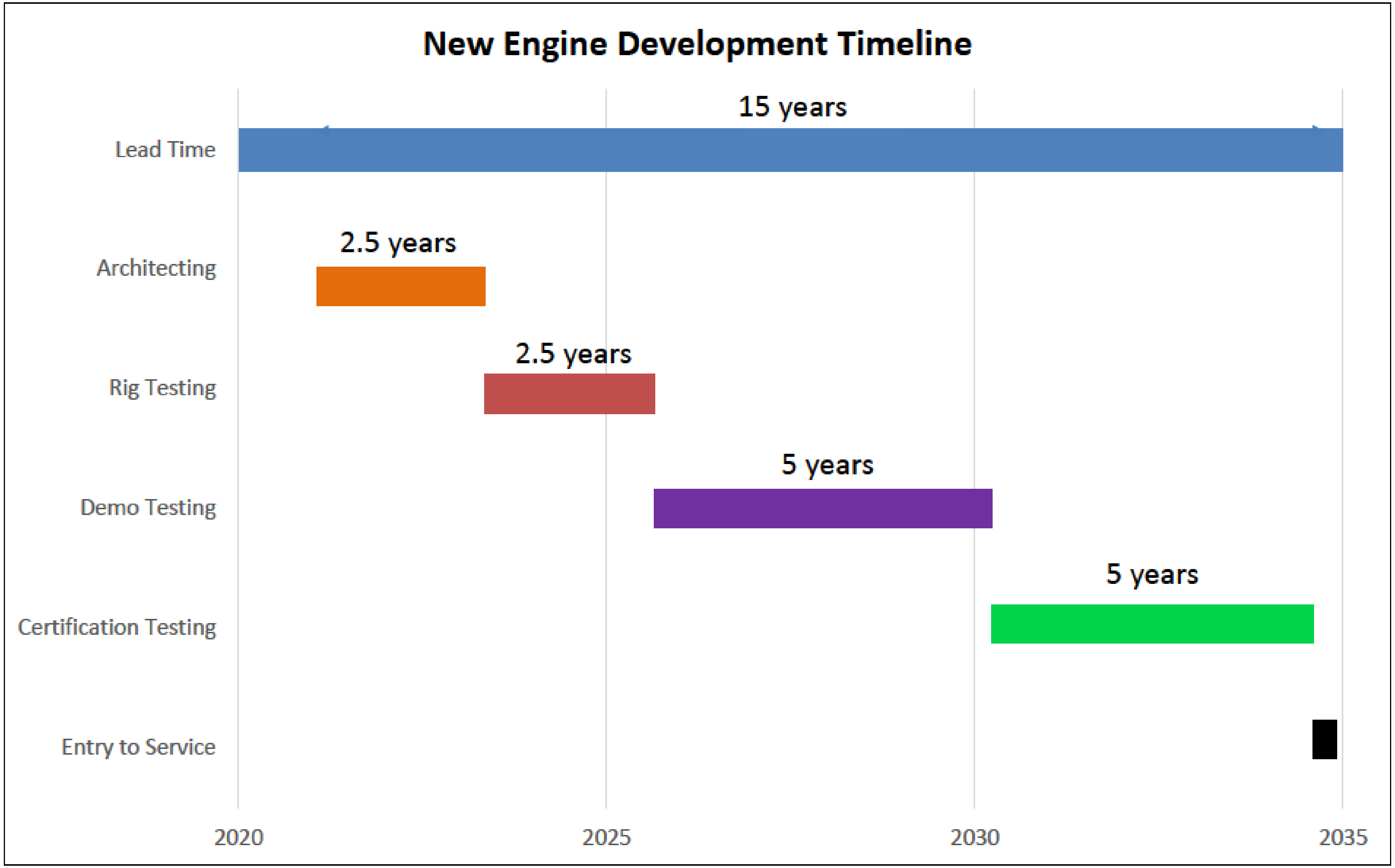
My Background: 8 years at Rolls-Royce

My Background: Future Concepts





Concern: Why aren't we working on technology?



The Climate & Ecological Emergency is a **<u>this decade</u>** issue – what's holding us back??

Concern: Are we sitting on solutions?

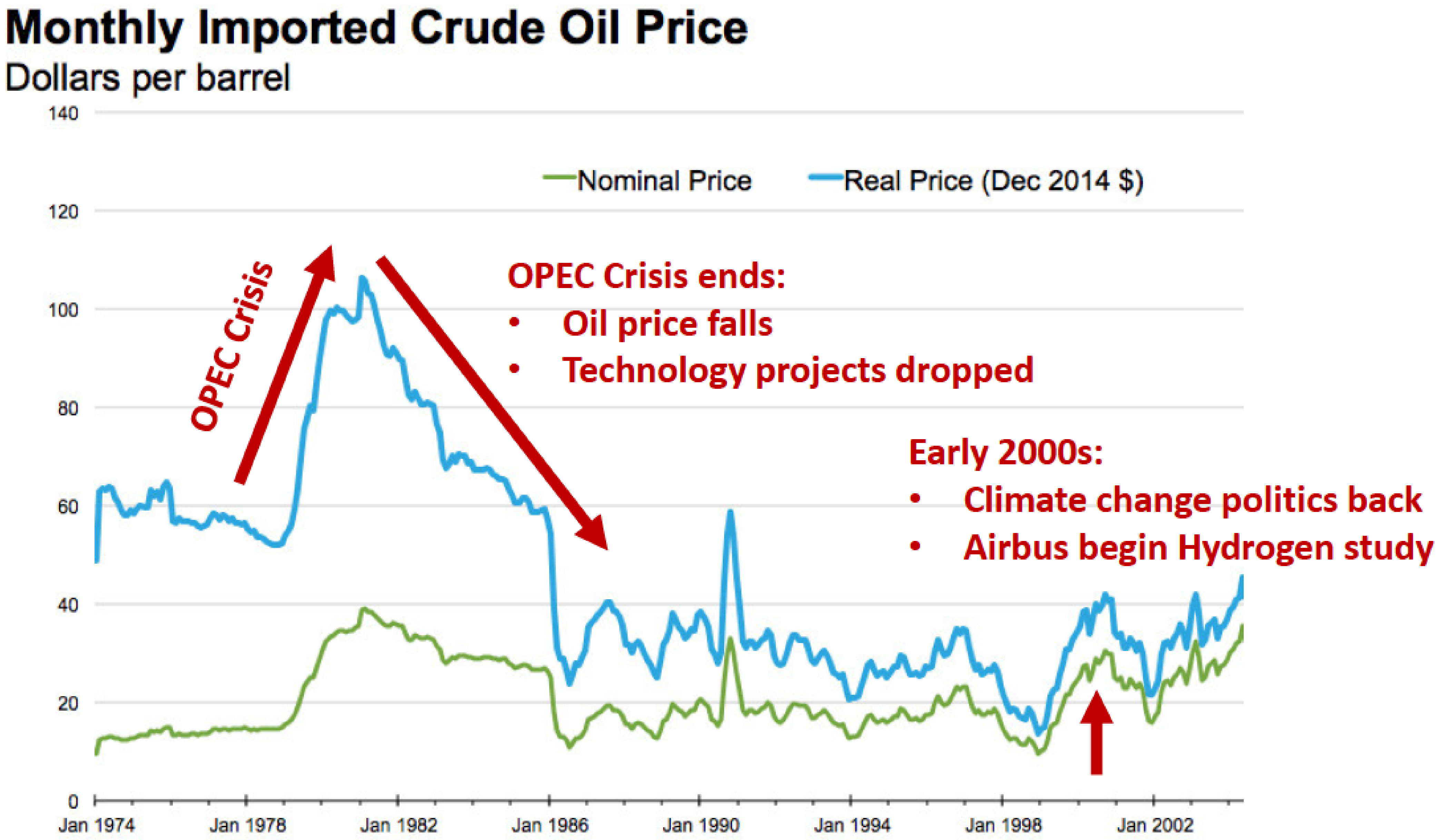
“Open Rotor”:

future concept for significant step-change in engine fuel burn

“Un-Ducted Fan”:

was already developed and flight tested in… *the 1980s*

Concern: It's all about oil price!



Concern: it's all about oil price

Aviation industry 'ditches' hydrogen

By Michael Fitzpatrick
Science and technology reporter

17 Nov 2010 | Science & Environment

It took just 32 seconds to extinguish faith in the airship and the hydrogen that once buoyed the Hindenburg, which erupted in a fatal inferno 73 years ago.

Now hydrogen is being dropped again by the aviation industry.

But this time the promised "green" fuel for powering flights of the future has been quietly shelved in favour of biofuels and more fossil fuel-sipping aviation.

Airbus looks to the future with hydrogen planes

21 September 2020 | Business

Aerospace giant Airbus has unveiled plans for what it hailed as the first commercial zero-emission aircraft.

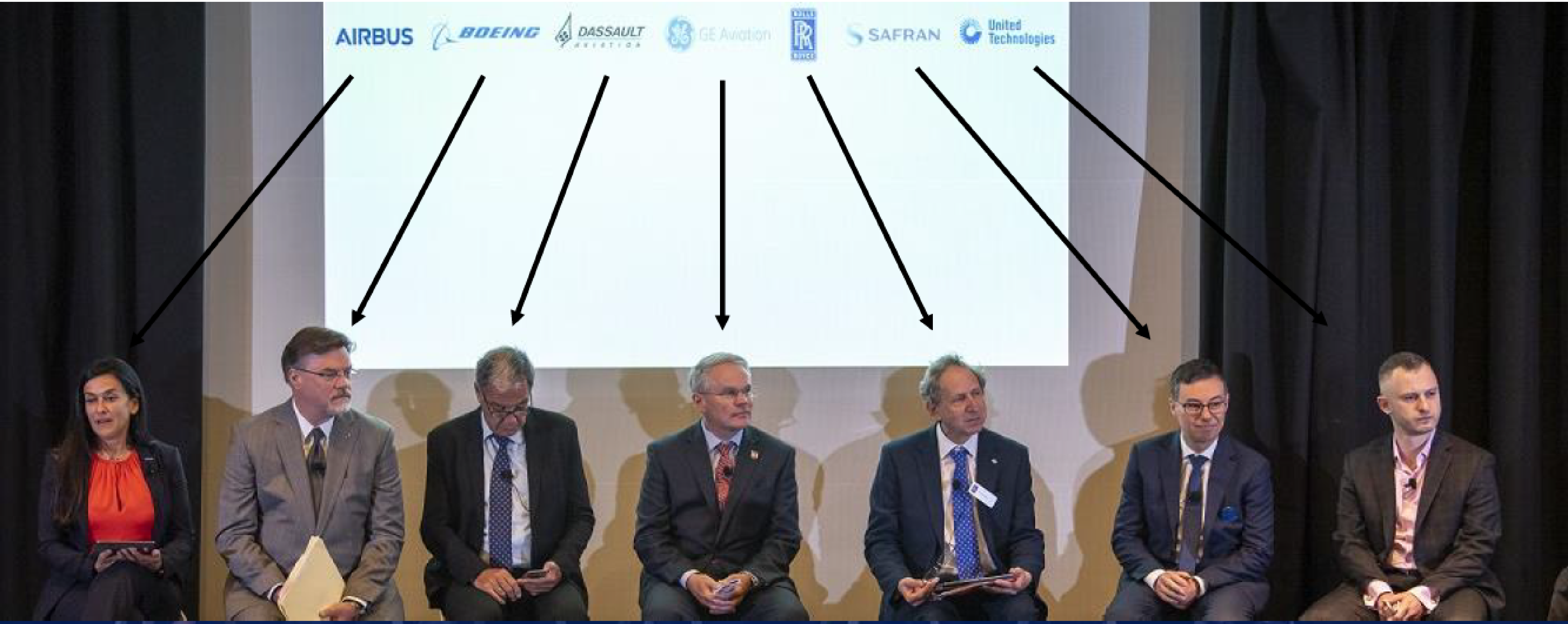
The company said its hydrogen-fuelled passenger planes could be in service by 2035.

Airbus chief executive Guillaume Faury said the three ZEROe concept designs marked "a historic moment for the commercial aviation sector".

April 2019: Extinction Rebellion in London, UK

August 2019: Greta Thunberg sails to USA

Paris Air Show 2019: Joint Aviation Statement



Chief technology officers commit to driving sustainability of aviation

Employee Sustainability Group

Safe Landing

AVIATION WORKERS
FOR A SUSTAINABLE FUTURE

www.safe-landing.org info@safe-landing.org

Safe Landing

AVIATION WORKERS
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- LinkedIn:
  https://www.linkedin.com/company/safe-landing-org/
- Twitter:
  https://twitter.com/_SafeLanding
- Facebook:
  https://www.facebook.com/safe.landing.workers
- Instagram:
  https://www.instagram.com/safe_landing/

Our Demands

As aviation workers, we demand that our leaders:

1. **Be honest** about the total environmental impact of flying

2. **Be realistic** about the limits of technology to solve this problem

3. **Be transparent** about future regulations required to reduce emissions

4. **Have a plan** that accounts for this and supports workers during transition

Our positions:

As aviation workers, we believe that:

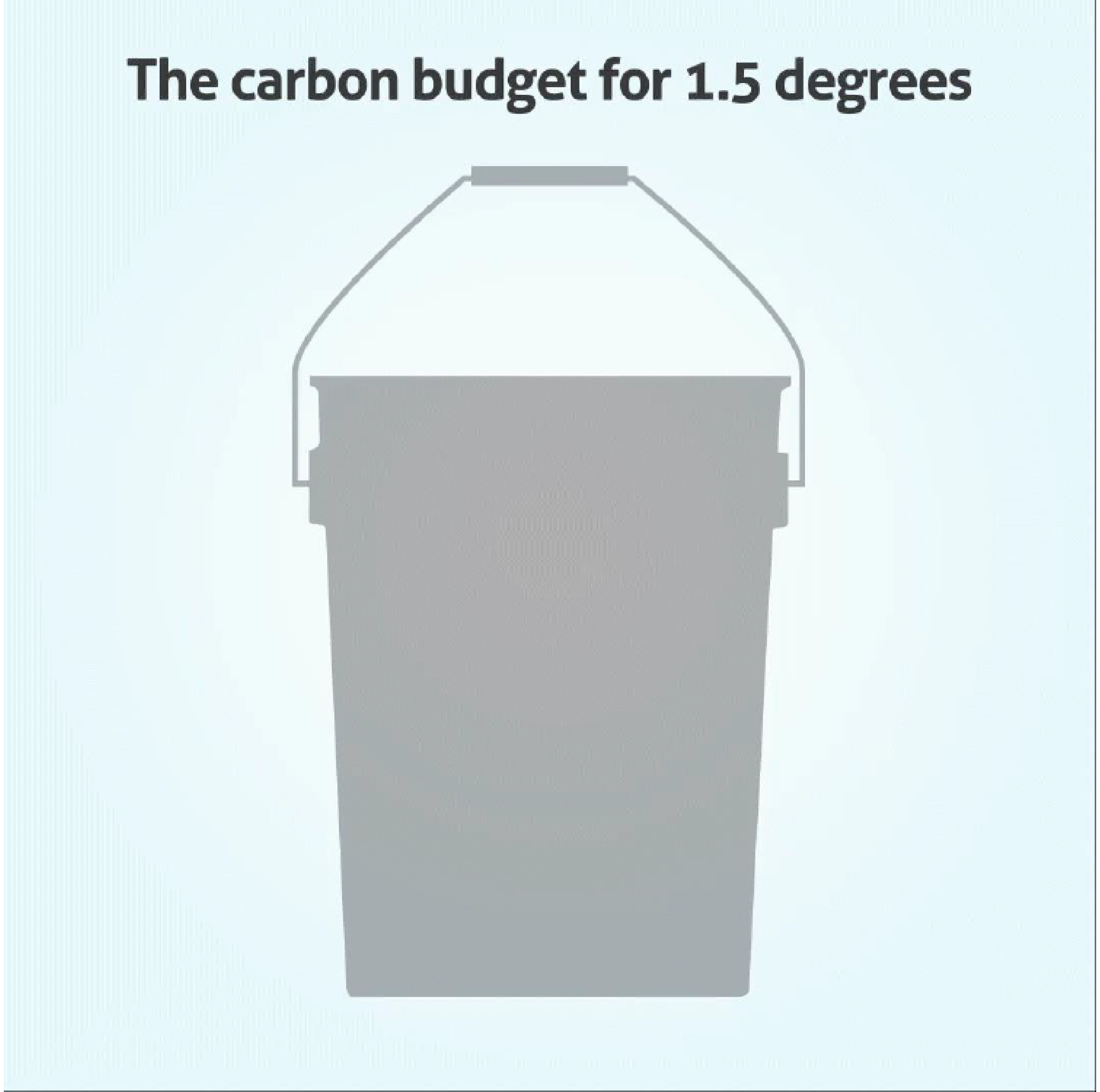
1. Flying has a **high environmental impact**, and is currently **highly inequitable**
2. Technology **will not be available at scale** in the time required (10-15 years)
3. Future regulations **are vital**, and this includes constraining air traffic capacity
4. Acknowledging this, **and planning for this**, is in all of our best interests


Heading for a Crash Landing?
Aviation and the Climate Crisis

Time:

We have very limited time before we blow our carbon budget for 1.5degC.

SOURCES:
[Stanford University]



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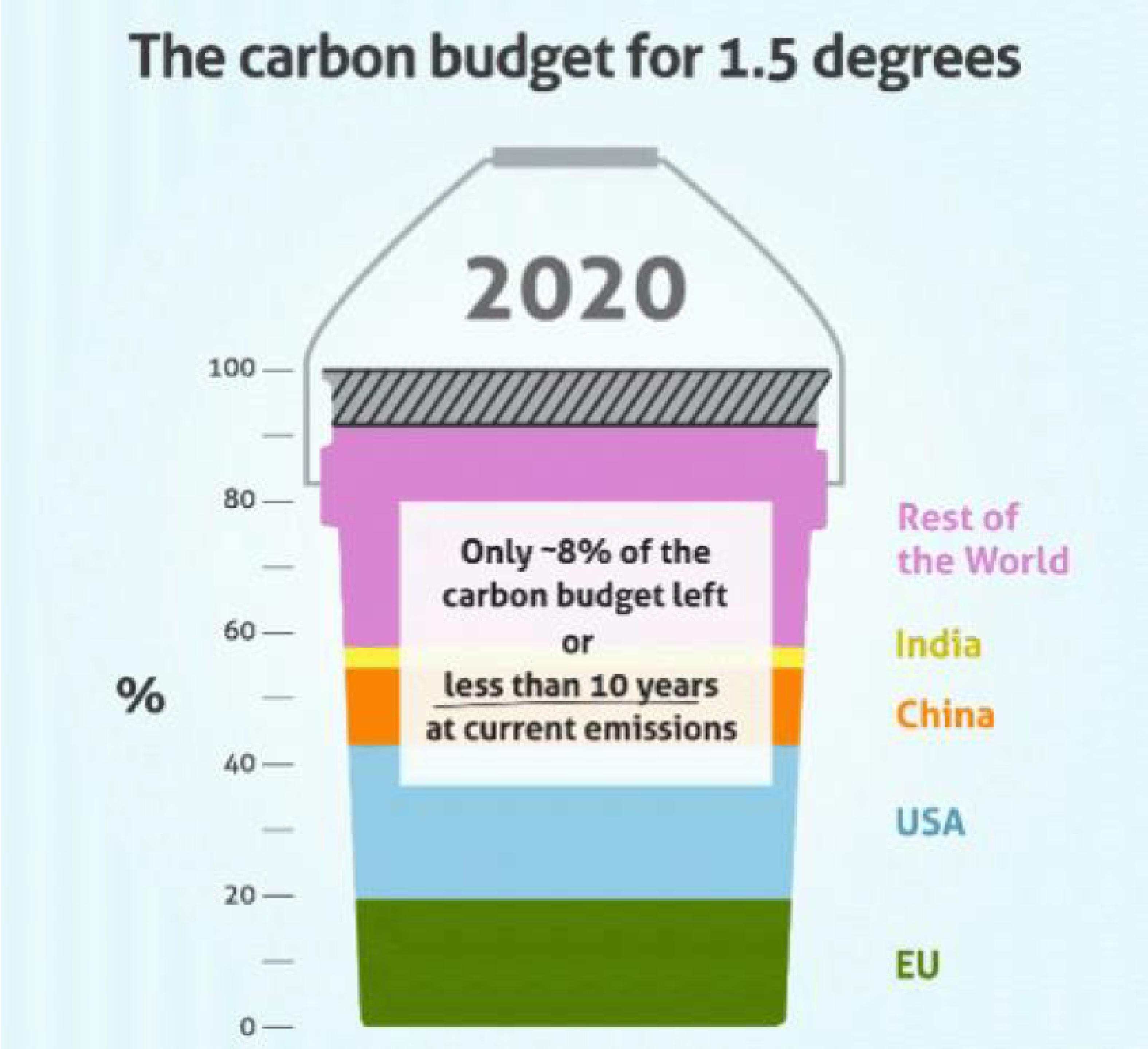
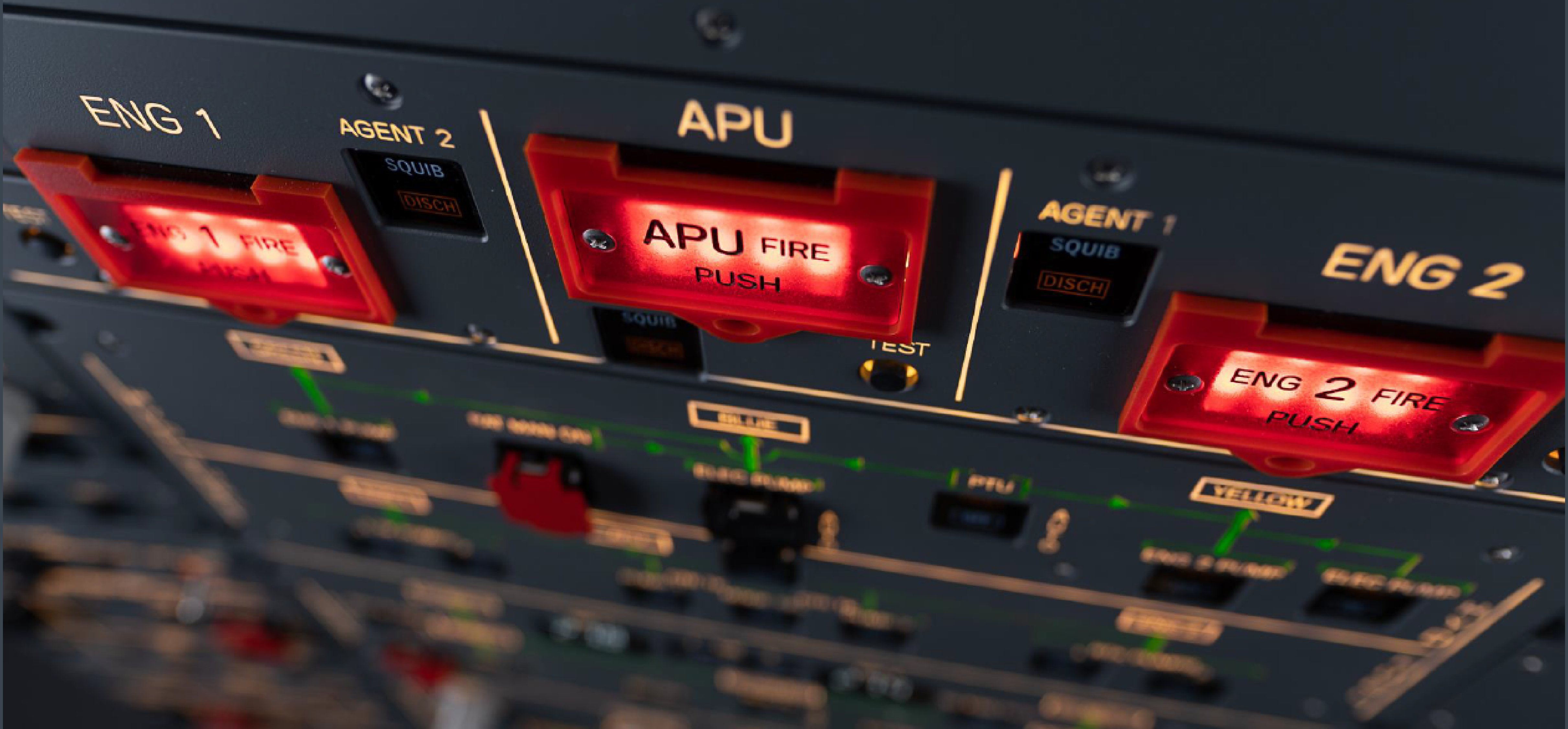
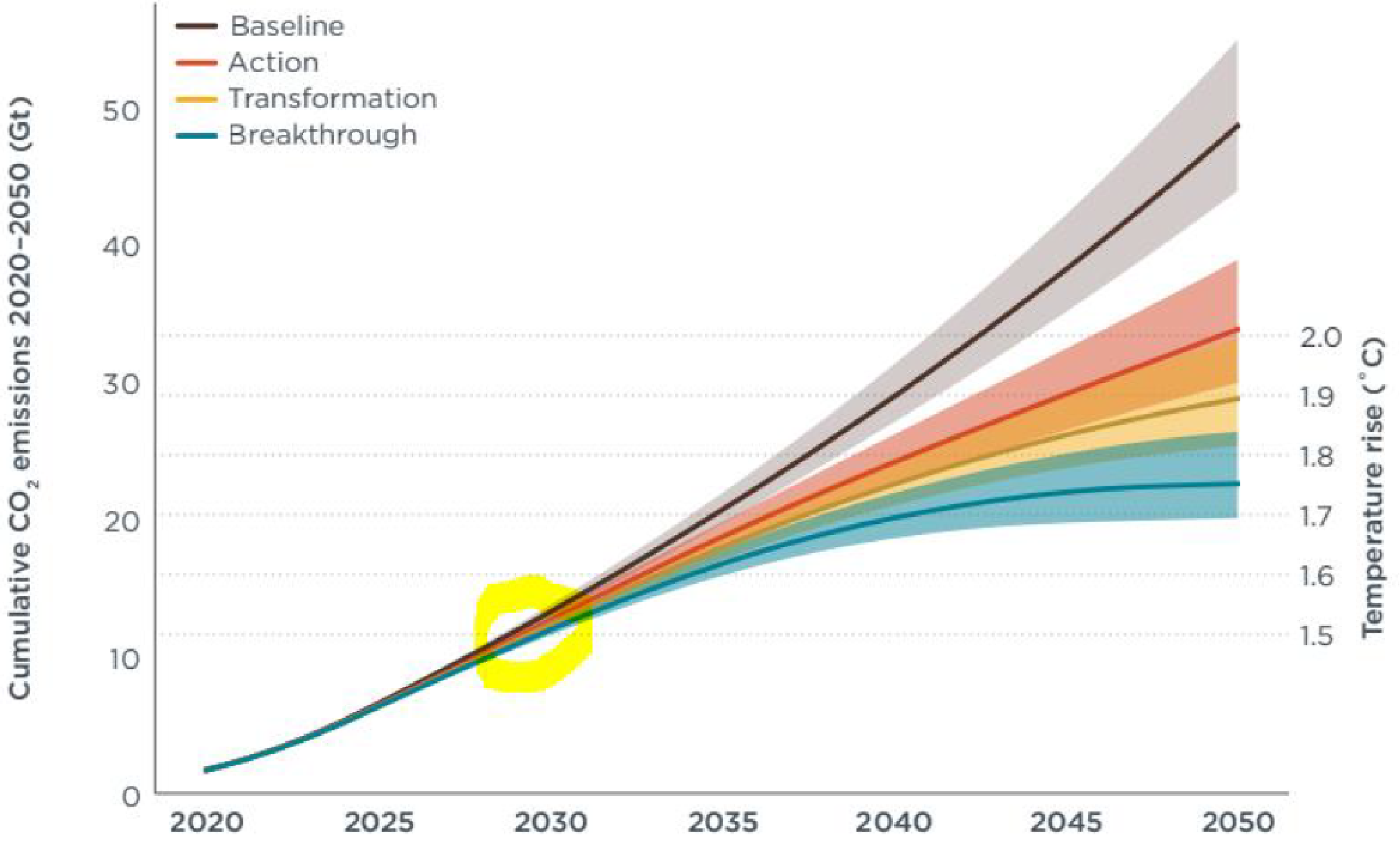


SOURCES:
[Stanford University]

THIS IS AN EMERGENCY





The solid line depicts the central traffic forecast; the shaded area depicts the range between the low and high forecasts.

Figure 9. Global aviation CO_2 emissions by scenario and traffic forecast, 2020-2050

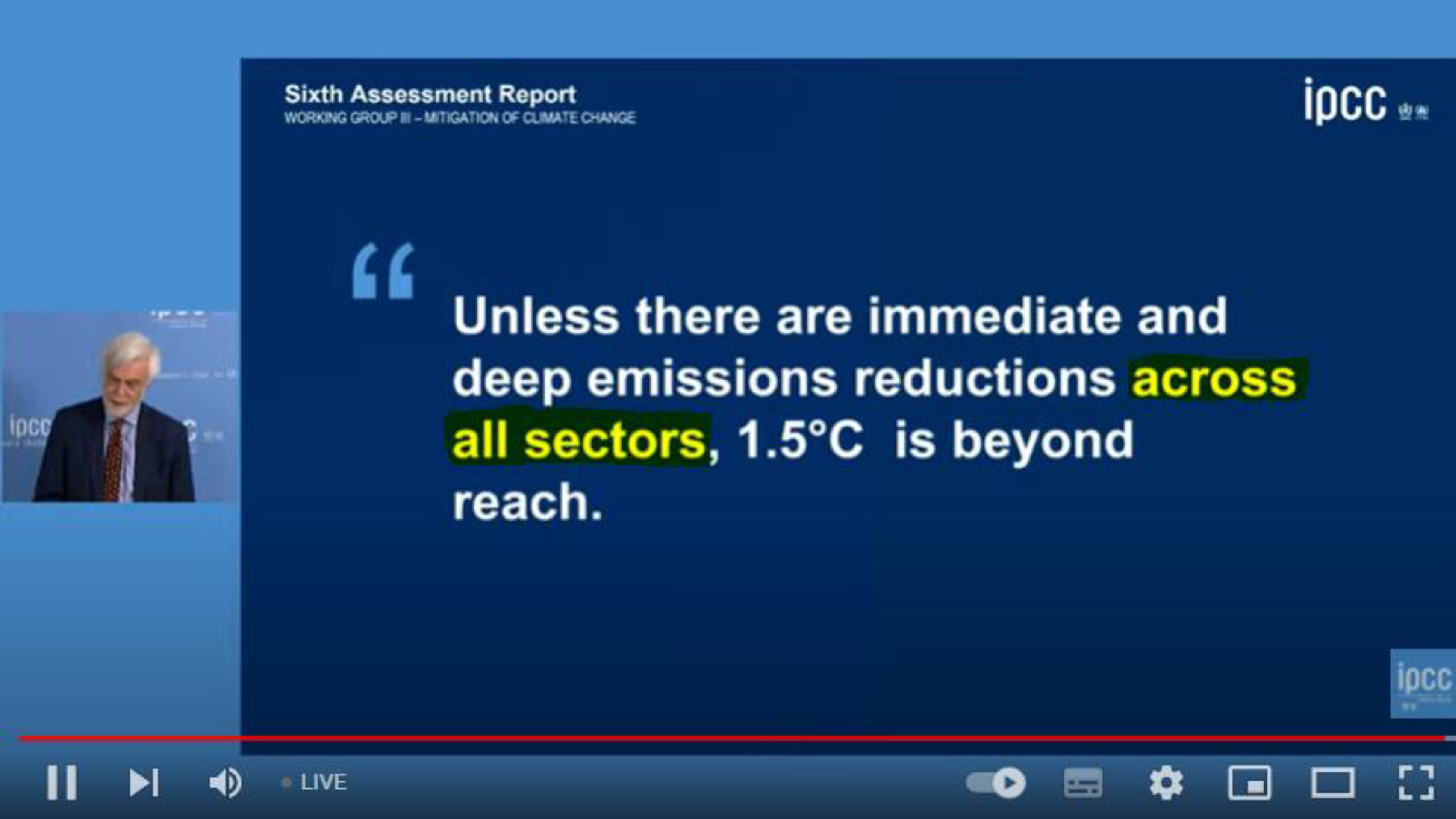
SOURCE:
[ICCT]

MARCH 8, 2022

Why "flying less" offers the best path to sustainable aviation

Transport & Environment (T&E) publishes its "Roadmap to climate neutral aviation".

SOURCE:
[Transport & Environment]


Sixth Assessment Report
WORKING GROUP III – MITIGATION OF CLIMATE CHANGE
ipcc
“
Unless there are immediate and deep emissions reductions across all sectors, 1.5°C is beyond reach.
ipcc
LIVE

Demand and services

- potential to **bring down** global **emissions** by **40-70%** by 2050
- walking and cycling, electrified transport, reducing air travel, and adapting houses make large contributions
- **lifestyle changes** require **systemic changes** across all of society
- **some** people require additional **housing**, **energy** and **resources** for human wellbeing

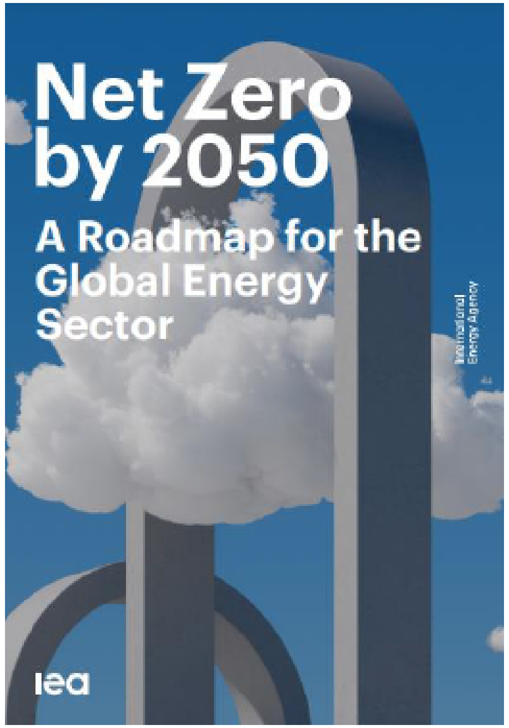


Table 2.4 ▷ Key global milestones for behavioural change in the NZE

Sector	Year	Milestone
Industry	2020	• Global average plastics collection rate = 17%.
	2030	• Global average plastics collection rate = 27%. • Lightweighting reduces the weight of an average passenger car by 10%.
	2050	• Global average plastics collection rate = 54%. • Efficiency of fertiliser use improved by 10%.
Transport	2030	• Eco-driving and motorway speed limits of 100 km/h introduced. • Use of ICE cars phased out in large cities.
	2050	• Regional flights are shifted to high-speed rail where feasible. • Business and long-haul leisure air travel does not exceed 2019 levels.
Buildings	2030	• Space heating temperatures moderated to 19-20 °C on average. • Space cooling temperatures moderated to 24-25°C on average. • Excessive hot-water temperatures reduced.
	2050	• Use of energy-intensive materials per unit of floor area decreases by 30%. • Building lifetime extended by 20% on average.

Note: Eco-driving involves pre-emptive stopping and starting; ICE = internal combustion engine.

SOURCE:
IEA

"*there is substantial mitigation potential to reduce emissions by avoiding and curtailing travel.* ***Reducing long-haul flights has strong potential to reduce emissions in an equitable manner****: air travel accounts for around 41 per cent of the carbon footprint of the highest emitting 1 per cent of households in the European Union, but less than 1 per cent of the emissions of the poorest 50 per cent of households*" **– UN Environment Programme, Emissions Gap Report, 2020**

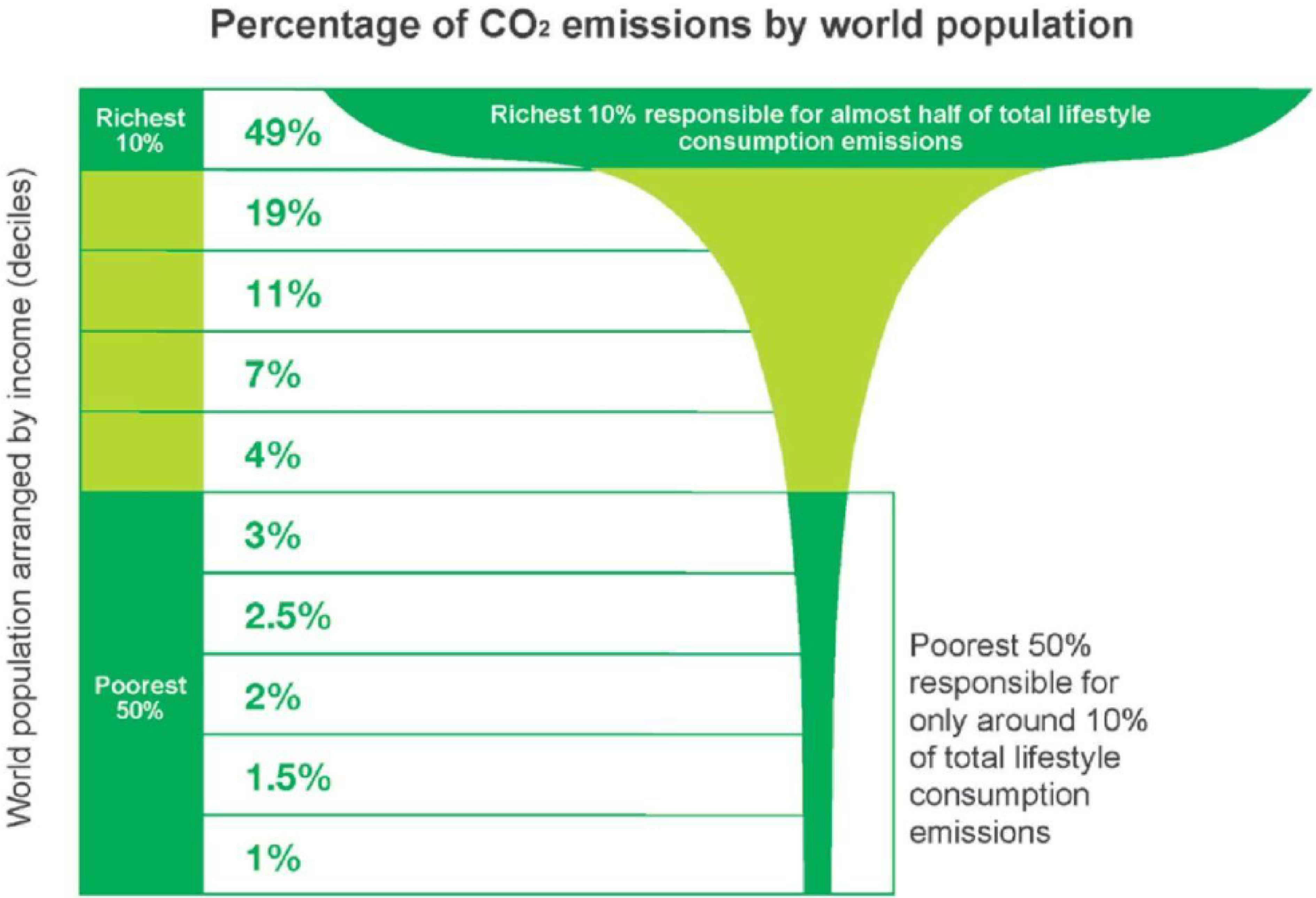
SOURCE:
UNEP

EQUITY

Figure 1: Global income deciles and associated lifestyle consumption emissions

Equity:

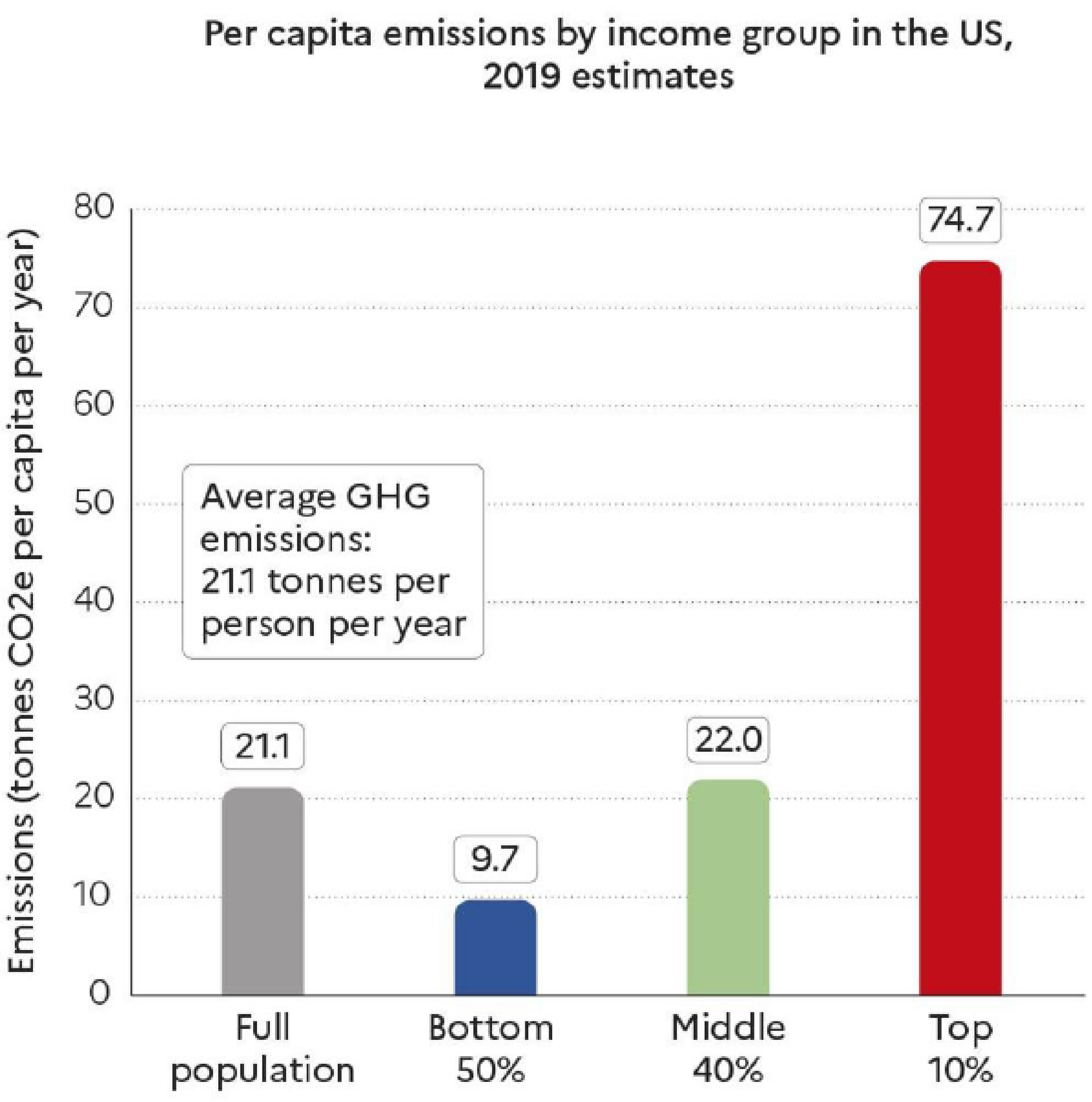
We can't reduce emissions without targeting high-income, high-emitters

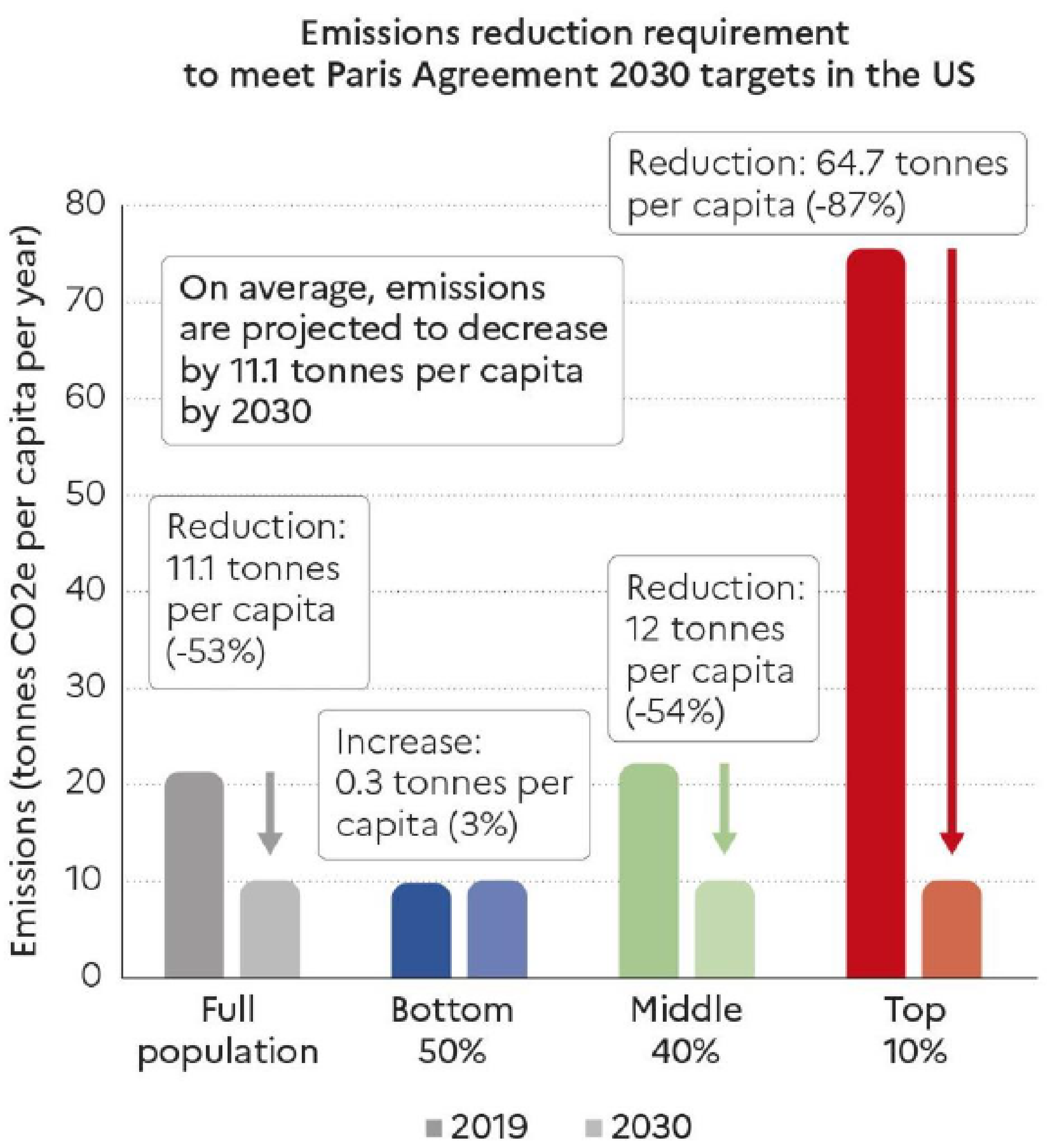


SOURCE:
[Oxfam]

2022 WORLD INEQUALITY REPORT

"Addressing large inequalities in carbon emissions is necessary to tackle climate change"



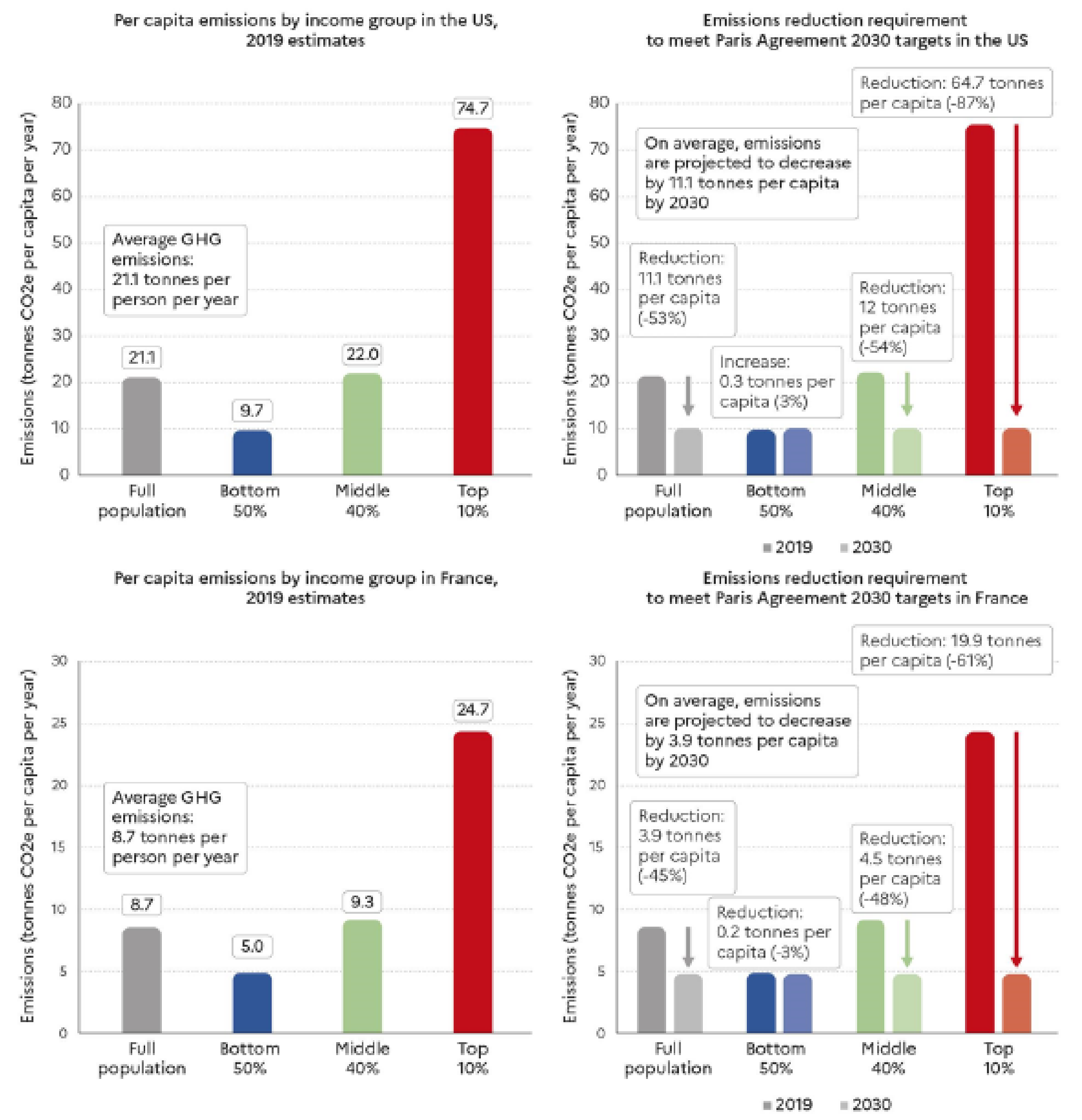


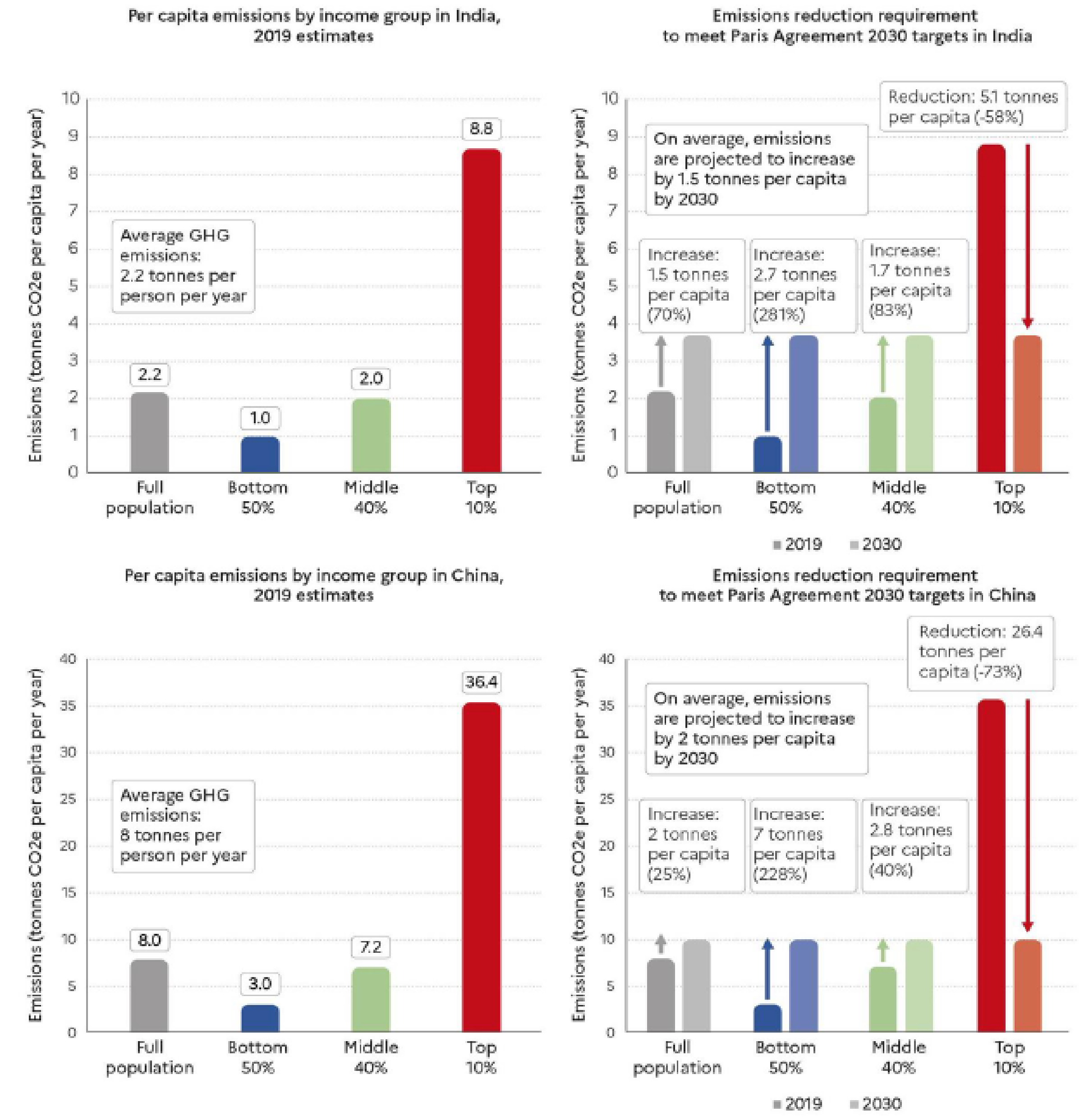
https://wir2022.wid.world/chapter-6/

2022 WORLD INEQUALITY REPORT

"Addressing large inequalities in carbon emissions is necessary to tackle climate change"

Figure 6.10abcd *Per capita emissions by income group and reduction requirements to meet Paris Agreement targets in the US, France, India, and China*





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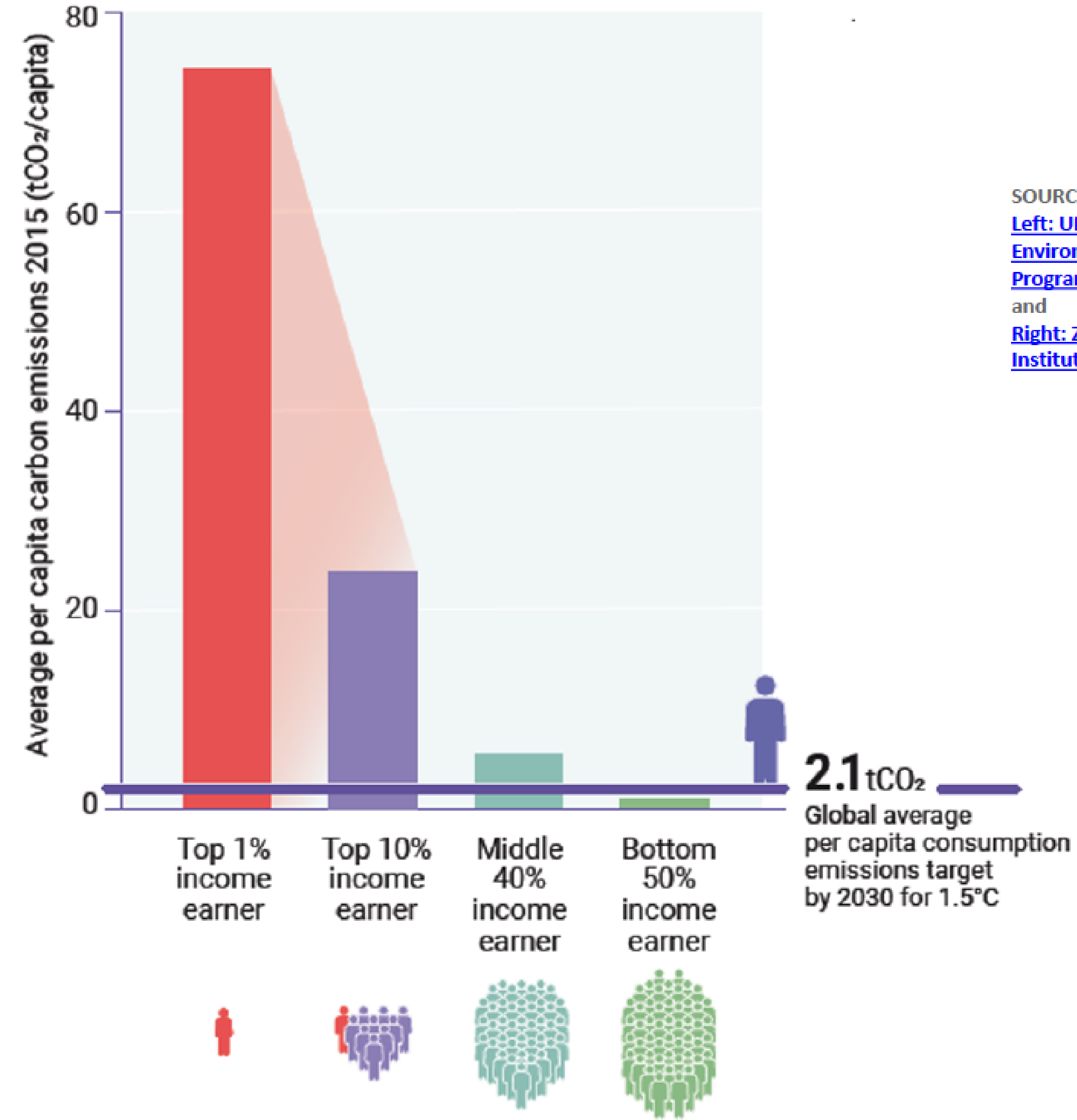


SOURCES:
[Left: UN Environment Programme](#)
and
[Right: Zoe-Institut](#)

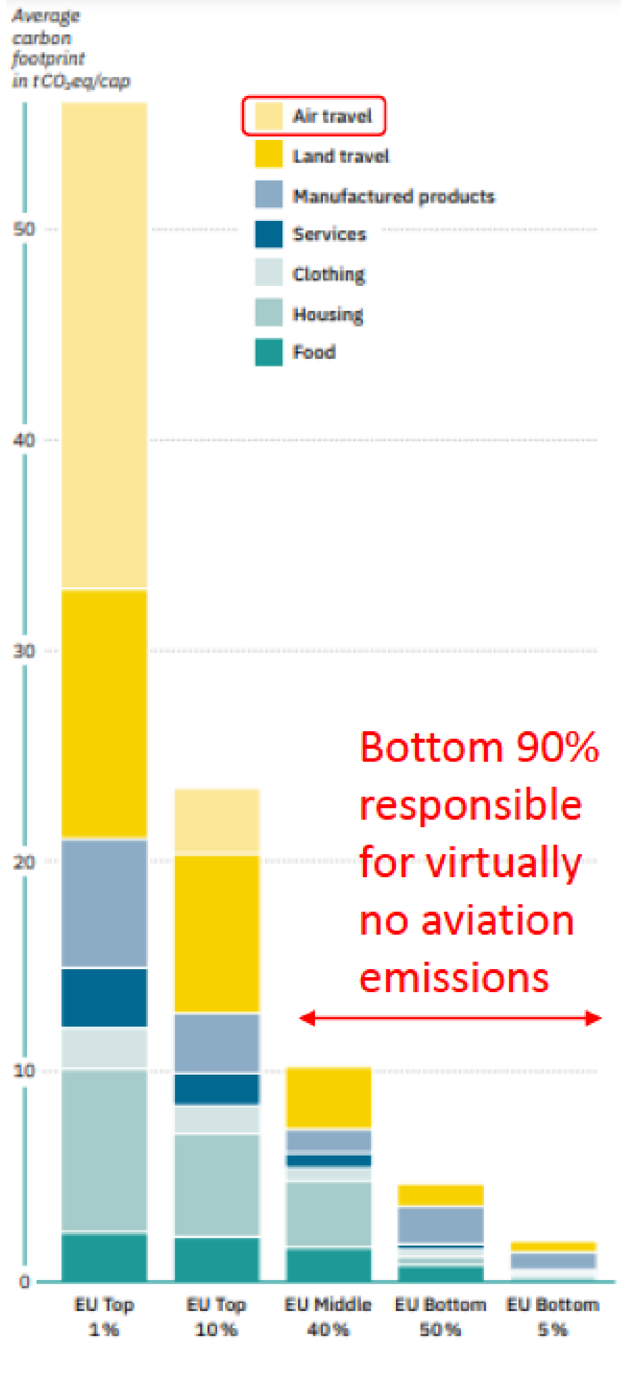
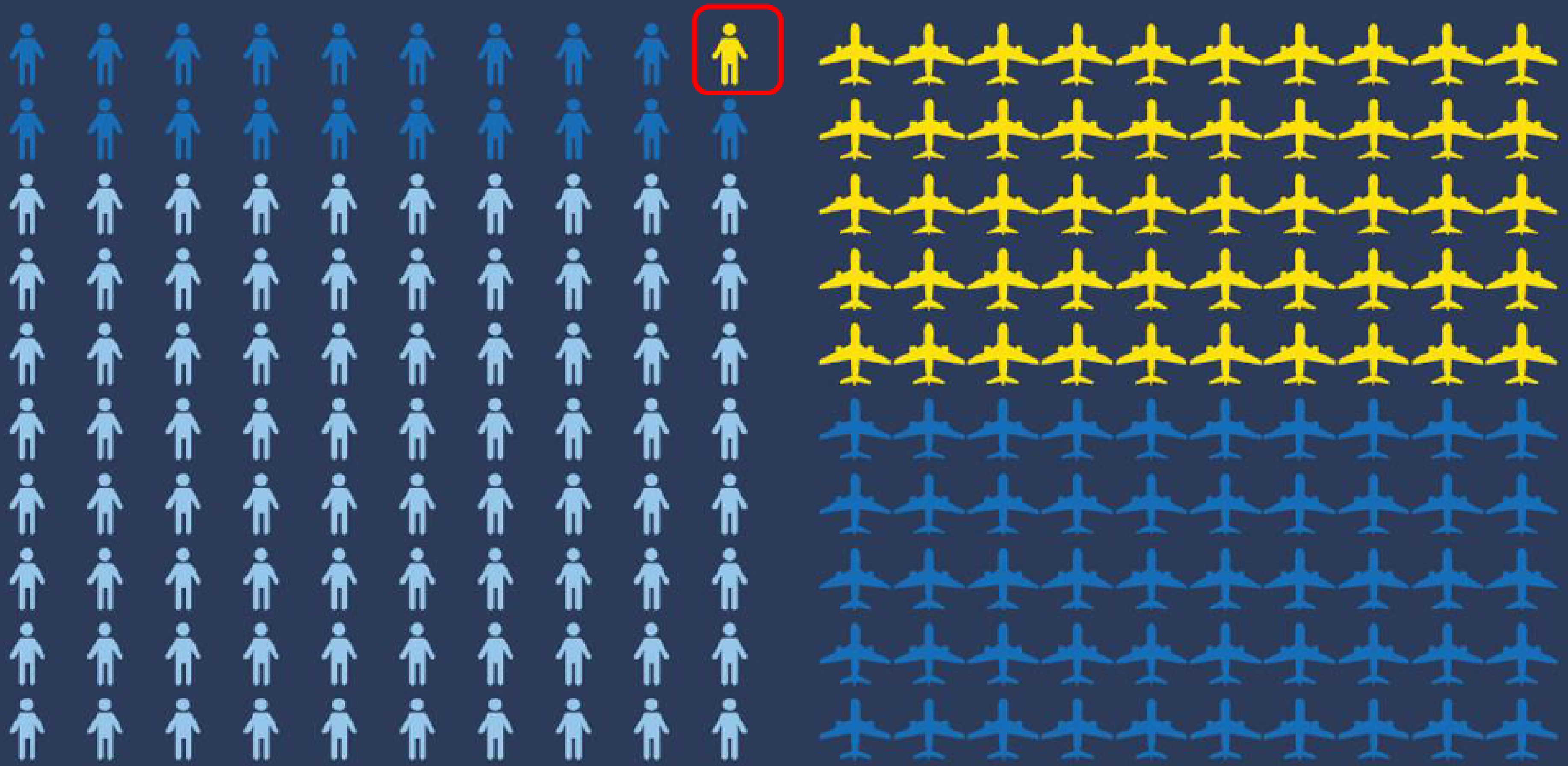


Figure 5: *Average carbon footprint (CF) distribution by consumption category in the European Union (Ivanova et al., 2017)*

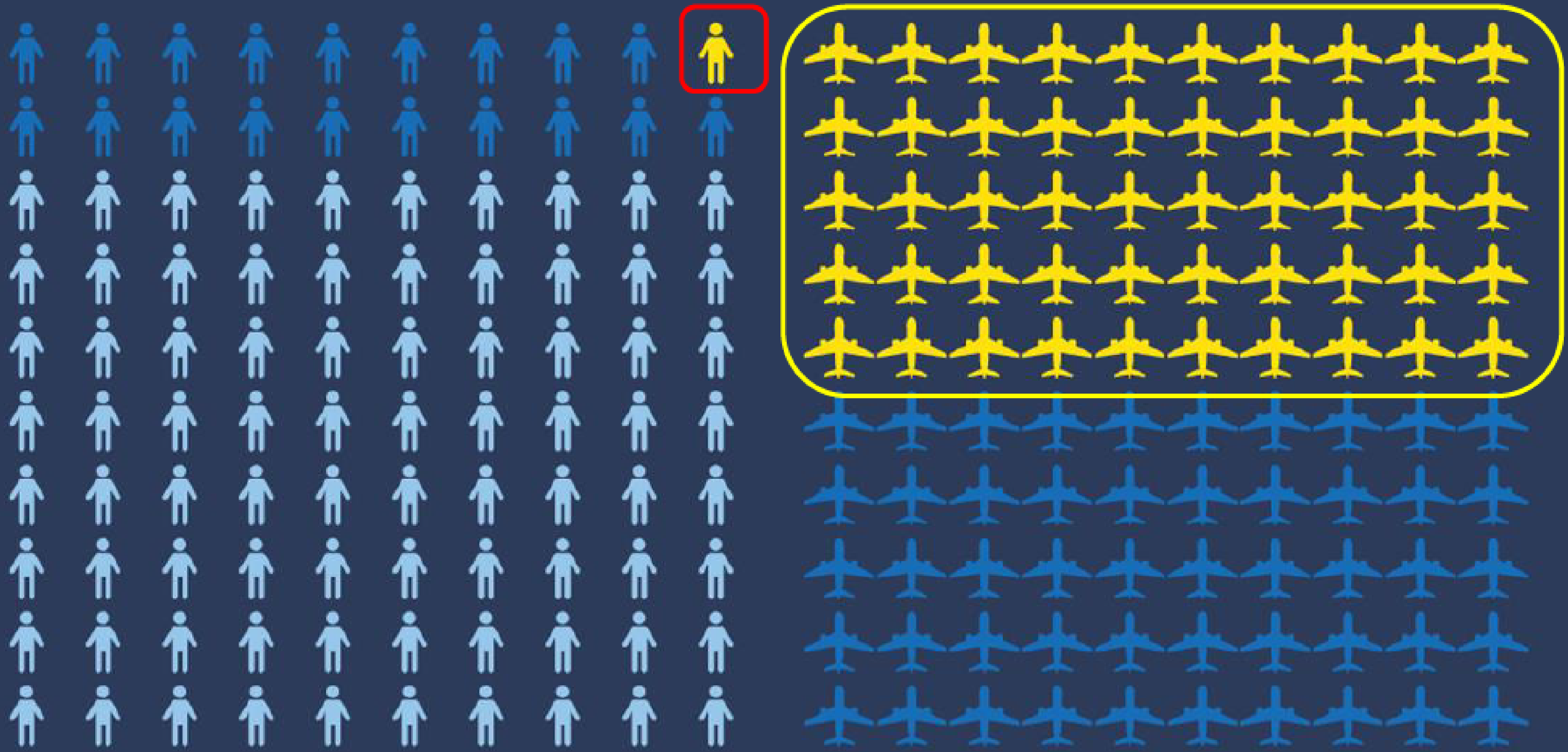
THE INEQUALITY OF FLYING



Only **1%** of the world's **population**

cause **50%** of **commercial aviation emissions**

while more than **80%** of the world's population **have never set foot on an aeroplane.**



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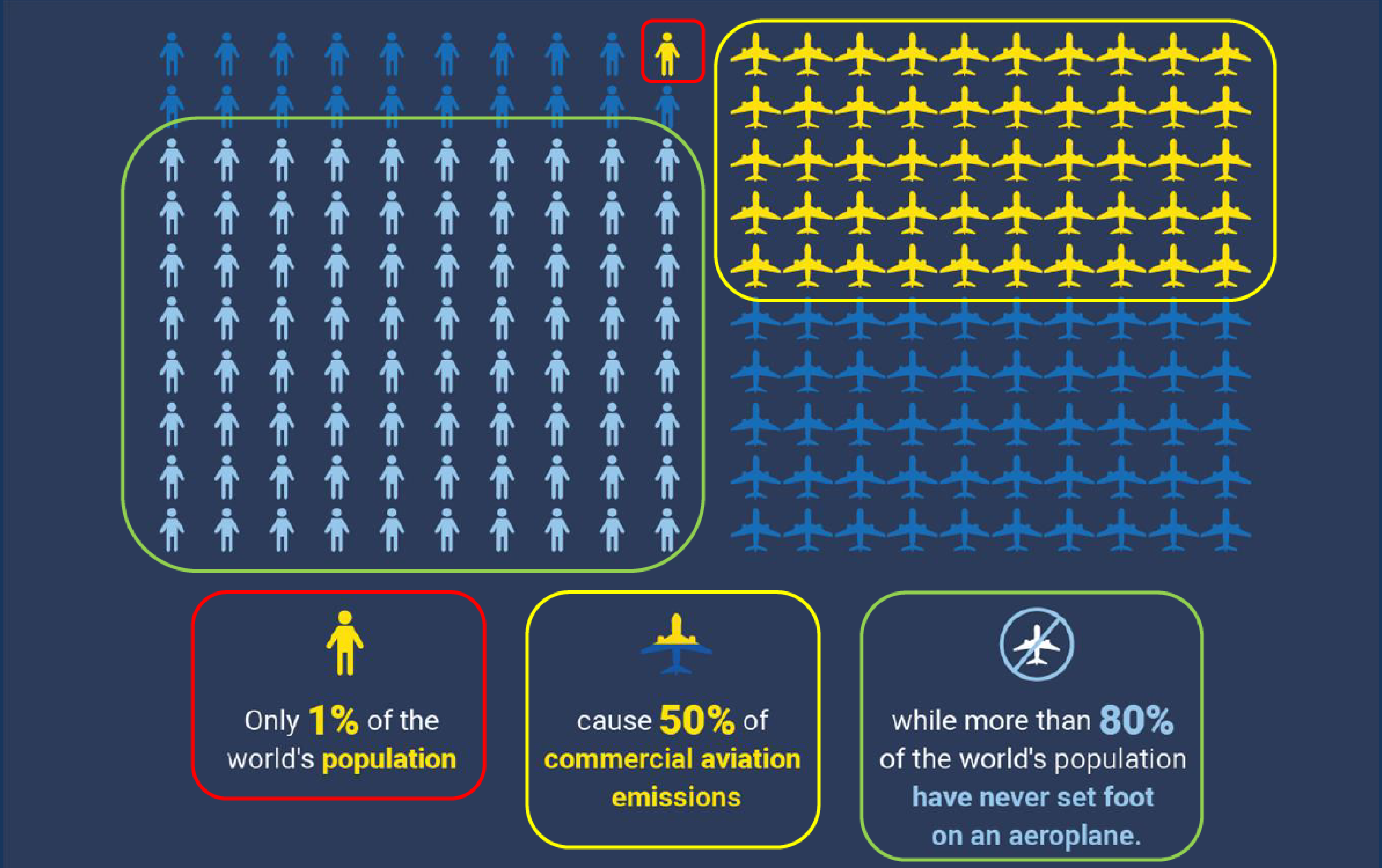
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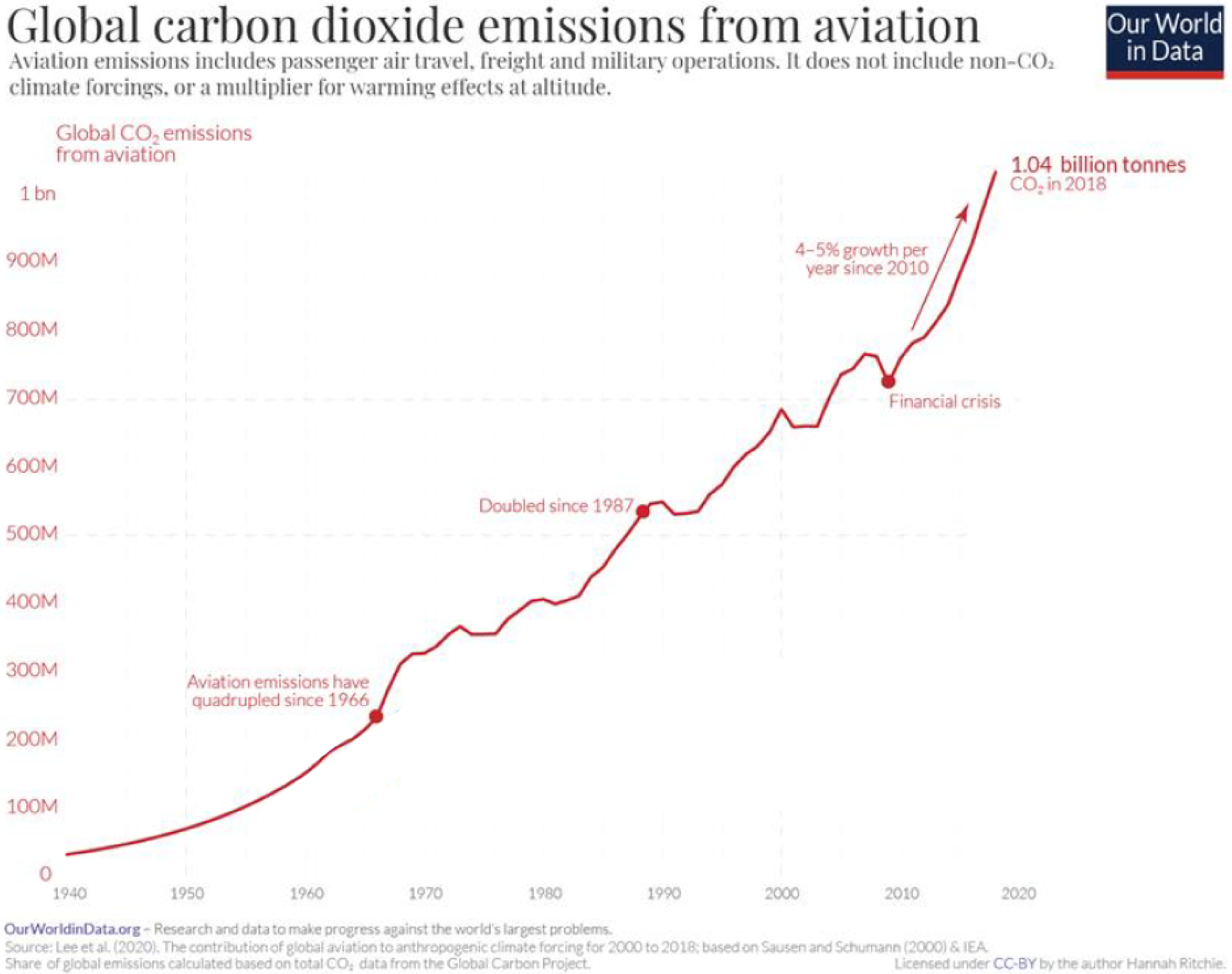
IS AVIATION EXPANSION A MATTER OF SOCIAL JUSTICE?

IS AVIATION EXPANSION A MATTER OF SOCIAL JUSTICE?

Our position:

- Air traffic growth can provide economic benefits.
- However, aviation emissions also provide massive climate risks = ecological, social and economic risks.
- Low-income countries face the highest risks.
- Air traffic growth is only socially just in the context of reducing aviation emissions and impacts.
- If air traffic grows in some countries, it will need to reduce in others in order to achieve this.


2022: 1/3rd OF
PAKISTAN
UNDERWATER



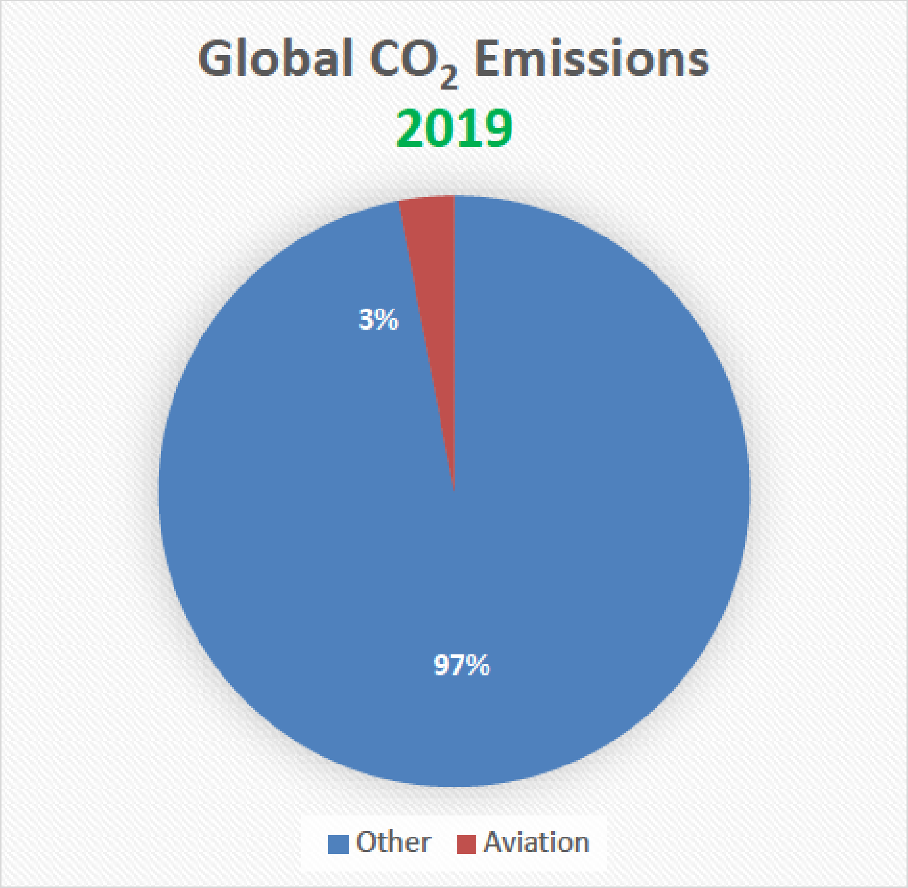
Safe Landing

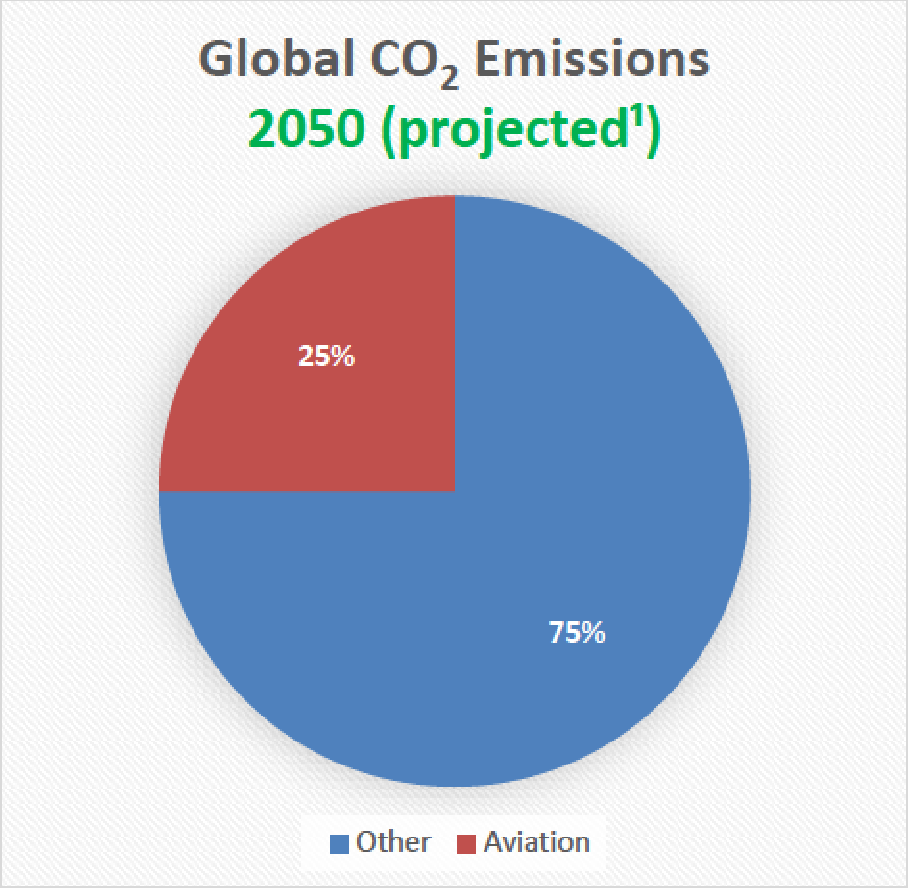
"Our industry is on a dangerous trajectory: we need to set a new flightpath"

Sustainable Aviation:

the industry uses a "sustainability play book" to justify future growth

How big is the problem?

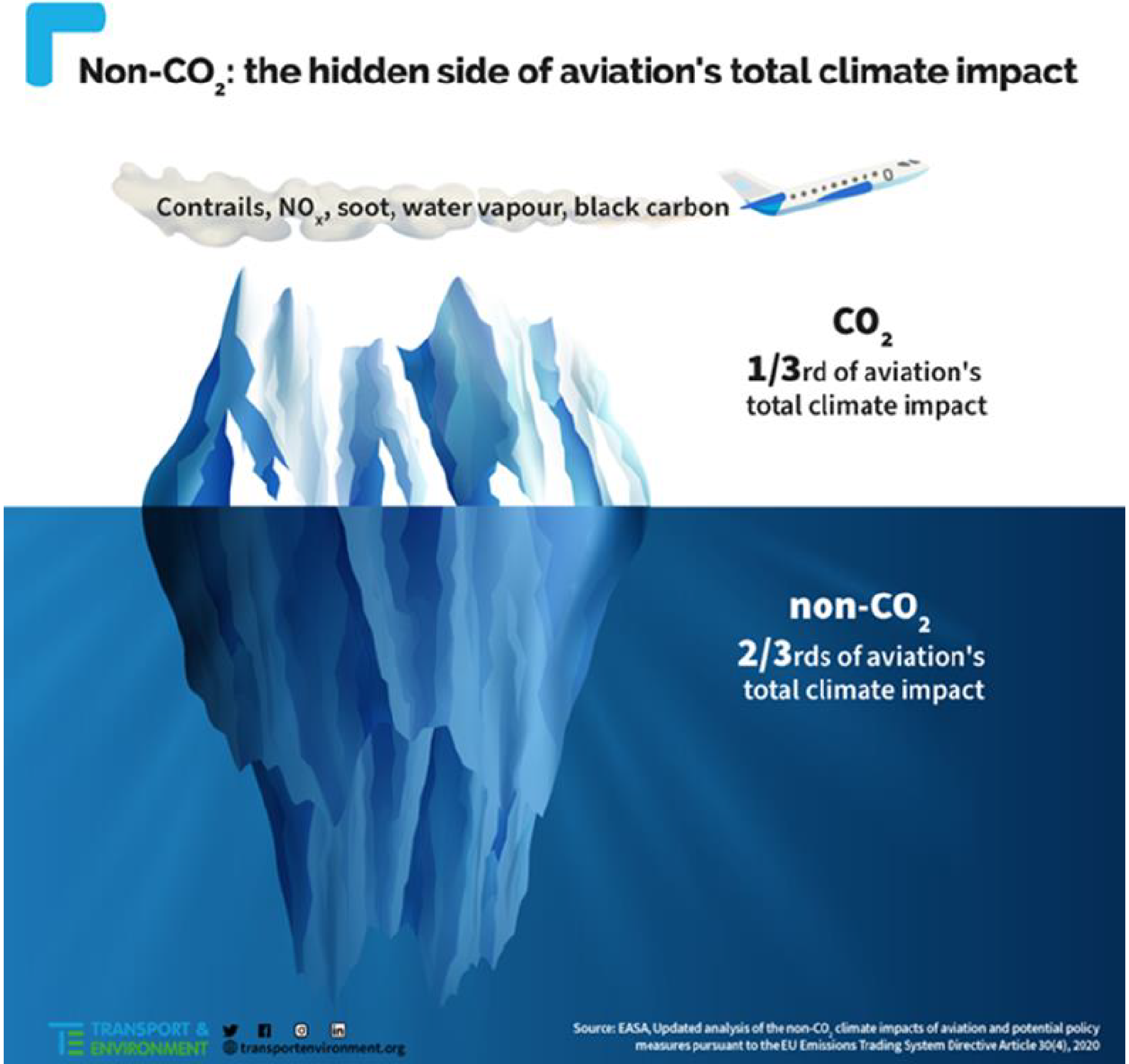




SOURCES:
1. Rolls-Royce
2. CarbonBrief

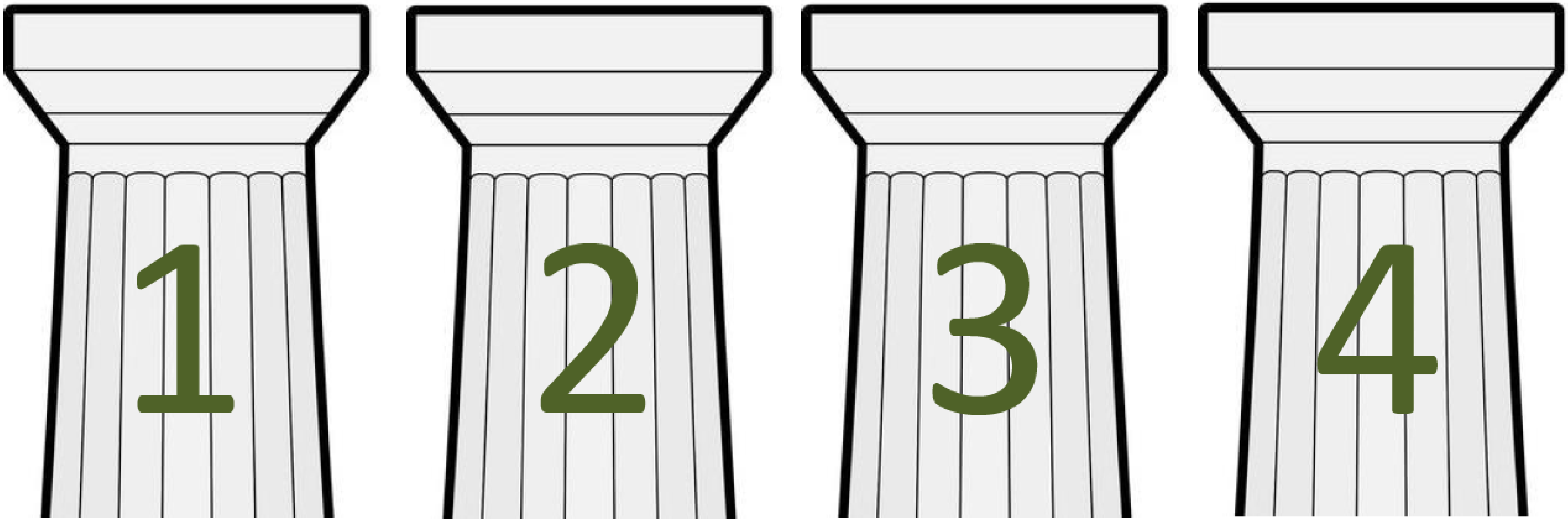
This also ignores aviation's Non-CO2 emissions

How big is the problem?

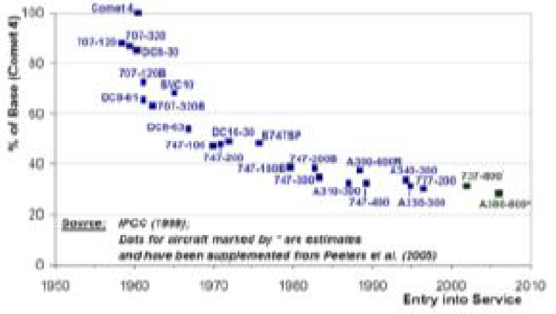


SOURCES:
[D.S. Lee et al., 2020]

Sustainable Aviation:
The 4 Pillars



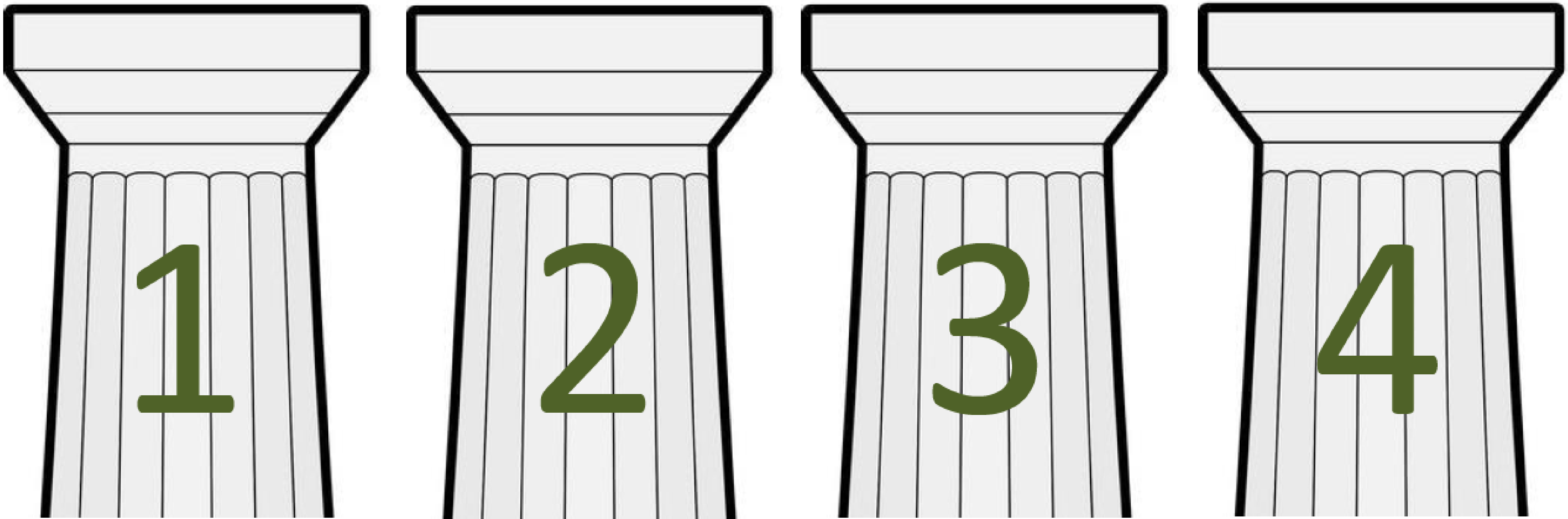
Efficiency Improvements



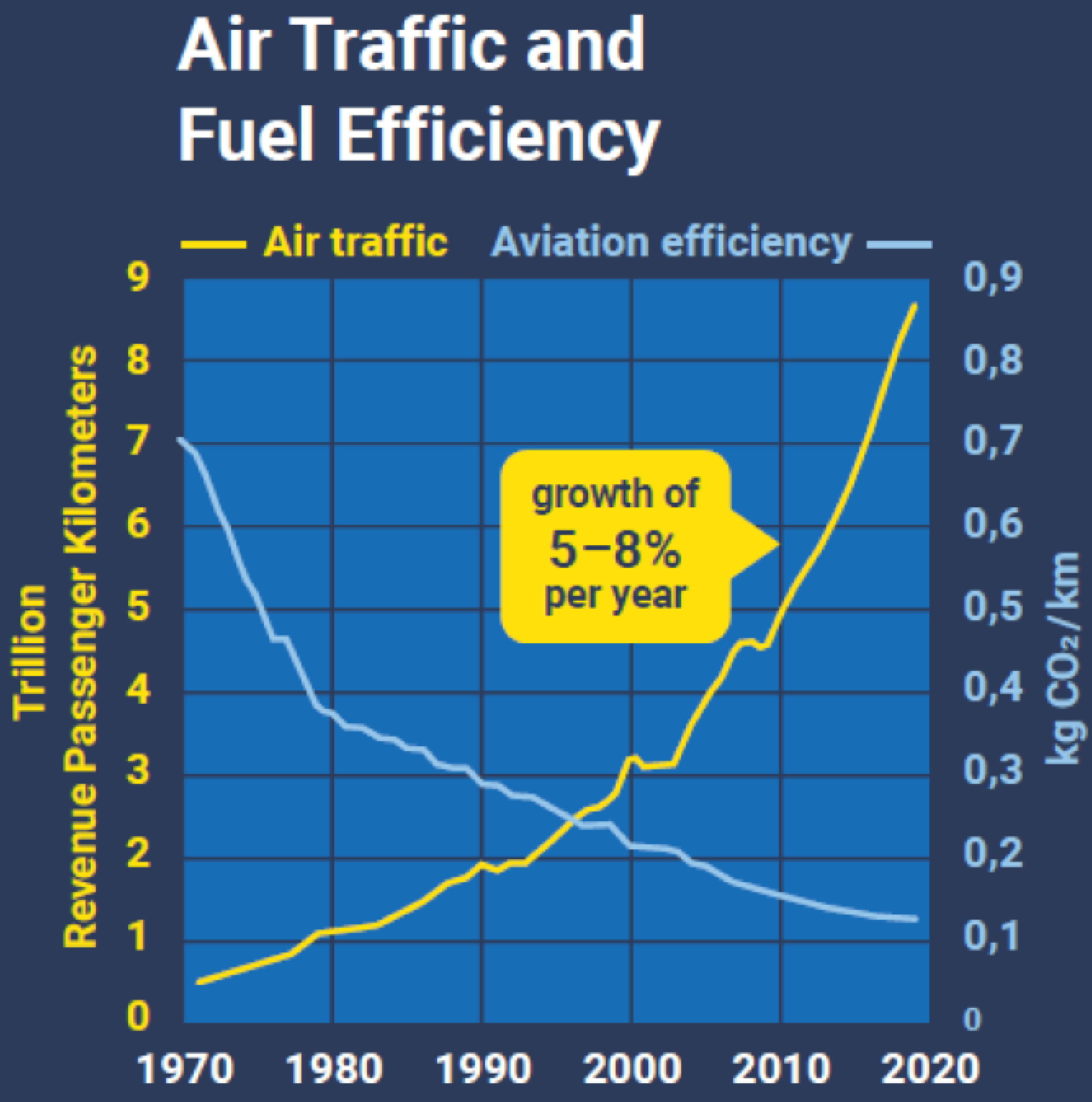
"Zero Emissions" Aircraft

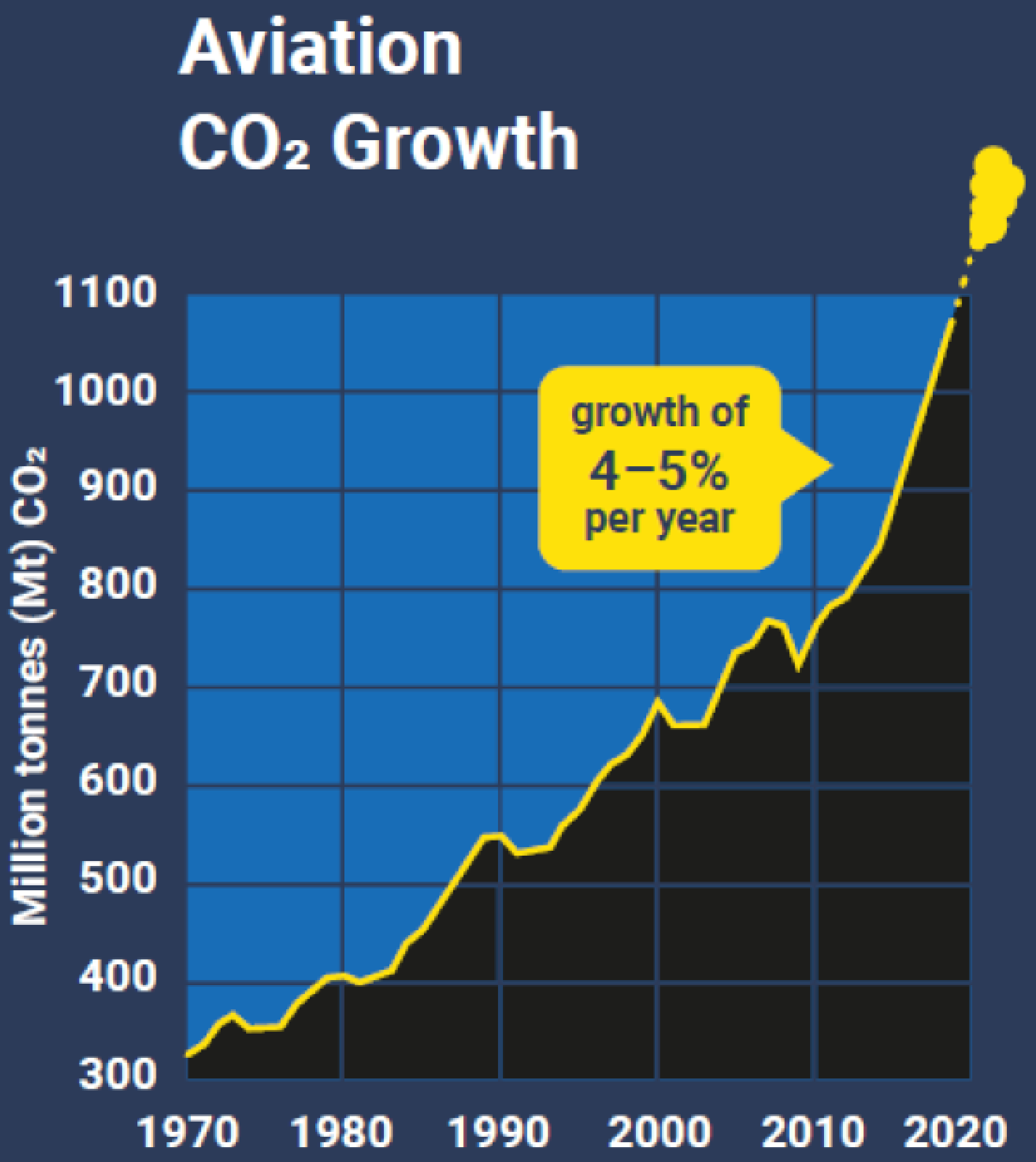
"Sustainable" Aviation Fuels

Carbon Offsetting



Aircraft Efficiency

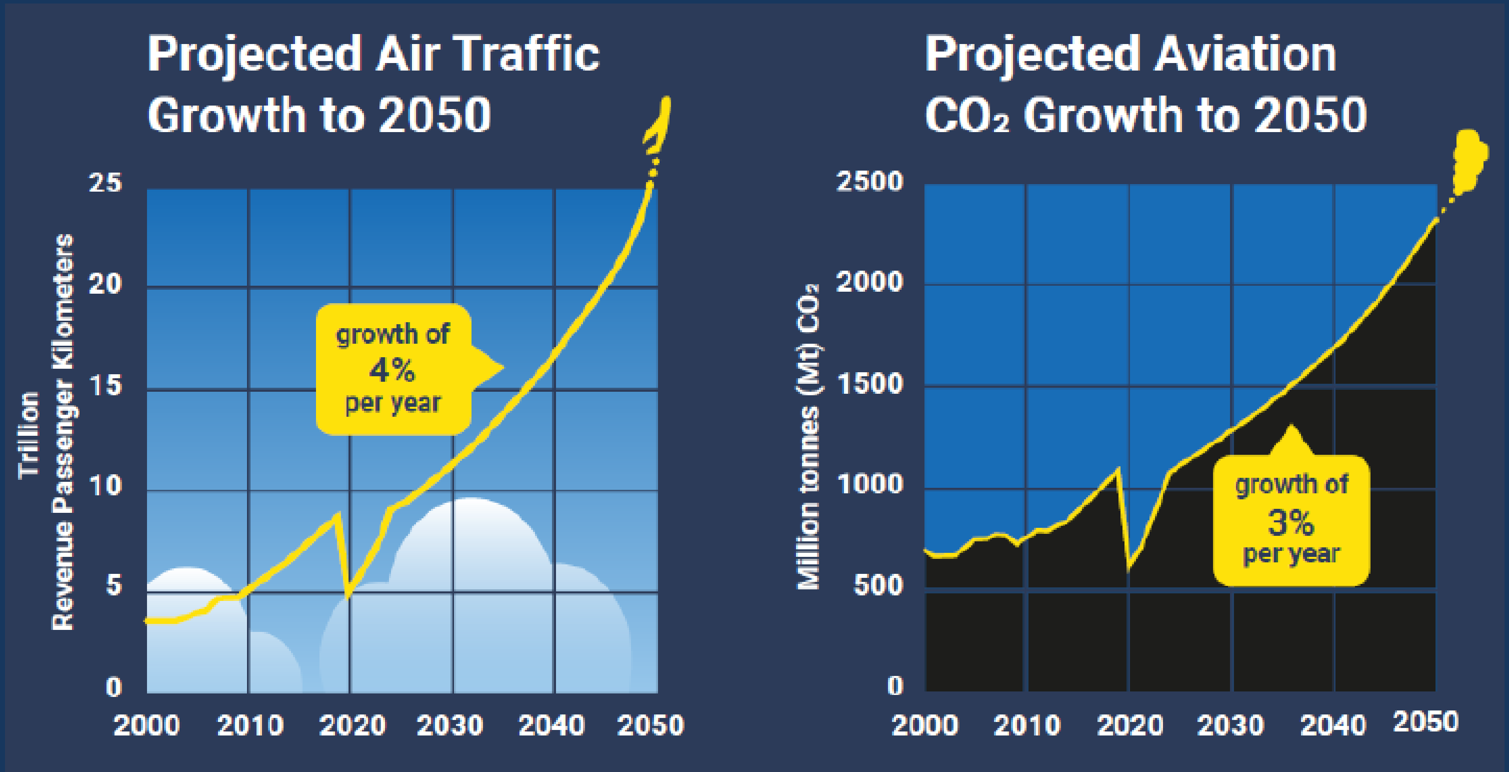




SOURCE: Stay Grounded

Aircraft Efficiency

- Historical aircraft efficiency improvements have led to total emissions **increasing**, not decreasing
- This will continue into the future – unless **air traffic growth is constrained**



SOURCE: Stay Grounded

Aircraft Efficiency – Supersonic is Worst

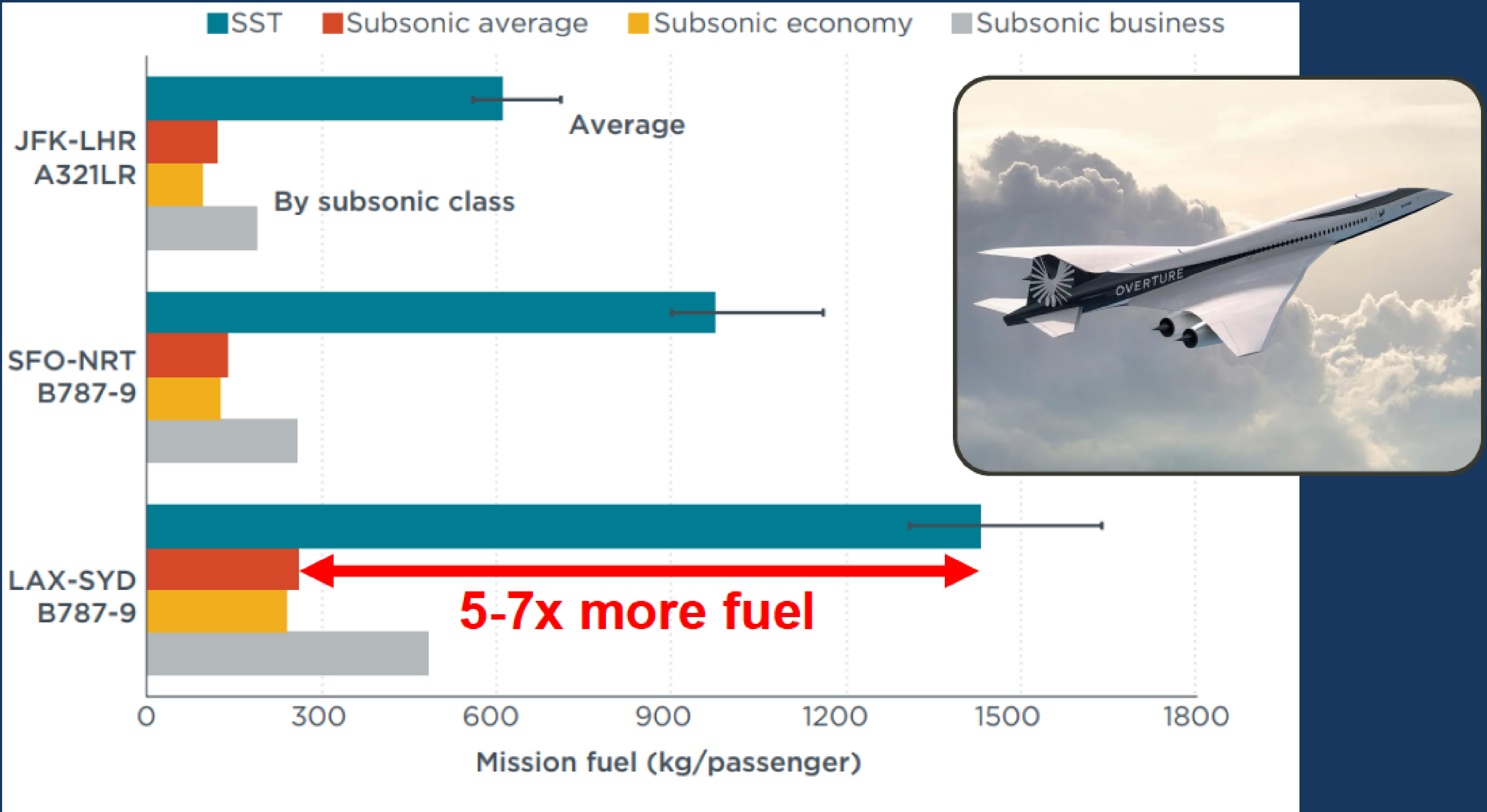
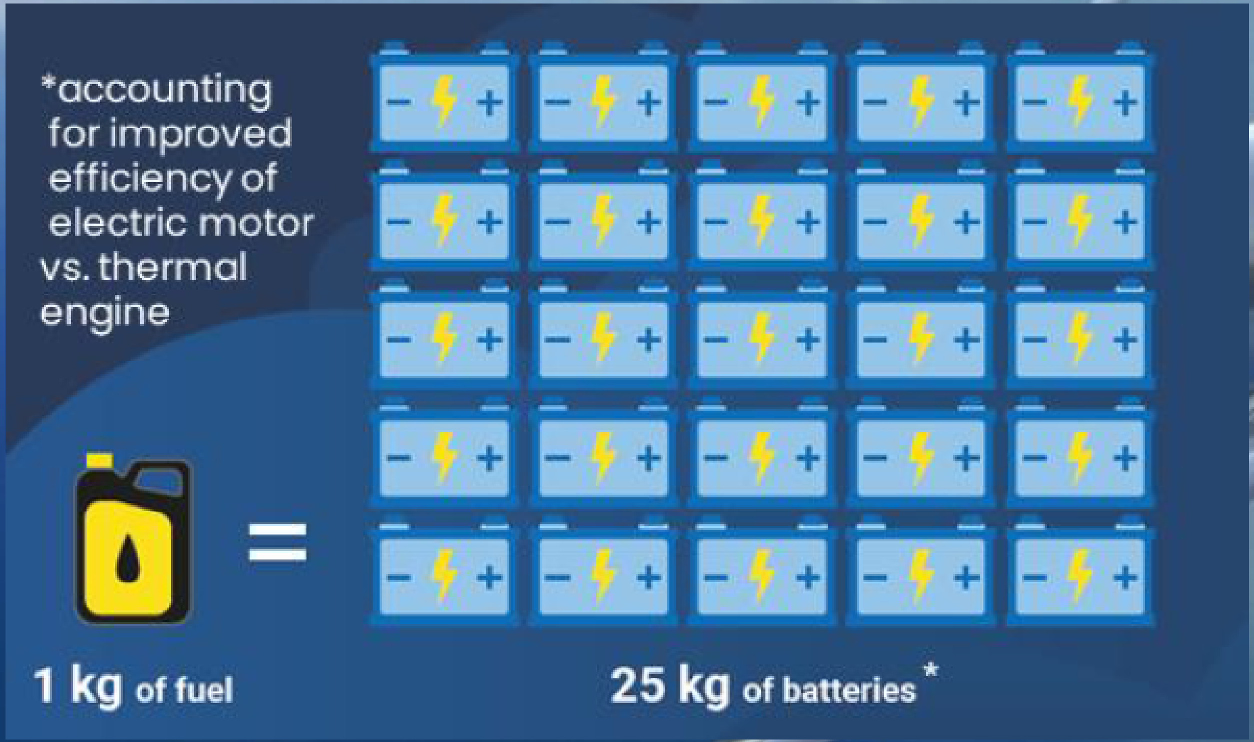


Figure 2. One-way mission fuel consumption per passenger by route and class.

SOURCE: ICCT

Electric Flight



... only viable for small aircraft, flying very short distances

... ground transport (trains, coaches, ferries) are a more efficient use of green electricity

eVTOL = electric Vertical Take-Off & Landing

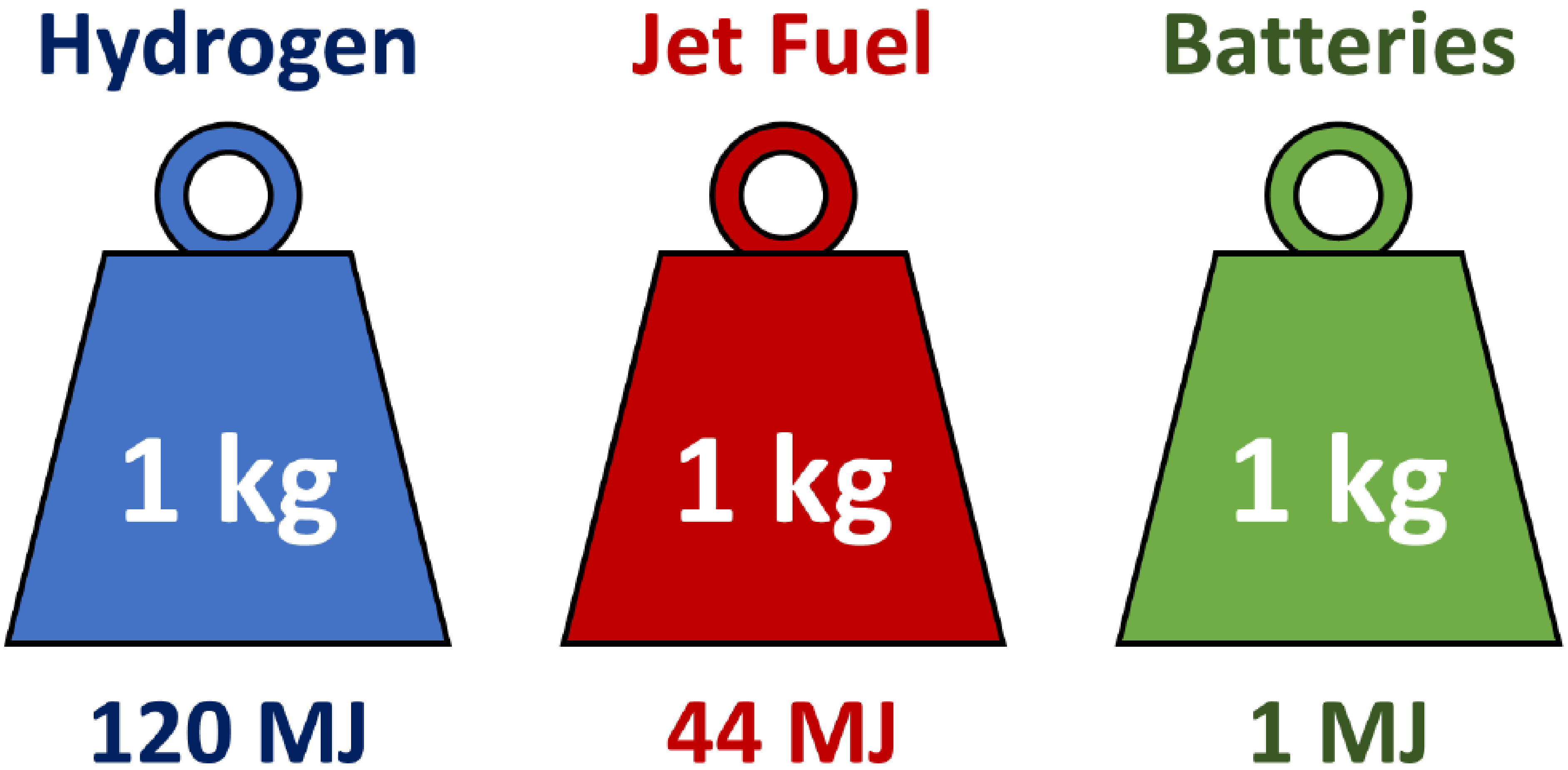
Very inefficient = even shorter range and payload capabilities.

SOURCE:
[Joby Aviation S4]

Hydrogen Flight

Hydrogen Flight

The energy density of Hydrogen looks great by mass:



SOURCE: Stay Grounded

Hydrogen Flight

The energy density of Hydrogen is terrible by volume:

Liquid H_2

8 MJ

$$= \frac{1}{4}\ of$$

Jet Fuel

32 MJ

SOURCE: [Stay Grounded]

Hydrogen Flight

The energy density of Hydrogen is terrible by volume:

Liquid H_2

32 MJ

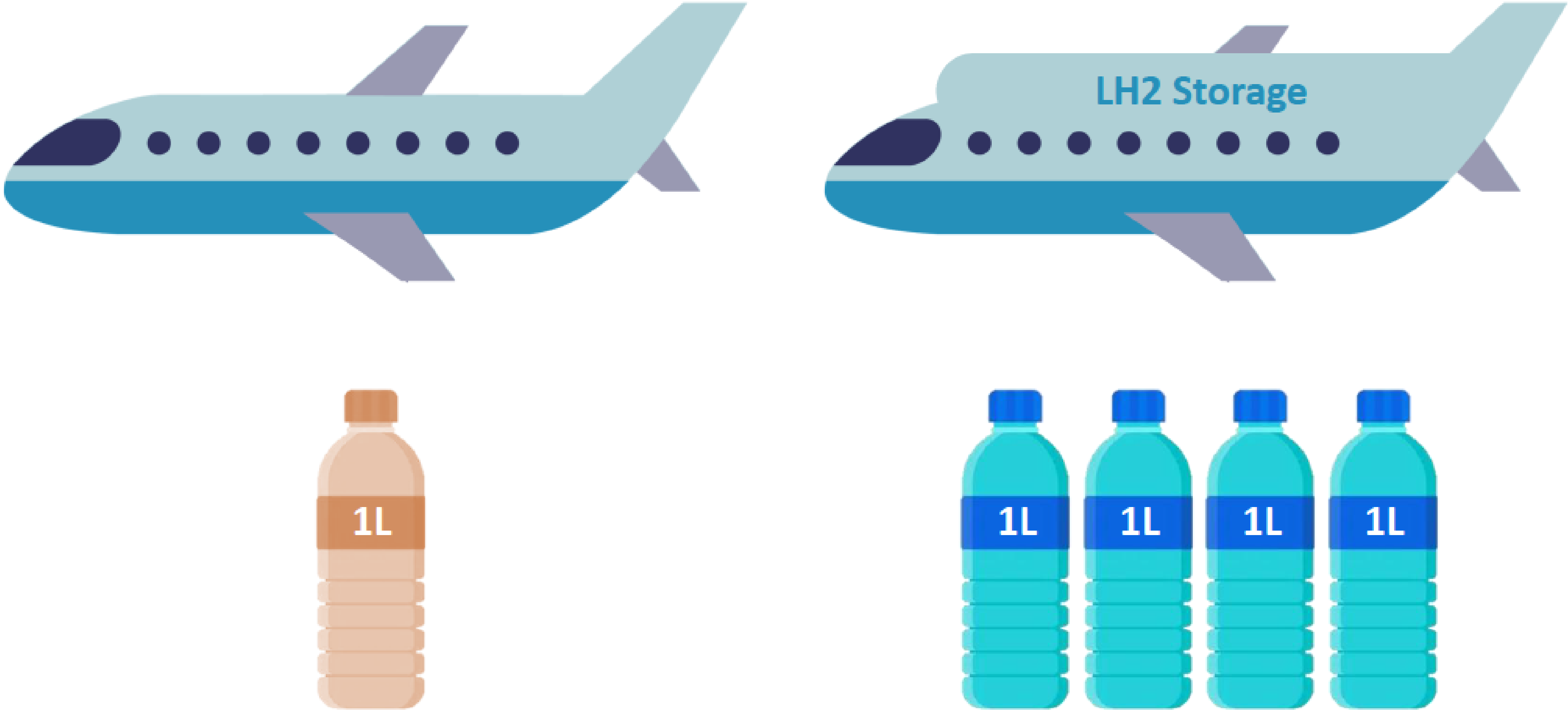
Jet Fuel

32 MJ

SOURCE: [Stay Grounded]

Hydrogen requires 4x the volume of Jet Fuel

… to store the same amount of energy.



Jet Fuel

Liquid Hydrogen

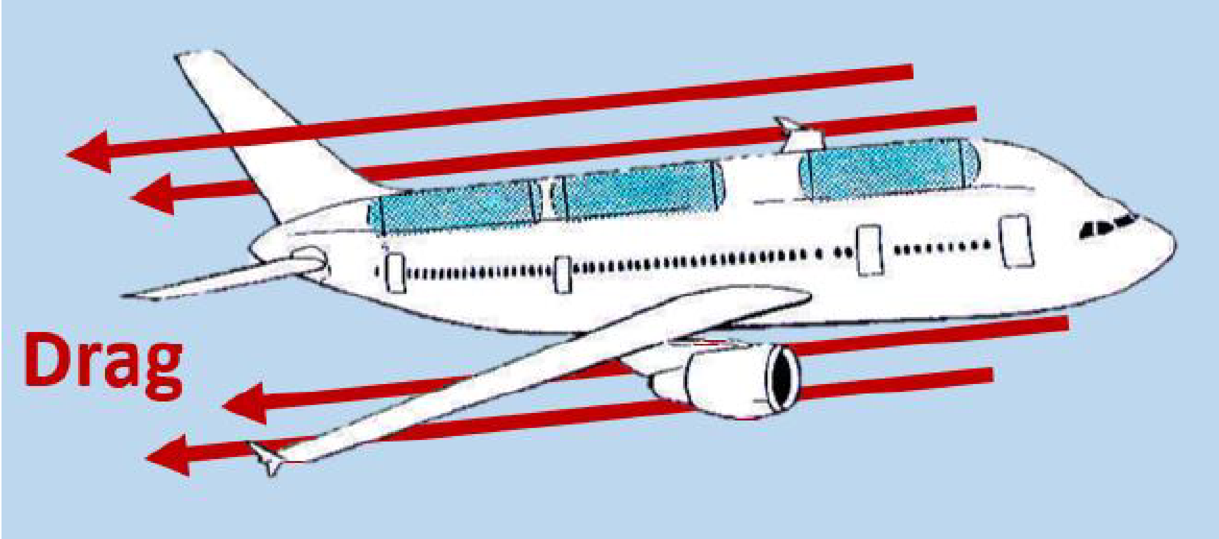
SOURCE:
[Stay Grounded]

Hydrogen Flight

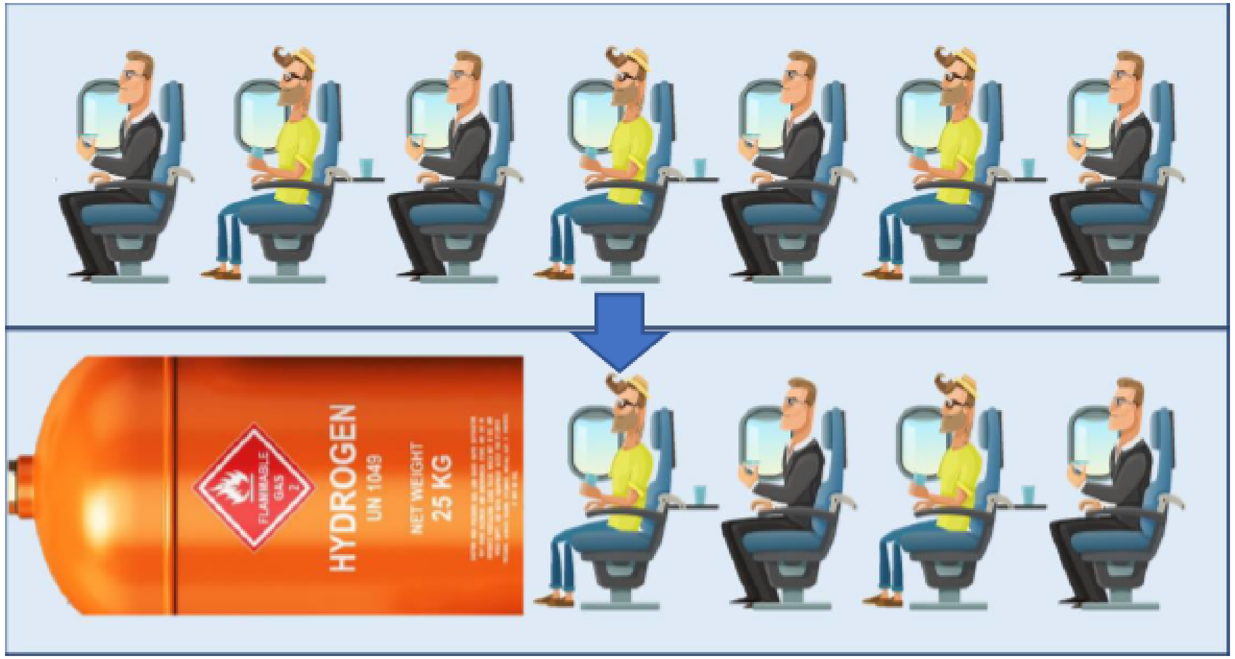
The energy density of Hydrogen is terrible by volume:

Either:

- **Increased aircraft size – increasing drag and weight:**



- **Identical aircraft size, but reduced numbers of passengers:**



SOURCE: Stay Grounded

Hydrogen Flight

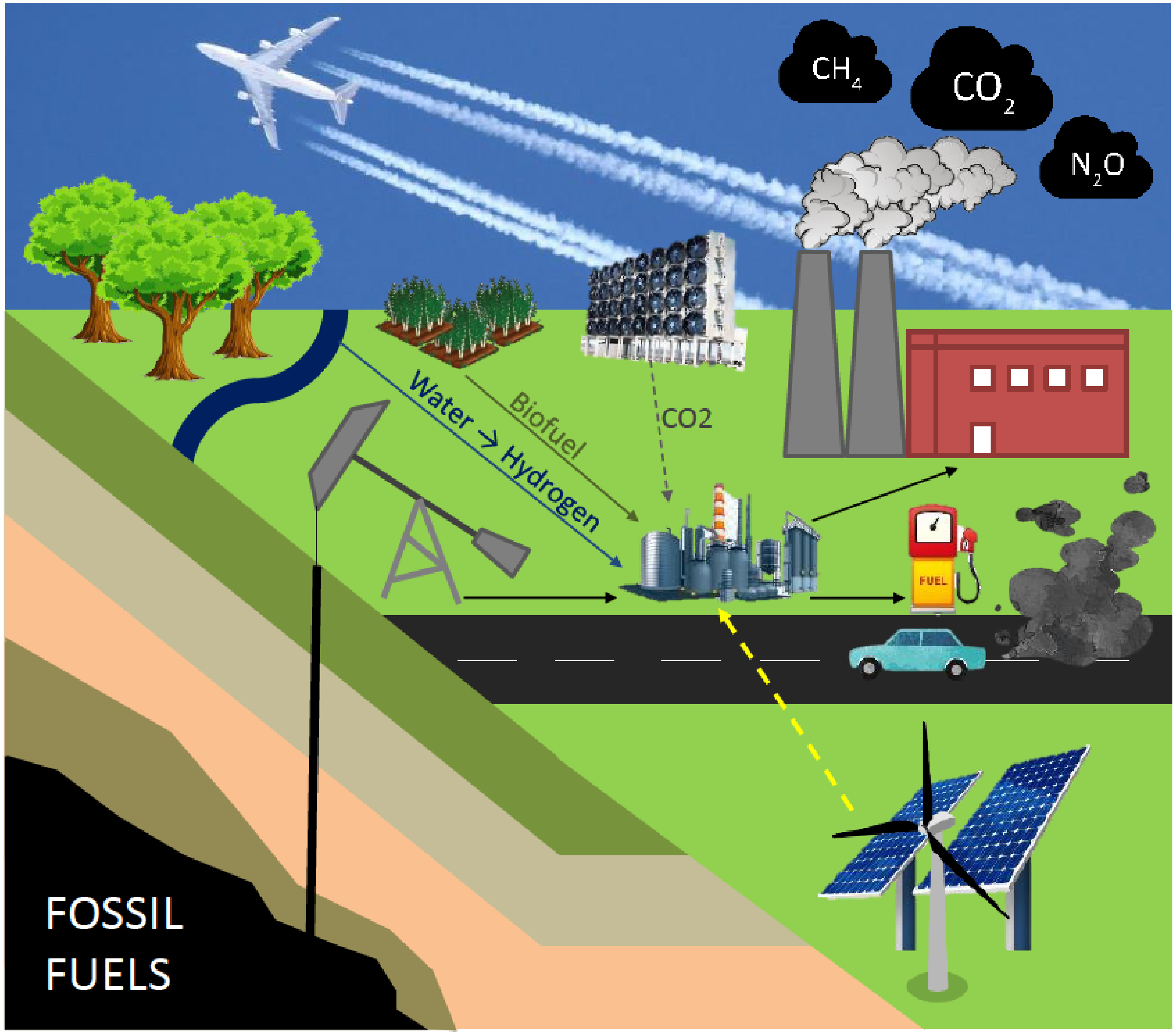
… likely viable for medium aircraft, flying medium distances

… will take 15-20 years to develop & certify first aircraft

Requires very different aircraft, airports – and huge amounts of energy

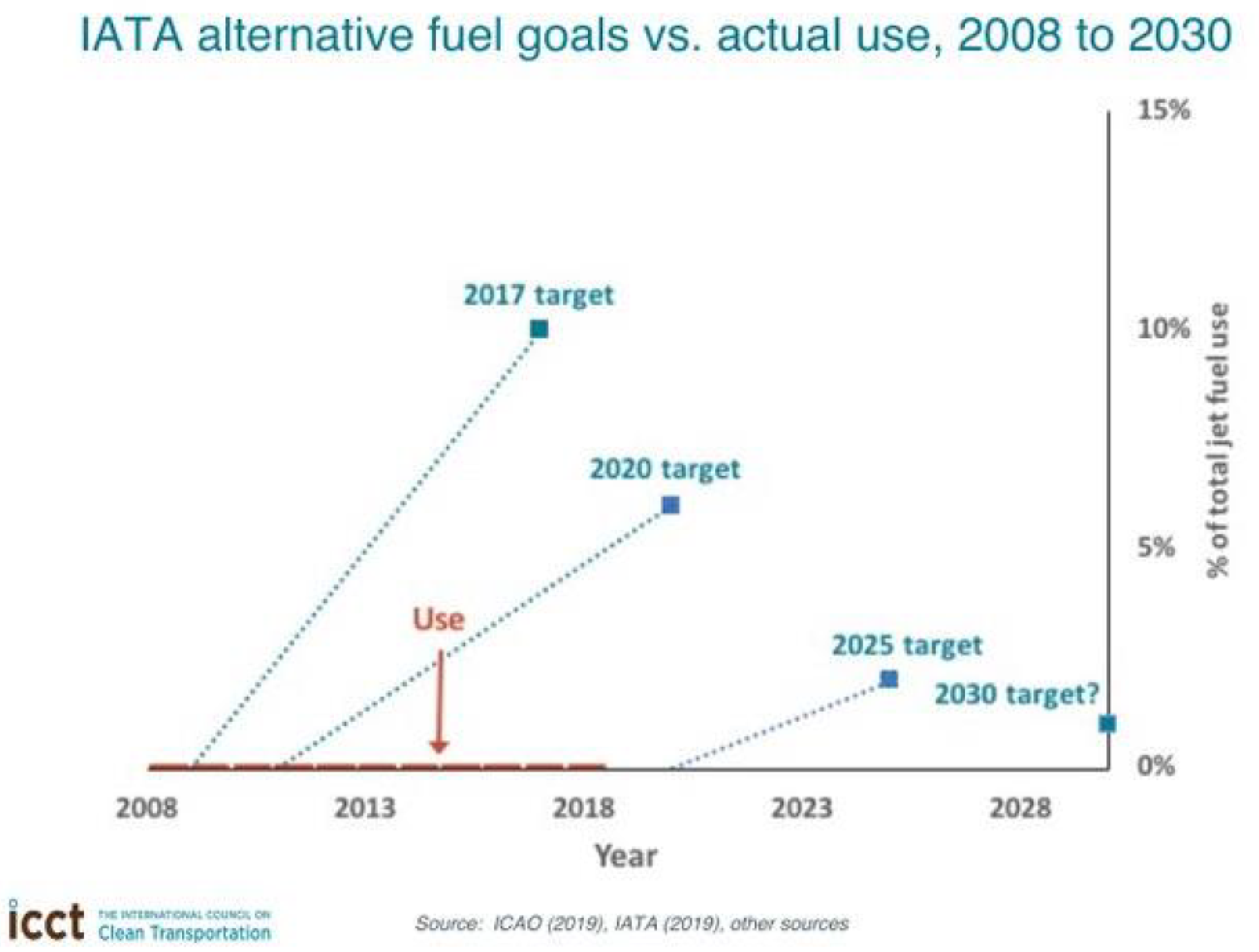
Alternative Jet Fuel

“Sustainable Aviation Fuels”



Alternative Jet Fuel

“Sustainable Aviation Fuels”



Biofuels

Alternative Jet Fuel

Biofuels

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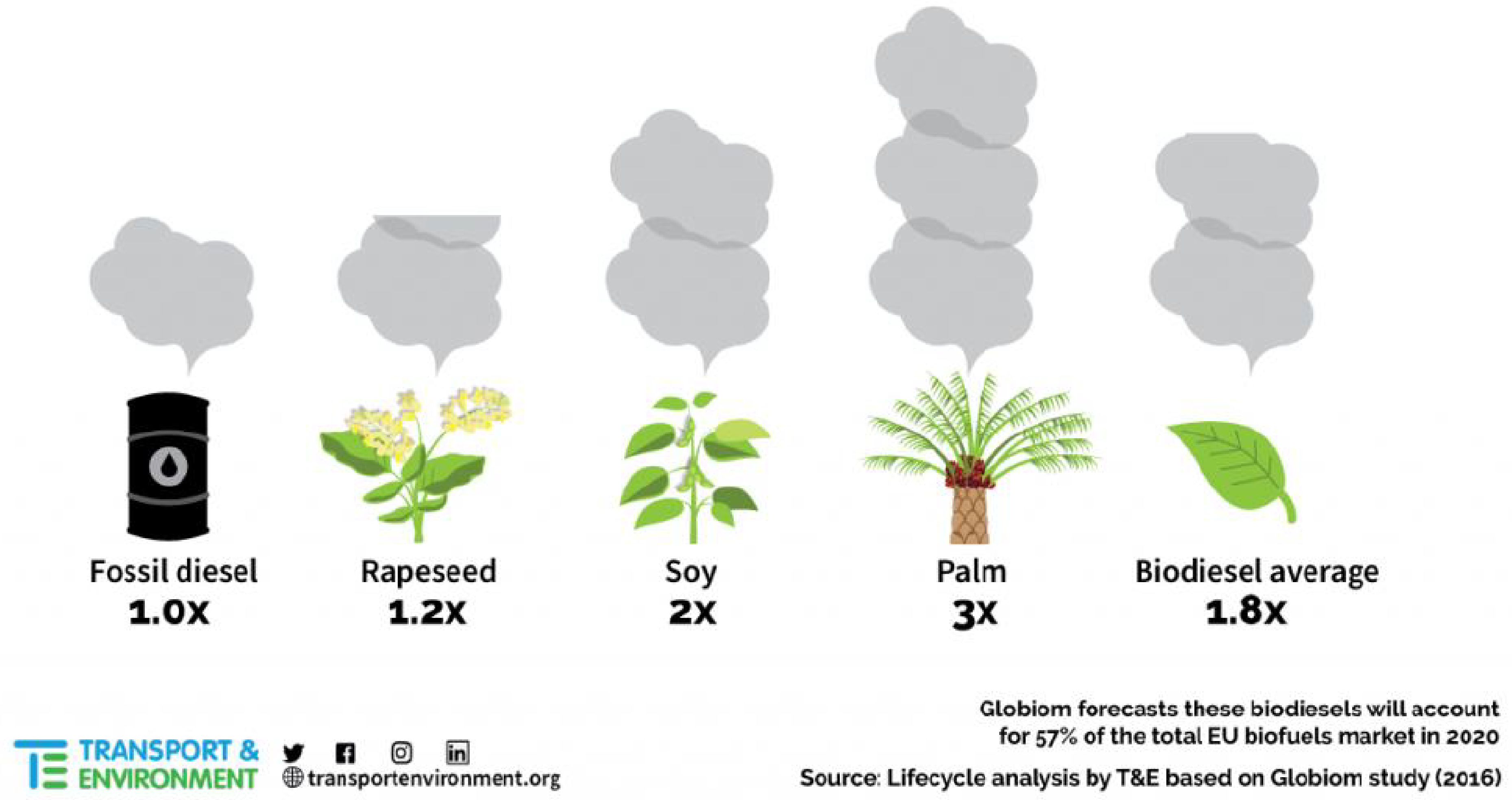
Biofuels

The danger of ‘fuel-from-crops’ biofuels

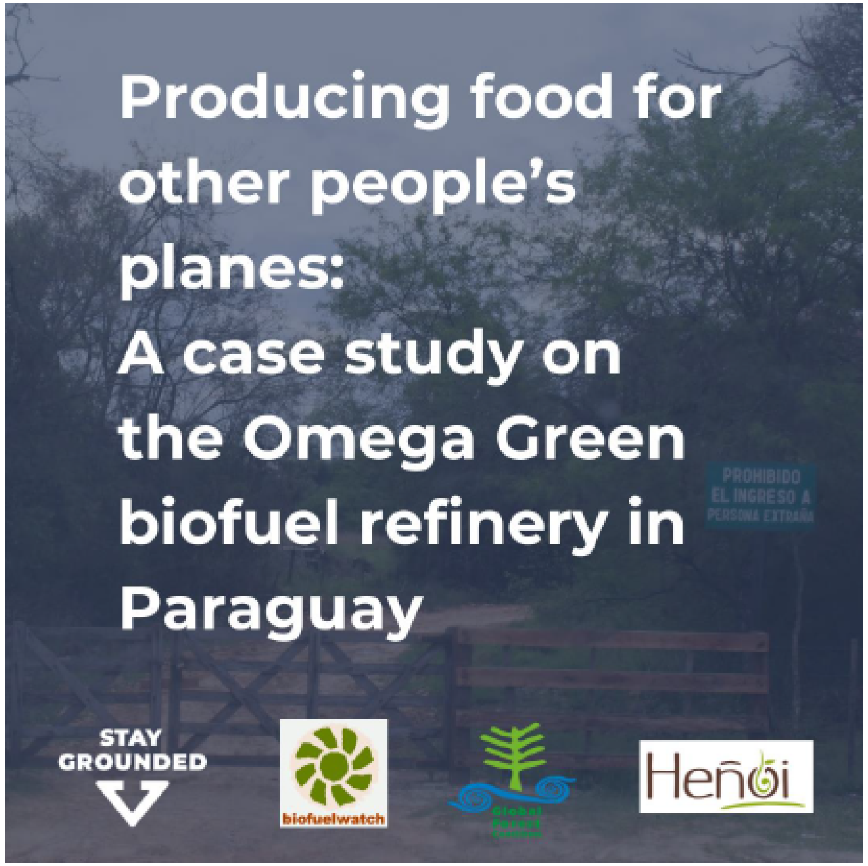


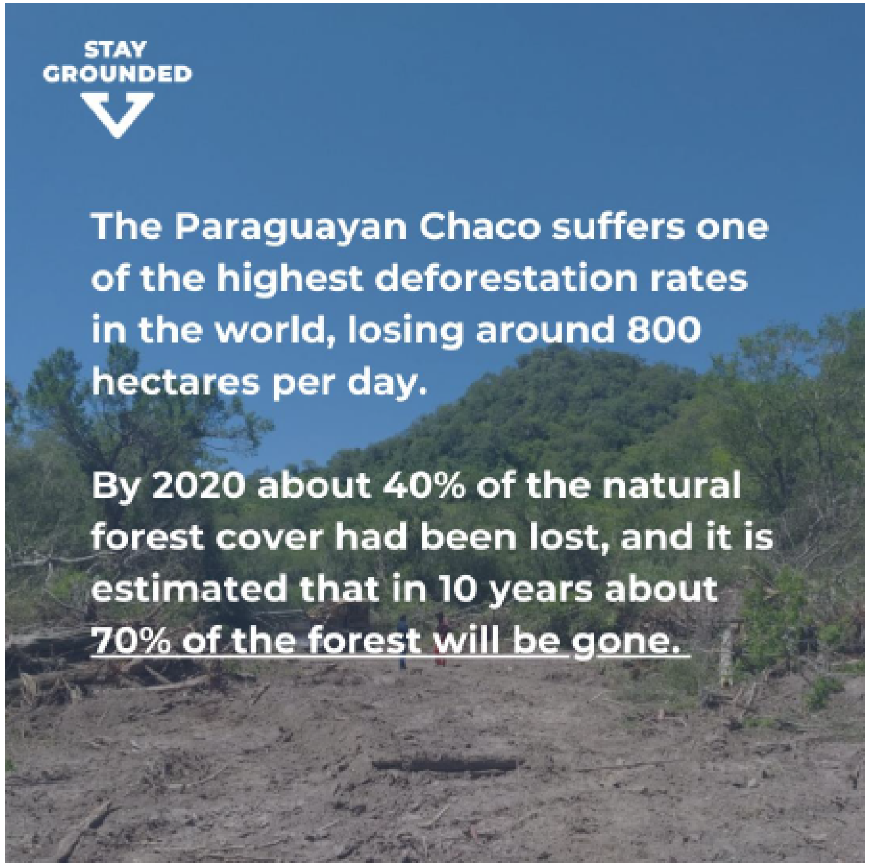
SOURCES:
[Transport & Environment]

Alternative Jet Fuel

Biofuels

The danger of ‘fuel-from-crops’ biofuels



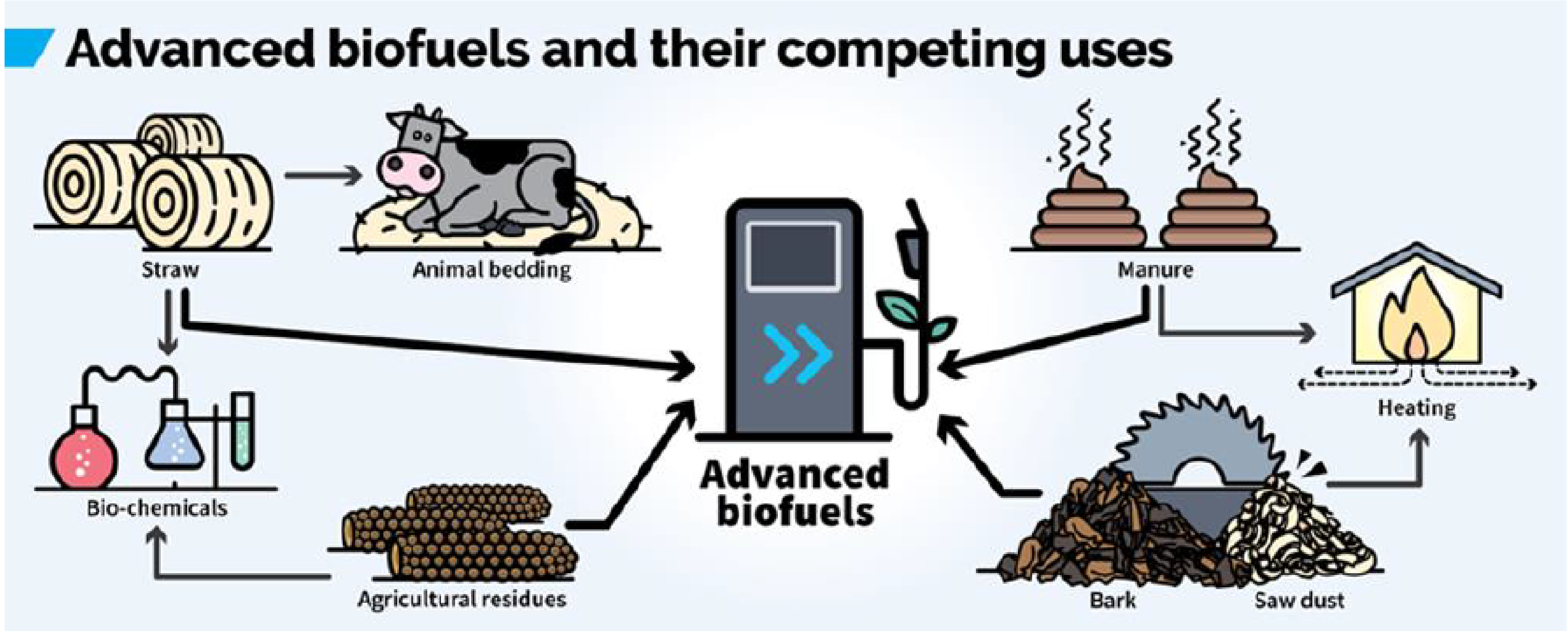


SOURCES:
[Stay Grounded]

Alternative Jet Fuel

Biofuels

Can ‘fuel-from-waste’ biofuels scale?



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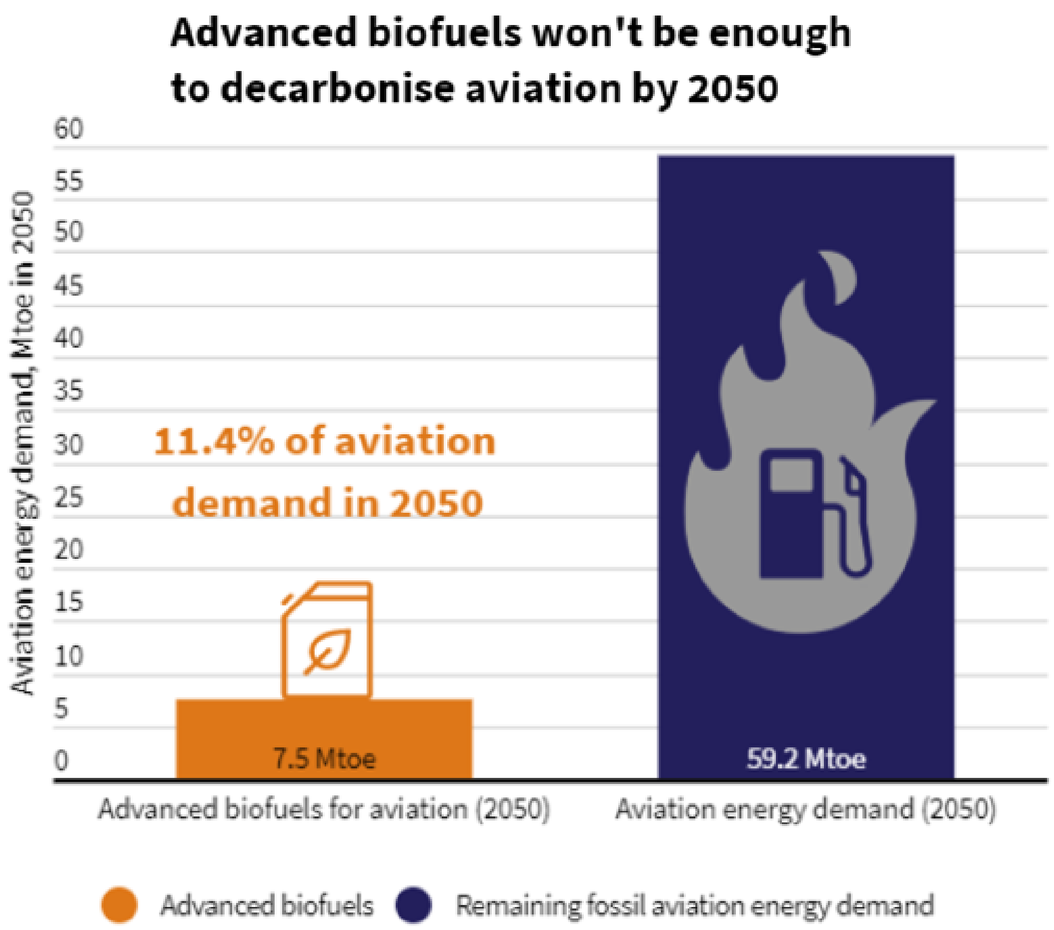


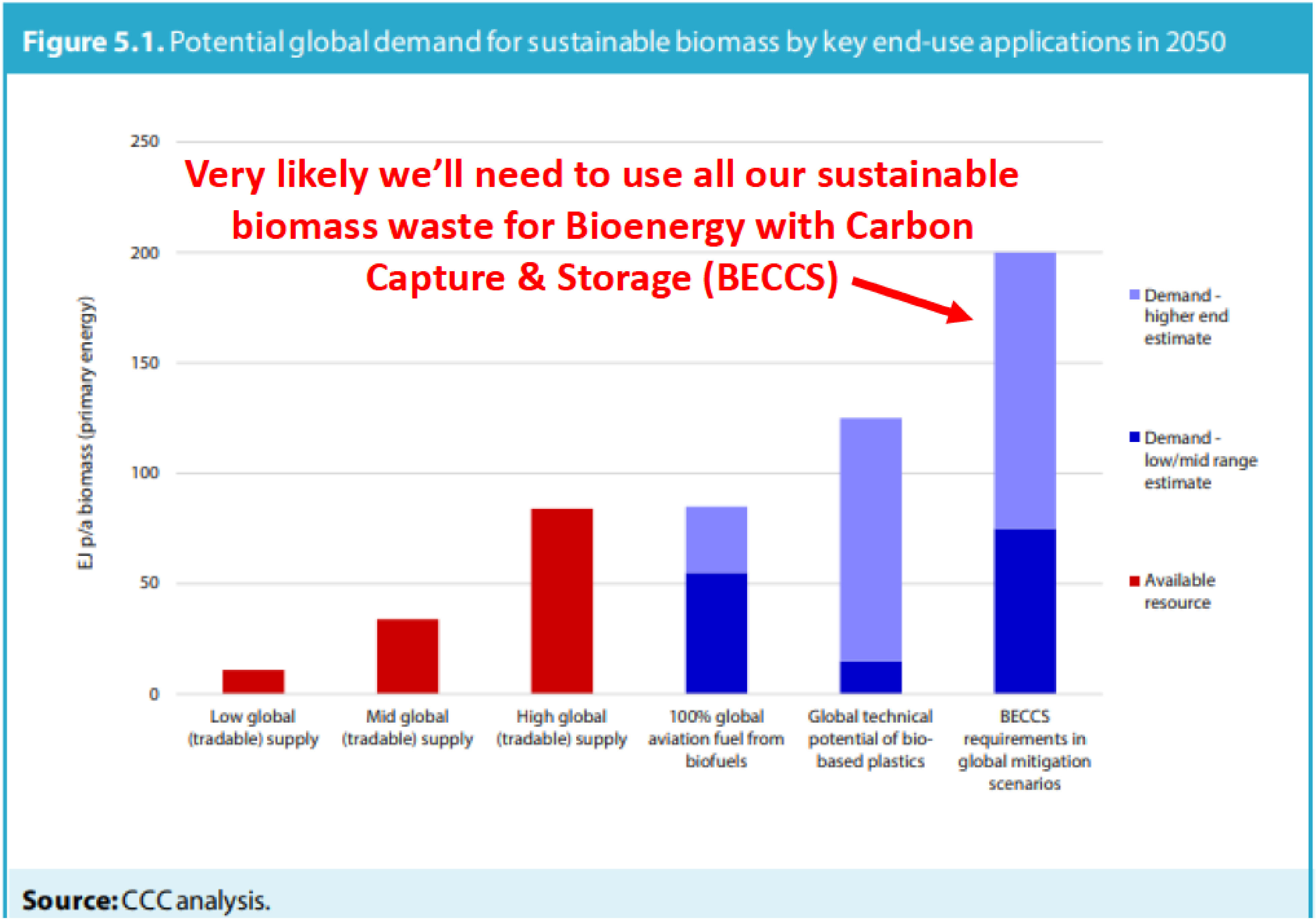
Competing uses:

- Non-fossil fertiliser
- Bioenergy Carbon Capture & Storage
- Road transport fuels (prior to complete electrification = next 15-20 years)
- Shipping fuels
- Bioplastics

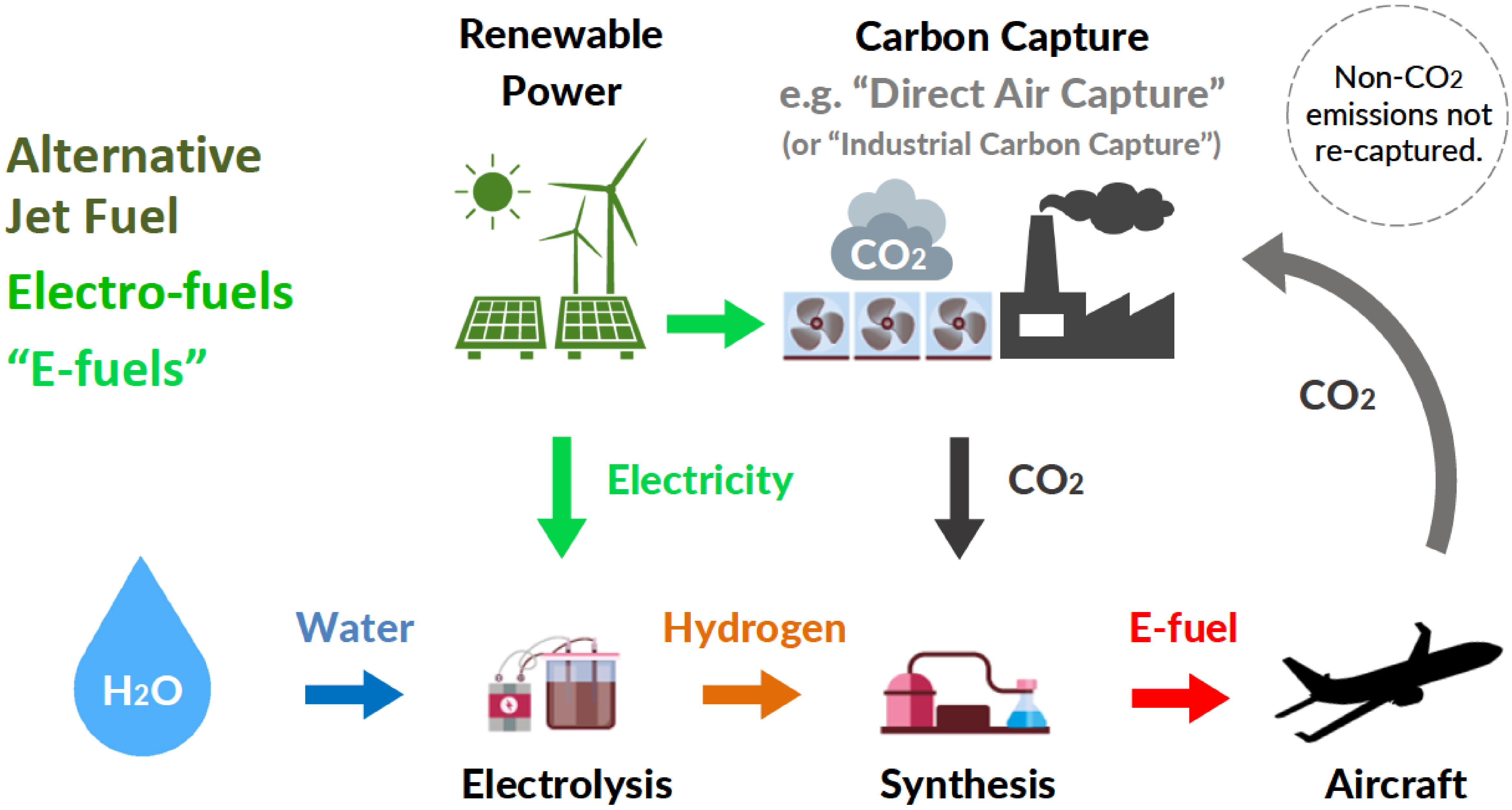
<u>Lack of cross-sector analysis and prioritisation of resource</u>

Alternative Jet Fuel

Biofuels



SOURCES:
[Climate Change Committee]



SOURCE:
Stay Grounded

100% Synthetic E-fuel Calculations

See:
https://www.transportenvironment.org/discover/e-fuels-too-inefficient-and-expensive-cars-and-trucks-may-be-part-aviations-climate-solution/
and also slide 12:
https://www.researchgate.net/publication/278686023_Power-to-Liquids_synthetic_fuels_from_a_sustainable_pathway

UK civil aviation emissions in 2018 = **38.2 Mt**CO_2 [source, page 6]

1kg fuel = 3.15kg CO_2 [source, page 17]

UK jet fuel consumption = 38.2Mt/3.15 = **12.1 million tonnes** of jet fuel.

Energy conversion for jet fuel = 12kWh/kg [source page 14] = 12,000 kWh/tonne

12,100,000 tonnes jet fuel x 12,000 kWh/tonne = **~145 TWh** of jet fuel

100% E-fuel: 145 TWh of jet fuel supplied from e-fuel (@ 45% efficiency) requires **323 TWh** of electricity.

UK electricity demand in 2020 was **330 TWh** [source], but only:

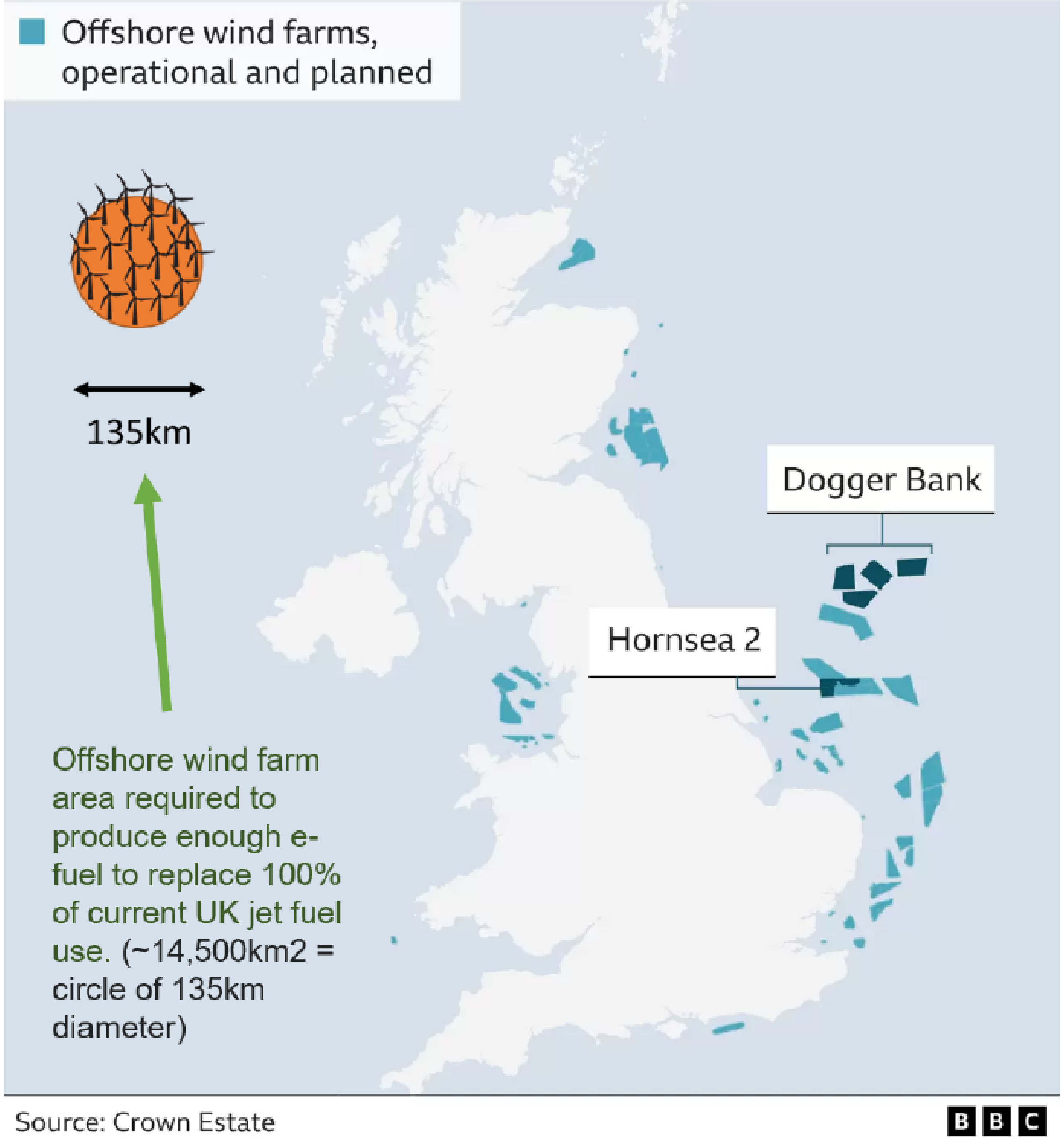
- **135 TWh** was from 'renewables' (includes bioenergy)
- **97 TWh** from wind/wave/solar/hydro combined (excludes bioenergy)
- **75 TWh** from wind
- **50-60 TWh** from nuclear

So: 100% e-fuel requires either:

- a similar quantity of energy to the entire UK electricity generation today (mostly non-renewables)
- > 3x current renewable generation (wind, wave, solar and hydro power)
- > 4x current wind energy generation

Alternative Jet Fuel

E-Fuels



Source: calcs on slide above

Alternative Jet Fuel

Synthetic Electrofuels

"Synfuels"

"E-fuels"

"Power – to – Liquid"

Synthetic E-Fuel

UK aviation fuel use in 2018 = 12m tonnes

To produce this in E-fuel = 325 TWh

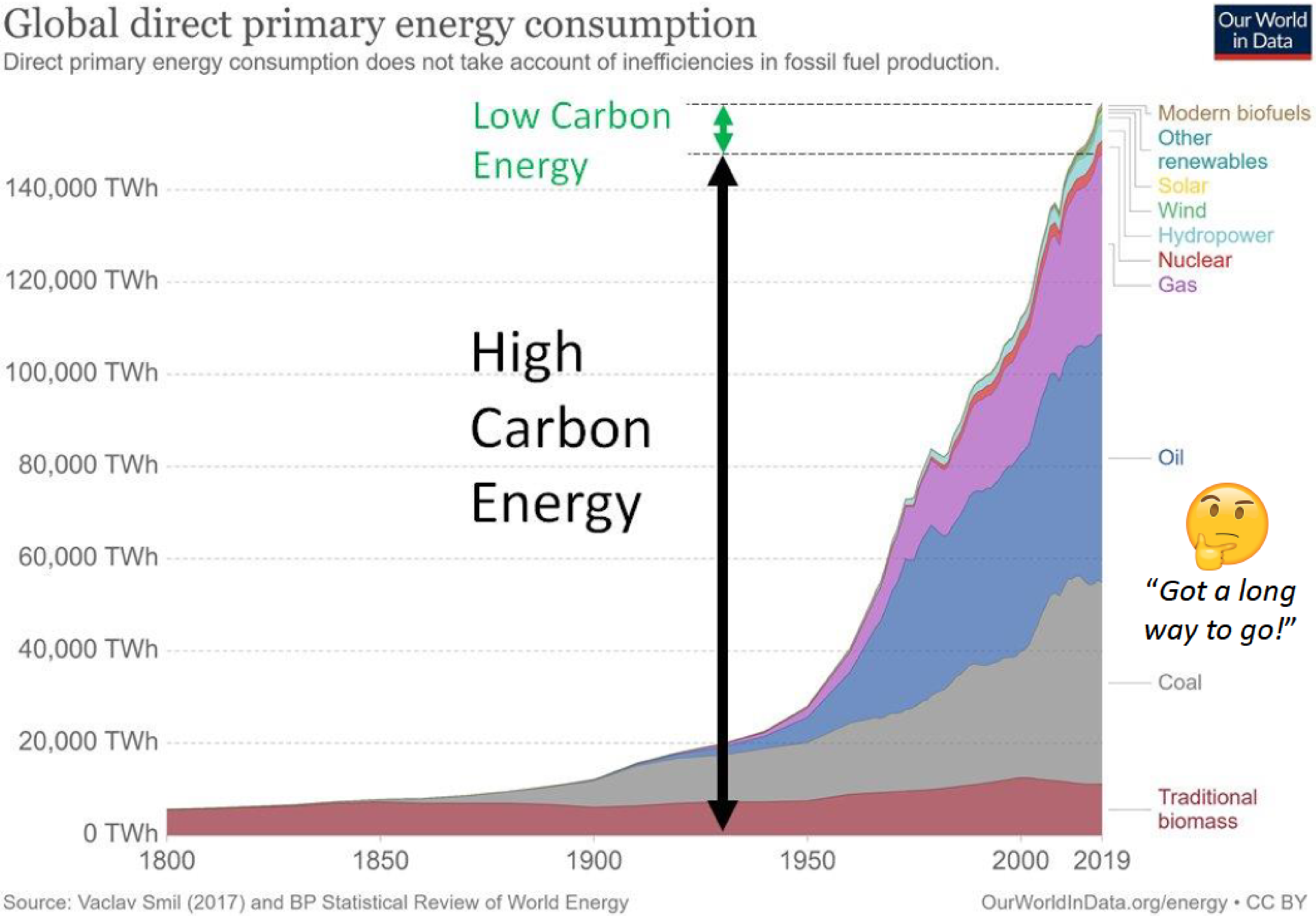
UK Grid generation in 2018 = 330 TWh = total grid

UK renewable generation in 2018 = 110 TWh = 3x renewables

We have a finite supply of renewable energy available and this is far less than current global energy consumption (see figure).

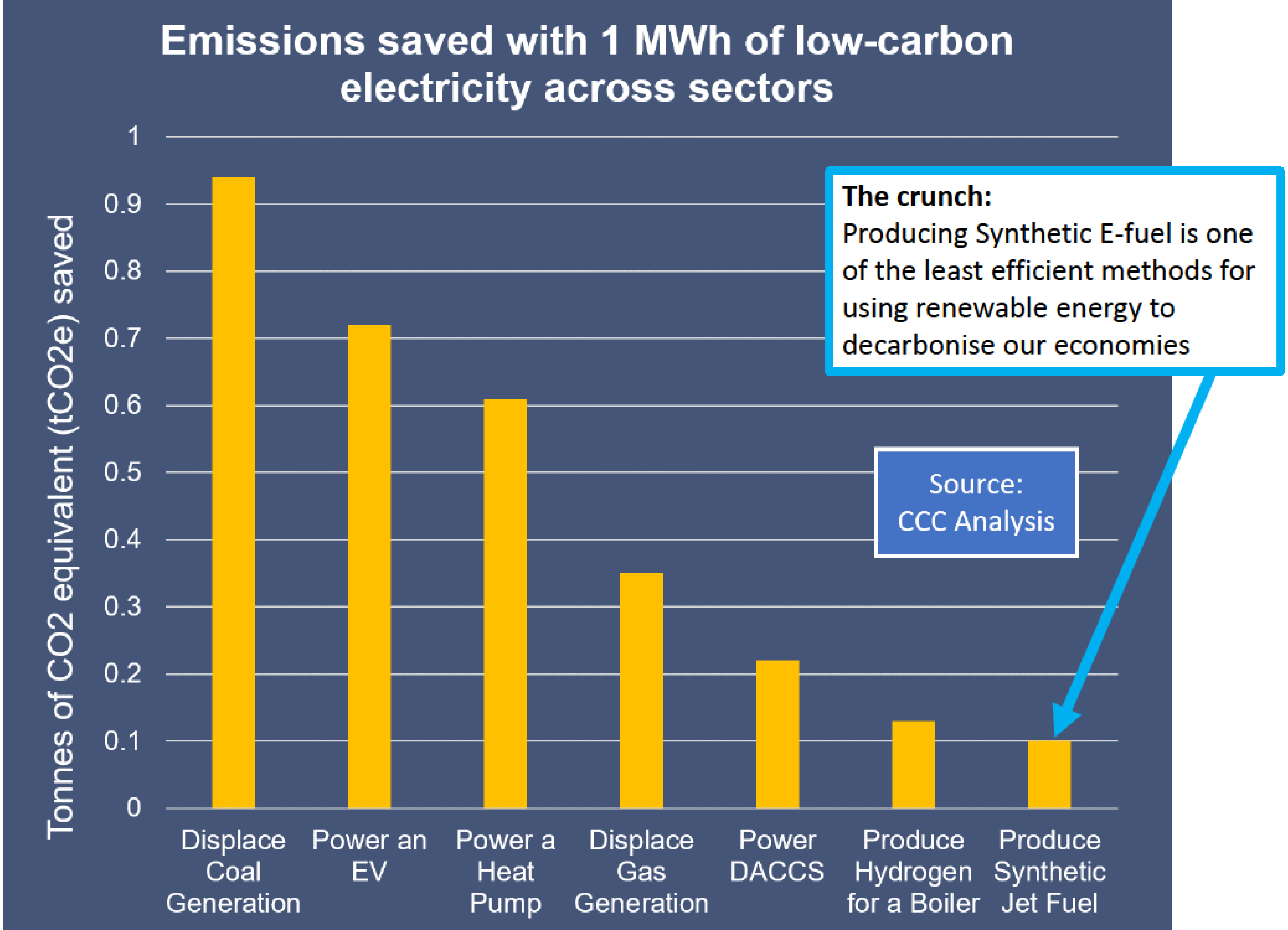
The difference is provided by burning fossil fuels.

It's very important that most green electricity produced isn't wasted through inefficient activities, e.g.: flying and 'e-fuel' production.



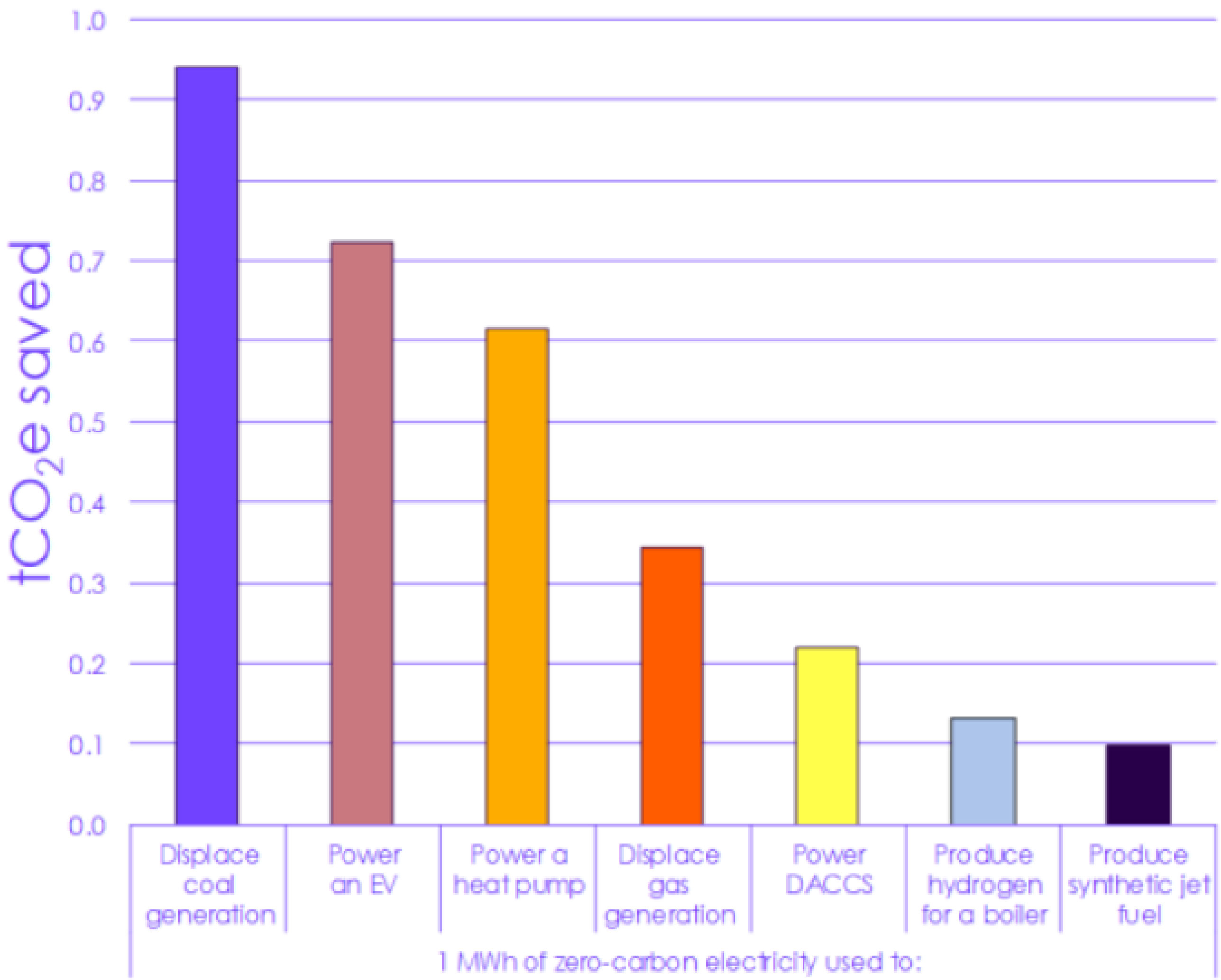
Alternative Jet Fuel

E-Fuels



Source: UK Climate Change Committee

Figure M5.4 Emissions saved with 1 MWh of zero-carbon electricity across sectors



Source: CCC analysis.

"Electrification represents a key abatement option to reduce emissions in other sectors.

Given potential limits to the pace of deployment of low-carbon capacity, it will be important to focus on sectors which have the **most efficient** use of low-carbon electricity (Figure M5.4).

Across our scenarios new demands therefore come primarily from the electrification of transport, heat, and industry.

Hydrogen production, Direct Air Capture, and synthetic fuels are **relatively inefficient** uses of electricity and should be **lower priority** than direct use of electricity for decarbonisation."

https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Electricity-generation.pdf , pg. 10-11

Carbon Offsetting

CARBON OFFSETTING IS FUNDAMENTALLY FLAWED

CEO of United Airlines:

"Covering entire planet in trees = 5 months of global emissions"

Source: https://www.youtube.com/watch?v=b9x67JN-9hQ (45-46 mins in)

Carbon Offsetting

The UK/EU

“Emissions Trading Scheme”

(ETS)

The UK/EU ETS provide many free carbon allowances to airlines, which means that carbon pricing has a limited effect. This pricing is also applied only to intra-EU/UK flights.

Carbon Offsetting

The UK/EU "Emissions Trading Scheme" (ETS)

Source: T&E

Carbon Offsetting

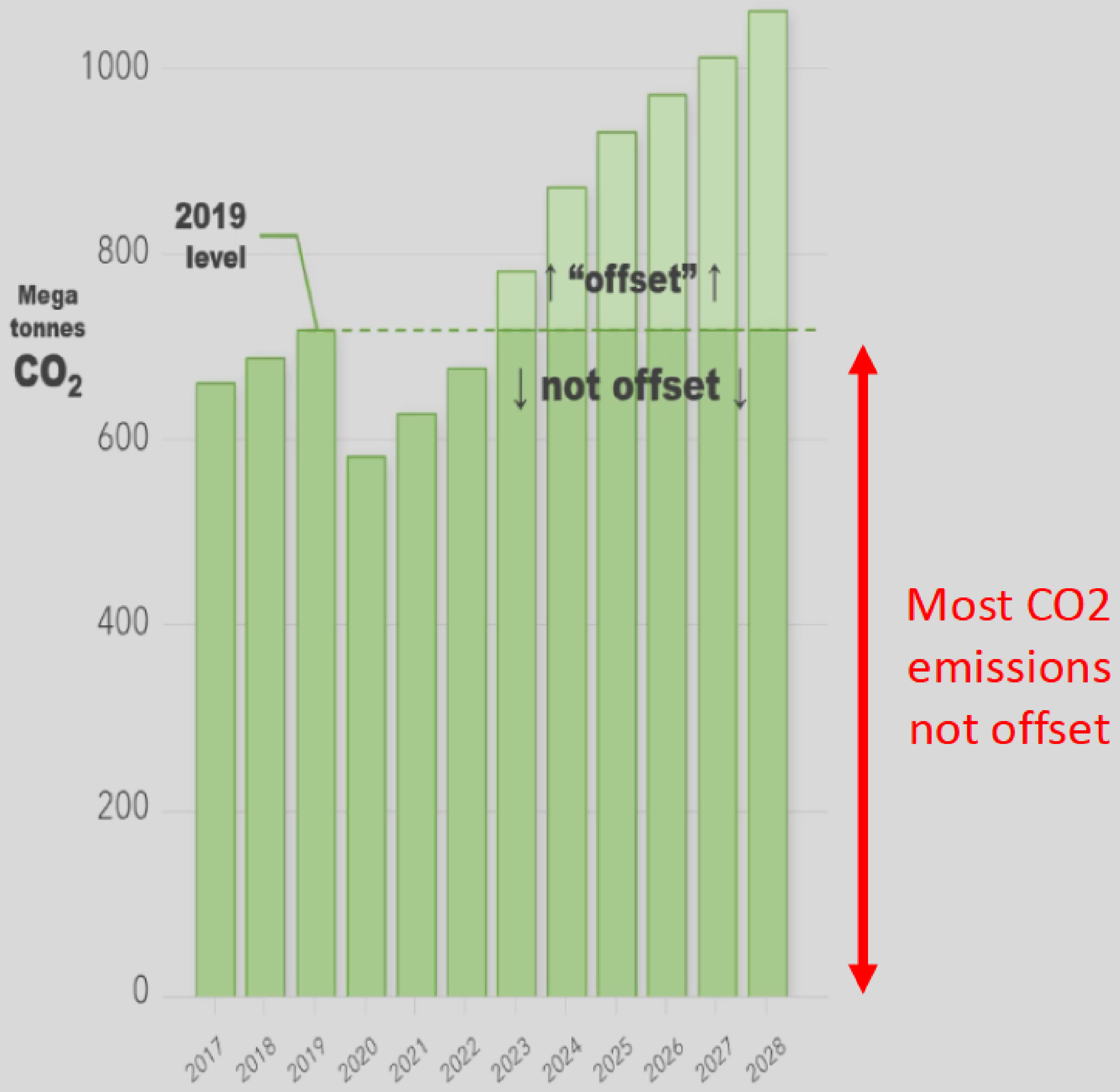
The international "CORSIA" Scheme

Carbon
Offsetting &
Reduction
Scheme for
International
Aviation

Carbon Offsetting

The CORSIA Scheme

Offset Application



Non-CO2 emissions account for 2/3rds of aviation's total climate impact...

... however, they are not accounted for at all in the UK ETS or CORSIA Scheme

SOURCE:
The ICCT


CORSIA
Industrial
Carbon Capture
1
tonne
CO2
1
tonne
CO2
GREEN SKY
THINKING
$ 9
$ 1000
Low cost
of offset
credits
Real cost
of actual
CO2 removal

Carbon offsetting/pricing

Both the UK/EU ETS and CORSIA :

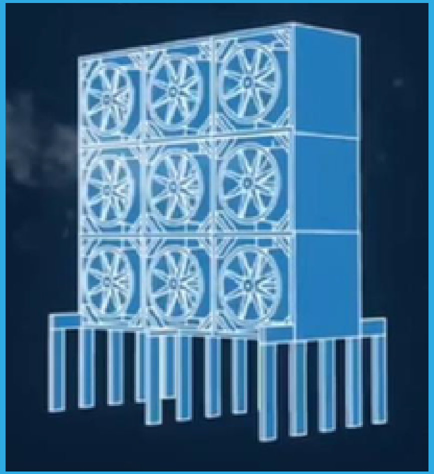
- are far too weak
- provide offset credits that are far too cheap
- have credit systems which don't even apply to the vast majority of aircraft emissions
- Won't reduce aviation emissions

SOURCE: DW

Negative Emissions Technologies

- All negative emissions technologies are <u>yet to be proven</u> at scale, and have a <u>very high risk</u> of worsening the climate and ecological crises and their human impacts
- <u>Bio Energy Carbon Capture & Storage</u> (BECCS) could contribute to rising food prices, biodiversity loss, and deforestation, whilst producing more emissions (due to land-use change) than it 'captures'

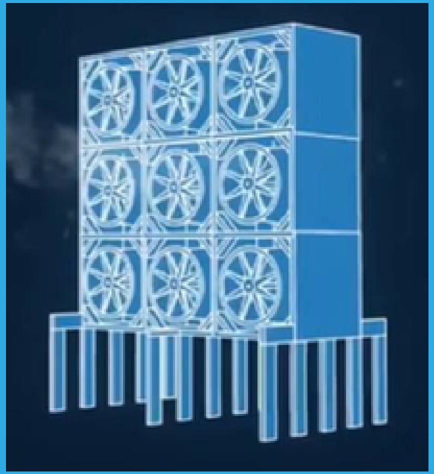
- <u>Direct Air Carbon Capture & Storage</u> (DACCS) could require huge quantities of green electricity and fossil gas (methane leaks?) – VERY expensive.



Negative Emissions Technologies

- Even if negative emissions technologies do prove to be workable and scalable, they would remain expensive due to their incredibly high energy / land / resource requirements

- If the costs of carbon removal of aviation emissions fall exclusively on ticket prices - which arguably they should - plane tickets would become much more expensive, <u>impacting on demand</u> and influencing aircraft design.



WHAT WE THINK WE NEED TO DO:

1. Challenge false solutions = greenwash
2. Demand real solutions = policies
3. Form Citizen-led and Worker-led movements to push for those policies
4. Prepare ourselves for change = adaptation

Policies Required

Safe Landing Opinion – **Policies required:**

- ALL aviation emissions accounted for in Nationally Determined Contributions (NDCs) submitted to UN:
  - International aviation emissions (as well as domestic) and Non-CO2 emissions (as well as CO2)
  - Allocate aviation emissions budget to each country, then allocate nationally by airports/airlines
- Emissions (CO2 + Non-CO2) Pricing e.g. jet fuel tax:
  - Clear roadmap of increasing price over next few decades
  - Progressive policies such as a frequent flyer levy to improve equity
- Technology:
  - More rapid development of more efficient aircraft and phasing out of older inefficient aircraft
  - Aircraft and air transport networks designed for minimum energy use and fuelburn
  - Flying less fast, less far and less frequently
- Fuels:
  - Low use of biofuels for aviation (no bioenergy-from-crops, and bioenergy-from-waste prioritised for fertiliser, BECCS and hard-to-abate ground transport).
  - Low use of e-fuels (e-kerosene and green H2) for aviation. Production unsubsidised, and with aviation fuel producers pay a premium for electricity for this use to discourage inefficient energy use.
  - Improved quality kerosene (hydrotreated) jet fuel, burned then emissions price pays for DAC.
- Offsets / NETs only as damage mitigation, not as “solution” that “*neutralises emissions*”.
- Limit air traffic in high-emitting countries that already fly far more than rest of the world

High Emissions Price – What Happens?

- We need to optimise for **minimum energy use**
- We'll likely fly :
  - Less fast
  - Less far
  - Less frequently

Concept aircraft tend to be designed for 0.7Mn (rather than 0.8-0.85Mn). *"The reduction in fuel burn achieved by designing for a lower cruise Mach number is now becoming widely recognised." "The minimum fuel burn aircraft, with unswept wings and a lower cruise Mach number, is aerodynamically and structurally more efficient than the minimum-cost aircraft. Evidently, with progressively increasing fuel price, the shape of the minimum-cost aircraft would evolve towards that for minimum fuel burn."* – RAeS (pg 10-11).

High Emissions Price – What Happens?

- Airlines will likely fly aircraft less fast, less and frequently
  - long journeys more likely to be multiple flights and take longer
- New aircraft (small electric and medium H2) will be developed more rapidly, and better "SAF" price-parity with fossil jet fuel
- Aircraft will likely have smaller capacities and ranges (due to volume/weight of batteries and hydrogen)
- Less-centralised mega hubs and more local, smaller airports?
- Possibly hydrogen/e-fuel production on-site at/near airports

✓ More sustainable long-term jobs

AVIATION TRANSITION

Safe Landing

AVIATION TRANSITION

ASSUMPTIONS

ASSUMPTIONS

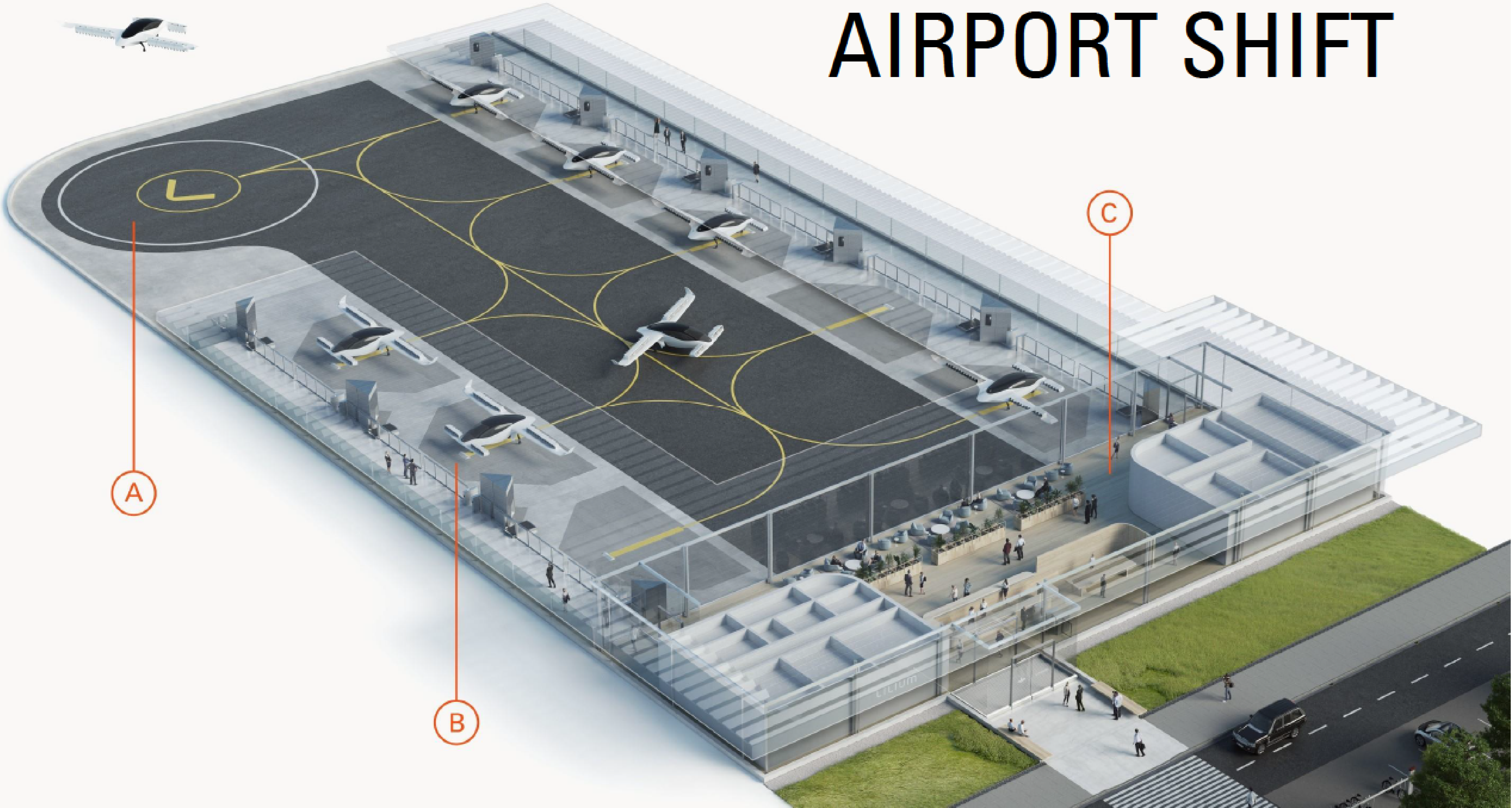
- **Higher emissions price**
  - CO_2 Emissions – conventional aviation fuel (fossil fuel kerosene) becomes **far** higher cost
  - Non-CO_2 – producing soot and contrails becomes **far** higher cost (affects long haul in particular)
- **Transition to road, rail, ferry, or small electric aircraft for journeys under 500 miles**
- **Transition to medium hydrogen aircraft for journeys 500-1500 miles**
  - Airlines have higher ticket prices due to cost of aircraft, fuel and reduced capacity due to H_2 volume
  - Aircraft fly slowly due to need to minimise drag
- **Transition to synthetic fuel aircraft for journeys > 1500 miles**
  - Airlines have higher ticket prices due to increased fuel costs

MODAL SHIFTS

MODAL SHIFTS

- Passengers choose to travel differently due to economics of an emissions constrained world
- It becomes FAR more expensive to travel longer distances, quickly
- Passengers fly less, or (at least) air traffic will grow more slowly than it did in 2000-2020
- Passengers opt for ground transport for journeys under 500 miles
  - Passengers opt for electric aircraft at that range if they want to pay a premium to arrive faster
- Hydrogen aircraft may be used as a medium range solution (but not until ~2040)
- Conventional aircraft powered by synthetic ‘e-fuel’ are used for long range and in the short-term this is used for medium range too
  - Medium and Long Range flight become FAR more expensive = less people fly long distances

AIRPORT SHIFT



AIRPORT SHIFTS

- **Airports of the future need to be designed differently taking into account these future modal shifts. This is also true of existing airport updates or "expansions".**
- **It would be a mistake to spend many million/billion of public and private investment on infrastructure that will not meet the needs of future market constraints and requirements.**
- **Any airport design and construction that is predicated on continued rapid expansion of low-cost and long-distance air travel – has a very high financial risk of failing to deliver returns.**
  - **Becoming either a stranded asset or requiring costly re-design and re-construction**
- **It's important that future airports are designed in a configuration that makes them capable of sustained use, profit and employment into the future.**

AIRPORTS OF THE FUTURE

- More small regional airports, rather than huge international hubs like London Heathrow
- More smaller, shorter runways
- More small aircraft, and thus smaller airport gate sizes
- May need MORE runways and gates – despite there being <u>less passenger miles flown</u>
- Facilities for providing electric power to electric aircraft
- Facilities for providing Liquid H2
  - Potentially production of LH2 at the airport
- Facilities for providing Synthetic E-Fuel
  - Potentially production of E-fuel at the airport

JOB CONSEQUENCES

JOB CONSEQUENCES

Be clear: fossil fuel company profits will reduce, aviation workers WILL NOT.

There is a LOT of work to be done transitioning our global modes of travel. The challenge is huge, so there will be plenty of work instigating it, for example:

- **Increased pilot, cabin crew, ground crew and airport staff jobs due to increased numbers of smaller and slower aircraft.**
- **Aircraft (+ engine and associated tech) design and development**
- **Airport architecting and design**
- **More training jobs for the new technology (e.g. flying schools for re-training existing pilots)**
- **Higher quality tourism for people and planet**

JOBS – AIRLINE AND AIRPORT EMPLOYEES

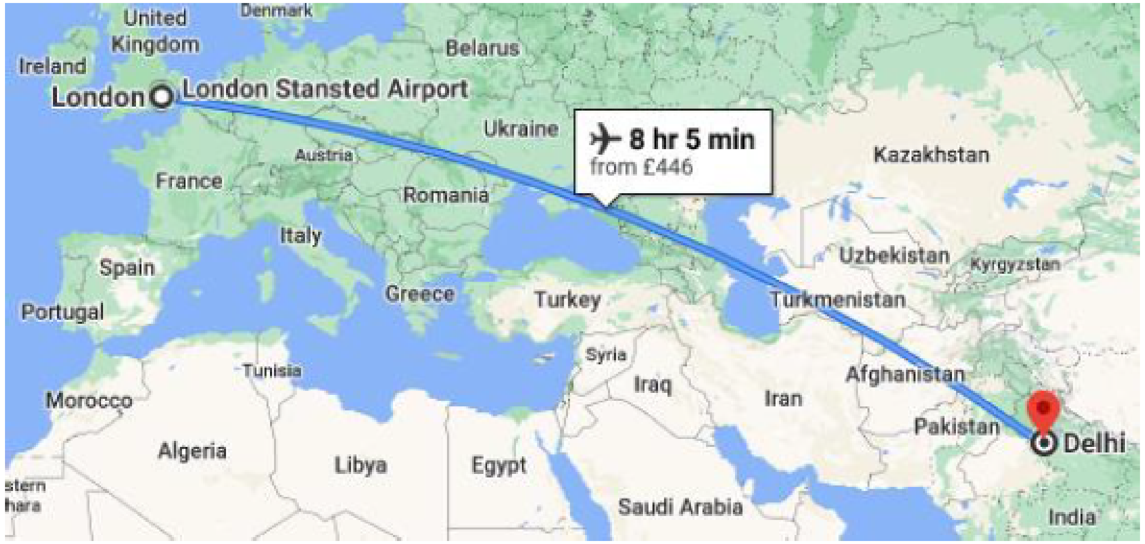
An energy/emissions constrained world could well feature less long haul flights… but also more small aircraft, flying short distances, at slower speeds, with few passengers (to enable electric and hydrogen).

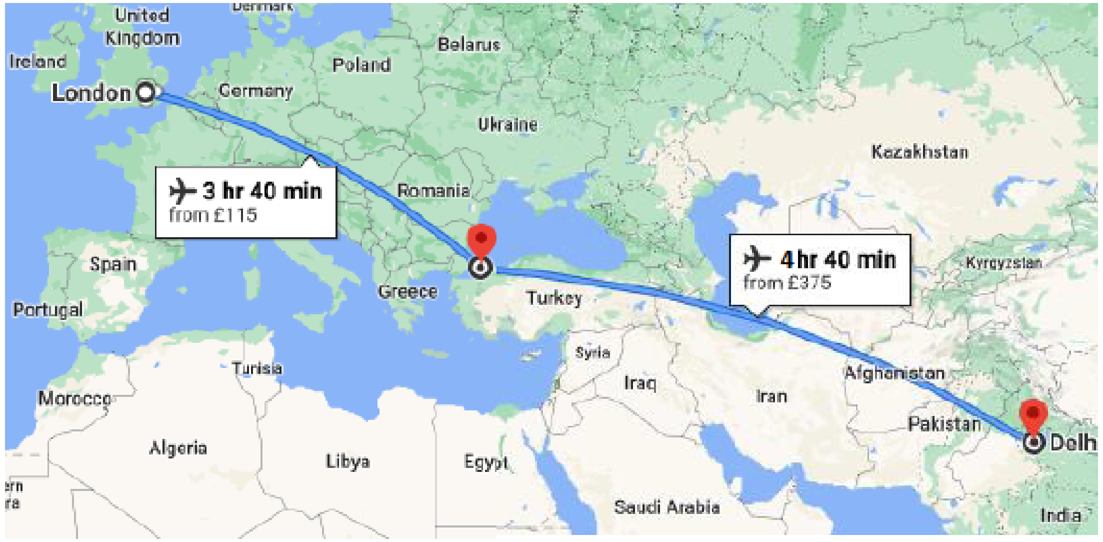
So even though there will be less miles flown, there may be a balancing effect on employment due to increased number of aircraft, number of flights, and time length of flights.

Basically, the airlines may need more employees – it's just the cost of flying will go up – which is bad for airline profit margins, but good for employment, and also limiting the growth of air transport emissions.

JOBS – AIRLINE AND AIRPORT EMPLOYEES

Example 1: 8h flight from London to Delhi will burn less fuel per passenger km by splitting into two ~4h flights completed in a smaller single-aisle aircraft. For 300 passengers, you would need two aircraft rather than one though – hence ~2x the flight crew*, and additional ground crew jobs at Istanbul airport.

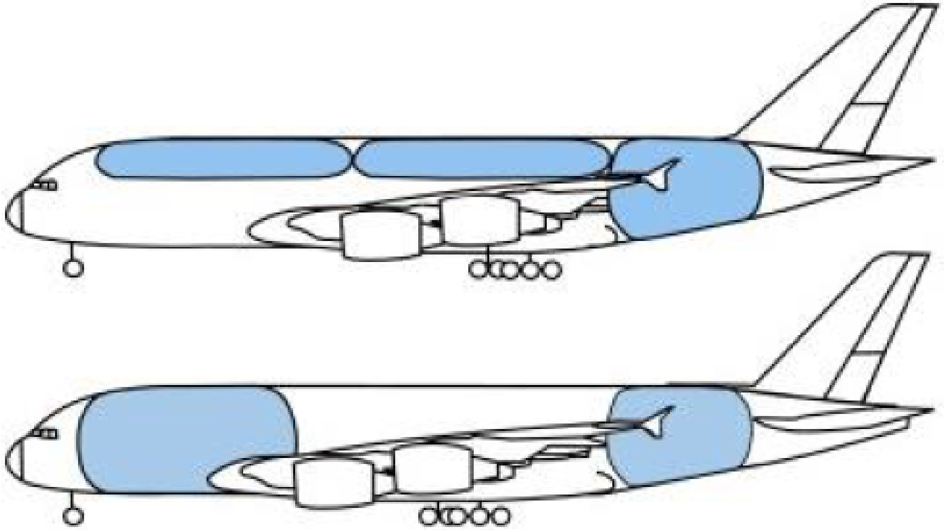


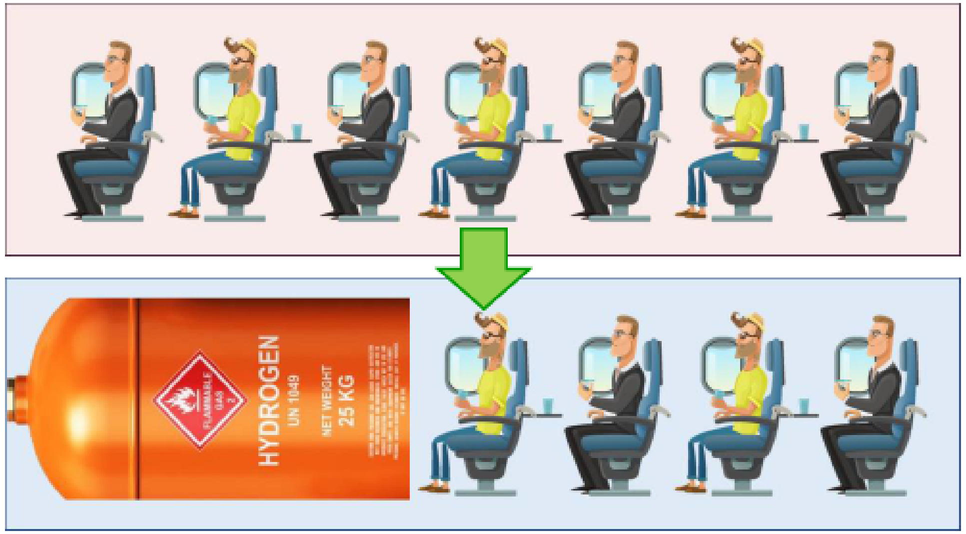


* if the aircraft are flying as slow as possible to minimise fuel burn emissions this also increases employee hours – it's therefore possible to reduce air miles, and emissions per passenger mile, without reducing employment

JOBS – AIRLINE AND AIRPORT EMPLOYEES

Example 2: if future low emissions aircraft are powered by hydrogen, then this will require compressed gas or liquid hydrogen storage tanks. These are more than 4x the volume of conventional aviation fuel. This means there will be less passengers on a given aircraft = more pilots for equal passenger miles.





JOBS – AIRCRAFT TECH: DESIGN & DEVELOPMENT

An energy/emissions constrained world will mean that fossil fuel is more expensive to burn, which will affect the “trade studies” determining whether more radical aircraft and propulsion system architectures are economic to develop.

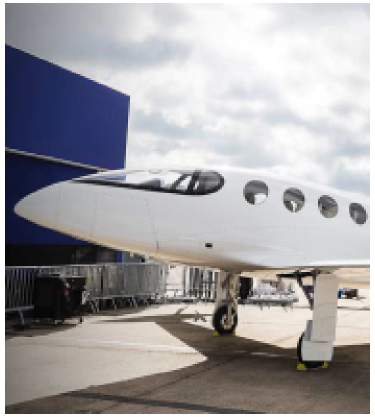
This will mean we’ll need to accelerate the design, development, testing and certification of these novel concepts. It will be a new era of aviation – that could surpass the 50s-70s in terms of innovation and will involve a complete re-definition air travel: electric, hydrogen, gull wings, blended-wing bodies etc.

There will be a huge engineering effort required for this – and it will be actual cognitive design work rather than mass-manufacturing production cost-reduction work that will face future disruption through automation and may involve loss of jobs to machines. Robots and Artificial Intelligence (AI) cannot (currently) design, develop and test themselves.

JOBS – AIRPORT DESIGN

We could advocate for some airports to be reconfigured as model "airports of the future" in the format necessary for enabling electric and hydrogen aircraft with less passengers. There could be genuine economic benefit of doing this as it's required for a low carbon future, and the countries/companies could then export that expertise to other countries/cities around the world.

“ Low Emissions Airport Consultants ”



JOBS – PILOT AND CREW TRAINING

If we advocate for a significant reduction in air traffic growth then we may reduce the number of new pilots who will be required to train over the next few decades (although as shown, this we may need more pilots and flight crew, despite passenger miles reducing).

This could also be balanced out by flight schools adapting to train pilots in the latest aircraft technology which will considerably different from existing conventional aircraft controls – due to the significant changes in aircraft configurations that we'll see.

There may also be a significant amount of training in non-CO2 emissions avoidance/minimisation.

JOBS – PRODUCTION, MAINTENANCE & REPAIR "JUST TRANSITION"

If we advocate for a significant reduction in air traffic growth then we may reduce the number of (existing generation) aircraft that will be flying = less jobs in mass production, maintenance & repair. This may be partly countered by more jobs making alternative, lower carbon, aviation technology.

Ultimately, there needs to be less energy and materials utilised making and fixing things. Electric flight may also lead to much lower maintenance requirements. There may be less jobs in this area and as such it's important that we:

a) don't train huge numbers of new employees.
b) help anybody who loses a job train and re-skill.

Aviation workers are very employable as they can work to high technical, quality and safety standards. This makes them very suitable for sustainable low carbon transport and housing jobs.


TOURISM:
PROVIDING SOME RELIEF…
TO THE GREAT BARRIER REEF…
REAL SUSTAINABLE AVIATION MEANS:
THERE WILL BE A REEF TO VISIT IN THE FUTURE

JOBS – RESPONSIBLE TOURISM

- We need **less travelling**: in terms of distance, and speed travelled
- We need to travel long distances less frequently, and travel more slowly
- However, it needs to be recognised that many low-income economies rely on tourism to an extent – whilst also highlighting the **negative consequences** of existing **over-tourism**.
- There's a clear opportunity to **both** reduce **negative over-tourism**, and improve **responsible tourism.** This can boost the **positive economic, environmental and social impacts** in regions.
- There are already many examples where the quantity of tourism has decreased the quality of life for local people, environment and biodiversity. **Resetting aviation can help to reset tourism.**

WORLD ECONOMIC FORUM

Clean Skies for Tomorrow

IATA

ATAG AIR TRANSPORT ACTION GROUP

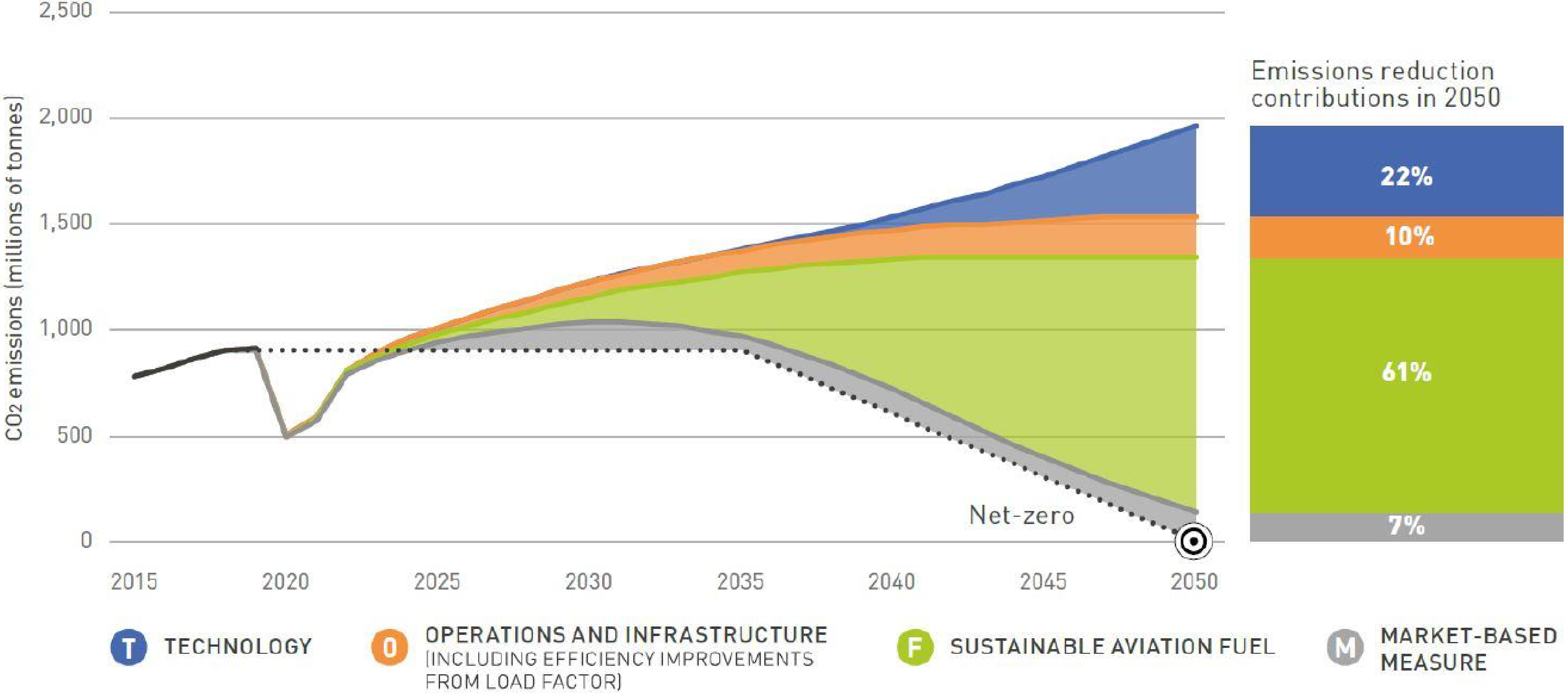
POLICIES TARGETING FOSSIL JET FUEL

… but without a plan to **cap and reduce** fossil jet fuel use each year… alternative tech and fuels will only **add to, rather than substitute**, fossil fuel.

SUBSIDIES FOR ALTERNATIVE TECH & FUELS

… but without higher fossil fuel prices – there'll be **no incentive** for airlines to adopt alternatives. And all taxpayers will subsidise high-income high-emitters.

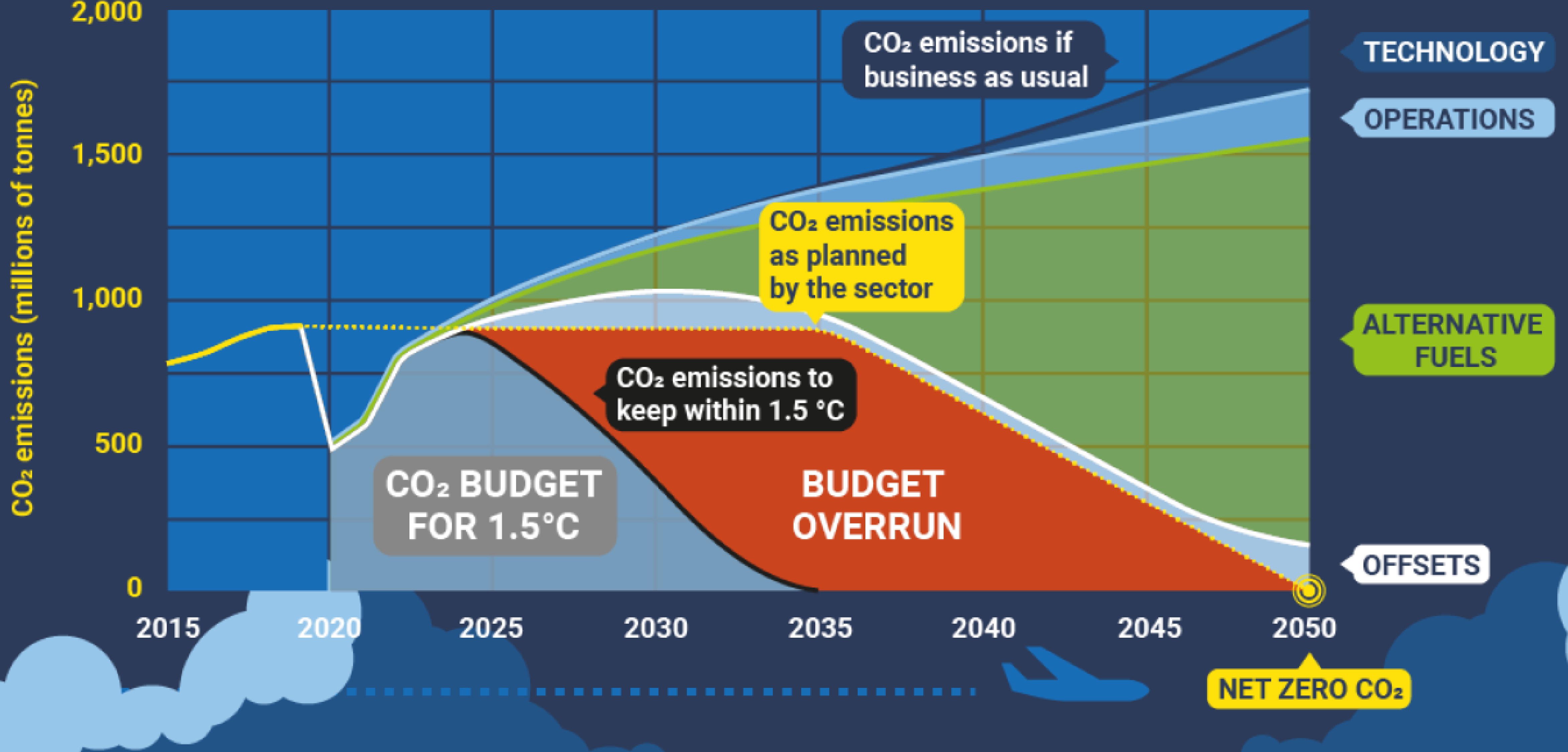
AVIATION SUSTAINABILITY PLANS: WORKER CRITIQUE

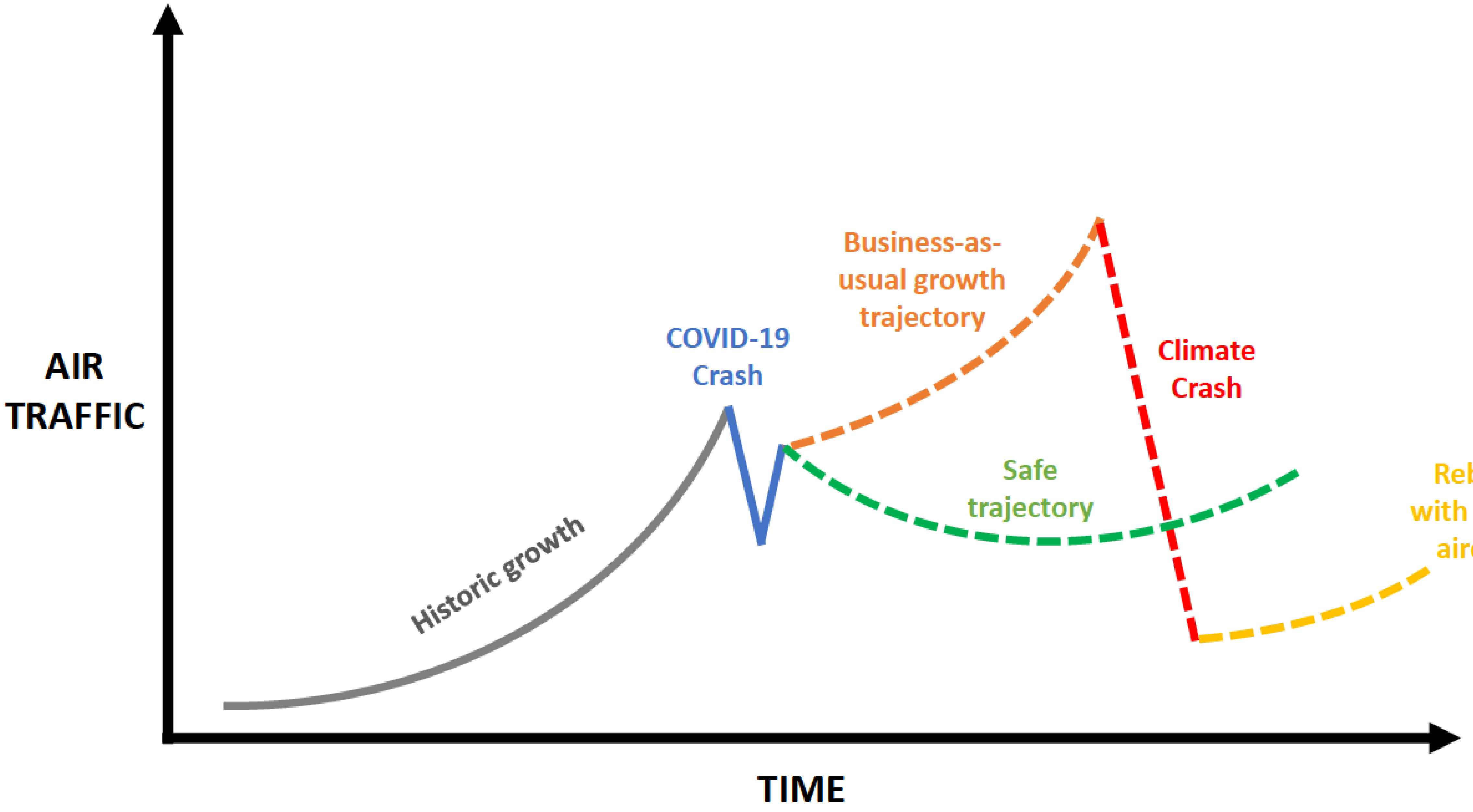


2,500
2,000
1,500
1,000
500
0
CO2 emissions (millions of tonnes)
Emissions reduction contributions in 2050
22%
10%
61%
7%
Net-zero
2015
2020
2025
2030
2035
2040
2045
2050
T TECHNOLOGY
O OPERATIONS AND INFRASTRUCTURE (INCLUDING EFFICIENCY IMPROVEMENTS FROM LOAD FACTOR)
F SUSTAINABLE AVIATION FUEL
M MARKET-BASED MEASURE

Source: ATAG

Sources:
ATAG(2021): https://bit.ly/Waypoint2050, Scenario 2 p. 25
UNEP (2021): https://bit.ly/Emissions_Gap, p. XXIII




AIR TRAFFIC
TIME
Historic growth
COVID-19 Crash
Business-as-usual growth trajectory
Climate Crash
Safe trajectory
Rebuild with zero-E aircraft

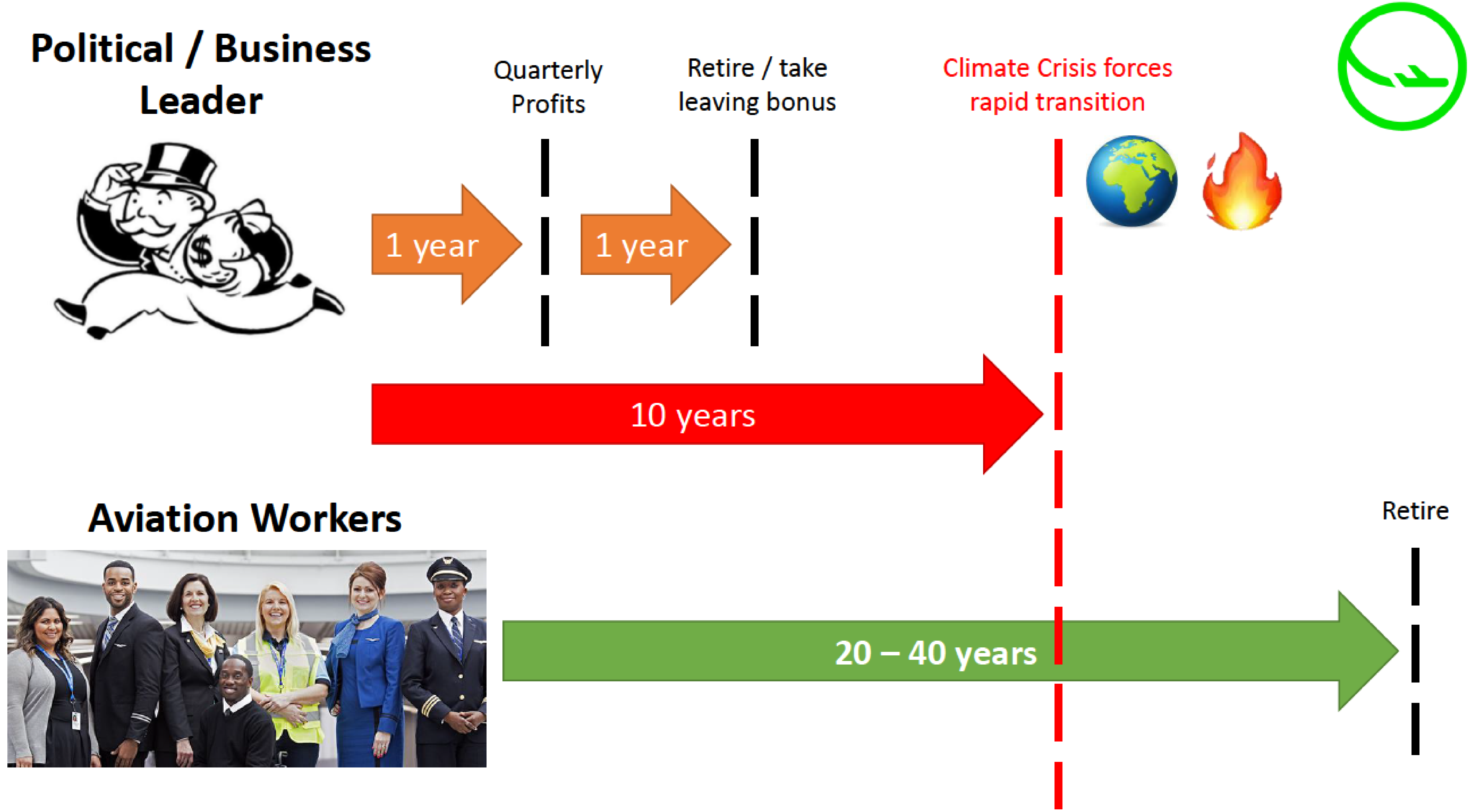
4. What is Safe Landing's explanation of a '**Just Transition**' for Aviation?

- An '**unjust**' transition is unplanned and chaotic. It happens by disaster with an industry shutting down overnight and workers being left to fend for themselves. Example: British coal mines.

- A '**just**' transition involves early planning so that it can be designed in advance, and provides the maximum chance of happening smoothly:

  "*by design, rather than by disaster*"

- If an industry adapts to make itself '*future fit*', this will minimise the need for workers to transition out-of-sector
- It involves workers being informed, consulted and their needs recognised.
- Workers should be given financial assistance and other support to retrain in anticipation of this transition (rather than afterwards or not at all!)


Political / Business Leader
Quarterly Profits
Retire / take leaving bonus
Climate Crisis forces rapid transition
1 year
1 year
10 years
Aviation Workers
Retire
20 – 40 years

Safe Landing believes that ICAO's "Net Zero by 2050" target simply continues to reinforce:

- ☑ **Zero accountability.**
- ☑ **Zero carbon budgets.**
- ☑ **Zero limits on CO_2 emissions.**
- ☑ **Zero action on non-CO_2 emissions.**
- ☑ **Zero tax on jet fuel, or Frequent Flyer Levy.**
- ☑ **Zero chance of preventing an industry climate crash.**

Safe Landing

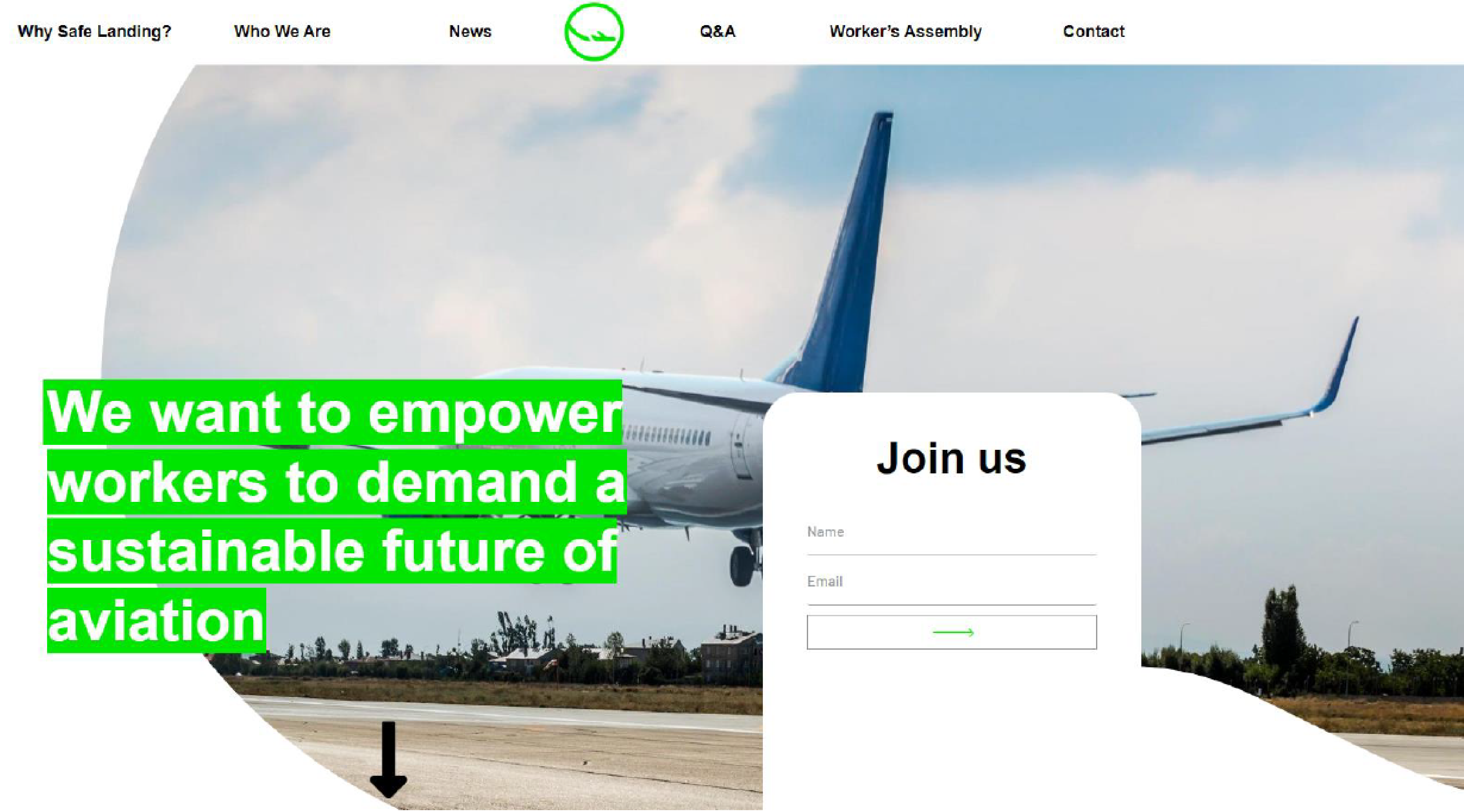
ICAO

Perform an
Aviation Workers' Climate Assembly:
NOW!

Sign the petition: tinyurl.com/AviationAssembly

WORKERS' ASSEMBLIES

Campaign Launched: www.safe-landing.org/assembly



Join us: www.safe-landing.org

End of Pack – Thanks

[#ShowYourStripes]