



## ASTM Earth 21

Can Aviation Be Made Sustainable?



"What if we don't change at all ...  
and something magical just happens?"

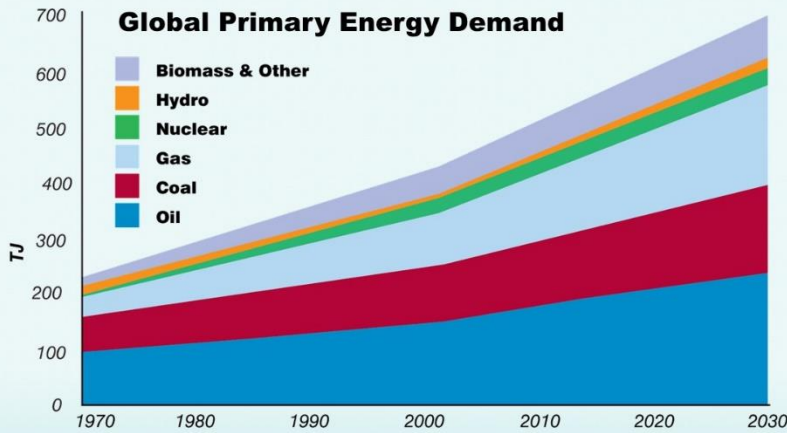
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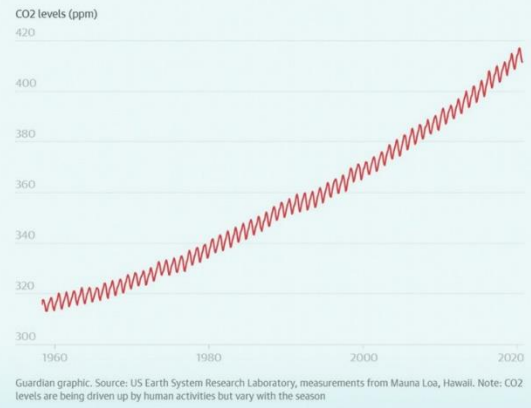
Good afternoon and welcome to the discussion about sustainable aviation. Which today is a contradiction in terms, isn't it?



## Replacing Fossils?



Atmospheric CO<sub>2</sub> continues to rise rapidly in 2020



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Talking about sustainability in aviation, let's set the playground. Where do we stand today?

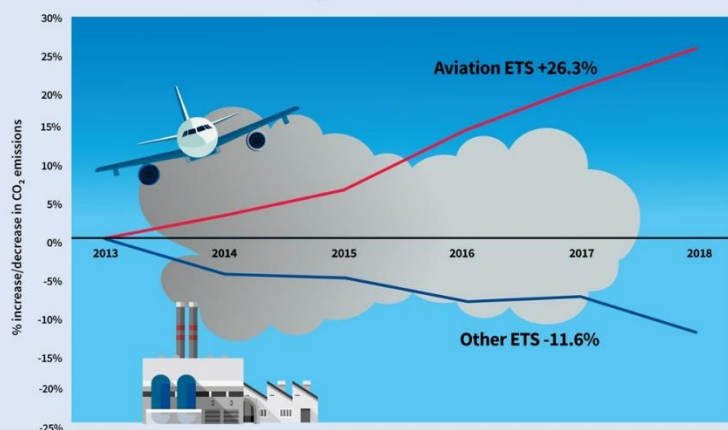
The global primary energy demand is based on fossils and the crude oil demand is on an unbroken rise. The brief drop in 2020 is already expected to "fully recover" in 2021.

And at the U.S. Earth System Research Laboratory in Hawaii, the rise of atmospheric CO<sub>2</sub> in 2020 had not slowed at all.



## Aviation Status Quo

### Aviation emissions growth since 2013 in the EU



Note: For emissions that were not lodged on time, 2018 emissions have been set to 2017. For aviation, this assumption amounts to approximately 8% of the verified reported emissions.

Source: European Commission, 2019

"Wizz Air's chief executive Jozsef Varadi has branded carbon offsetting as 'a bit of a joke', despite offering the scheme as part of the airline's sustainability programme." [Euronews]

"Eine neue Bundesregierung könnte Lufthansa 2022 in Sachen Klimaschutz stärker in die Pflicht nehmen - und Kurzstreckenflüge einschränken. Ein "Szenario Frankreich" will Lufthansa unbedingt vermeiden" [aero.de]

G20, COP26: #toolittletoolate


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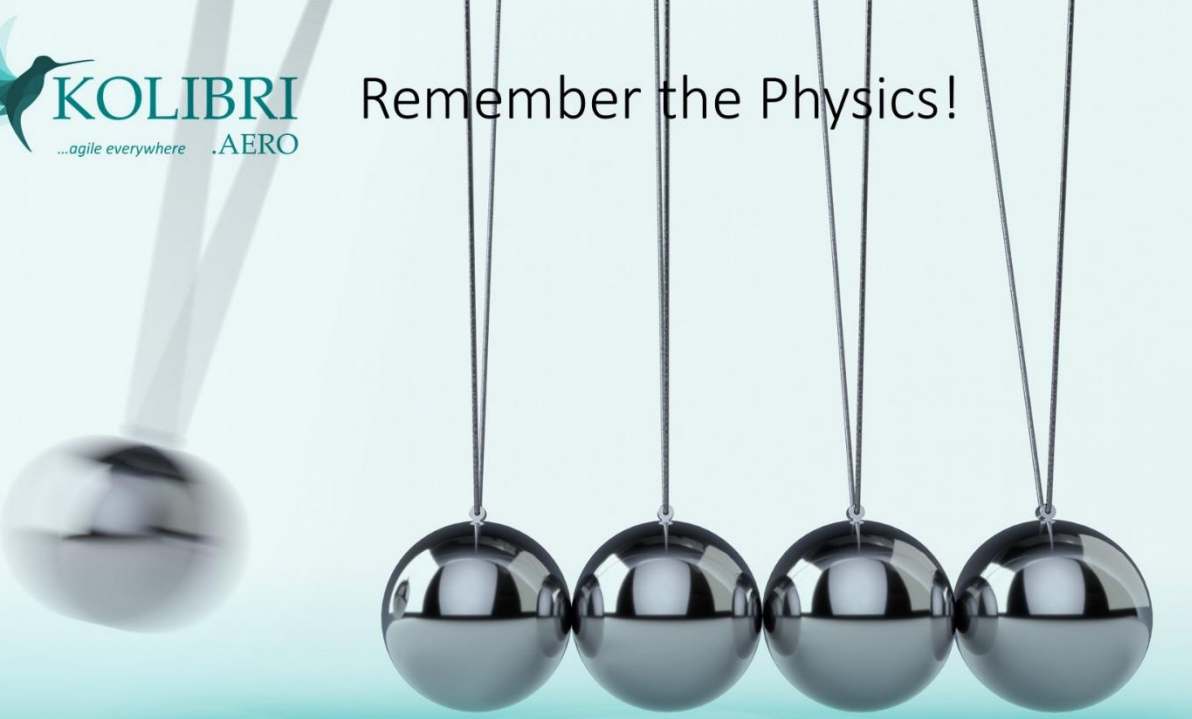
Our industry use of fossils increases and our leaders express open disinterest and opposition to sustainable aviation.






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## Remember the Physics!



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Remember your physics classes. We cannot talk about zero energy, that would be entropy, the end of all movement. Movement requires energy. Me traveling here, me walking to the other side of the room, me blinking. So we do not talk Zero energy. We talk about conscious use of the energy.



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## The Liquid Hydrogen Fairy Tale






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- ENABLEH2 – Strategic Importance
- The Case for LH<sub>2</sub> for Civil Aviation
- ENABLEH2 Project Overview
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  - WP2: Fuel System Heat Management
  - WP3: Hydrogen Micromix Combustion
  - WP4: Safety
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So where are we? What about those Zero-E and hydrogen aircraft Airbus says to be available by 2035?

Academic sources claim that a first prototype to be possibly available by 2035. But until those aircraft make it into fleets, it will likely be 2045 or later. Given a life-expectancy of 20 years, until such aircraft becomes "standard" we more likely talk 2070 to 22nd century. Aside, they need all new cryo storage and logistics. And would you want to sit next to or under a cryotank in case of a failure? Shockfreezing?





## The Electric Flight Fairy Tale



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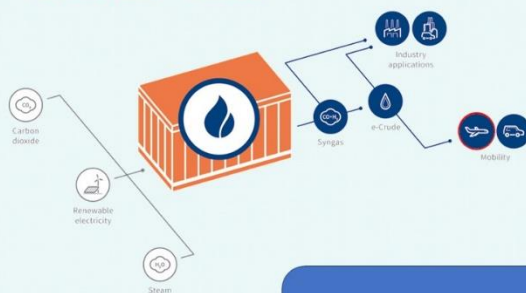
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Before Pandemic and MAX-disaster, Boeing moved out of their electric flight project Zunum, claiming max 500 km/300 mi range **or** max 50 passengers. And who remembers the Samsung and B787 batteries catching fire? "Air Taxi" will replace helicopters and follow the fate of fly-in communities. A niche. Aside of the expected problems with ATC.



## Synthetic Kerosene?



**BLUE SynFuel**

Made using unsustainable resources (i.e. "natural" gas, coal energy)

**GREEN SynFuel**

Made using sustainable energy and resources

**BROWN SynFuel**

Made using coal and/or crude-oil products

**GRAY SynFuel**

Made using mixed sustainable and unsustainable resources (i.e. blended with fossil fuels)

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My personal and profession bet is on Synfuel, which even the Liquid Hydrogen experts consider a necessary "bridge technology". Though in first tests, using green Synfuel proved actually more sustainable than liquid hydrogen. So is it a bridge? Or a solution?

While technically available today, the first commercial facility at Norsk e-Fuel in Oslo is sized for a mere 20 million liters per year. A drop on a hot stone!

And the main question is not the technical availability but the Sustainability Energy Dilemma.



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## The Sustainability-Energy Dilemma

Energy per 1 liter or Synfuel = 15.3 kWh.

1 Embraer 100-seat aircraft: ~40 Million liters kerosene/annually  
**= 612 GWh/a**

1 Liter Hydrogen electrolysis needs about 3 kWh. But with required cryo-cooling the energy will likely be more energy consuming than Synfuel.

European aviation in 2018 consumed 75.48 million metric tons or at 1255 liters per metric ton almost 95 billion liters. Or 95 thousand Terawatt or **95 Petawatt** Energy.

### GREEN ENERGY

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Just our plans require 12 Terawatt-hours per year in 10 years. The Sustainability-Energy Dilemma. Replacing fossils will require a lot of **green** energy. A lot! And the aviation industry considers energy a commodity they buy, but nothing they worry about. Power comes from oil. Or the grid. Who cares?



### The IATA Commitment



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### 2% BLEND with 98% Fossil



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IATA commits for the aviation industry to blend 2% sustainable aviation fuels with 98% fossil-based kerosene. By 2030! Currently, where sustainable aviation fuels are available, it is blended at about 10% with a single case where Neste trials a 1:1 blending. Technically, it is possible to replace fossil kerosene 100%. Lufthansa proved it for their greenwashing based on the pilot facility in Hamburg that they otherwise opposed.  
So





**Beware of the Greenwashing Demon!**



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## What About Other Industries?



Source: Volkswagen\*  
Source: ZDF...

**200,000 km**


planet@

Vehicle	CO <sub>2</sub> Emissions (t)
Benzin	37,5
Diesel	32,1
ID3	27,9
ID3	33,7



**Methane**  
 $CH_4$



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Just a quick look, to understand the scale of the issue. It ain't a problem, just a big challenge!

**Hyperloop:** It ain't a new idea, but will operate like an ICE/TGV "plus" on high density, longer routes. And I also keep wondering, why to put them on stilts and not under ground? But in my opinion they won't connect regional really.


**e-Mobility:** A Volkswagen-own lifecycle assessment for the ID.3 only benefits if electricity is cheap and green. Taken into account the typical energy prices and sources, it is less "sustainable than a Diesel. Now replace that Diesel with SynDiesel...?"



**Cargo Ships, Steel Mills, etc:** There are industries aplenty in need of energy, be it fossil, green, whatever. To replace a few cars is just a drop on a hotstone. And our politicos talking about an “energy transition” base their “facts” on lobby-information that intentionally ignores those industry-needs. And did you know that the data centers in the city of Frankfurt account for 25% to 1/3rd of the entire energy need of the city? More than the airport. And those are just the dedicated data centers, not all those company servers and infrastructure.




**Methane:** Recently another distraction. Methane is hydrogen and carbon dioxide and can also be caught and refined. It’s just not done (yet).


**Reforestation:** “Between 2015 and 2020, the rate of deforestation was estimated at **10 million hectares per year**, down from 16 million hectares per year in the 1990s. U.N. reports the area of primary forest worldwide has decreased by over 80 million hectares since 1990.” [U.N. FAO, <https://www.fao.org/state-of-forests/en/>]



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## Not Either/Or but AND

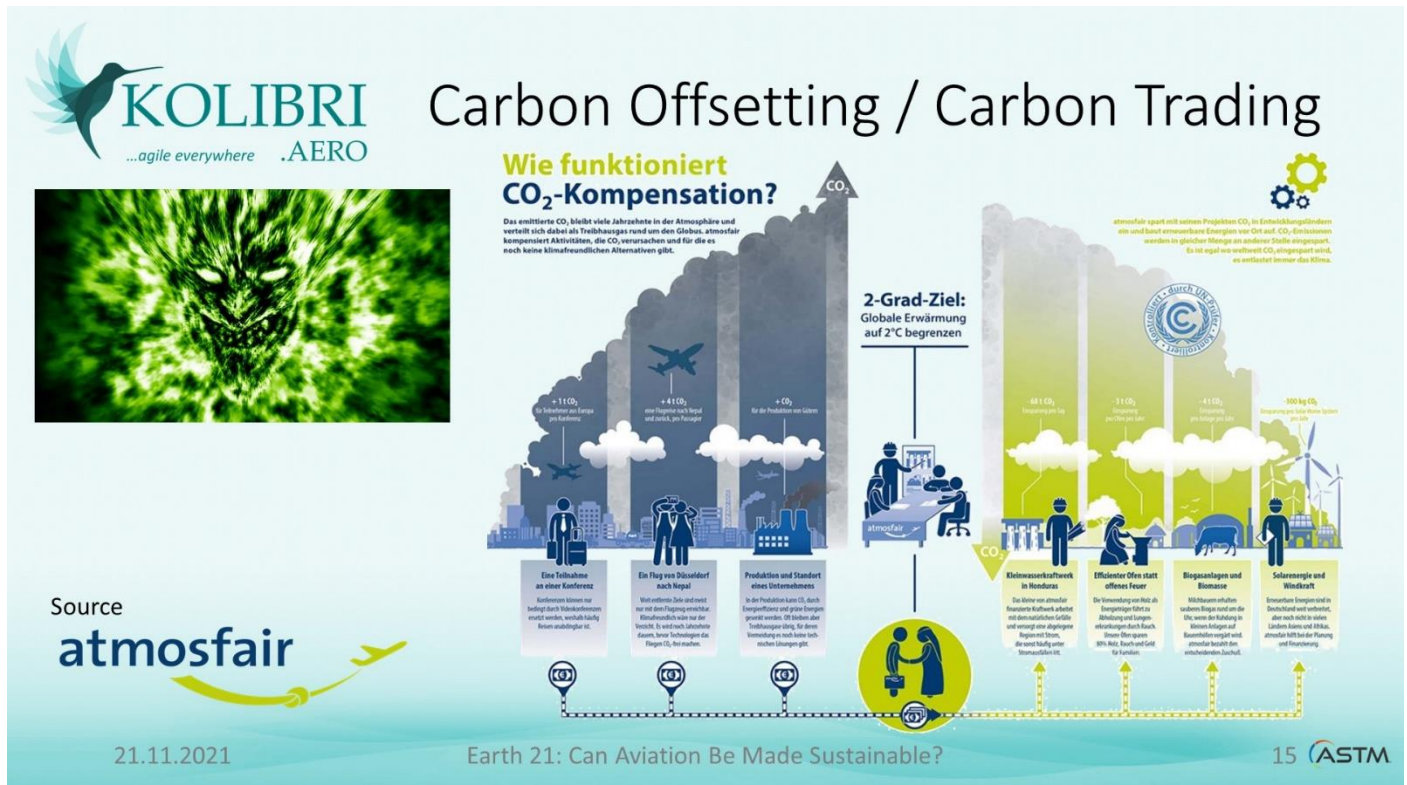


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To secure the energy to replace fossil sources such cannot be wind **or** solar **or** water **or** waste to liquid or energy ...

**We need it all!**





So what about Carbon Trading? This image is by atmosphair. But at COP26, a big topic was, who to credit for the carbon savings really. Carbon Trading is meant as a way to mitigate the impact in the phase of change. The way it is executed, it is more "valuable" to build new coal power plants than to remove. The same is true for aviation I'm afraid.



There are a lot of efforts to improve Air Navigation, be it the Single European Sky SESAR or Airport Collaborative Decision Making A-CDM. The slow progress it makes to get away from "air street"-concept worries me, when I see all those fancy new ideas like Air Taxi or package delivery drones, that are expected to share the same air space.

The easiest way to improve our own "impact" to the planet is to optimize the energy consumption. i.e. flying direct instead of using connecting flights. Back to the energy required to move an object (or traveler) from A to B.





***“The problem is that we continue to put lipstick on pigs instead of addressing the structural problems that lead to this mess.”***

**Michael Boyle**  
commenting on ESG Greenwashing



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Based on our idea of a regional low cost airline (no, no contradiction in terms), we started with Bio-fuel-blending...

Incorporating SynFuel into our plans, the technical side is a piece of cake. The challenge is in the energy. In our case planning the replacement of 1 billion liters in 10 years, requires 12 Terawatt-hours green energy per year to produce the green SynFuel. Saving 2.5 gigatons CO<sub>2</sub> and more every year by then. It is possible. It just ain't easy.

This is, why I commit to 10 years and not to three as it would need to establish the technical side. The remaining time we will need to secure the **green** fuel source. #nolipservices, but the real thing!

*“We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too.”*

[John F. Kennedy, 1962]

“We choose to **fly Carbon-Neutral** in this decade and do the other things, not because they are easy, but because they are hard; because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one we intend to win, and the others, too.

**For there is no Plan[et] B”.**

[Jürgen Barthel, 2020]





## Thank You

*"For those who agree or disagree,  
it is the exchange of ideas  
that broadens all of our knowledge"*

[Richard Eastman]



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I could (and can) talk in all detail and for hours about this. For a 15-minute snapshot, I appreciate your understanding for this overview. And I keep it very much with Richard Eastman or Francis Picabia: *"Our heads are round so our thoughts can change direction."* And ever since I started digging into sustainable aviation, I'm on a constant learning curve...



## More Reading

🔗 [https://foodforthought.barthel.eu/  
Whitepapers + Posts](https://foodforthought.barthel.eu/Whitepapers+Posts)

🔗 <https://sdgs.un.org/goals/>

🔗 <https://www.linkedin.com/in/jbarthel/>

🔗 <https://www.linkedin.com/company/kolibri-aero>



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If you look for more details, I am in the process to compile my findings in some whitepapers on my blog (at <https://foodforthought.barthel.eu/whitepapers/>) you are sure welcome to also add the blog to your RSS-feed. Or follow Kolibri and me on my LinkedIn profile, where I also post quite frequently also sharing a lot on current developments.

<https://www.linkedin.com/in/jbarthel/> and <https://www.linkedin.com/company/kolibri-aero/>

If you are not familiar with the U.N. Sustainable Development Goals, please have a look at their website <https://sdgs.un.org/goals/> - there are 17 of them.