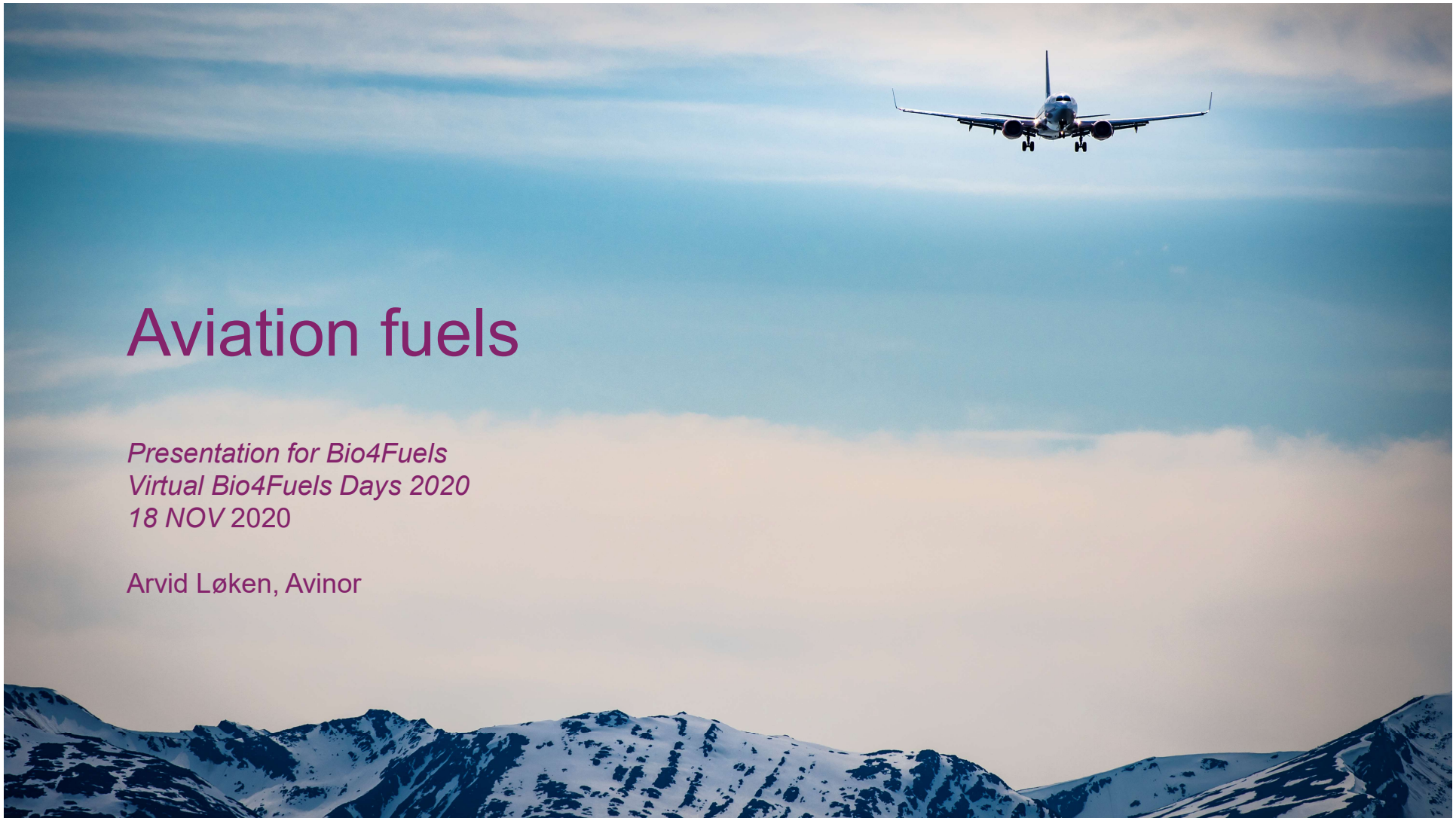


# Aviation fuels

*Presentation for Bio4Fuels*
*Virtual Bio4Fuels Days 2020*
*18 NOV* 2020

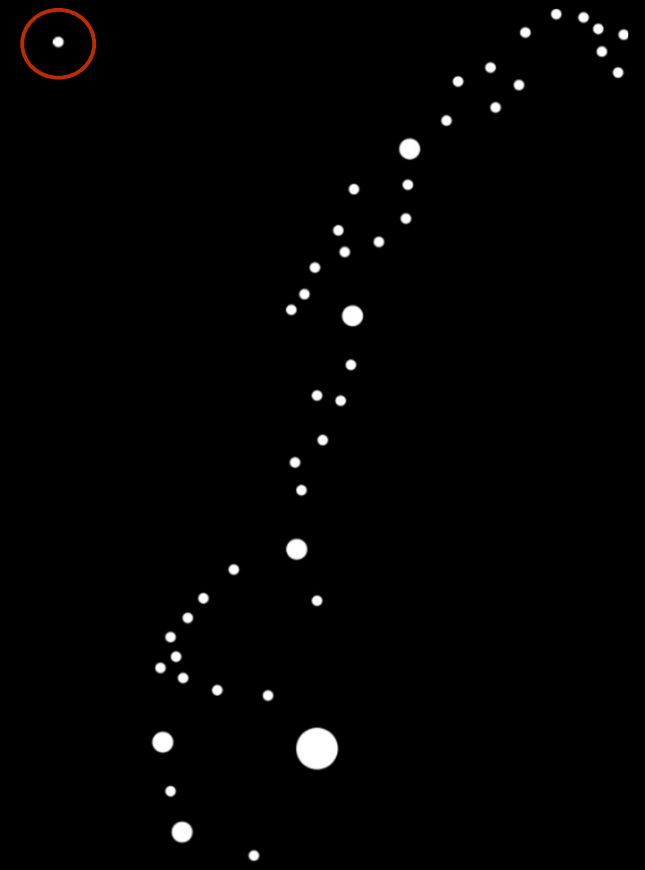
Arvid Løken, Avinor


BE SURE TO WASH YOUR HANDS AND ALL WILL BE WELL
COVID-19
RECESSION
CLIMATE CHANGE

**44** airports

Norway’s Air Navigation Service Provider

Norway is totally dependent on aviation



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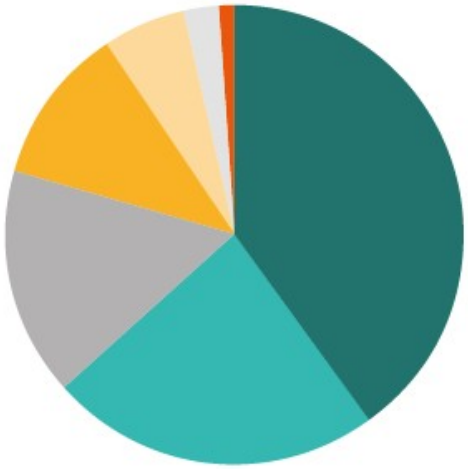
# Avinor's own emissions

By 2022 reduce own emissions by 50%
(compared to 2012) and be fossil free by 2030



Total 13. 527 tonnes of $CO_2$ equivalents.

- Vehicle
- Track de-icing
- District heating
- Thermal energy
- Fire drill
- Svalbard (electricity and district heating)
- Business trips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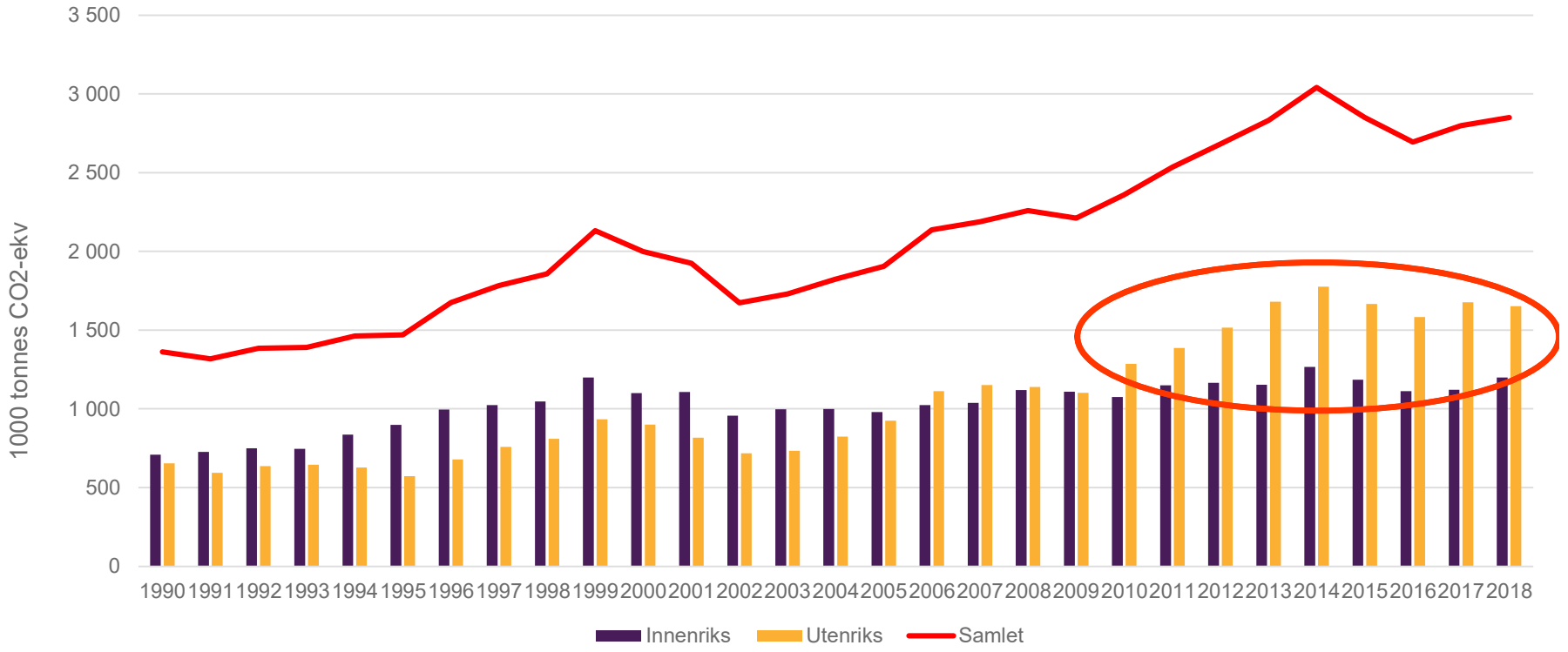
# GHG EMISSIONS CIVIL AVIATION NORWAY 1990-2018




*(I tillegg kommer effekten av utslipp i høye luftlag)*

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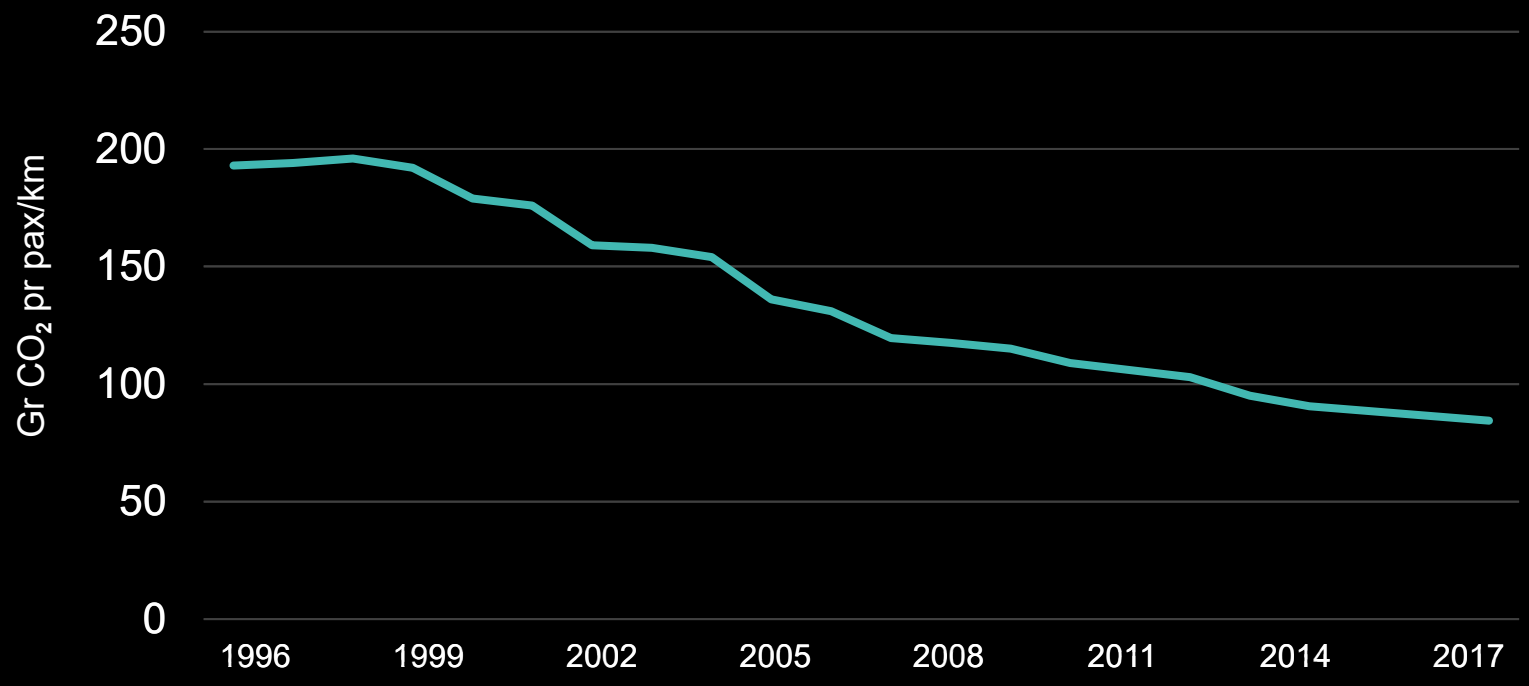
# Emissions per passenger km decreasing




Average SAS and Norwegian

Traffic growth % > Emission reductions %

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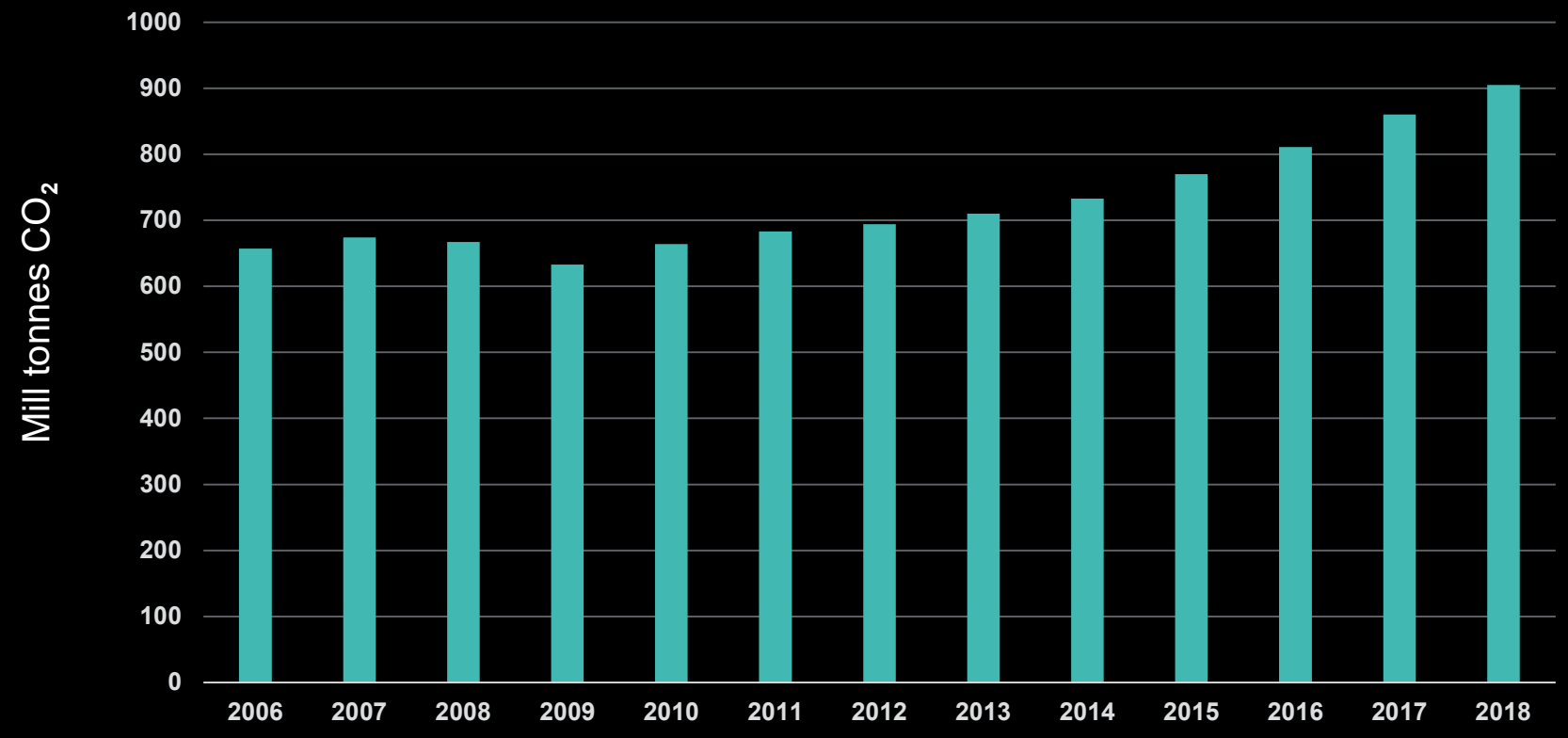
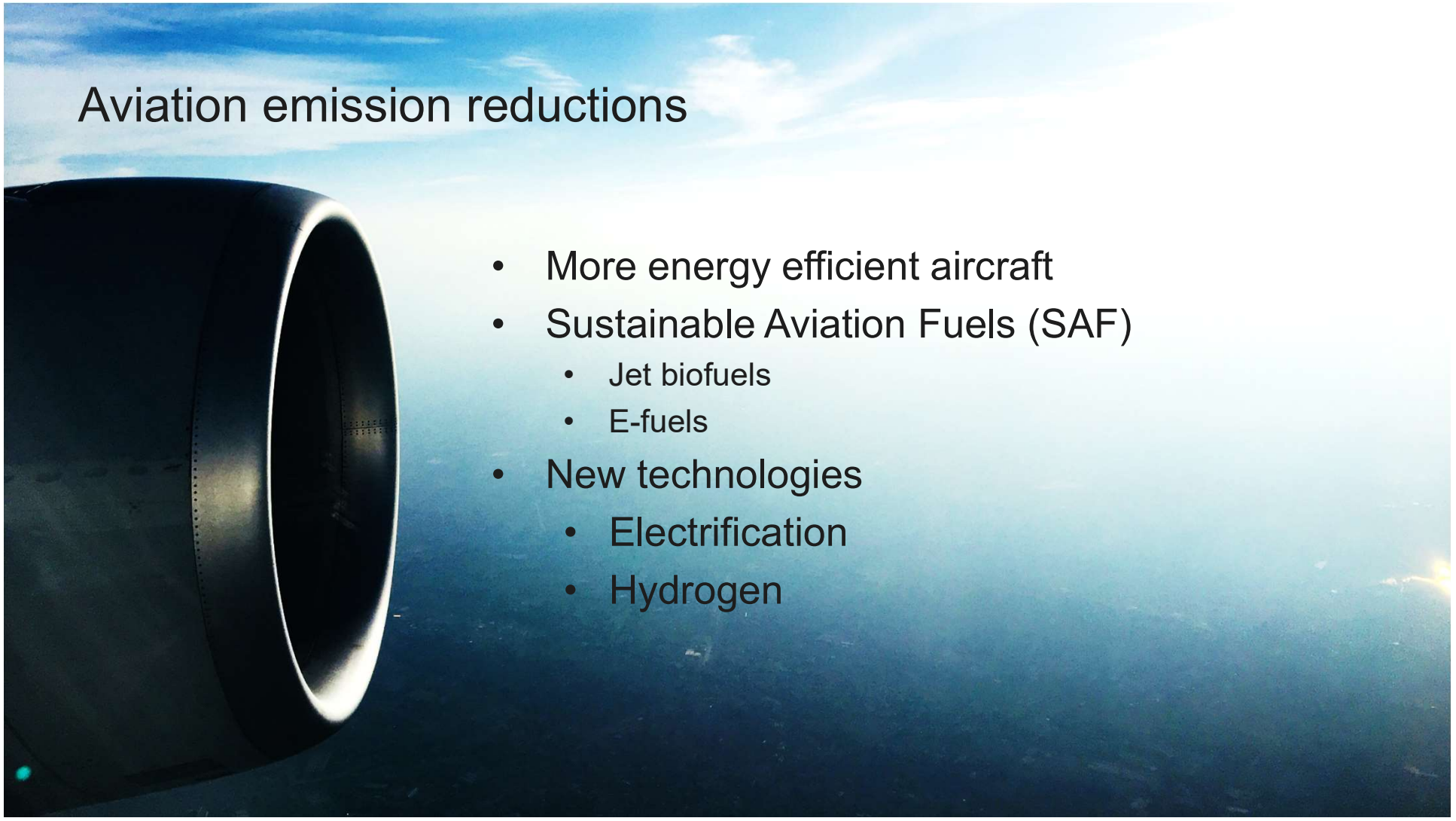
# Air traffic total emissions worldwide increasing




Source: IATA

# Aviation emission reductions



- More energy efficient aircraft
- Sustainable Aviation Fuels (SAF)
  - Jet biofuels
  - E-fuels
- New technologies
  - Electrification
  - Hydrogen

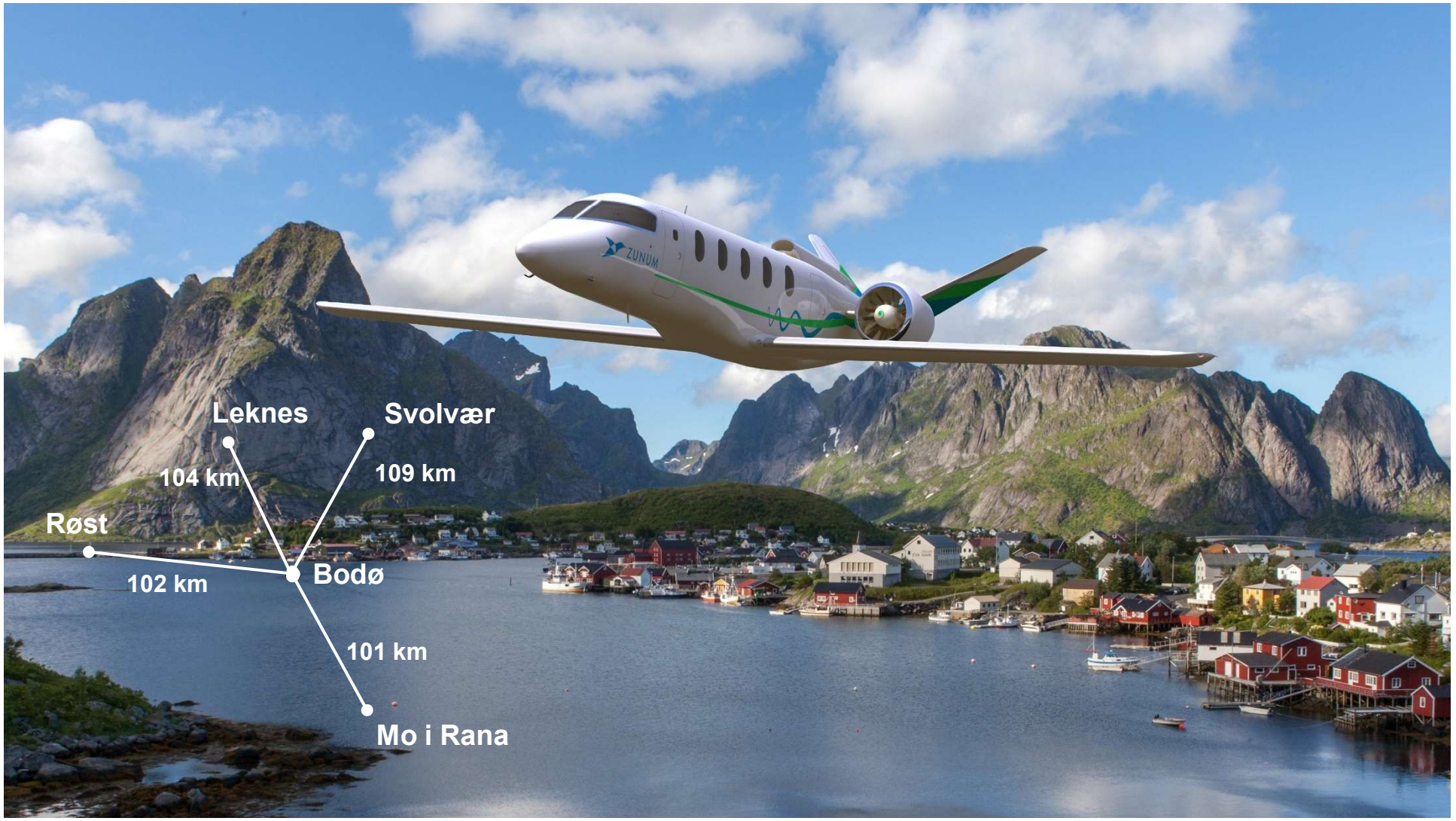
# 2014: CONFERENCE AND DEMO FLIGHTS

## JAN 2016: OSL #1 HUB TO OFFER SAF TO ALL AIRLINES ON A COMMERCIAL BASIS

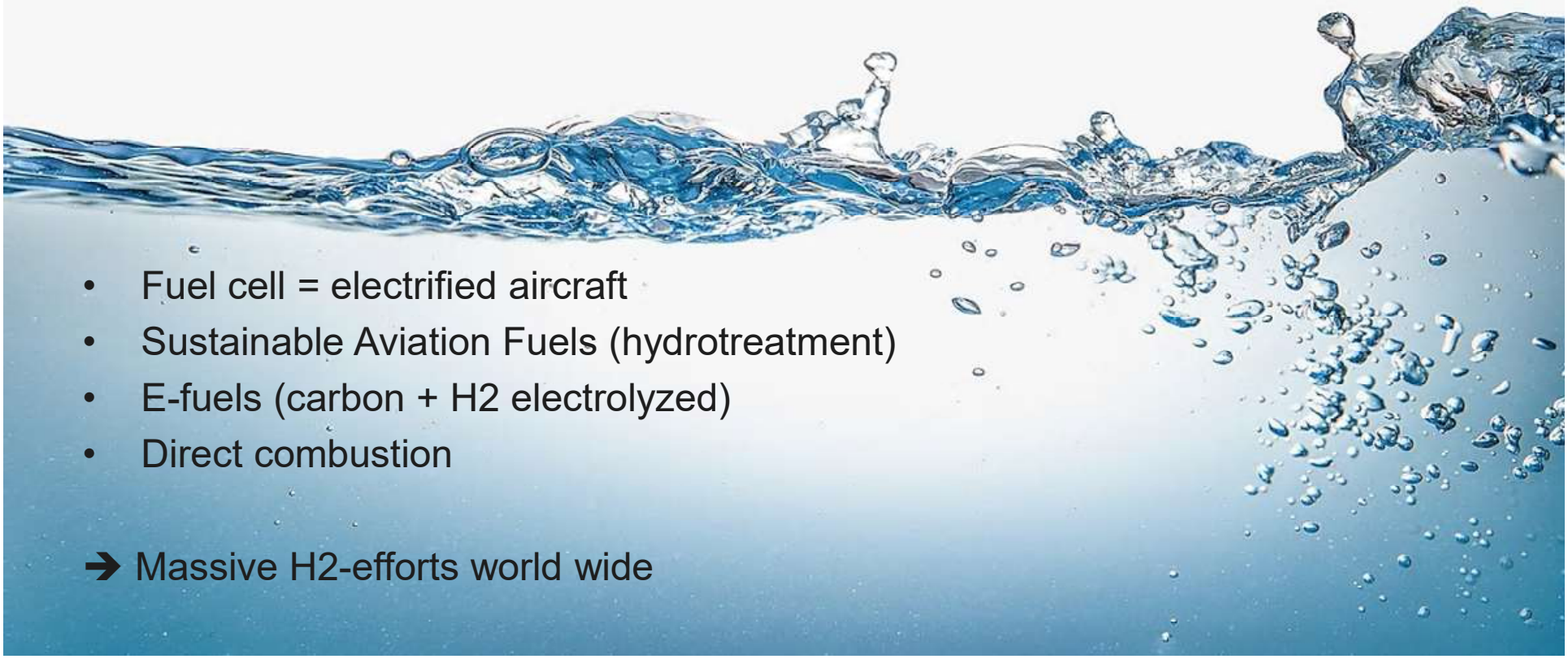
- Cooperation with aviation industry
- Dropped into the main fuel farm
- Distributed in the hydrant and dispenser system
- Premium cost split between the project partners
- Camelina and UCO
- Works very well!
- Aug 2017: Program expanded to Bergen
- 2018: A very small volume dropped in at OSL and BGO

# DROP IN MANDATE

- **0.5 % Advanced Biofuel from 1 JAN 2020**
- Fuel suppliers responsible
- All civil traffic
- Domestic and international
- Approx 6 mill litres annually
- Scaling up not yet decided

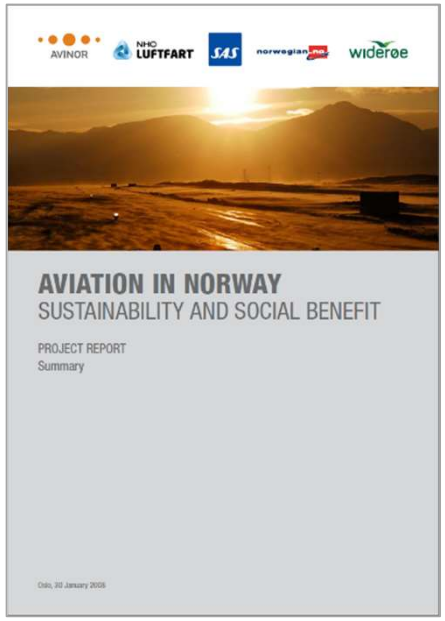

Leknes
Svolvær
104 km
109 km
Røst
Bodø
102 km
101 km
Mo i Rana

# H2



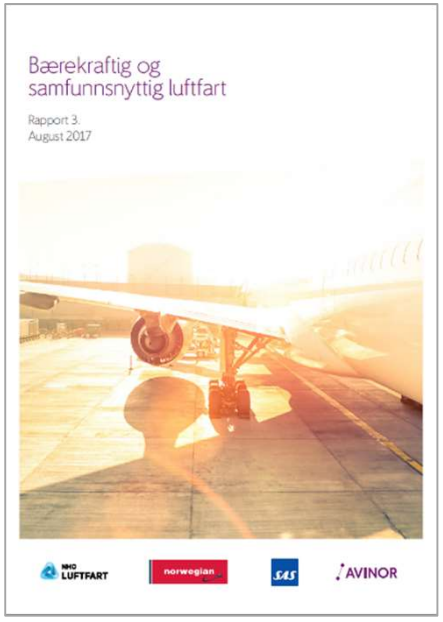
- Fuel cell = electrified aircraft
- Sustainable Aviation Fuels (hydrotreatment)
- E-fuels (carbon + H2 electrolyzed)
- Direct combustion

➔ Massive H2-efforts world wide

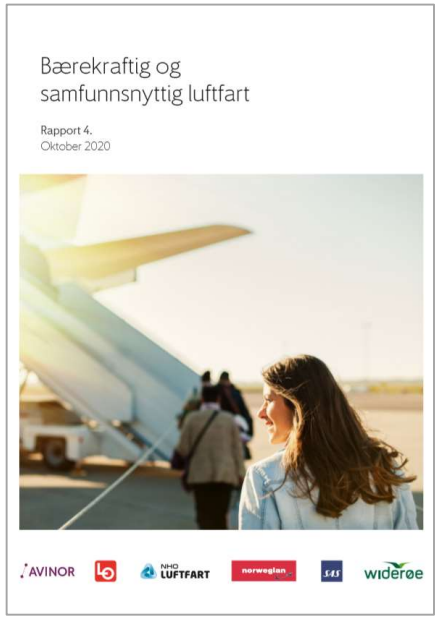



2008


2011




2017




2020

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# Paris Agreement

1.5 – 2 ºC
80-95% emission reduction by 2050

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Norwegian aviation fossil free by 2050
(No fossil fuels will be used on flights within and from Norway from 2050)
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# A challenging task

**The goals of the Paris Agreement**

- Costly, but necessary measures
- An industry with tough international competition

The technological solutions exist

- Sustainable fuel, but volumes are low and prices high
- Electric aircraft under development
- Large potential in use of hydrogen

Cooperation and R&D(&I) of crucial importance

# The roadmap

- Why?
  - Paris goals, Leading role, Industry, Planning horizon
- How?
  - Tech exists, but must be developed further
- Norwegian aviation will
  - Phase in SAF + new tech, program for SAF, facts, reporting
- Partnership with government
  - Increased R&D, framework conditions/funding, ETS/CORSIA

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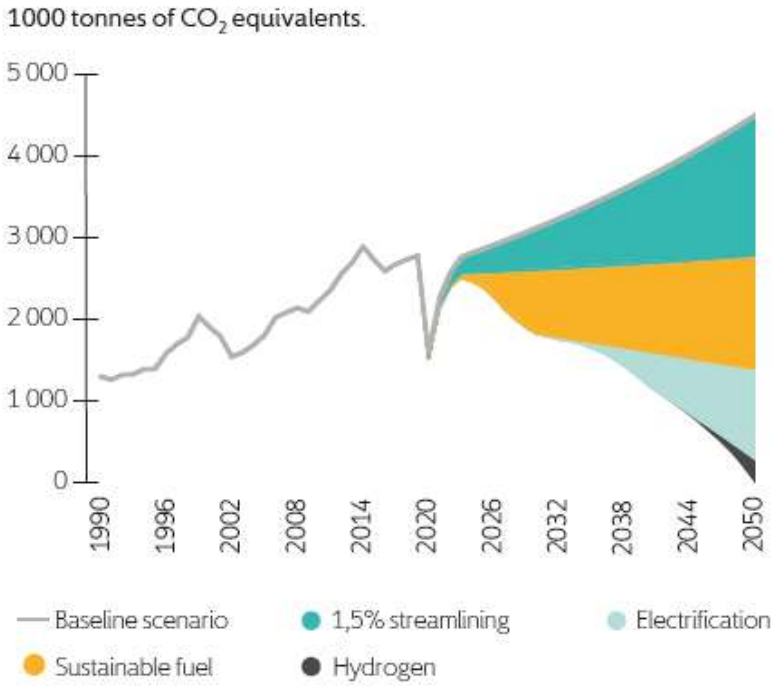
# Towards 2050




- Fossil free by 2050
- Relative strength of technologies can change
- Dependent on technology, markets and policies working together

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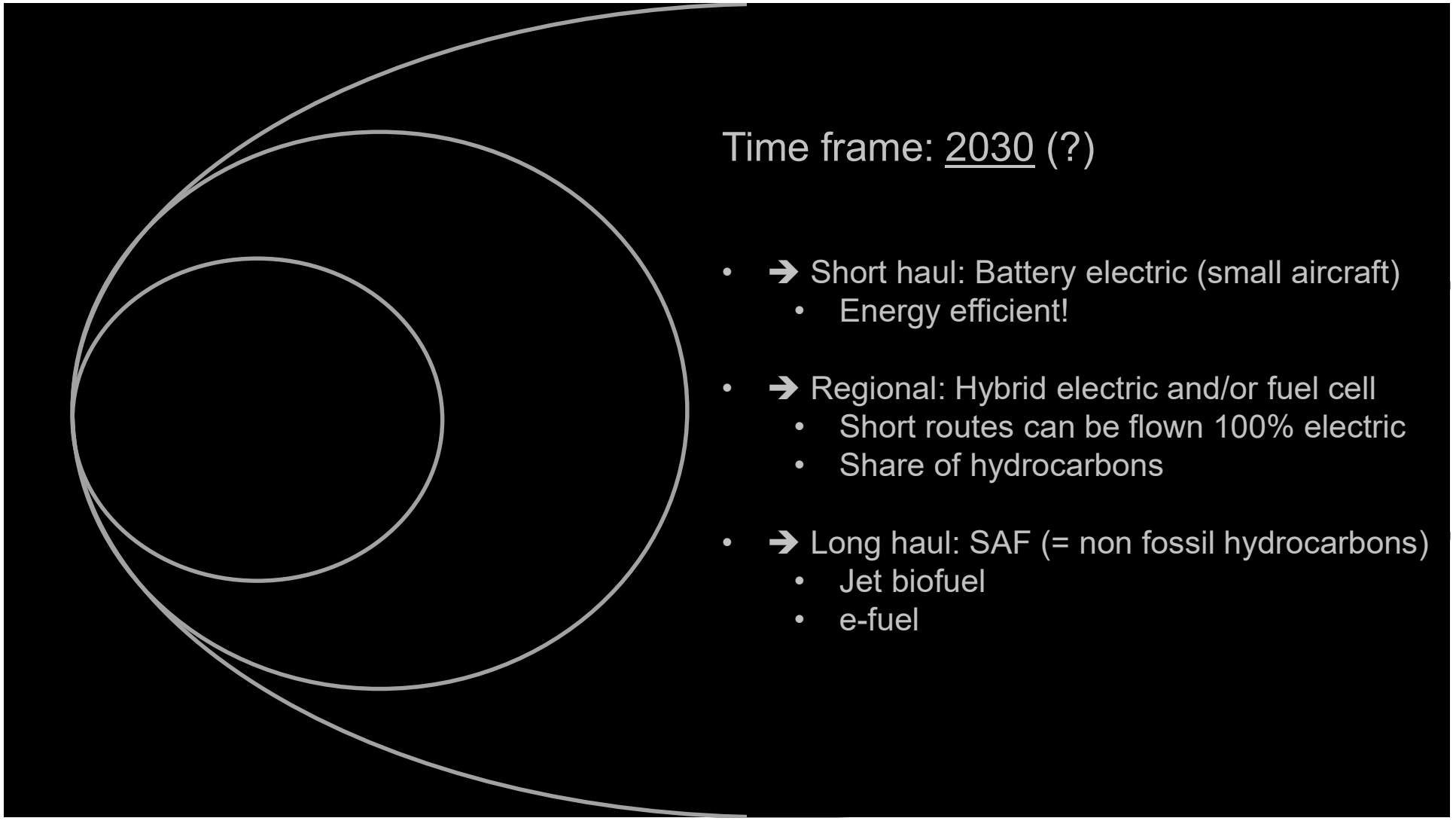
Time frame: 2030 (?)
• ➔ Short haul: Battery electric (small aircraft)
• Energy efficient!
• ➔ Regional: Hybrid electric and/or fuel cell
• Short routes can be flown 100% electric
• Share of hydrocarbons
• ➔ Long haul: SAF (= non fossil hydrocarbons)
• Jet biofuel
• e-fuel

# Challenges for SAF (Norway og internationally)

- Reduce price difference to fossil
- Enough relevant biomass
- Production capacity
- Sustainability

**Every Sustainable Aviation Fuel supply chain is basically the same**

**Minimum requirements for a SAF business case in Europe:**

**And to reach real impact scale for the aviation sector you need:**


Fit with the Renewable Energy Directive II

Technology Readiness Level

ASTM certification

SkyNRG

# Certified pathways for Sustainable Aviation Fuels

1. D7566 Annex A1: **Fischer Tropsch (FT) Synthetic Paraffinic Kerosene** (**FT SPK**), approved in 2009.
2. D7566 Annex A2: **Hydro-processed Esters and Fatty Acids** (**HEFA SPK**), approved in 2011.
3. D7566 Annex A3: **Hydro-processed Fermented Sugar** (**HFS-SIP**) approved in 2014.
4. D7566 Annex A4: **SPK plus aromatics** (**FT-SPK/A**), approved in 2015.
5. D7566 Annex A5: **Alcohol to Jet** (**ATJ-SPK**), approved in 2016 for isobutanol feedstock and updated in 2018 for ethanol feedstock.
6. D1655 Annex A1: **co-processing** of fats and oils in a conventional refinery, approved in 2018.

**BLEND**

Up to **50%**

Up to **10%**

Up to **50%**

Biogenic input **up to 5 vol%** of fossil fraction.

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A-råstoff: kostbare eller umodne råstoff, i hovedsak rester og avfall

B-råstoff: modne råstoff: slakteavfall og brukt frityrolje

## Vedlegg V. Råstoff som gir grunnlag for medregning i delkrav for avansert biodrivstoff og dobbeltelling

A. Råstoff fra vedlegg IX del A til direktiv 2009/28/EF:

a) alger dersom de dyrkes på land i dammer eller fotobioreaktorer
b) biomassefraksjon av blandet kommunalt avfall, men ikke sortert husholdningsavfall som omfattes av gjenvinningsmålene i artikkel 11 nr. 2 bokstav a) i direktiv 2008/98/EF
c) bioavfall som definert i artikkel 3 nr. 4 i direktiv 2008/98/EF fra private husholdninger som er gjenstand for separat innsamling som definert i artikkel 3 nr. 11 i nevnte direktiv
d) biomassefraksjon av industriavfall som ikke er egnet for bruk i næringsmiddel- eller fôrkjeden, herunder materiale fra detalj- og engroshandel samt landbruksbasert næringsmiddelindustri og fiske- og akvakulturindustri, unntatt råstoffer oppført i del B i dette vedlegg
e) halm
f) husdyrgjødsel og slam fra renseanlegg
g) avløpsvann fra palmeoljemøller og tomme palmefruktklaser
h) talloljebek
i) råglyserin
j) bagasse
k) pressrester av druer og vinberme
l) nøtteskall
m) agner
n) kolber som er renset for maiskjerner
o) biomassefraksjon av avfall og rester fra skogbruk og trebasert industri, dvs. bark, greiner, førkommersielle tynninger, blader, nåler, trekroner, sagmugg, sagspon, svartlut, brunlut, fiberslam, lignin og tallolje
p) annet celluloseholdig materiale som ikke er næringsmiddel, som definert i § 3-2 bokstav g)
q) annet lignocellulosemateriale som definert i § 3-2 bokstav f), unntatt sag- og finértømmer
r) bakterier, dersom energikilden er fornybar i samsvar med artikkel 2 annet ledd bokstav a) i direktiv 2009/28/EF.

B. Råstoff fra vedlegg IX del B til direktiv 2009/28/EF:

a) brukt matolje.
b) animalsk fett klassifisert som kategori 1 og 2 i samsvar med europaparlaments- og rådsforordning (EF) nr. 1069/2009 av 21. oktober 2009 om fastsettelse av hygieneregler for animalske biprodukter og avledede produkter som ikke er beregnet på konsum, og om oppheving av forordning (EF) nr. 1774/2002 (forordningen om animalske biprodukter) (EUT L 300 av 14.11.2009, s. 1).

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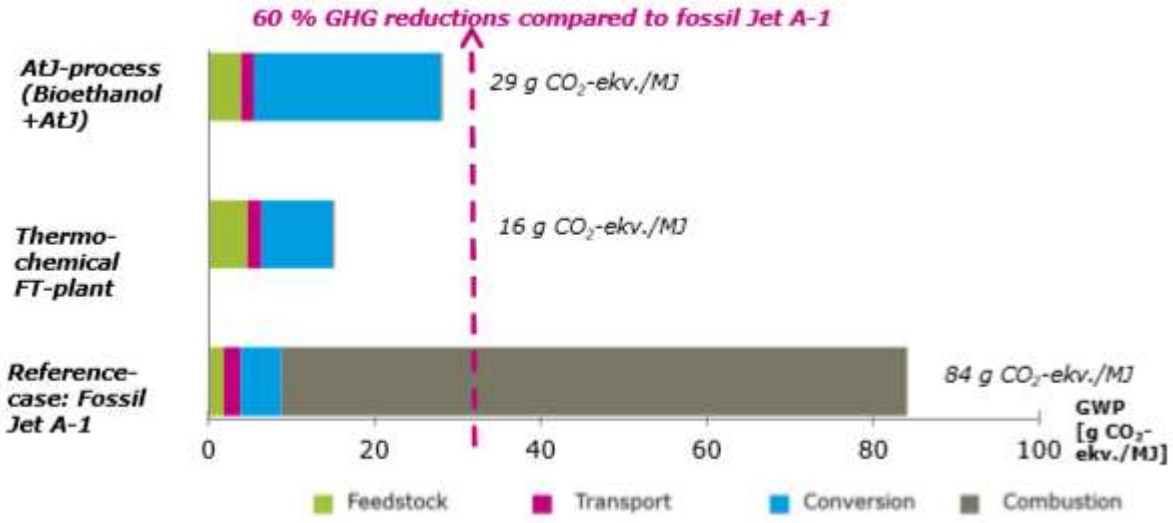
# 60 percent GHG reduction required

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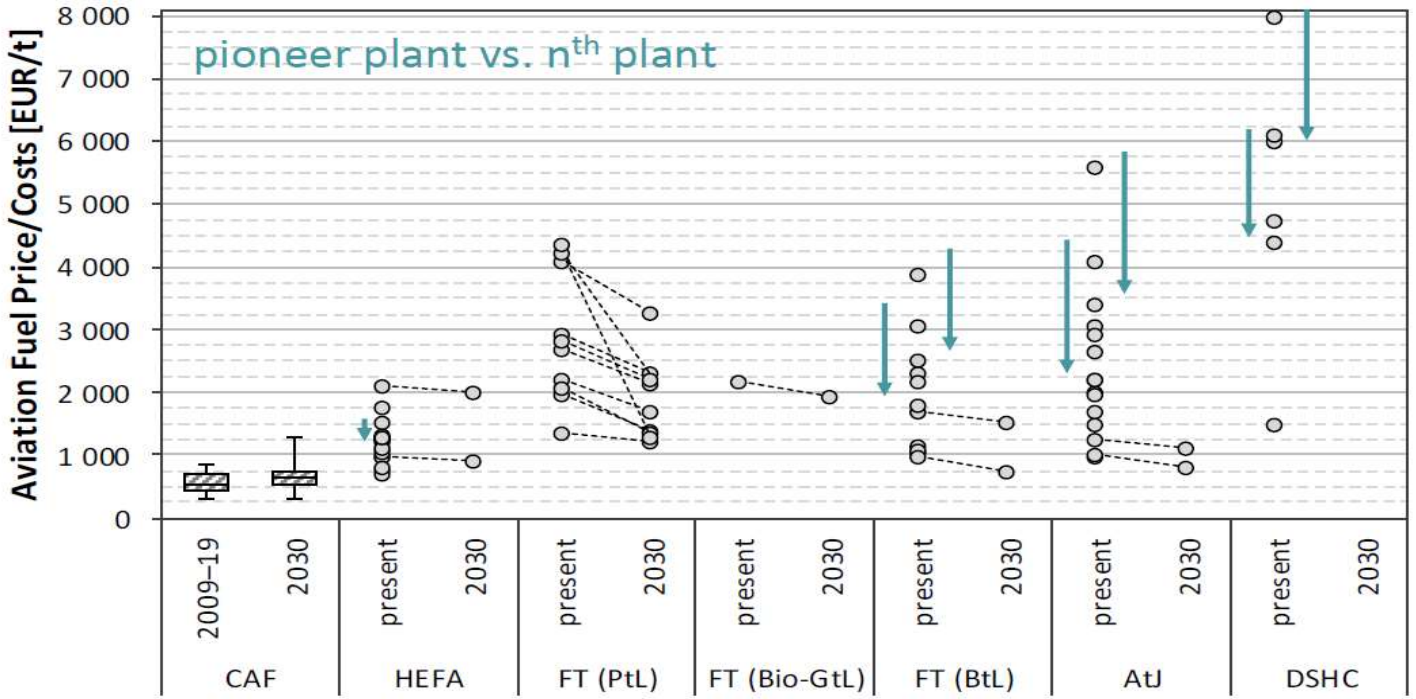
Injecting SAF into the market

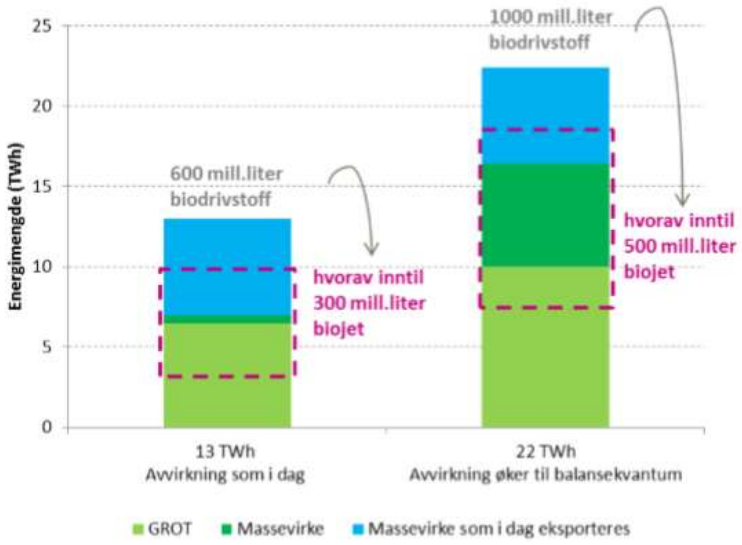
# Conventional vs. Sustainable Aviation Fuel Costs




A price parity of conventional aviation fuel and SAF does not yet exist and will not be ensured in the future without effective measures.

CAF: Conventional Aviation Fuel – EIA 2019; Pavlenko et al. 2019; Agora 2018; Brynolf et al. 2018; Dietrich et al. 2017; Neuling 2019; De Jong 2015; etc.

# Residues from Norwegian forests an important feedstock




- Substantial potential in forest residues
- Algae also interesting in a longer perspective

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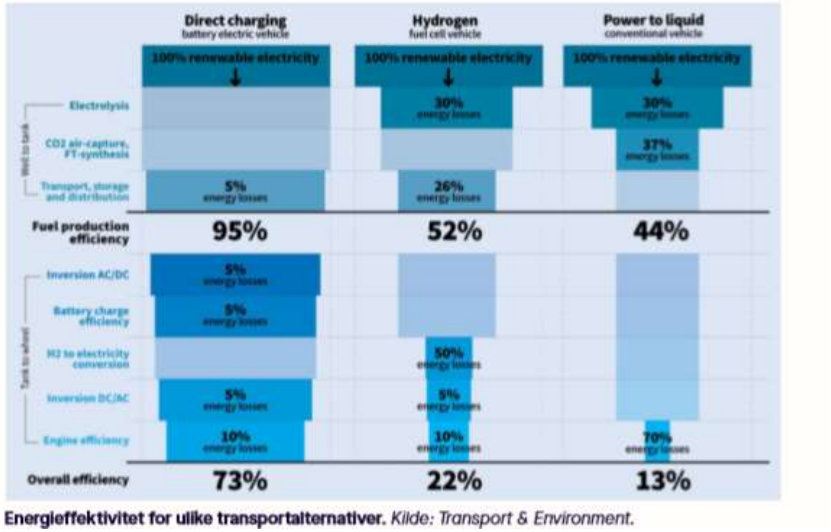
# E-fuels




**Energieffektivitet for ulike transportalternativer.** *Kilde: Transport & Environment.*

- Low energy efficiency but still very relevant for uses that cannot be electrified
- Very high on the agenda in some European countries, like Germany and Denmark
- Norway's high renewable share in the grid is an asset
- Production planned at Herøya

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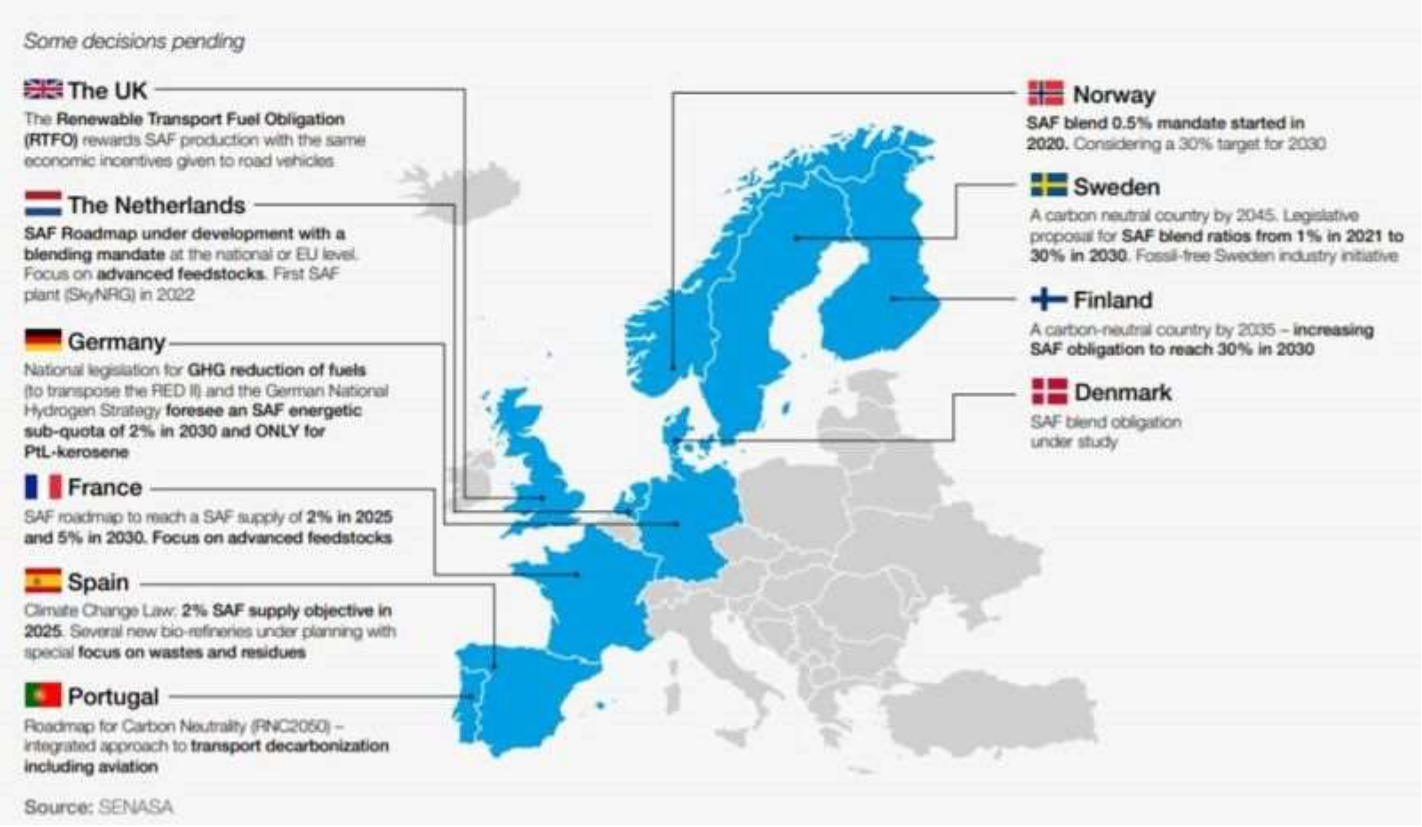
# Blending mandate being discussed in many countries + EU

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## Discussions in Europe

- GHG-reduction or volume targets?
- Special targets for e-fuels?
- Preference for aviation?
- Support for novel biofuels?

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## Production and plans, examples

**Internationally**

- Neste
- World Energy
- SkyNRG
- Fulcrum
- Red Rock

**Norway**

- Silva Green Fuel
- Biozin
- Quantafuel
- Norsk E-fuel

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# CONCLUDING REMARKS

- Norway is totally dependent on aviation
- Green House Gas emissions must be mitigated
- Biofuel very relevant for aviation both in the short and long run


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