Photo Johanna Niemistö

Aviation emissions – Measures to decrease emissions in line with the 1.5 degree climate target

Photo Ari Nissinen

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SYKE

19th European Roundtable for Sustainable Consumption and Production (ERSCP 2019), Barcelona 15th-18th October 2019

The first author Johanna Niemistö
is on maternity leave
until autumn 2020.

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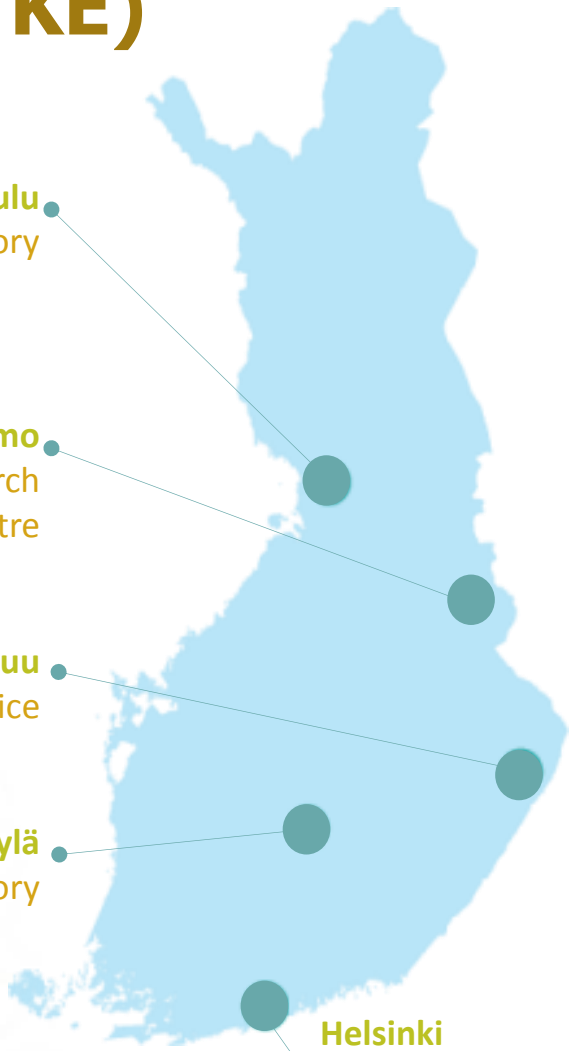

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Johanna Niemistö, Sampo Soimakallio,
Ari Nissinen and Marja Salo
Aviation emissions
The Finnish Environment Institute Report Series 2/2019, published 15.1.2019

(in Finnish, abstract also in English)

Report aims to provide the readers with an overview of the aviation sector and its climate impacts. The report looks at the factors that are considered when assessing and calculating emissions for different purposes and the amount of emissions from air traffic. In addition to this, it discusses various ways of reducing emissions, focusing specifically on technical and legislative means. The review also looks at various emission scenarios and other flight-related items, such as aviation tax, emission calculators, carbon neutrality, possible changes in travel modes, and consumers' individual carbon budgets.

The work was funded by The Finnish Innovation Fund Sitra and SYKE.

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Aviation emissions

- Globally aviation industry (including cargo) caused 859 million tons of CO_2 emissions in year 2018.
- Around 65 % of flights are international and 35 % domestic.
- Globally aviation accounts 2–3 % (around 3 % in EU and 2 % globally) of CO2 and 4–5 % of total climate impact* originating from human activity.

However, the emission share of aviation is likely increasing as the number of air passengers is growing fast annually.

* Often expressed as CO_2e or GHG emissions, GHG=greenhouse gases

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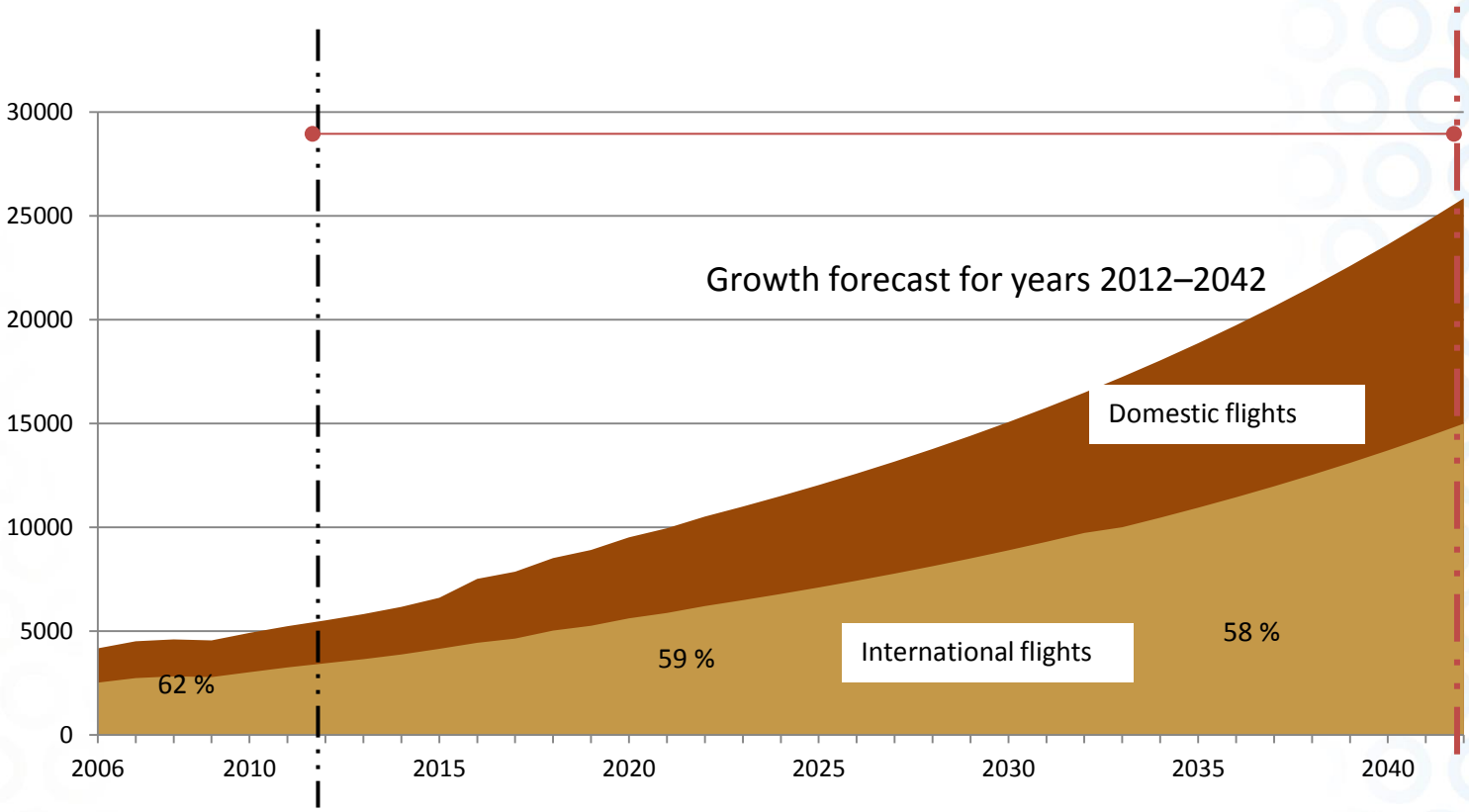
Passenger kilometres rising

Billion Revenue passenger kilometres (RPK)



Sources:
ICAO 2016a,
IHLG 2017

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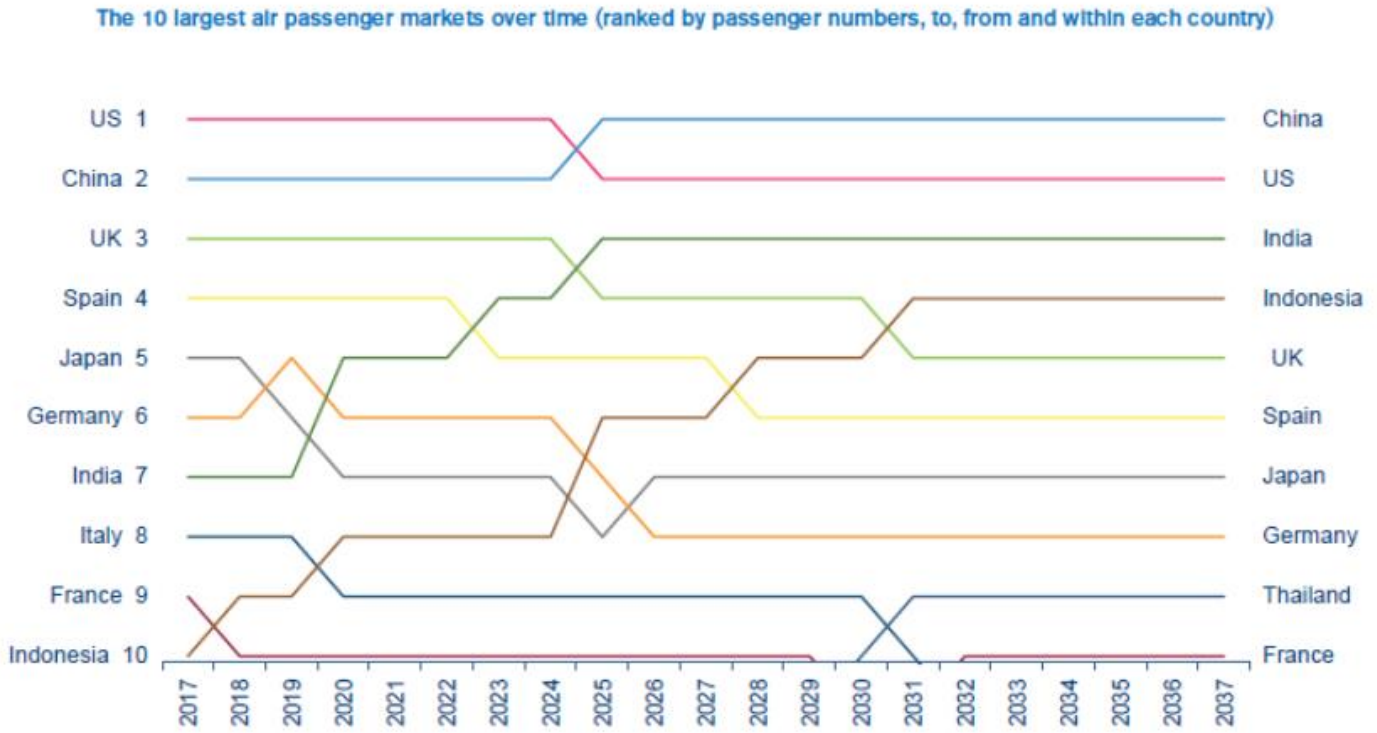
The number of air passengers is increasing

- There were around 4 billion air passengers in year 2017 (same person can be air passenger several times). The number is expected to double to 8.2 billions by 2037.
- The fastest growing aviation markets are in Asia and Pacific Region.



Source: IATA/TE
https://www.iata.org/pressroom/pr/Pages/2018-10-24-02.aspx

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Remarks on passenger numbers

- When calculating numbers of passengers at each airport, one air passenger is often calculated as two, if both departing and (later) arriving, or arriving from abroad and departing abroad (i.e. connecting international flights).

- When calculating numbers of passengers at each country, one air passenger can be calculated even as three passengers, if e.g. first flying a domestic flight, and then having a connecting international flight.

- **The statistics do not provide a clear picture of the air passengers nationality**: For example flights taken by foreign travelers in Finland affect the level of Finnish air traffic emissions, while flights taken by Finnish citizens between two foreign states or from a foreign country to Finland have no impact on the calculated Finnish air traffic emissions.

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Aviation emissions

When calculating emissions, air traffic is divided into domestic and international. This division is based on the amount of flight fuel sold. Of international flights, only departing ones count for each country.

Emissions caused by aviation include CO_2, water vapour, nitrogen and sulphur oxides, volatile organic compounds and particulate matters, etc.

1 kg (about 1,25 litres) of aviation fuel burned in an engine equals around 3,16 kg CO_2. - 'Average' or typical consumption is about 3 litres per 100 passenger km.

Complex reactions occur in the atmosphere between different compounds, and total radiative forcing is much higher than that of only CO_2 emissions. Scientific understanding about total impacts is still rather low, but they are assumed to be at least double compared to only CO_2 emissions.

(See e.g. https://www.easa.europa.eu/eaer/climate-change/aviation-environmental-impacts)

Aviation emissions – apparent paradox?

National and personal greenhouse gas budgets:
Why is the share of flights so low in the national GHG emissions, but so high in the personal GHG budgets of many people?

1) Regarding national reports about greenhouse gas emissions (NIR), domestic flights are included, but international ones are not.

   For example regarding emissions of Finland in year 2016,
   CO_2 emissions of domestic flights were 0,19 Mt,
   and emissions of international flights from Finland were 1,97 Mt.
   Share of 0,19 from 58,1 is **0,3 %**, whereas share of 2,16 from 60,1 is **3,6 %**.

2) Personal carbon footprint calculators often take into account also other warming impacts of the emissions in the upper atmosphere, using coefficient values between 2 and 4. When using coefficient 2, the share of the emissions of Finland would be 6,9 %.

3) Not all people fly.

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How to decrease aviation emissions?

Aviation emissions [t CO_2] =

flight kilometres [km]*

energy intensity of flying [MJ/km] *

emission intensity of
aviation 'fuels' [t CO_2/MJ]

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How to decrease aviation emissions?

In order to decrease the emissions, there is need to:

- **Reduce the number of flight kilometres**
- **Increase the energy efficiency**
  - **Technology development of aircrafts:** better fuel efficiency, reduction of mass by new materials, etc.
  - **Operational improvements**: optimised flight routes, flight speeds and taxiing distances at airports.
- **Switch the fuel or energy source to low carbon 'fuels'**
  - **More renewable and sustainable aviation fuels**
  - **Electric or hybrid motors/aircrafts.**

- **Behavioural changes:** online meetings, holiday travel destinations closer to home (staycations), changing of travel destination or mode (or choosing not to fly) -> the action of consumers is important.
- Also employers can be in a key position, to affect the travel policies and practises with work related travelling.

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Market-based measures

- **Taxation** is not imposed on aviation fuels and no VAT is imposed on international flight tickets, and domestic flight tickets might have lower VAT than other transport modes.
  - Air passenger duties ('taxes') are used in some European countries (Sweden, Norway, Germany, Italy, Great Britain, Austria, Greece), the taxation level varies.
- **EU Emissions Trading System:** Flights between the European Economic Area have been subject to emissions trading since 2012.
- **Obligations to distribution of renewables:** Norway is the first country which have decided that as of January 2020, 0.5 per cent of aviation fuels sold in Norway must be from renewable sources.
- **Subsidies and incentives** e.g. for the introduction of renewable and sustainable aviation fuels.
- **Compensation**
  - Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)
  - Voluntary compensation systems through various operators for the passengers.

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CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation)

- The United Nation's specialist agency ICAO (International Civil Aviation Organization) has pledged the sector to engage in carbon-neutral growth after 2020. Carbon neutrality is based on emission compensation through the ICAO's CORSIA emission offsetting scheme.
- CO_2 emissions of international flights will be measured and reported starting from year 2019 and based on monitoring, reporting and verification (MRV) system stated by ICAO.
- Average flight emissions from years 2019 and 2020 will be set as a baseline for CORSIA. Emissions excessing the baseline will be compensated.
- The compensation scheme includes three phases during years 2021–2023, 2024–2026 ja 2027–2035. Only the last phase will be mandatory for all actors.
- https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

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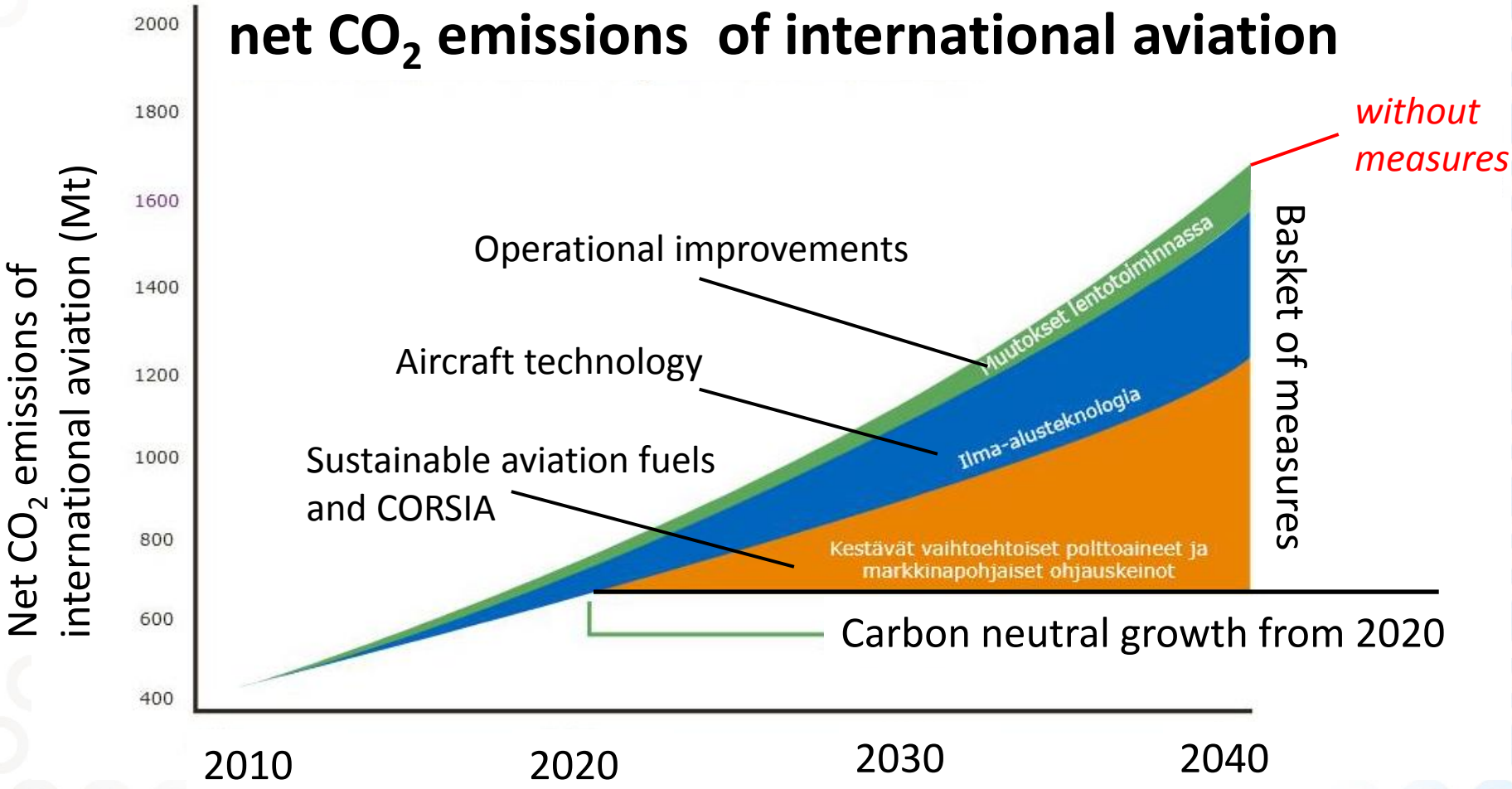
Contribution of measures for decreasing net CO_2 emissions of international aviation



Source: ICAO,
https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA_FAQs_Update_9Aug18.pdf

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Share of flight CO_2 emissions of the personal CO_2 budget (if emissions per flight would not decrease)

Based on estimated global CO_2 emission path* leading to the 1.5 ° C temperature target, and estimated global population path.

	2017	2020	2030	2040	2050
Global total carbon dioxide emissions (billion tons of CO_2)	37	34,2	24,8	15,4	6
World population (billion)	7,6	7,8	8,5	9,3	10
Global carbon dioxide emissions per person (kg CO_2/capita)	4868	4372	2901	1660	600
Helsinki – Oulu (134 kg CO_2)	2,8 %	3,1 %	4,6 %	8,1 %	22,3 %
Helsinki – Wien (272 kg CO_2)	5,6 %	6,2 %	9,4 %	16,4 %	45,3 %
Helsinki – Bangkok (826 kg CO_2)	17,0 %	18,9 %	28,5 %	49,8 %	> 100 %

* Rockström, J., Gaffney, O., Rogelj, J., Meinshausen, M., Nakicenovic, N. & Schellnhuber, H. J. 2017. A roadmap for rapid decarbonization. Science, 355(6331), 1269-1271. DOI: 10.1126/science.aah3443

IPCC, 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, https://www.ipcc.ch/sr15/

Flight calculator of Finnair

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Estimated CO_2 emissions of the flight sector in 2050, based on different assumptions

Different assumptions about aviation in 2050	Estimated emissions of aviation in year 2050, billion tons of CO_2
With the current growth forecast without any emission reduction measures	2,7
With the current growth forecast and ICAOs emission reduction measures	0,7
If the entire global carbon budget were given to oil refining products, and the share of aviation kerosene in oil refining would be at current levels	0,5
If aviation's share of global carbon dioxide emissions were to remain at the current level of about 2 percent	0,1

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Concluding remarks

- Is it realistic that technological development and emission offsets **would lead to stable net-emissions**, if air traffic continues to grow at its forecasted rate? - The **combination of rapid growth** in air traffic and its emissions **and the compensation** of the emissions will be in focus and criticized – **can one sector take care of growing emissions so largely by compensation/offsets?**
- How to clear out better the role of **other warming impacts** (coefficient 2-4 to CO_2 emissions), and how to decrease them?

- The **taxation on flights** and the measures to increase the use of **alternative sustainable fuels** may prove to be important steering measures in the future.
- **Reforming and making regulation globally more uniform** will enable more equal competition between airlines and airports. At the same time, **national experiments and reforms** can also contribute to the development of international regulation. For example, the use of aviation taxes by some states raises debate in other countries.

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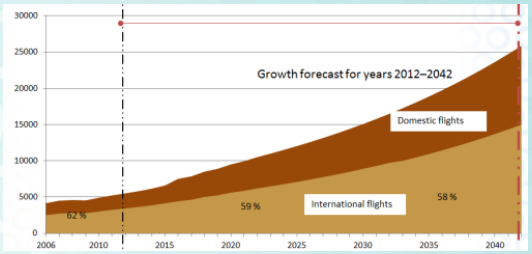

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Thank you for your interest!

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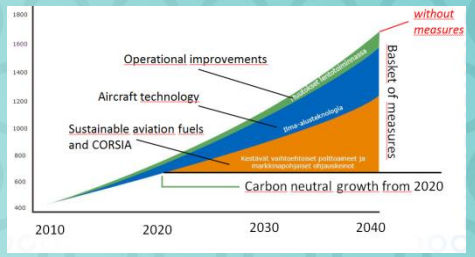

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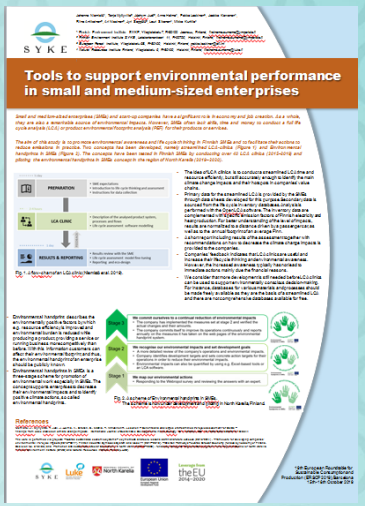
See also poster about another topic in ERSCP 2019:
Tools to support environmental performance in small and medium-sized enterprises, Niemistö et al.



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