ECONOMIC ESTIMATES OF THE CLIMATE COSTS OF THE AVIATION SECTOR DUE TO AIR MANAGEMENT: INSIGHTS FOR 2018 AND 2019

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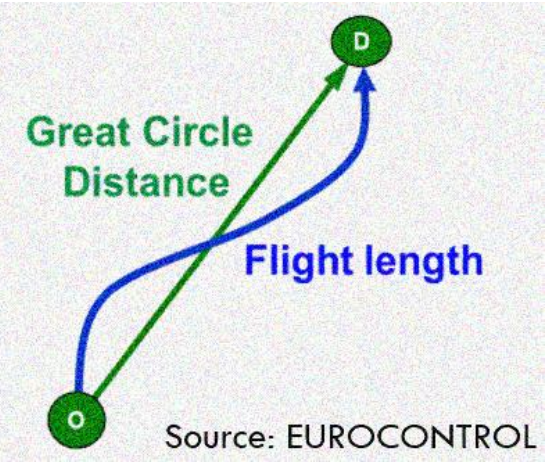
FLIGHT EFFICIENCY AND THE ENVIRONMENT

- Aviation: 1 Gt CO_2 in 2019 – 2.8% of global emissions from fossil fuel combustion
- ANSPs ensure that aircraft on the ground and in the air keep safely apart by prescribing vertical and horizontal distances to each other
  - Regulation → In EU: performance scheme (targets for key performance areas)
    - Environment: 2015-2019 (RP2) → reduce the actual trajectory of a flight to minimize fuel consumption → improvements for the Key Performance Environment indicator based on KEA

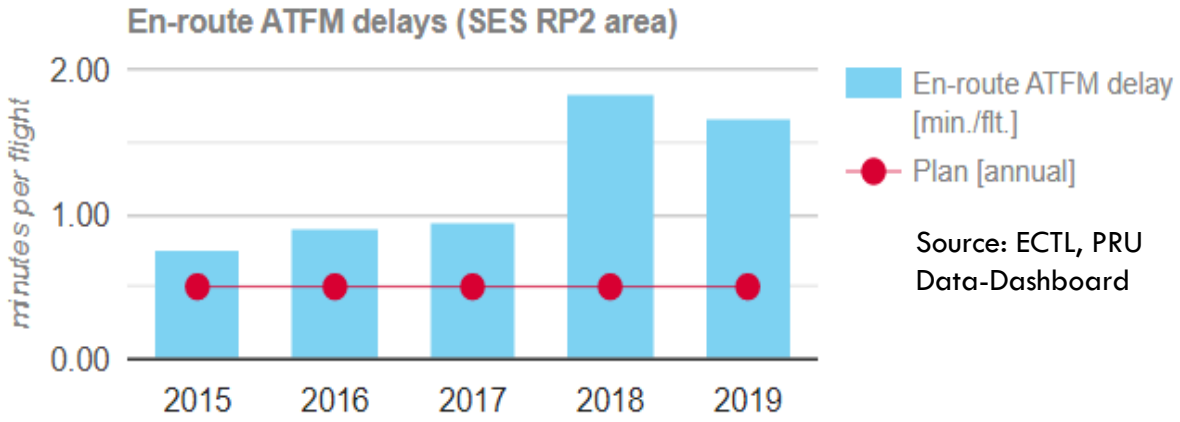
- In the assessment of **horizontal flight efficiency** (HFE) targets, all planned network changes were considered
  - A higher HFE measurement usually means a more direct flight trajectory → but not necessarily a *climate optimal trajectory*
  - Other variables needs to be considered → **Vertical flight efficiency** + **Wind, temperature** conditions, the presence of significant **weather along the route** and the possible occurrence of **contrails**



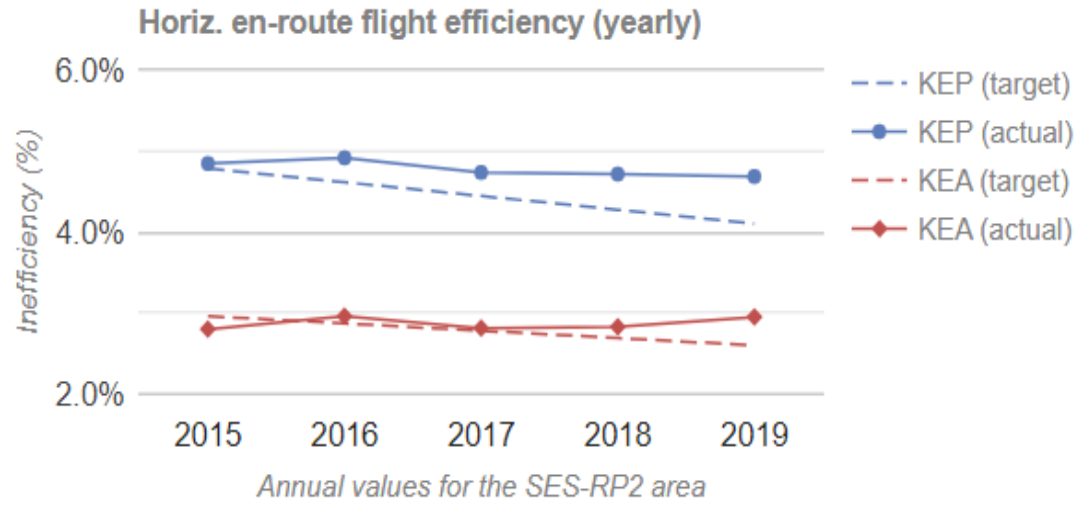
FLIGHT EFFICIENCY AND THE ENVIRONMENT

- There is also an interdependency between the different Key Performance Areas → Link between *Airspace, Air Traffic Management Capacity and Environment*

  - When the offered capacity falls short of the demand for flights, ground delays, holdings and traffic shifts to adjacent areas occur. This entails de-tours and a deterioration of the HFE-indicator



  - For actual HFE, it should be noted that the target of 2.78% of KEA was met in 2017 but afterwards deteriorated to 2.95%, which was a clear reflection of the shortfall of capacity and the increase in delays



FLIGHT EFFICIENCY AND THE ENVIRONMENT

- How changes in HFE can be translated into costs

KEA comparisons between target and actual

	2017	2018	2019
KEA (target)	2.78	2.69	2.60
KEA (actual)	2.78	2.83	2.95
Difference	0.00	0.24	0.35

PPR (2020): an improvement of 0.1 points in HFE leads to savings of 5.4 million NM (or 9.9 million km) in distance

ADDITIONAL DISTANCE FLOWN PER YEAR

- 2017: 0 NM additional distance flown
- 2018: 2.4 4 x 5.4 million NM = 12.96 million NM
- 2019: 3.5 x 5.4 million NM = 18.9 million NM

In the period 2018 to 2019, 31.86 million NM was flown beyond optimal distances as a result of capacity constraints

THE ENVIRONMENTAL COST

- AVOIDANCE COSTS: Climate change avoidance costs in Euros per tonne of CO2 equivalent

Forecast	Low	Medium	High
Short and medium run (up to 2030)	63	105	199
Long run (from 2040 to 2060)	164	283	524

(adjusted from € 2016 to € 2019 prices)
Source: ECTL Standard Inputs for economic analysis, edition 9

  - *Carbon cost* of that extra distance flown up to 2030 (*112 million EUR* – using the medium value) and from 2040 to 2060 (*301 Million EUR*)
  - But CO_2 emissions account for only 34% of the total climate impact → total **environmental costs of aviation** for 2018 and 2019: to be ranging from **336 to 903 million EUR**

- EUROPEAN EMISSIONS TRADING SCHEME (EU ETS): as aviation is one of the sectors included in the EU ETS since 2012, the price of carbon will be determined by the market

  - Price of CO2 in the future market (2021-2027) → *carbon cost* by 2030 (*54 Million EUR*) and for the long-run (*153.5 million EUR*)
  - Total **environmental costs of aviation** to be ranging from **162 to 460.5 million EUR**

RISK OF A VOLATILE CARBON PRICE

- As the aviation sector in the EU is affected by EU ETS, changes in the price of carbon may represent and additional risk that should be managed
  - The volatility of EU ETS is considerable
  - Thus: stochastic diffusion model

Historic spot carbon prices

From March 2018 to February 2021

- **Results for carbon price risk:**

Expiring	**Dec-2025**		
Volatility	$\sigma = 0.4764$	$\sigma = 0.25$	$\sigma = 0.125$
Percentile 90% €/tonne	101.69	79.04	62.99
Percentile 10% €/tonne	8.84	21.94	33.18

If the volatility remains high and similar to its historical values (σ=0.4764), in 80% of cases prices will be between 8.84 and 101.69 €/tonne, but in 10% of cases the price will be greater than 101.69 €/tonne.

With lower volatility are less likely that in the medium term the future carbon prices will be significantly high compared to today.

FINAL CONSIDERATIONS

1. A shortfall of capacity leads to delay costs (Abadie, Galarraga & Ruiz-Gauna, 2021) and environmental costs → capacity is planned in the medium to long-term, so traffic forecasts are a crucial element
   - Further research into the **interdependency of traffic forecasts, capacity and environmental costs**

2. A **vertical flight efficiency measure** is also a very important aspect of operations → aircrafts burn more fuel when flying at lower altitude as a result of capacity constraints
   - ECTL Network Manager: so-called "level caps" → an aircraft can be told to fly at a lower level than usual
   - The number of occasions when environmentally friendly procedures such as Continuous Descent Operations (CDO) and Continuous Climb Operations (CCO) has fallen by some 5 to 10%
   - This has also caused additional fuel burn. However, this cannot be quantified with the current available data.

3. Emerging challenges for ATM due to imminent effects of **climate change** and **variability**.
   - It requires a highly flexible and well-trained staff of ANSP, and a close cooperation with meteorological service providers to minimize adverse effects
4. One should not ignore the role that **volatility of carbon prices** may play for the calculation of the environmental cost → stochastic modelling can help to better understand the risks associated to carbon pricing volatility. Fortunately, the existence of CO2 markets may allow to hedge this risk

THANK YOU