Sustainable aviation - challenges and policies

Stefan Grebe, 8 December 2023

CE Delft
Committed to the Environment

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A. I only know TU Delft

B. The name sounds familiar

C. These are the environmental guys

D. I regularly read their excellent reports

CE Delft

- Independent research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- More than 80 employees, based in Delft, the Netherlands
- Not-for-profit

Clients

Industries
(Small and medium size enterprises, transport, energy and trade associations)

Governments
(European Commission, European Parliament, regional and local governments)

NGOs

Selection of aviation projects in 2022 and 2023

- Phasing-out of excise tax exemption for bunker fuels. Quick scan of the impact on aviation and shipping – Ministry of Finance
- **Effects of including transfer passengers in the air passenger tax – Ministry of Finance**
- CO2 emissions of private aviation in Europe - Greenpeace
- **Impact assessment of a CO2 ceiling for Dutch aviation – Ministry of Transport**
- Social Cost-Benefit Analysis of Schiphol growth and contraction. Analysis of growth and contraction for prosperity of the Netherlands and Schiphol region – Municipality of Aalsmeer

Published on www.ce.nl

- *Carbon budget aviation - Schiphol*
- *Social Cost Benefit analysis on capacity reduction Schiphol – KLM, Schiphol, Barin*
- *A tool for quantifying the non-CO2 climate impacts of aviation – Ministry of Transport*
- *The price of a flight. A study on the costs of and for aviation in the Netherlands – Ministry of Transport*

Not published yet

Content

- The decarbonization challenge for aviation
- External costs of aviation
- The Dutch national aviation model AEOLUS

- Case study 1 – Effects of a potential aviation tax for transfer passengers
- Case study 2 - Dutch CO_2 ceiling for aviation

Part 1 - The decarbonization challenge for aviation

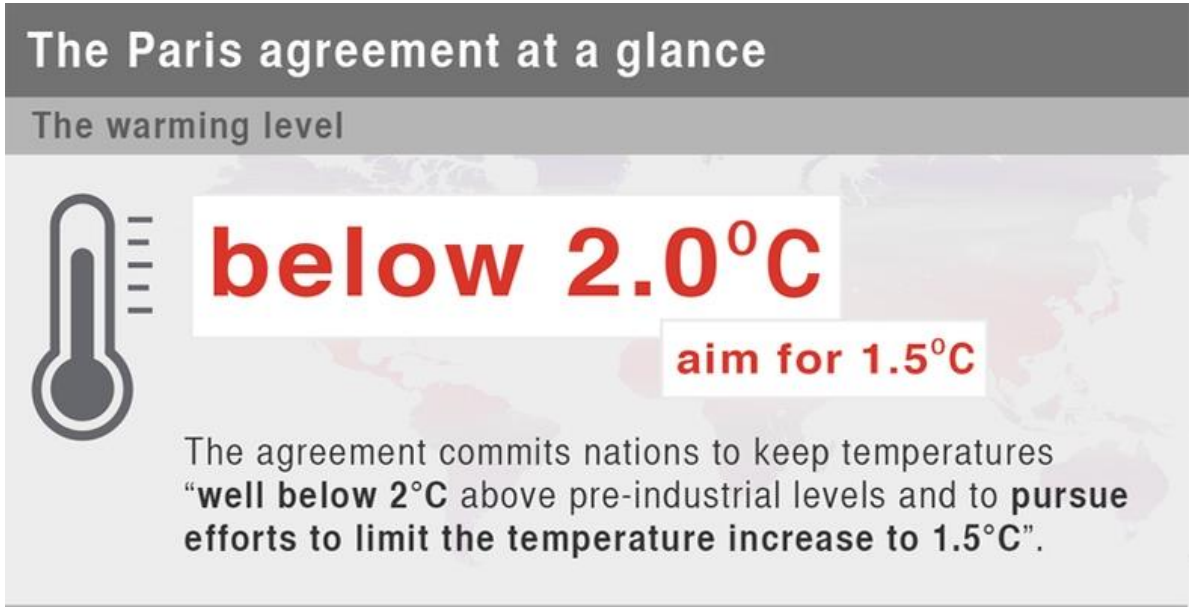
What is the key to align aviation with the Paris agreement?

A. Technological innovation

B. International agreements

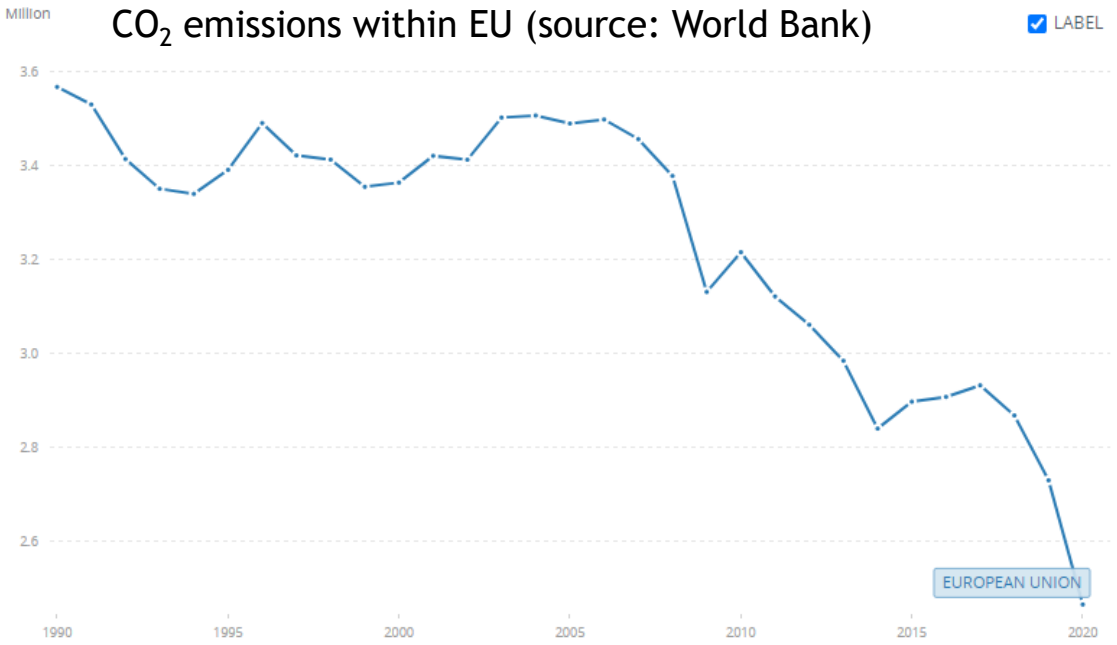
C. National policies

D. Adjusted consumer behavior

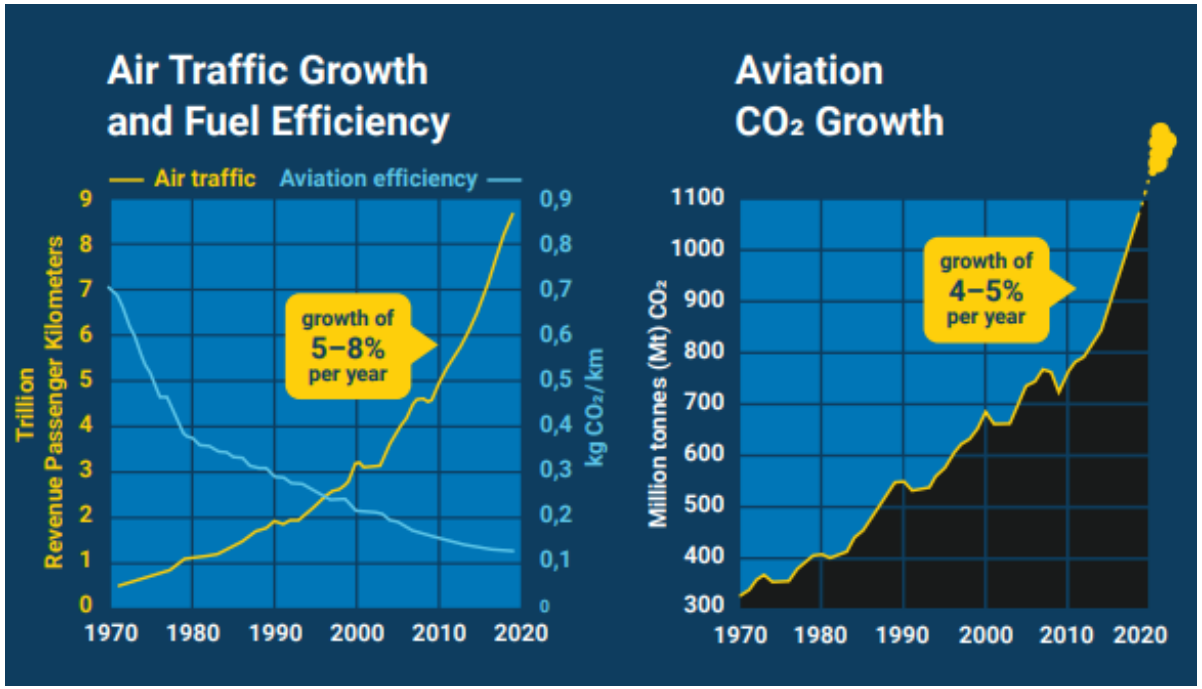


Historic CO_2 emissions

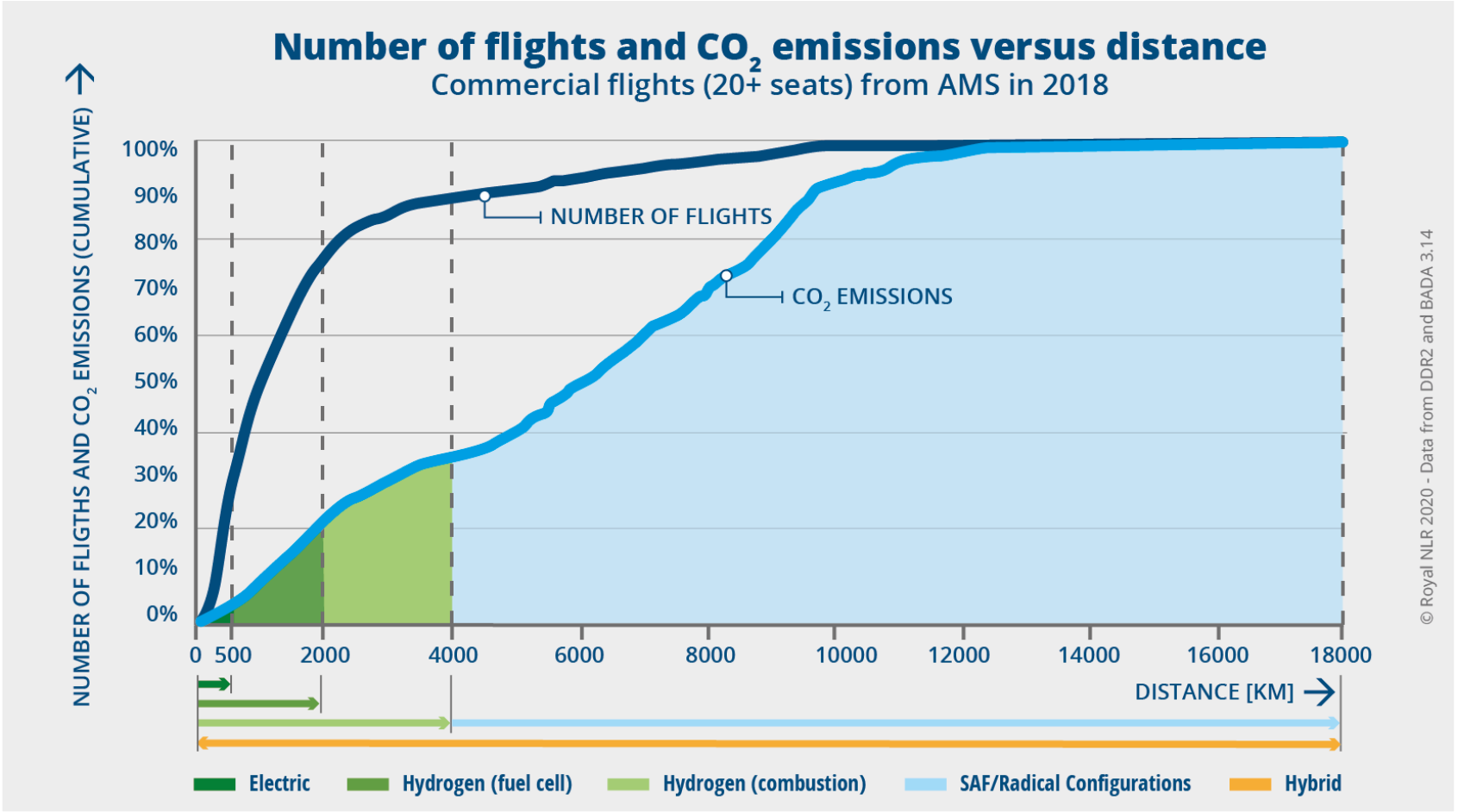
- In Europe emissions are decreasing, global still increasing
- Aviation emissions are growing (more demand growth than efficiency improvements)



CO_2 emissions within EU (source: World Bank)

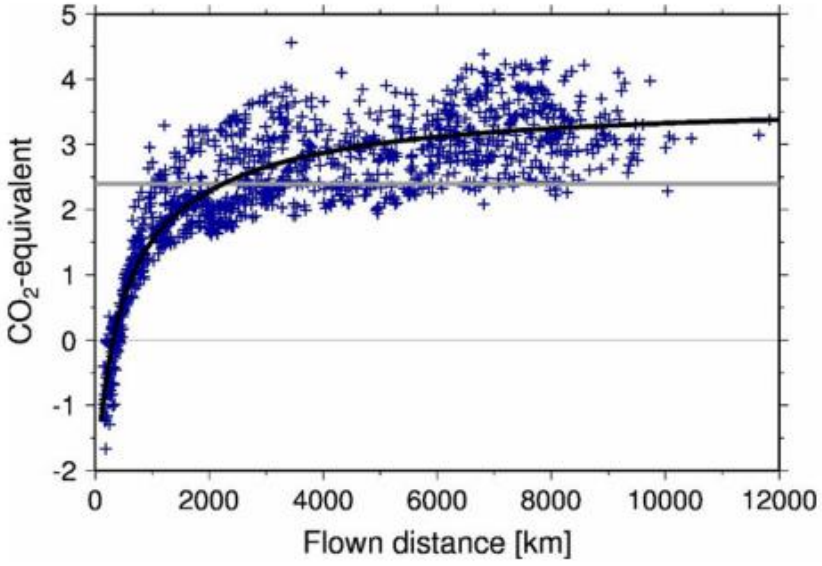


75% of flights below 2000 km -> 16% of emissions
25% of flights above 2000 km -> 84% of emissions



Non-CO_2 emissions of aviation

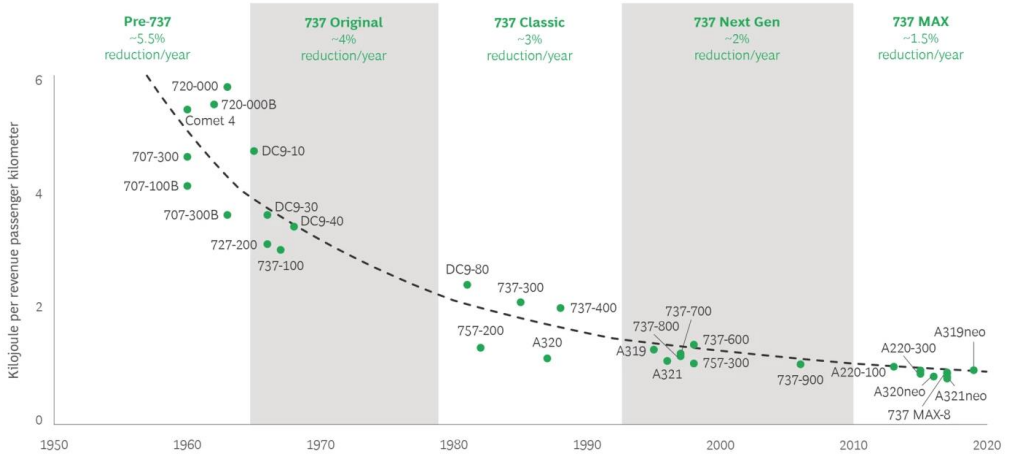
- Non-CO_2 effects of aviation are responsible for 2/3 of the total aviation climate effect
- Largest effects by contrail cirrus and NO_x (short-term ozone increase)
- Time horizon of non-CO_2 is much shorter than CO_2 (break down quicker through chemical reactions)
- Non-CO_2 route dependence, CO_2-equilvalents:
  - Increase with flight distance
  - Increase with latitude (highest at poles)
  - Slightly decrease with aircraft size



https://assets.publishing.service.gov.uk/media/5d19c4fc40f0b609cfd97461/non-CO2-effects-report.pdf
https://ce.nl/publicaties/updated-analysis-of-the-non-co2-climate-impacts-of-aviation-and-potential-policy-measures-pursuant-to-eu-emissions-trading-system-directive-article-304/
https://pure.tudelft.nl/ws/portalfiles/portal/105100657/15568318.2021.pdf

Decarbonization of aviation - challenges for long-haul

- 84% of emission from Schiphol are caused by 25% of flights
- Fuel efficiency gains of conventional propulsion is reaching natural limits
- Alternative propulsion technologies (electric, hydrogen) not realistic in near future
- Traffic and payload efficiency have potential, but are no game changers



- Sustainable aviation fuels (biofuels and e-fuels) only feasible option for the next decades
  - Need immediate ramp-up
  - Feedstocks for biofuels and clean energy are scare resources
- Demand management and internalizing external costs essential measures

https://www.bcg.com/publications/2022/a-and-d-industry-need-for-speed
https://theicct.org/wp-content/uploads/2022/06/Aviation-2050_report_final_v2.pdf
https://ce.nl/wp-content/uploads/2021/03/CE_Delft_190325_STREAM_Freight_Transport_2020_FINAL.pdf

Part 2 – External costs of aviation

Are we paying the true price for aviation tickets?

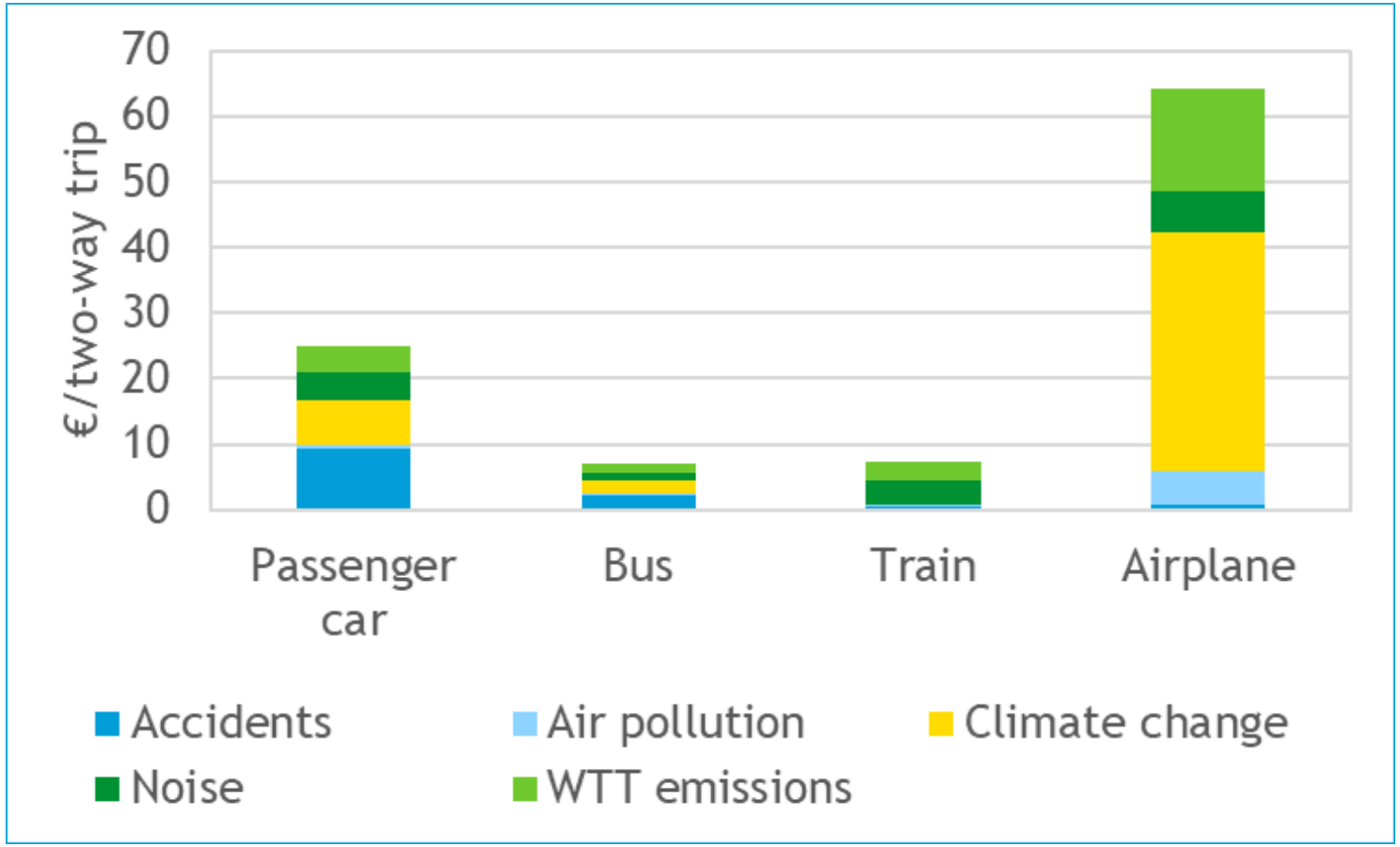
A. Tickets are already too expensive

B. Yes, we pay the true price

C. Yes for short flights, no for long flights

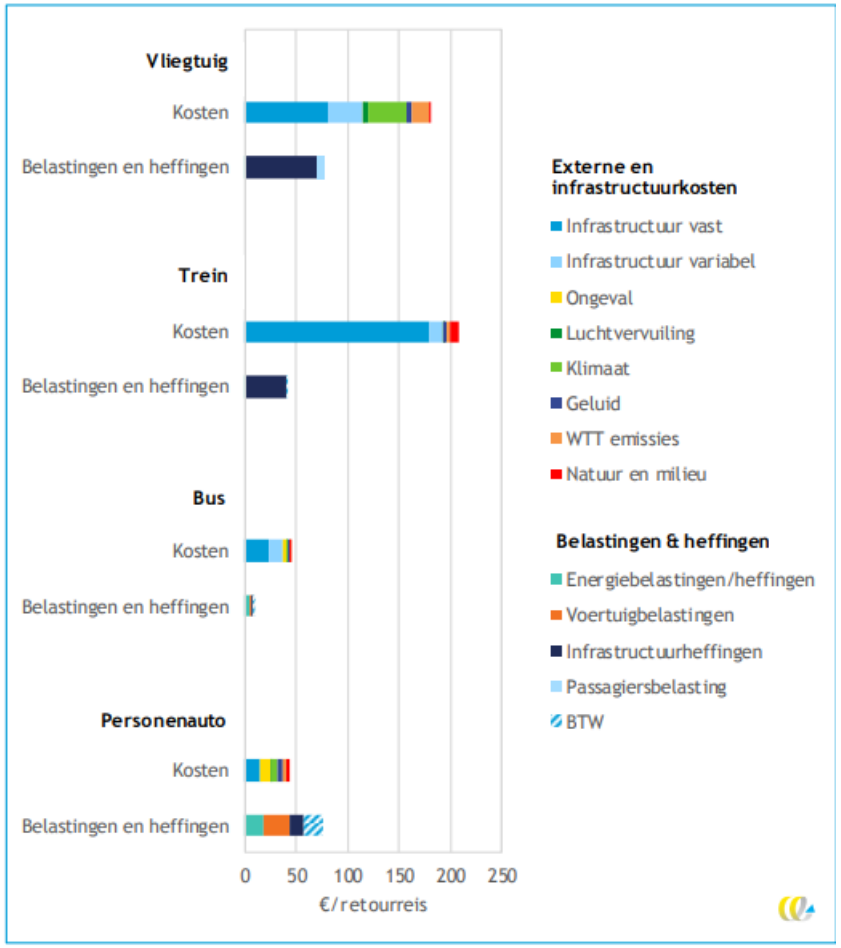
D. All tickets are too cheap

External costs of a trip from Amsterdam to Paris

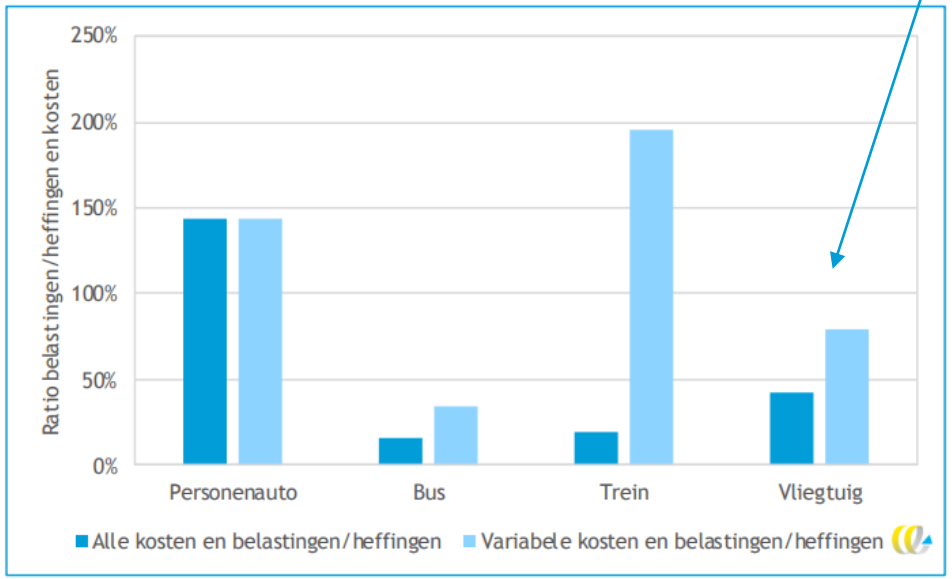


- Climate change dominant for aviation
- Non-CO2 accounted with factor 2 in aviation (on average 3 is more realistic)
- Update of this study from 2019 will be published in December

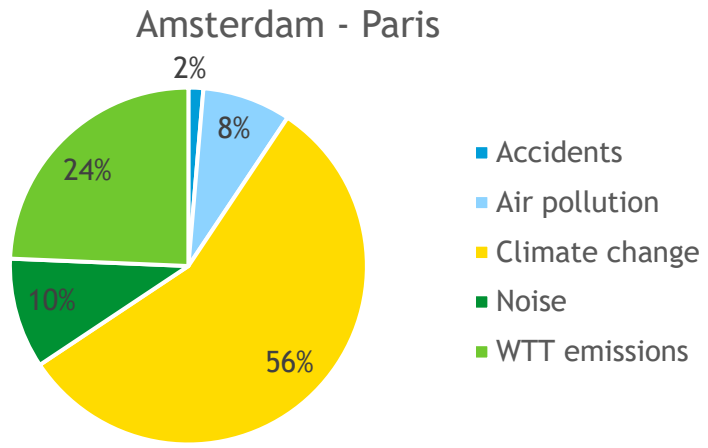
Comparison external effects with taxes and levies

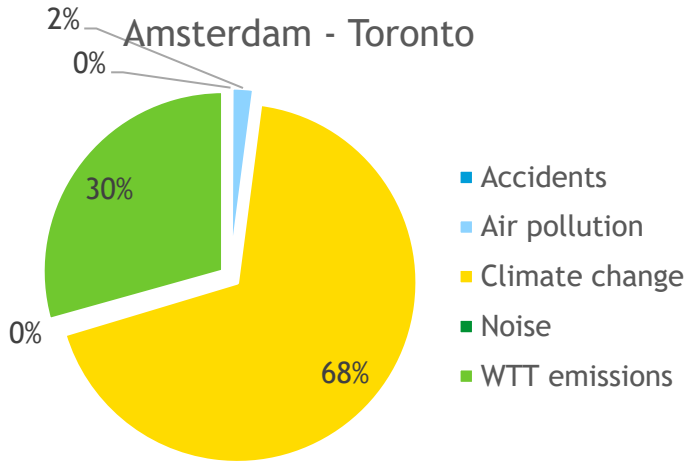


- Return trip: Amersfort - Paris
- 2018 situation without Dutch aviation tax and without EU-ETS costs
- Distinguish all costs and variable costs
- Taxes and levies smaller than external effects (<100%)
- Today: airplane approx. 100%

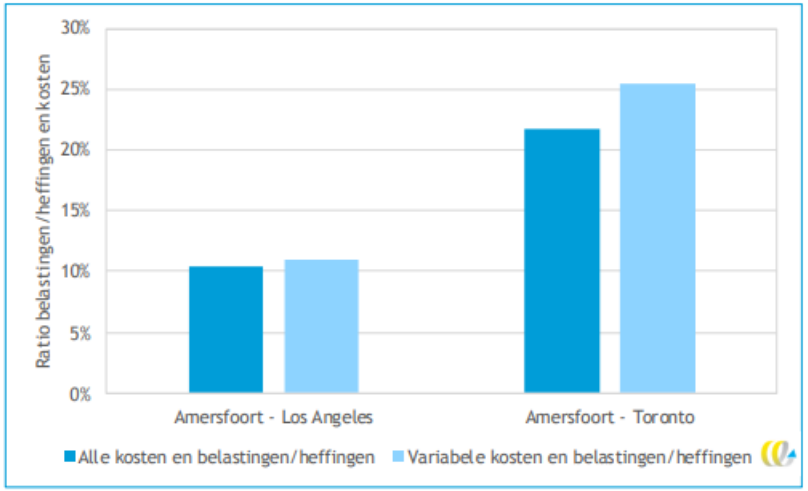


External costs on short vs long-distance flights





- Climate costs increase strongly for long-distance flights
- Taxes and levies cover between 10% and 25% of external effects for intercontinental flights
- Today same situation:
  - CORSIA CO_2-prijces much lower than EU-ETS prices
  - Dutch aviation tax constant (no distance dependence)



Part 3 – AEOLUS, the Dutch national aviation model

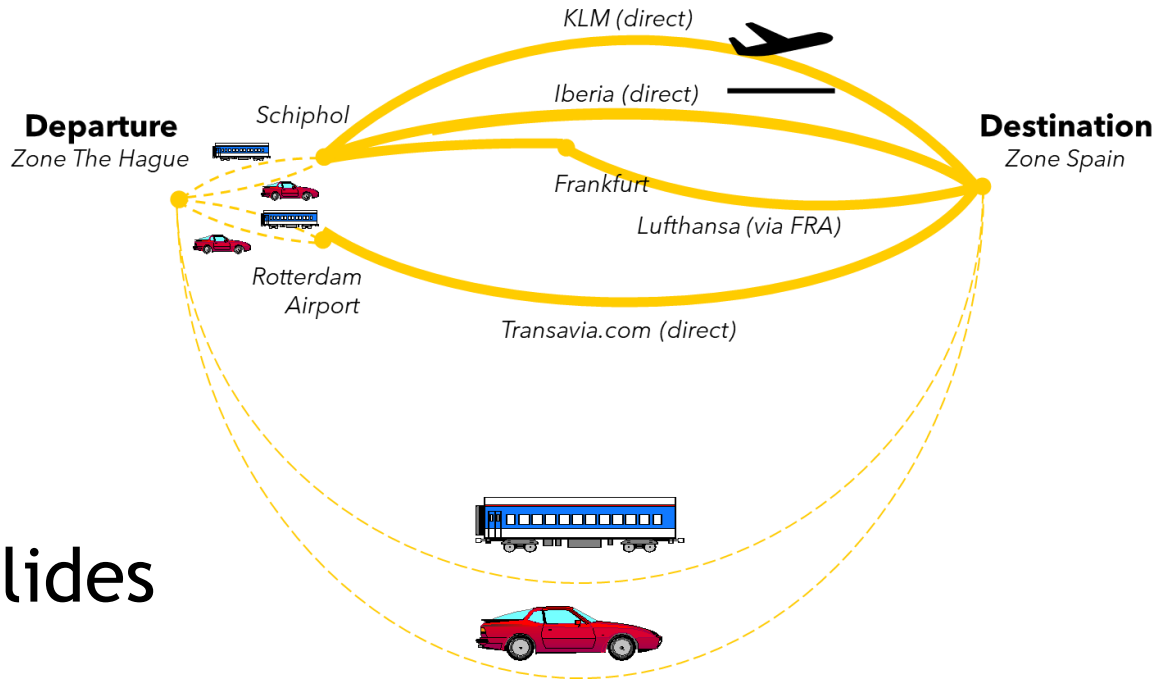
Would you like to skip this part?

A. Yes

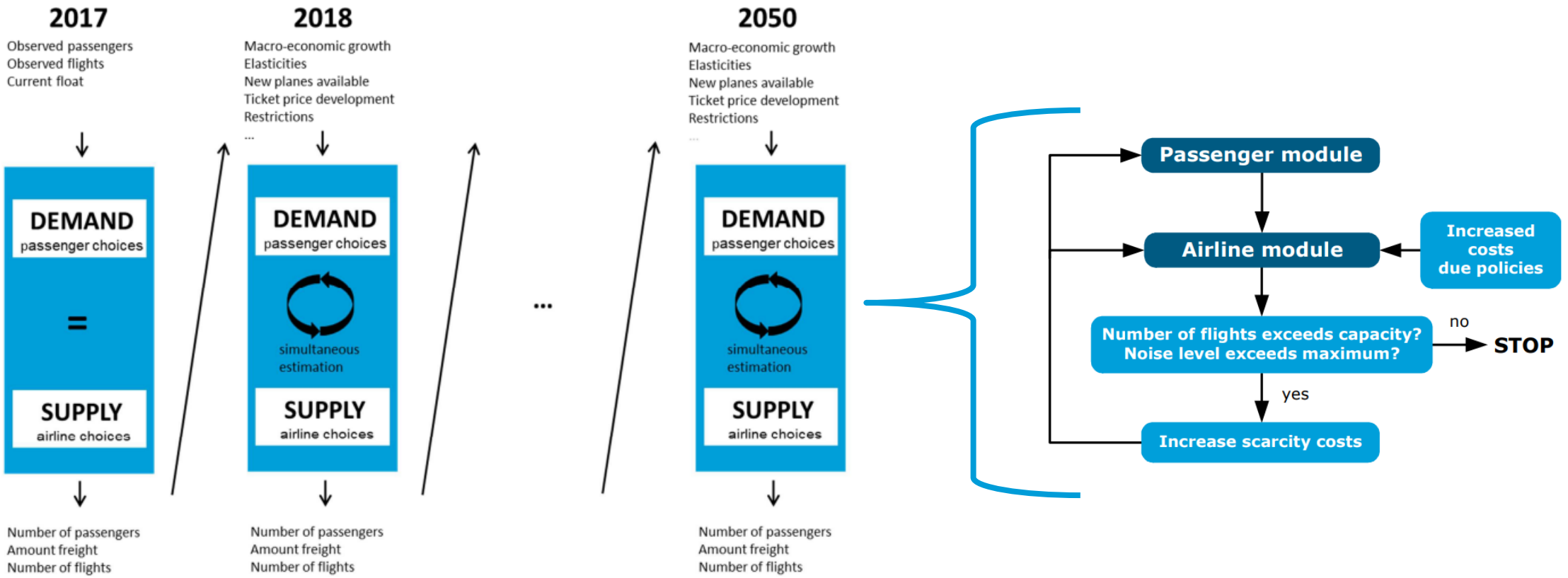
B. YES!!!

C. Okay, if it is not more than 2 slides

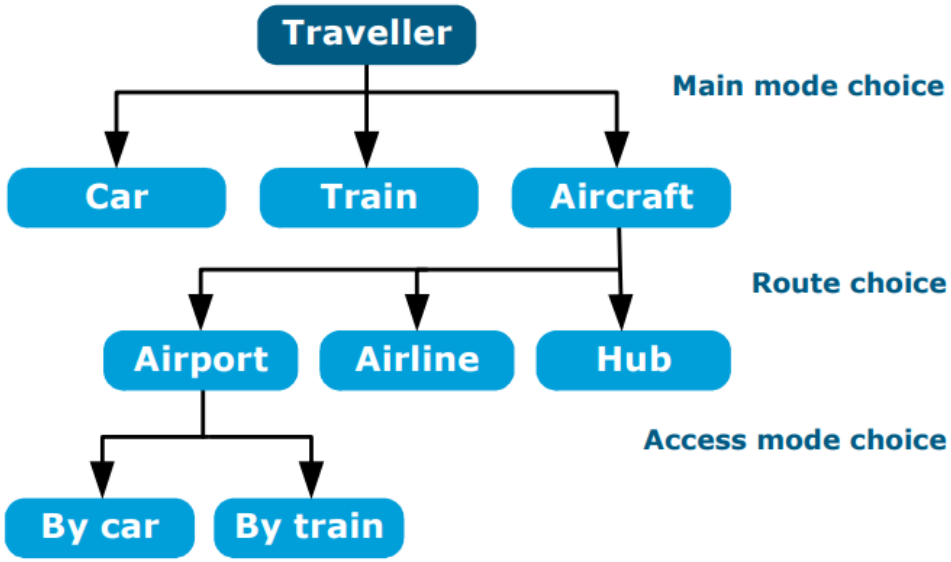
D. Explain me all details about discrete choice models

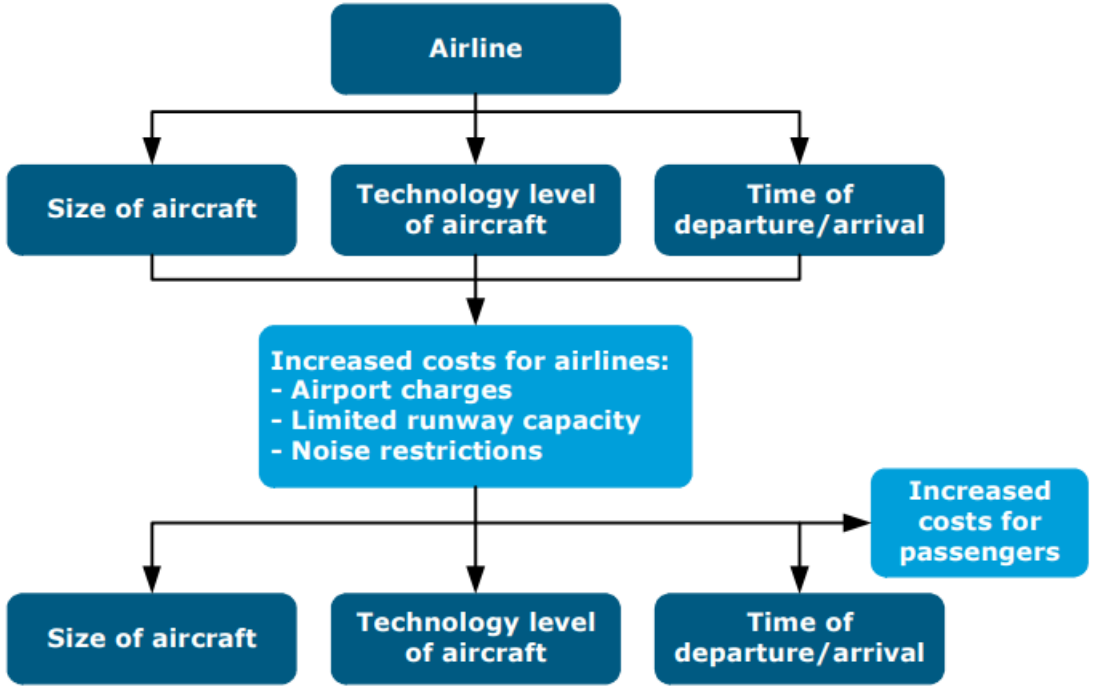


Basic principle



Traveler and airline choice models





Part 4 - Case study: Effects of a potential aviation tax for transfer passengers

How many European countries have a national aviation tax?

A. 1

B. 4

C. 9

D. All

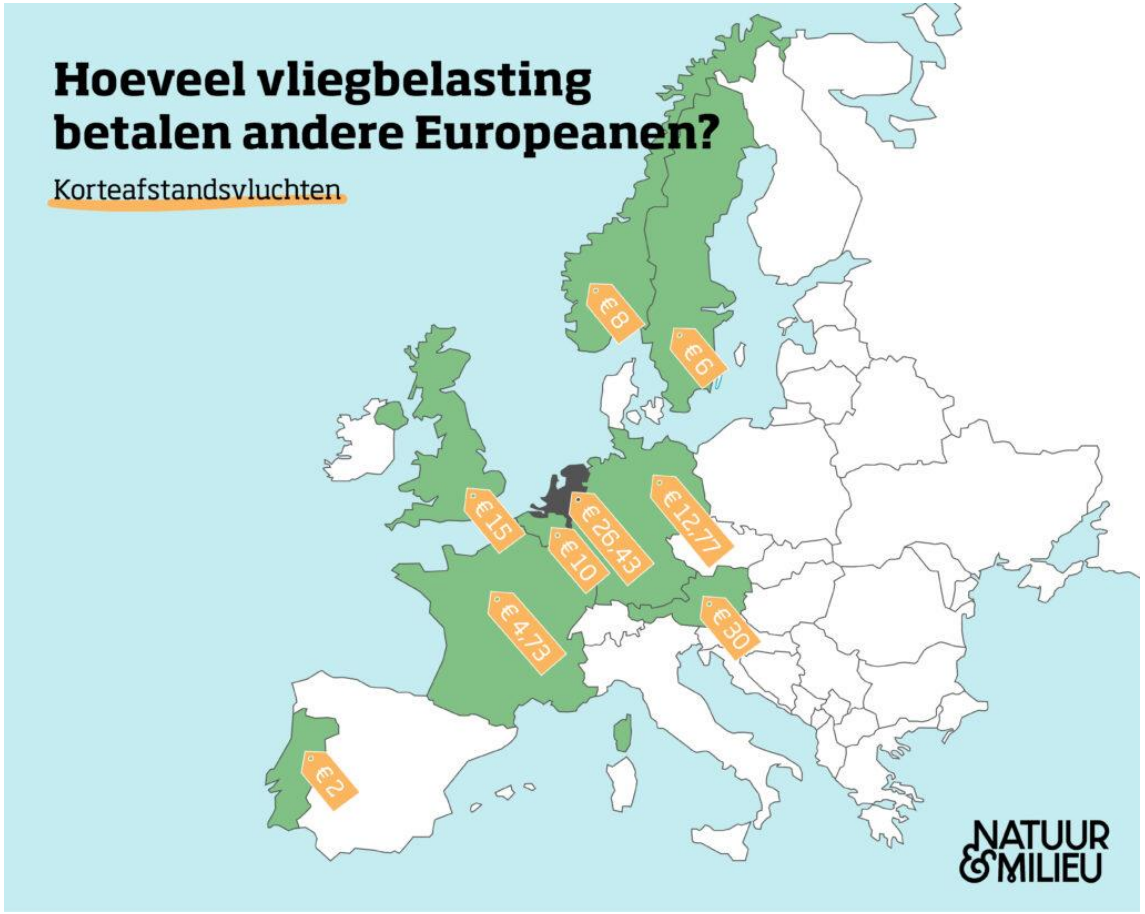
How many European countries have a national aviation tax?

A. 1

B. 4

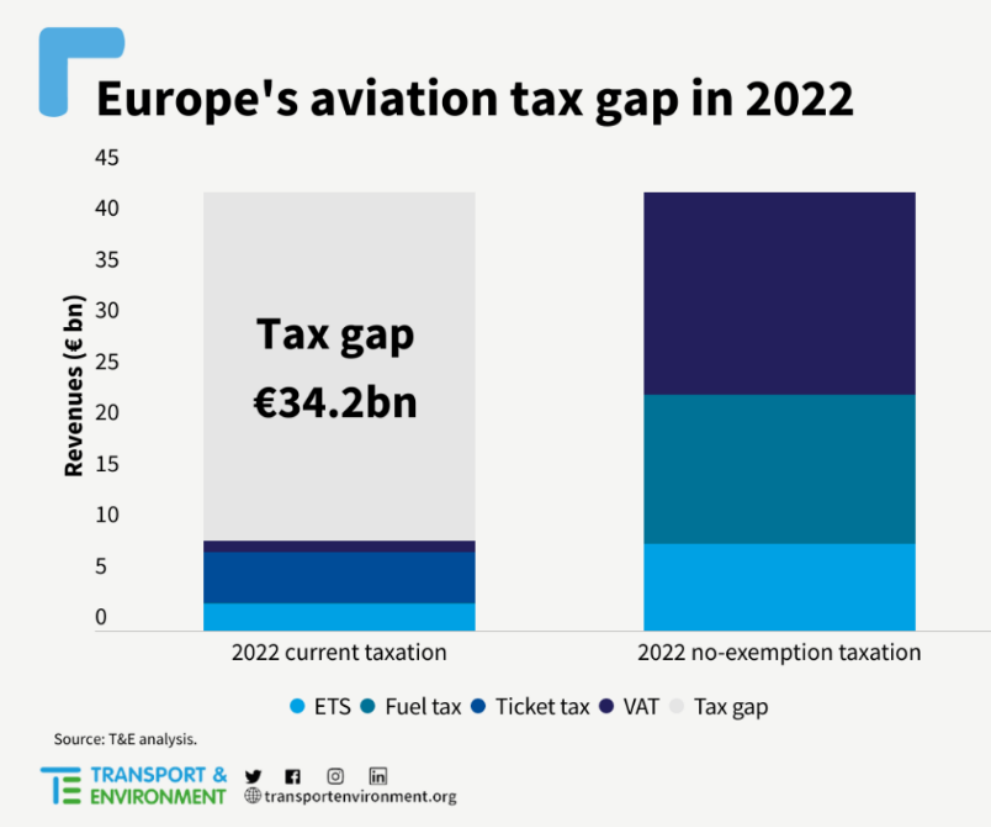
C. 9

D. All



Taxation and levies for flight tickets

- Infrastructure and security levies at airports
- Dutch aviation tax
  - OD passengers per departure: 23.43 Euro (since January 2023)
  - Transfer passengers and freight excluded
- No excised duty on kerosene
- No VAT on aviation tickets
- Free ETS-allowances (phase-out in 2025)



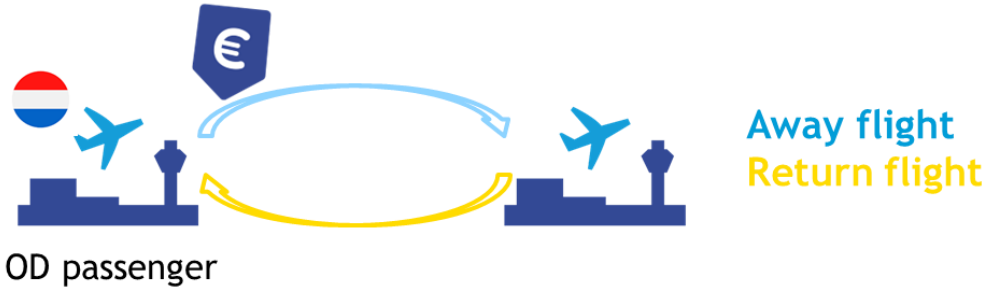
Remark: this is from an NGO!

Overview study

- Questions in Dutch parliament on aviation tax for transfer passengers
- Deputy minister of Finance announces to carry out effect study
- Ministry of Finance commissioned CE Delft and Significance to estimate effects in summer 2023
- Full report (in Dutch with English summary) online available: https://cedelft.eu/publications/effects-of-including-transfer-passengers-in-the-air-passenger-tax/

Aviation tax in the Netherlands

- Introduction in 2019: 7.84 Euro for departing passengers
- Rate for OD passengers since January 2023: 23.43 Euro
- Transfer passengers and freight excluded



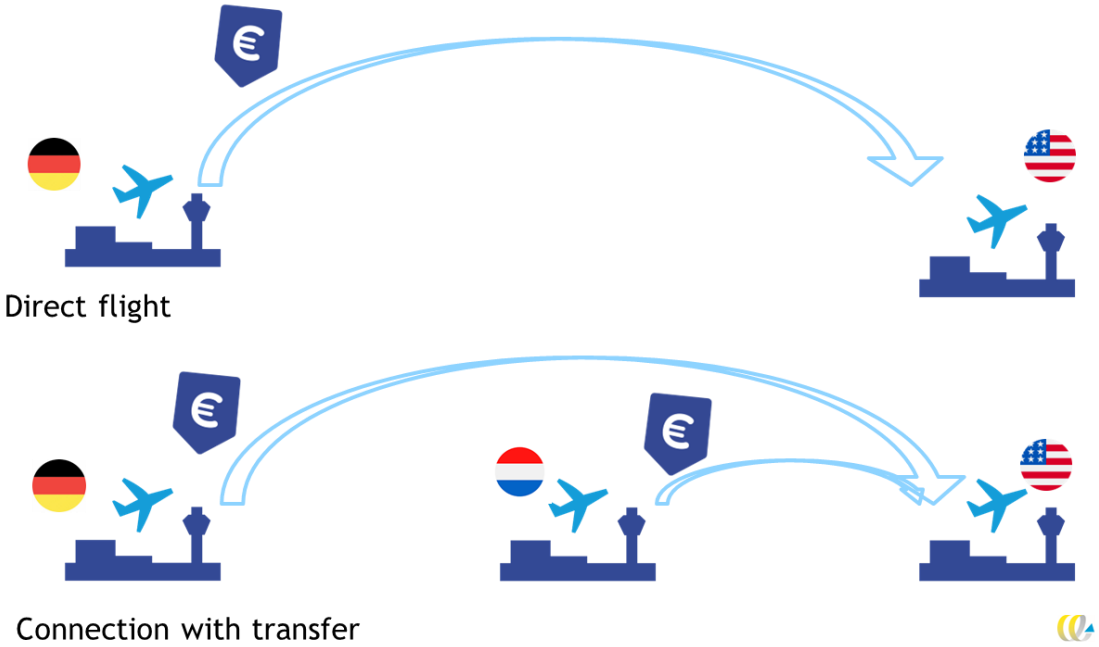
- In this study two options for transfer passengers:
  - Low rate: € 13,215 for departing transfer (23.43 Euro return flight)
  - High rate: € 26,43 for departing transfer (52.86 Euro return flight)

Double taxation

- Example: connection from Germany to US
- Germany has distance dependent tax
- Rate depends on final destination

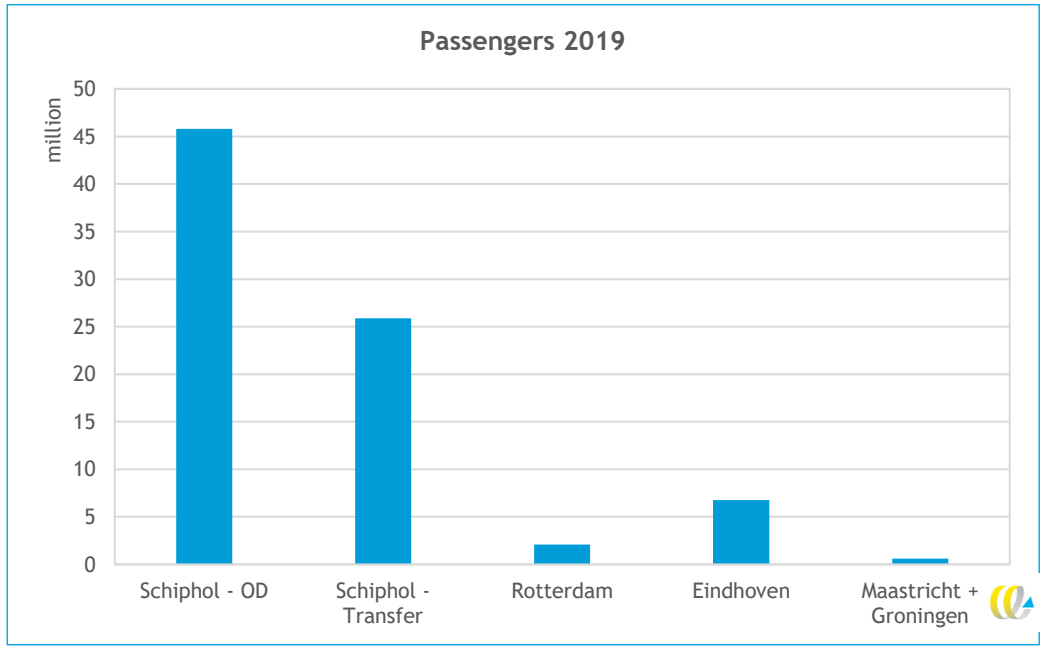
- Rates German air passenger tax:
  - Direct flight to Schiphol: 12.88 Euro
  - Direct flight to US: 58.73 Euro
  - Flight to US via international hub: 58.73 Euro

- Dutch passenger tax would be added

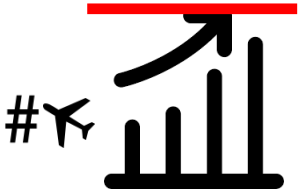


Passengers at Dutch airports

- Schiphol by far the largest airport
- Operated 2019 at capacity limit (500.000 annual aircraft movements)
- Transfer passengers only at Schiphol (1/3 of passengers)



Qualitative assessment of effects (tax transfer passengers)



Segment	Demand for aviation lower than available capacity	Demand for aviation higher than available capacity
OD travellers Schiphol	**Reduces moderately** *lower frequencies*	**Increases** *reduction of scarcity*
Transfer travellers Schiphol	**Reduces significantly** *higher costs*	**Reduces** *higher costs but also lower scarcity*
Freight Schiphol	**No effect**	**Increases** *Due to reduced scarcity*
OD travellers regional airports	**No effect**	**Reduces moderately** *Due to growth at Schiphol*
Freight Maastricht	**No effect**	**Reduces moderately** *Due to growth at Schiphol*

Assessment for 4 possible future developments

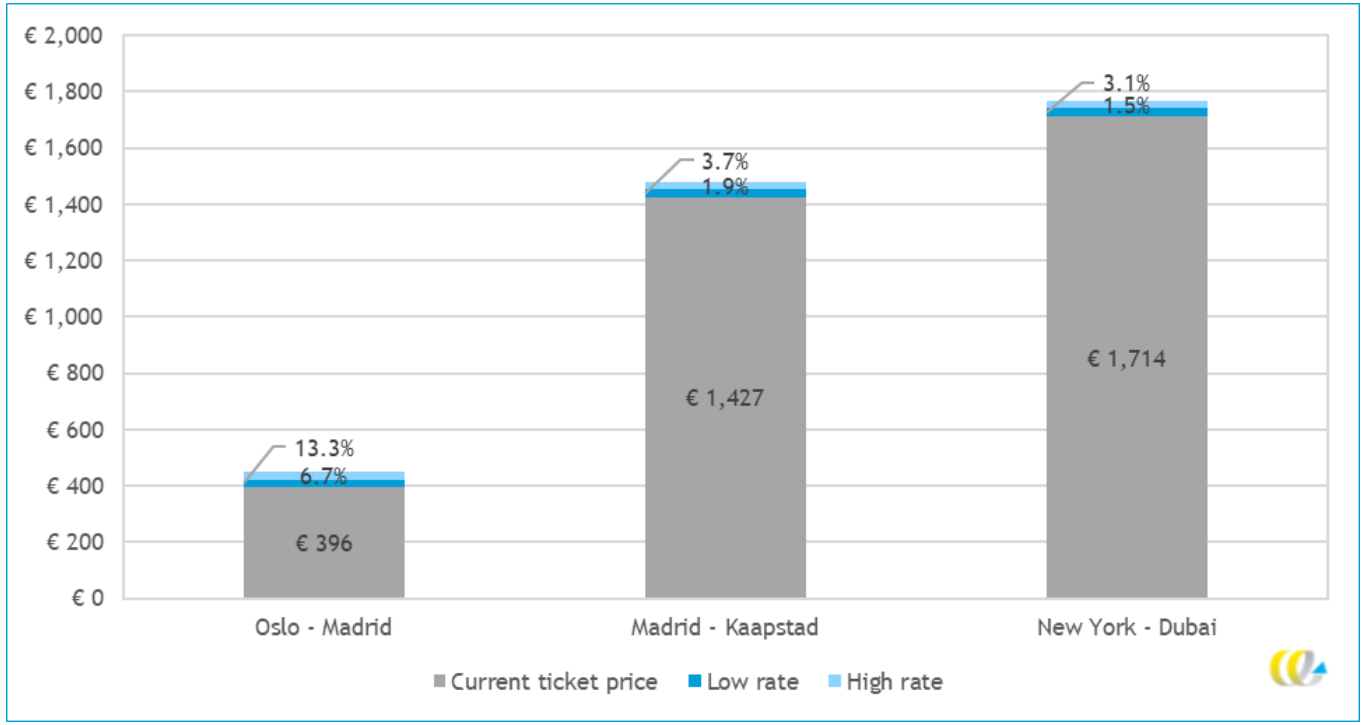
Scenarios	WLO Low Cap. Low	WLO High Cap. Low	WLO Low Cap. High	WLO High Cap. High
Socio-economic development (demand for aviation)	Low	High	Low	High
Capacity Dutch airports	440.000 Amsterdam no opening Lelystad		500.000 Amsterdam opening Lelystad in 2025	

- Modelling with Dutch national aviation model AEOLUS (owned by Dutch transport ministry)
- Background scenarios defined by
  - PBL (Netherlands Environmental Assessment Agency)
  - CPB (Bureau for Economic Policy Analyses)
- Analyze effects for 2025 and 2030 (in presentation only 2025)

Effect on ticket prices

- Highest relative increase on transfers with two European flights
- Average effect without scarcity

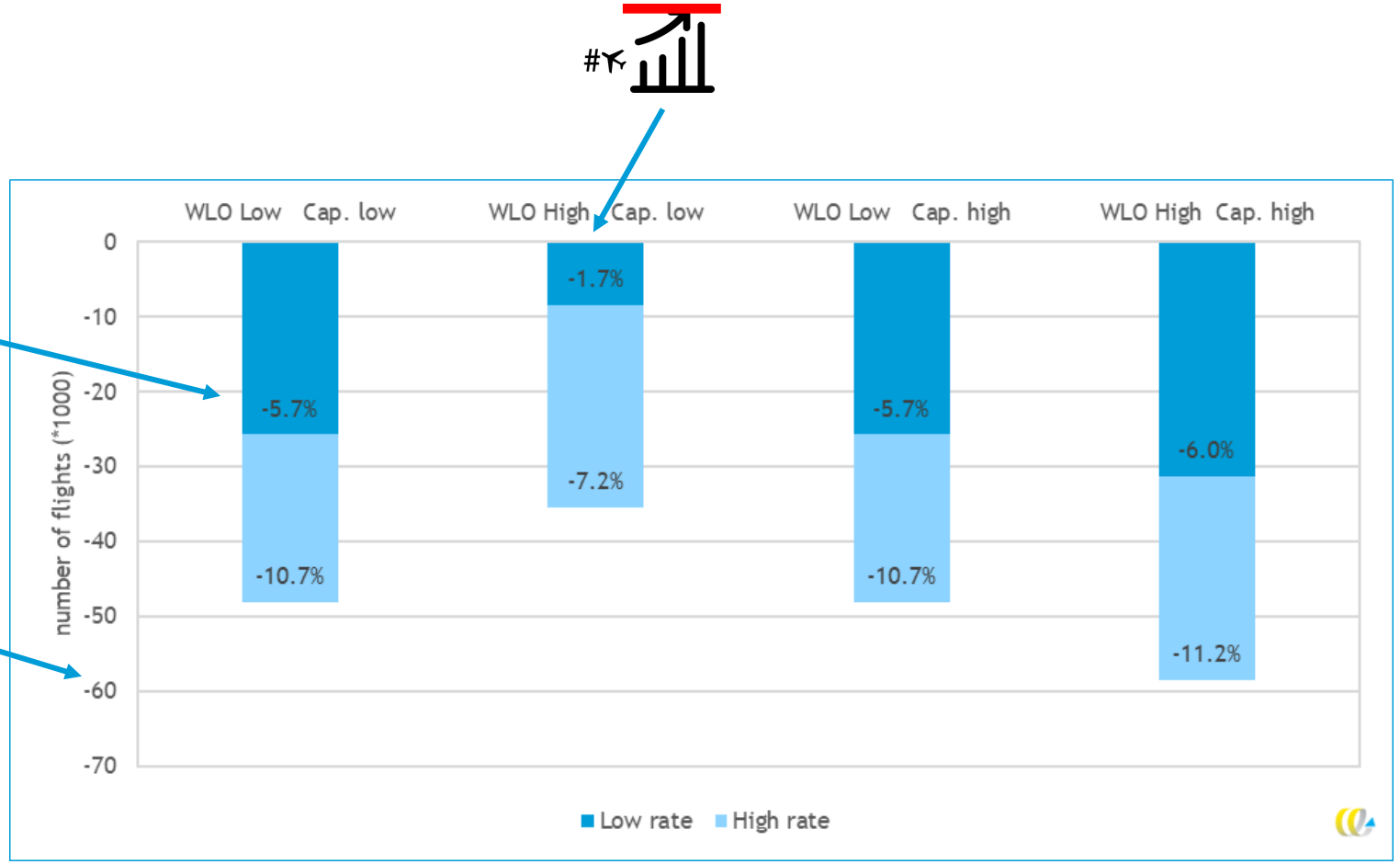
	Low rate	High rate
OD	0%	0%
TR EUR-EUR	6.5%	13.0%
TR ICA-EUR	2.1%	4.2%
TR ICA-ICA	1.6%	3.3%



Effect on total number of flights

Relative change compared to baseline in this scenario

Absolute change compared to baseline in this scenario



Impact on number of OD and transfer passengers

Tax transfer passengers

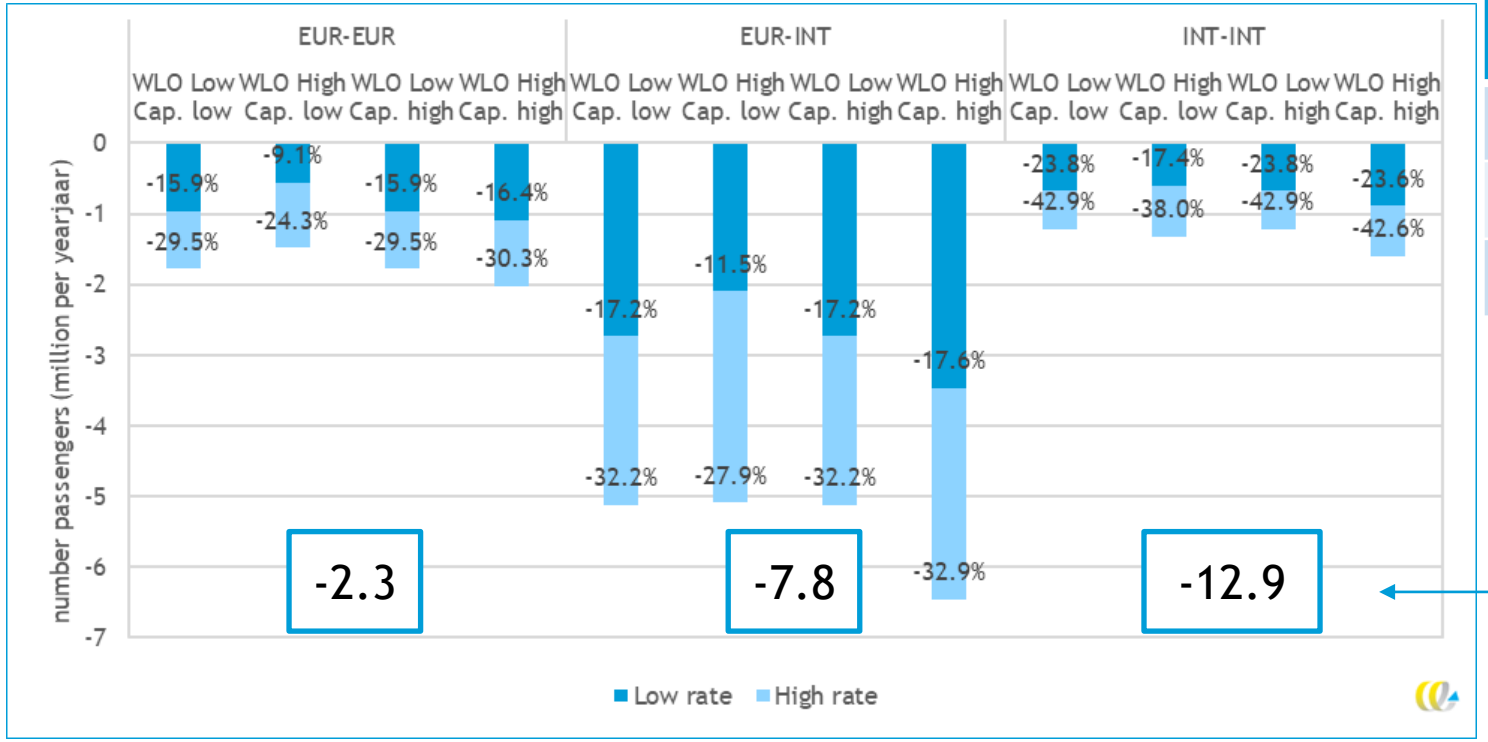
Strong decrease transfer passengers

Reduction in number of flights

Moderate decrease in OD passengers

Effects on different transfer segments

- Lowest increase in ticket prices for ICA-ICA passengers but largest effect
- Number and quality of alternative routes determines effect



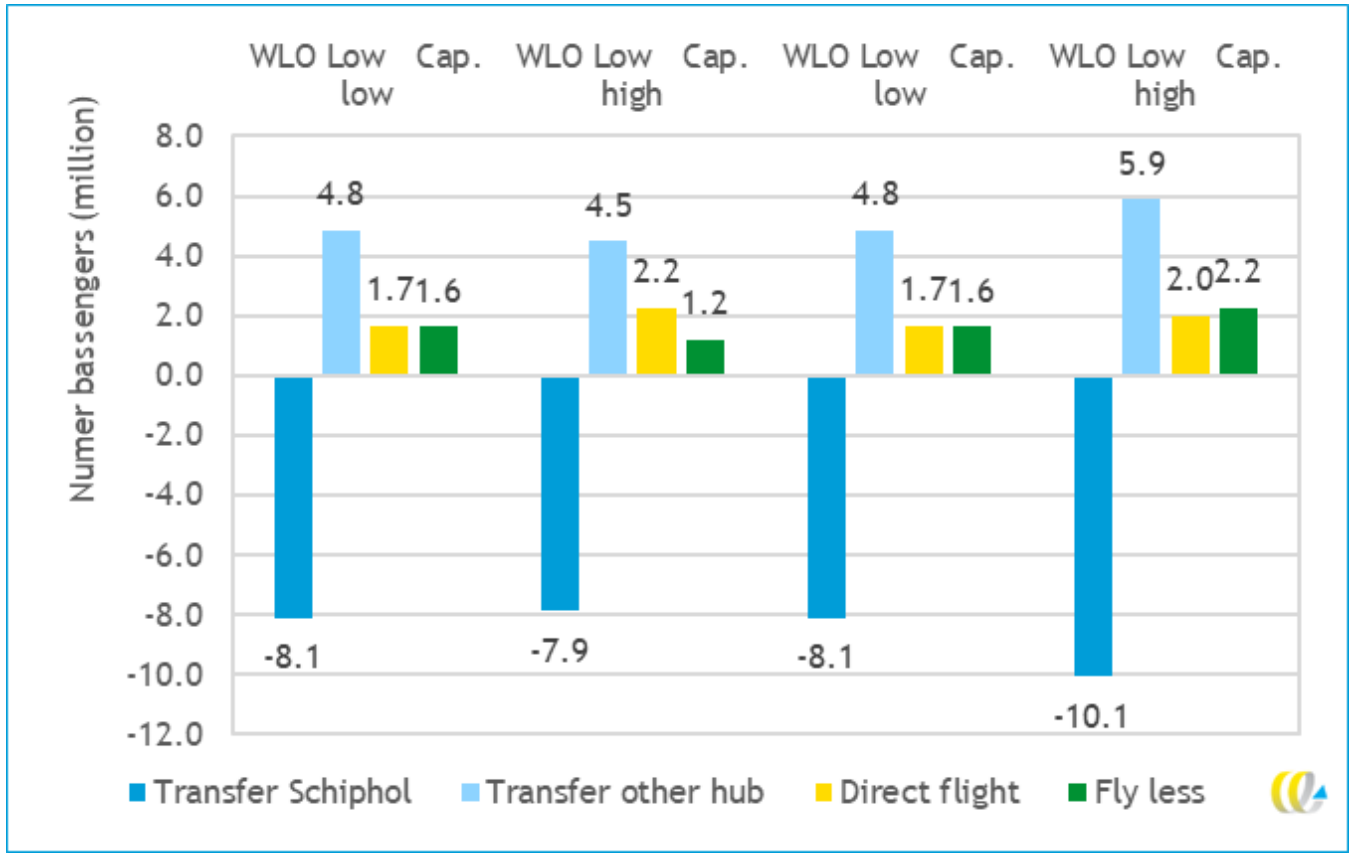
Ticket price increase	Low rate	High rate
TR EUR-EUR	6.5%	13.0%
TR ICA-EUR	2.1%	4.2%
TR ICA-ICA	1.6%	3.3%

Elasticities
% change in passengers / % increase in ticket prices

Evasion of transfer passengers

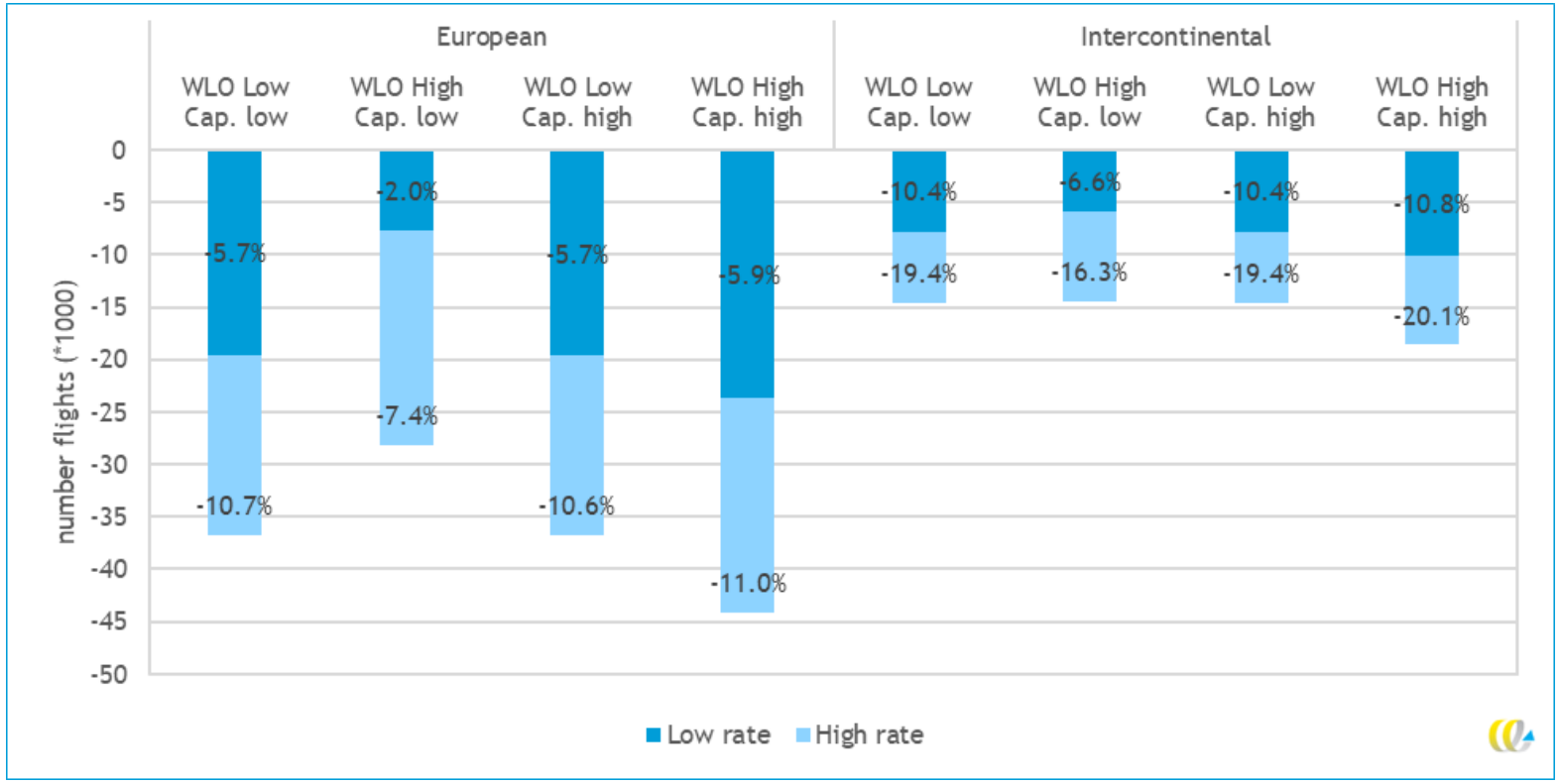
- Transfer passengers that adjust their travel behavior due to the tax:

- 20% reduction in flights
- 80% evasion
  - 25% direct flights
  - 55% transfer via other hubs



Impact on connectivity Schiphol

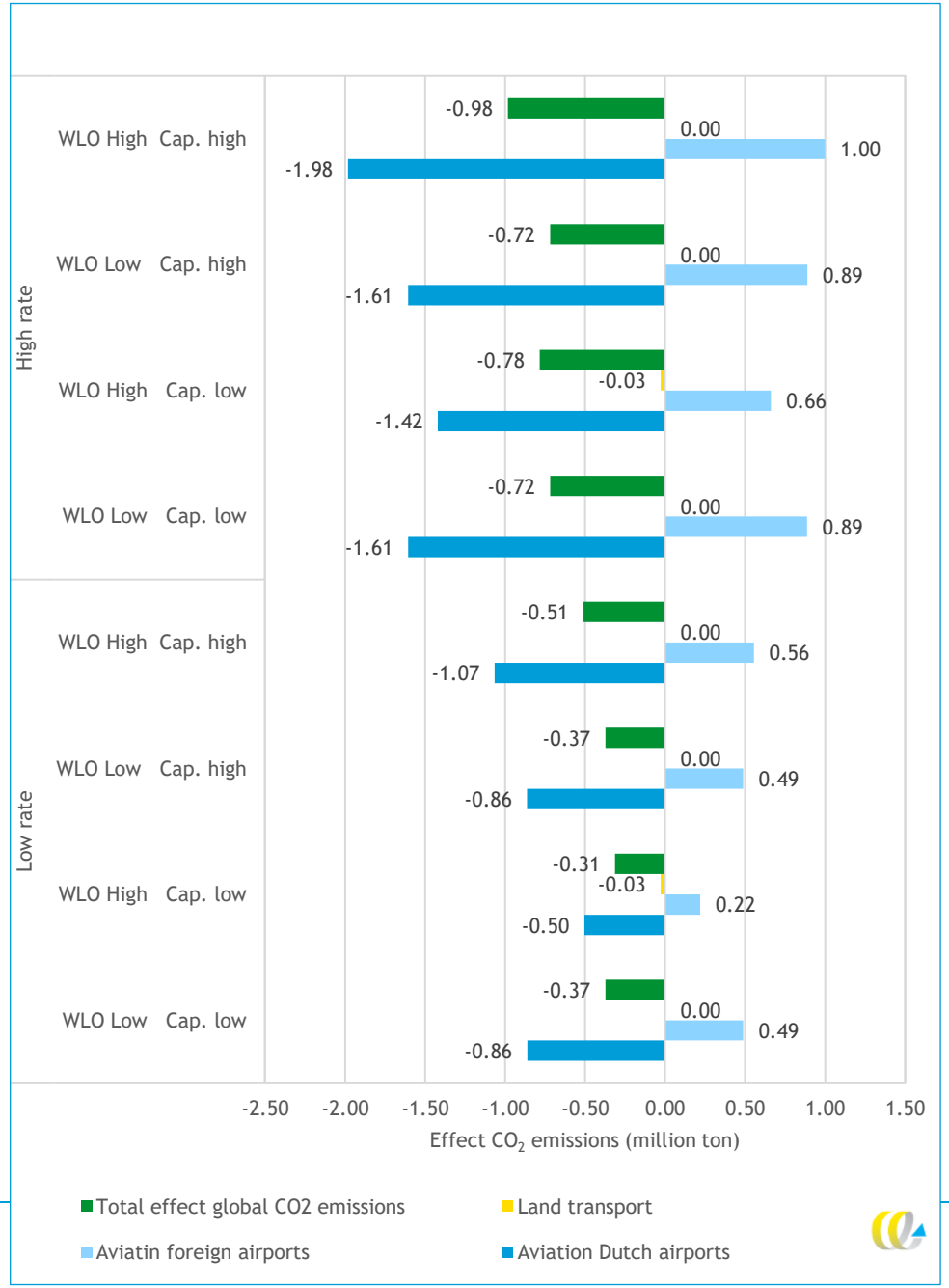
- European destinations:
  - Moderate relative decrease (2% - 11%)
  - Absolute decrease up to 45.000 flights
- Intercontinental:
  - 10% reduction for low rate
  - 20% reduction for high rate



Climate impact

- In each scenario reduction of global aviation CO_2 emissions
  - Low rate: about 0,5 Mton
  - High rate: about 1 Mton

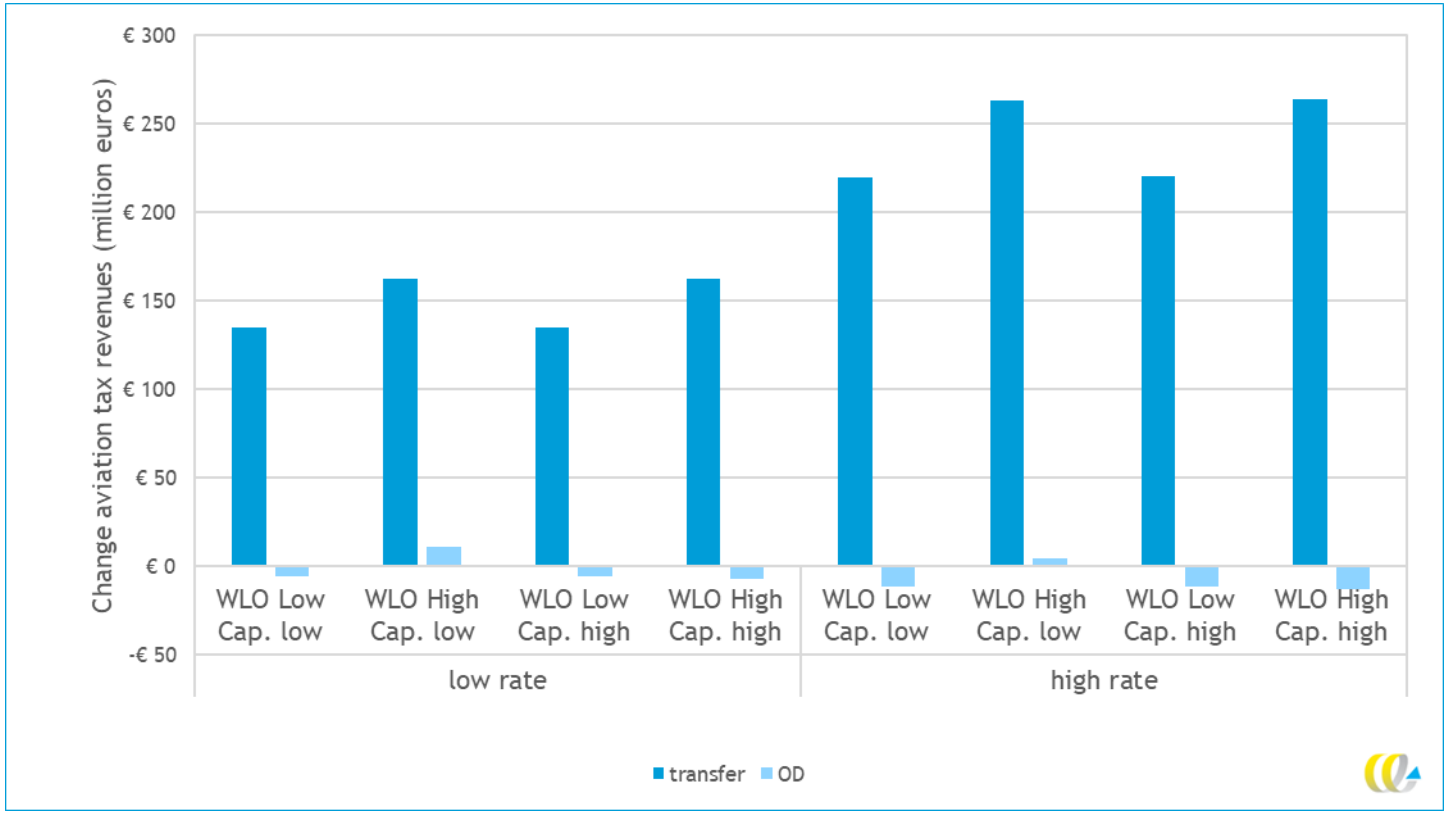
- Reference: 11.5 Mton emissions of all departing flights from Dutch airports in 2019



Additional tax revenues

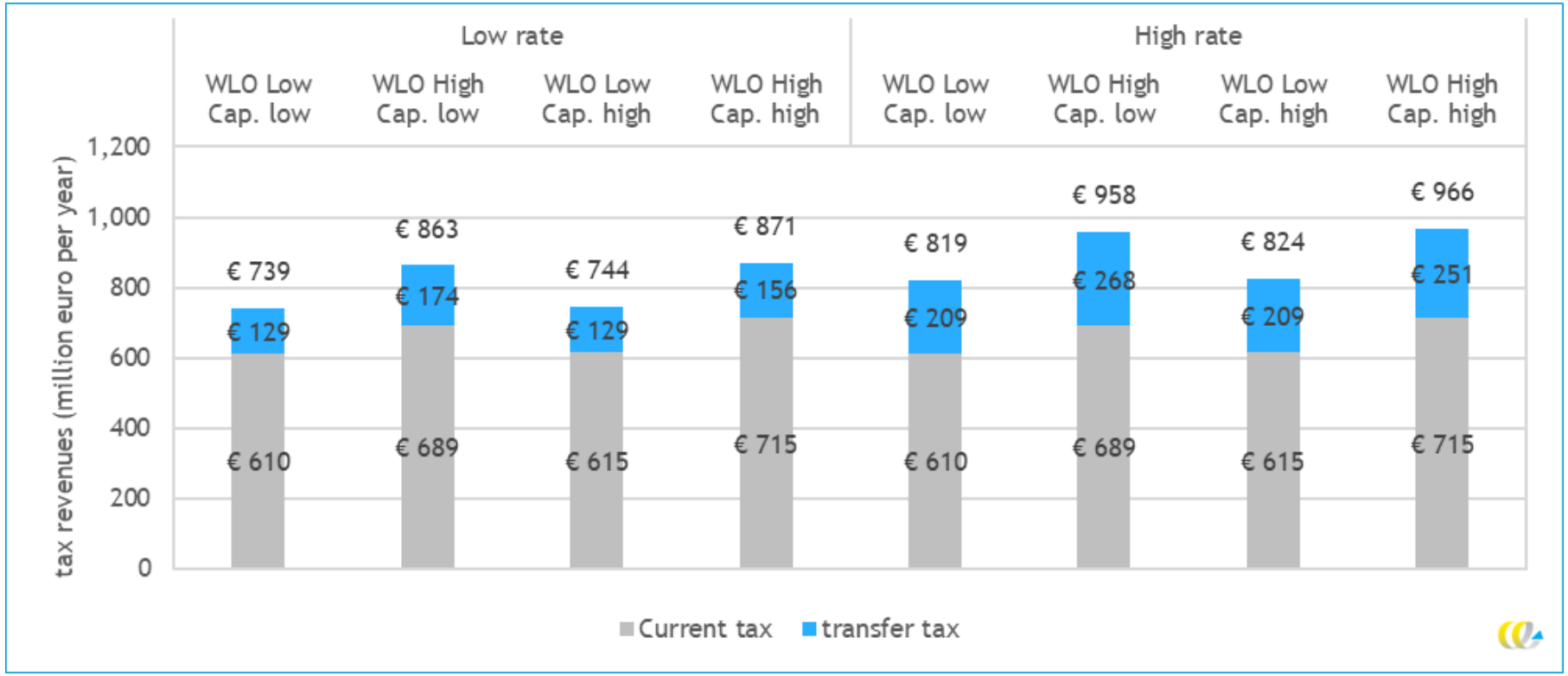
- Additional tax revenues from transfer passengers
  - €140 to €160 million for low rate
  - €220 to €260 million for high rate

- Slight decrease of revenues from OD passengers in most scenarios



Total revenues of Dutch aviation tax

- Low rate: 129 – 174 million per year extra
- High rate: 209 – 268 million per year extra (less than factor 2 due to evasion)



Conclusions (numbers for high rate)

- Taxes
  - Revenue for the state treasury would increase by € 209 million to € 269 million
  - 34 to 39% more than with the current air passenger tax.
- Dutch aviation sector
  - Ticket prices for transfer passengers would rise by 6.1% on average
  - Number of transfer passengers would reduce by about 8 million (28 to 34%)
  - Effects are largest in the segment with two intercontinental flights (38 – 43%), despite a relative ticket price increase of not even 4%
- Climate, environment and noise
  - Reduction of emissions is partly compensated evasion
  - Overall positive impact on climate
  - Local reduction of air pollution and noise pollution

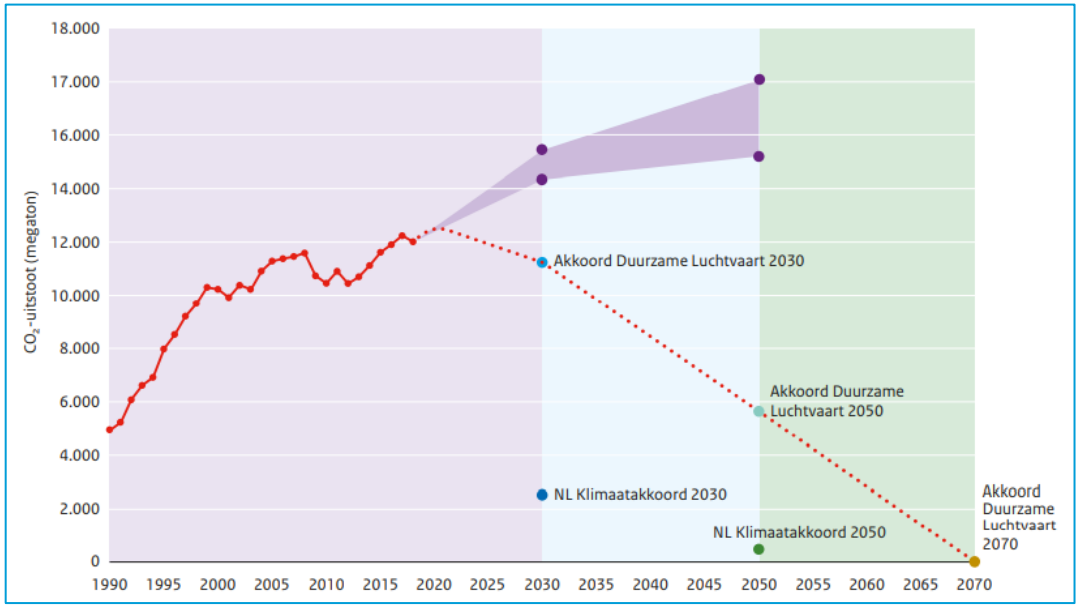
Part 5 - Case study: Dutch CO2 ceiling for aviation

The research project

- Dutch government announces investigation of a CO_2 ceiling for international flights from The Netherlands in White Paper
- Client: Dutch Ministry of Infrastructure and Water Management
- Consortium:
  - CE Delft
  - Significance
  - TAKS
  - ADECS
  - Erasmus University Rotterdam
  - ADSE
- Type of study: Impact assessment of the policy

Aim of the instrument 'CO_2 ceiling'

- Set clear limits for all flights departing from the Netherlands
- In-sector emissions reduction targets, no offsetting
- Obligation for regulated entities to meet the targets
- Worldwide first effort to implement such an instrument
- Legislation in preparation
- 3 main options (regulated entities)
  - Airports
  - Fuel suppliers
  - Airlines



2030: < 2005 level

2050: < 50% 2005 level

2070: zero emissions

Impacts accessed in the study

- **Dutch aviation**
  - Number of passengers at Dutch airports
  - Ticket prices and freight rates
  - Flights, destinations and network quality
  - Cargo
  - Fleet renewal
  - Impacts on fuel consumption
  - International relations
- **Economic impacts**
  - Compliance costs
  - Administrative costs
  - CO_2 allowance price and auctioning revenue
  - Fiscal impacts
  - Costs of enforcement
  - Upstream and downstream effects
  - Impacts on innovation
- **Social impacts and safety**
  - External safety
  - Jobs in the Dutch aviation sector
- **Environmental impacts**
  - Impacts on aviation CO_2 emissions
  - Impacts on land transport CO_2 emission
  - Impacts on EU ETS and CORSIA
  - Total impact on global CO_2 emissions
  - Non-CO_2 climate impacts of aviation
  - Impacts on air pollutant LTO emissions
  - Impacts on airport noise

3 main options for the CO_2 ceiling

- **Airport options**
  - National CO_2 ceiling divided over airports
  - Embedded in airport permits, comparable to limit values with regard to noise and local air quality
  - If restrictive: airports reduce number of slots (no control over usage of slots)
- **Fuel supplier options**
  - Limit on the amount of fossil fuel, which fuel suppliers are allowed to supply to aircrafts
  - Auctioning of a decreasing number of allowances to sell fossil fuel
  - If restrictive: fuel suppliers have to pay higher prices for allowances
- **Airline options**
  - Closed national Emissions Trading Scheme for airlines departing from Dutch airports
  - Attentional allowances to the EU-ETS (open to other sectors and countries)
  - If restrictive: airlines have to pay higher prices for CO_2 emissions allowances

- Collective incentive to reduce emissions

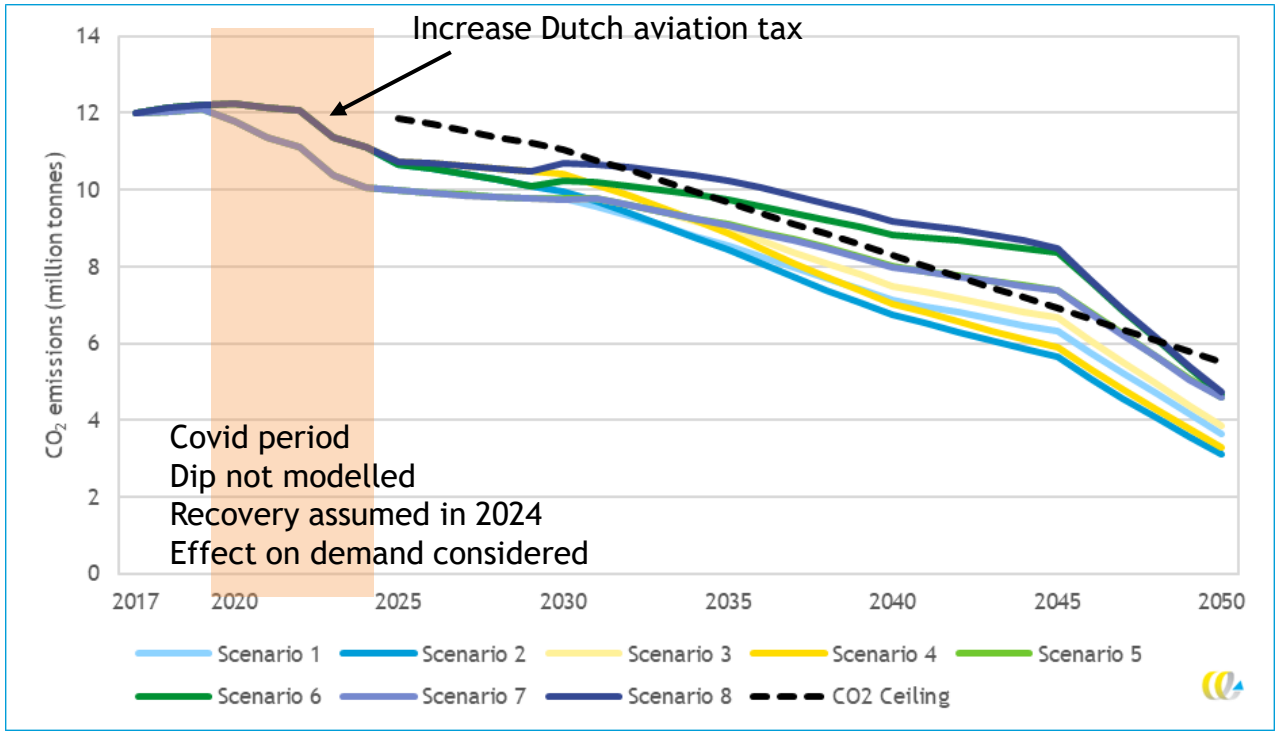
- Individual incentive
- Polluter pays principle

Main uncertainties taken into account by defining multiple baseline scenarios

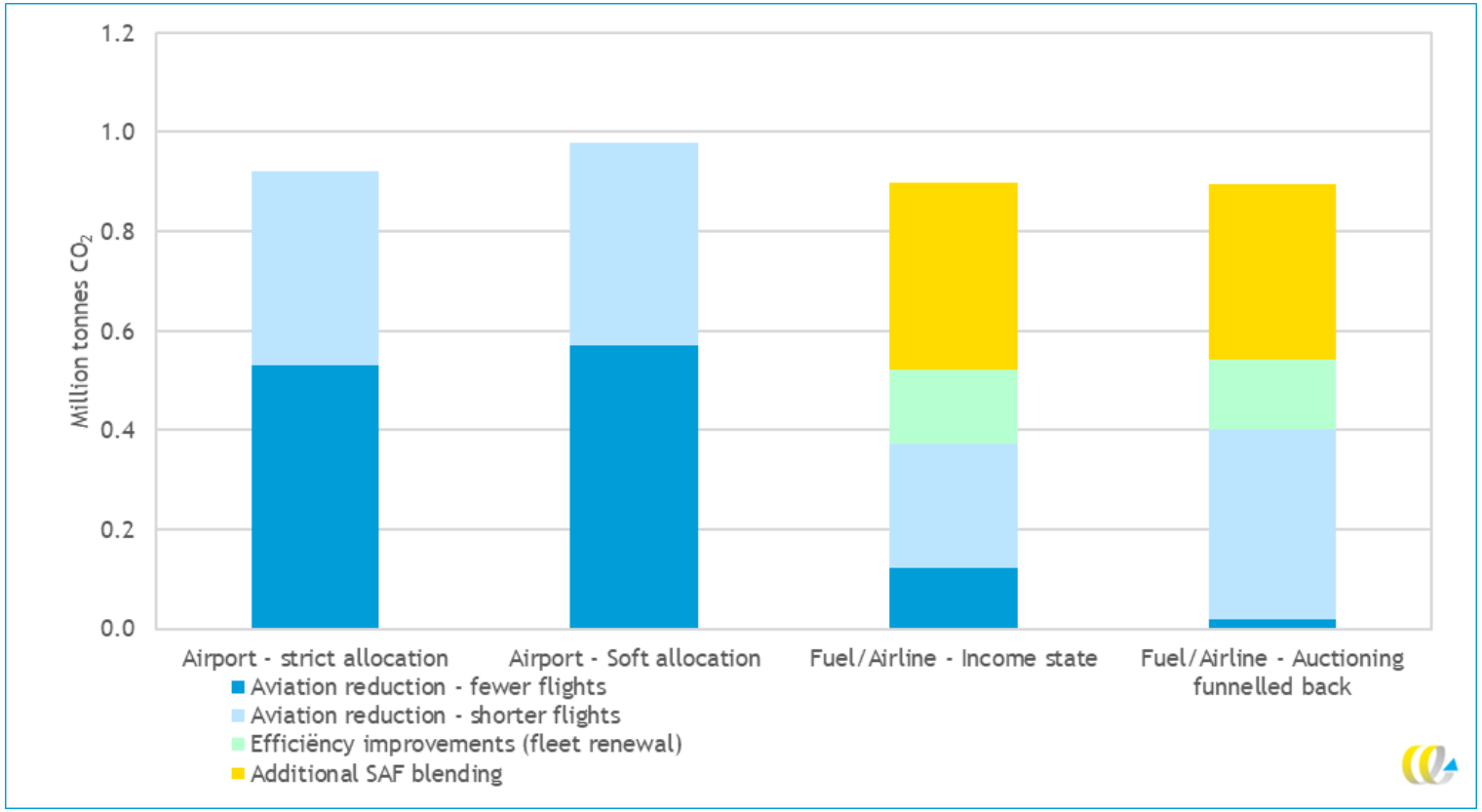
	Low demand	High demand	
Scenario	WLO Low	WLO High	
Low capacity *Schiphol: 440,000 constant* *Lelystad: no opening*	Baseline scenario 1	Baseline scenario 2	
Middle capacity 1 *Schiphol: 440,000 constant* *Lelystad: opening in 2025*	Baseline scenario 3	Baseline scenario 4	
Middle capacity 2 *Schiphol: 440,000 until 2029, after that growth based on noise reductions. Hard cap of 630,000 due to safety and operational restrictions.* *Lelystad: no opening*	Baseline scenario 5	Baseline scenario 6	
High capacity *Schiphol: 440,000 until 2029, after that growth based on noise reductions. Hard cap of 630,000 due to safety and operational restrictions.* *Lelystad: opening in 2025*	Baseline scenario 7	Baseline scenario 8*	Reference scenario
Status baseline emissions	Never above ceiling	5-15 years above ceiling	=> 15 years above ceiling

Baseline scenarios and quantification of the CO_2 ceiling

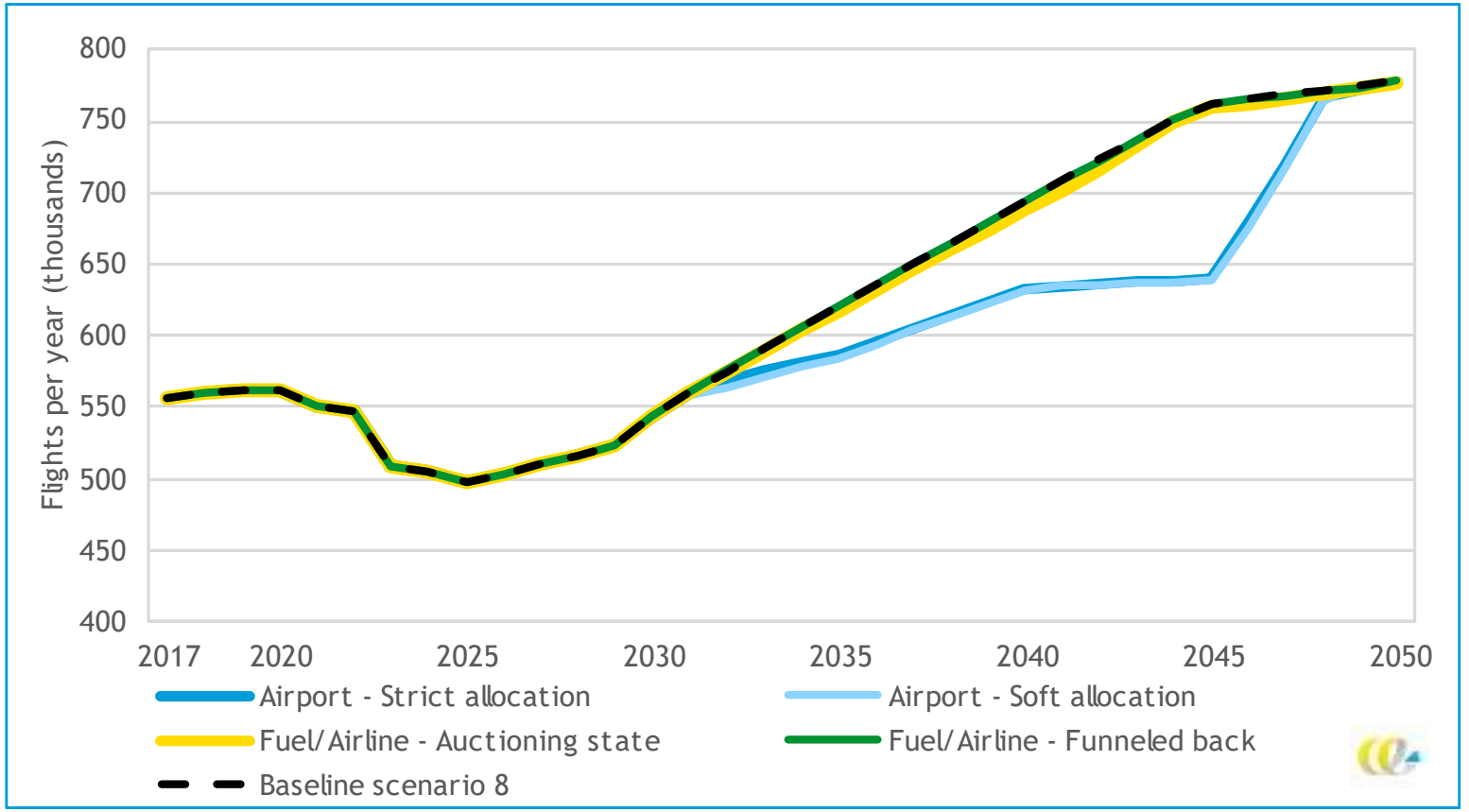
- For each baseline scenario, CO_2 emissions have been quantified



Options of airlines to reduce CO2 emissions

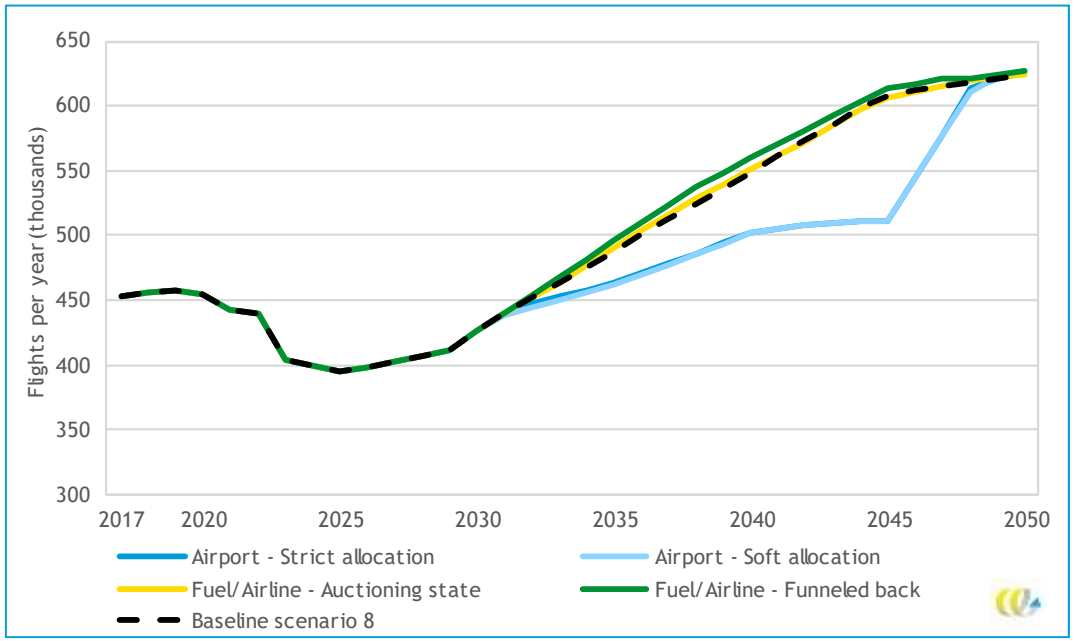


Effect om total number of flights

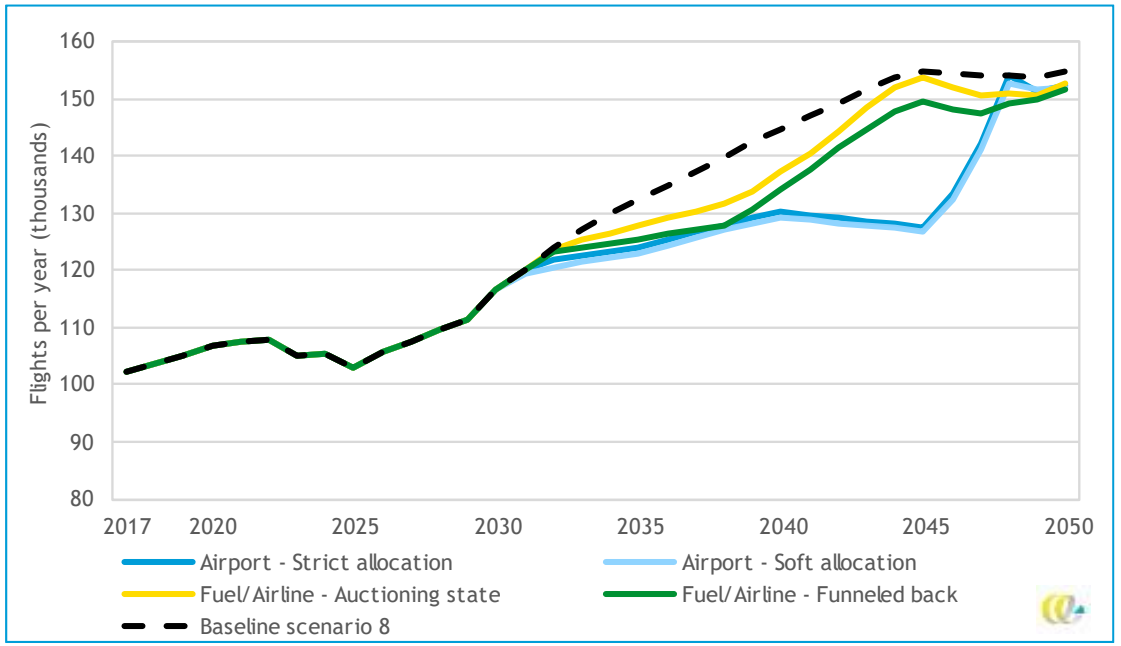


Effect on different types of flights (reference scenario)

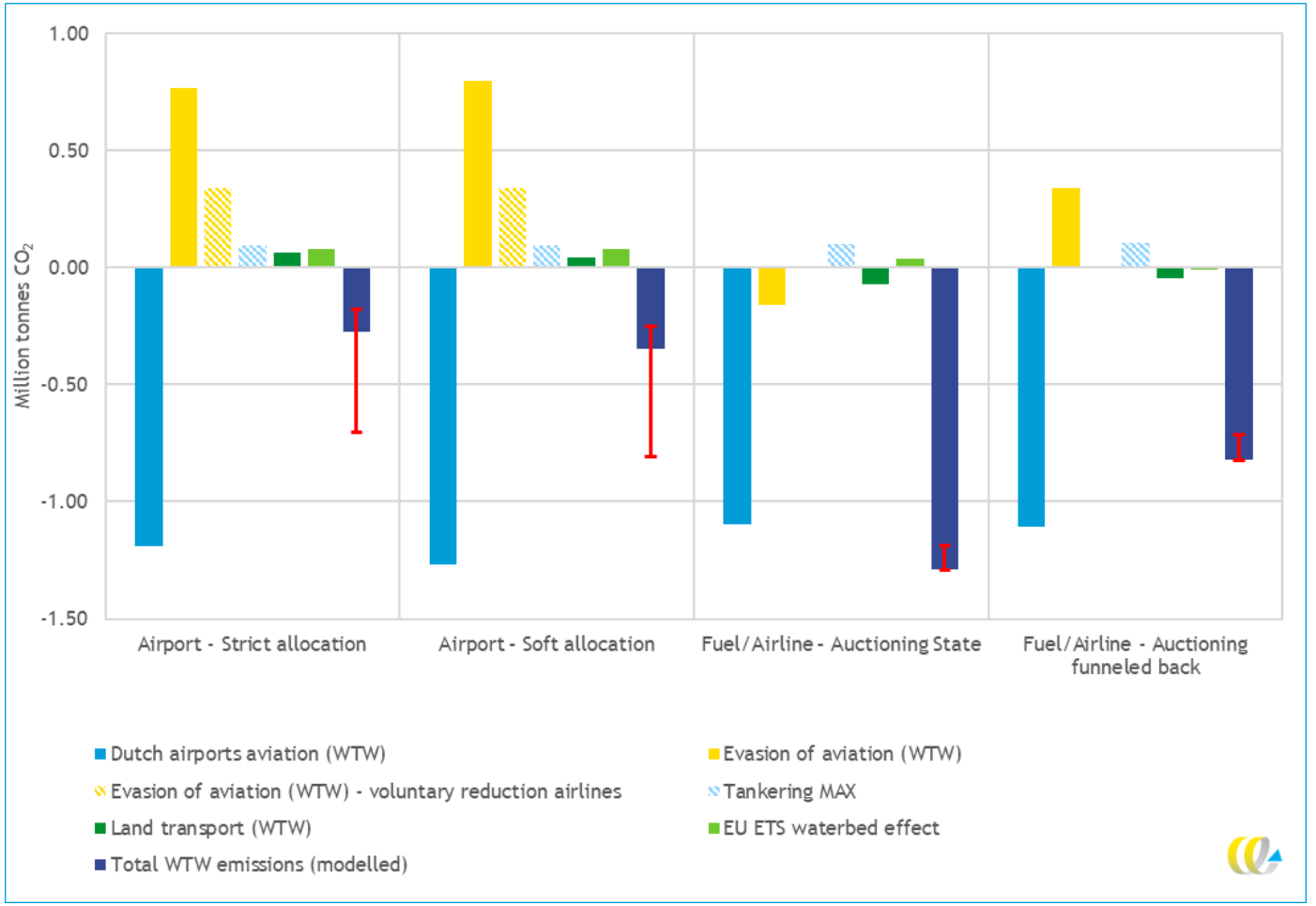
European destinations (EEA)



Intercontinental destinations



Change in CO_2 emissions



Multi criteria analyses

	Airport - Strict allocation (3-year cycle)	Airport - Strict allocation (1-year cycle)	Airport - Soft allocation (3-year cycle)	Fuel supplier - Auctioning state	Fuel supplier - Auctioning funnelled back	Fuel supplier - no stability	Airline - Auctioning state	Airline - Funnelled back
Certainty about aviation CO_2 emissions	+	0	+	0	0	0	0	0
Total climate impacts	+	+	+	++	++	++	++	++
Overall costs	0	0	0	0	-	0	-	-
Overall impact on the local environment of airports	++	++	++	+	+	+	+	+
Impacts on aviation sector	-	-	-	-	0	-	-	0

Design and effects of the ceiling

573 pages

Airports

- via slots

Fuel suppliers

- via sold kerosene

Airlines

- via emission permits

Design and effects of the ceiling

Airports

- via slots

And finally, the lawyers decided …

573 pages

Did you learn anything?

A. My neighbor just woke me up

B. Nothing new for me

C. I got a few new ideas

D. I would like to know more:

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