Environmental, Employment and Competitive Impacts of Market-Based Measures for the Limitation of Aviation's Full Climate Impact

WCTRS Conference, Karlsruhe, 10 October, 2014

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Knowledge for Tomorrow

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Outline

1. Background
2. Objectives of research
3. Modelling approach and main results
4. Conclusions

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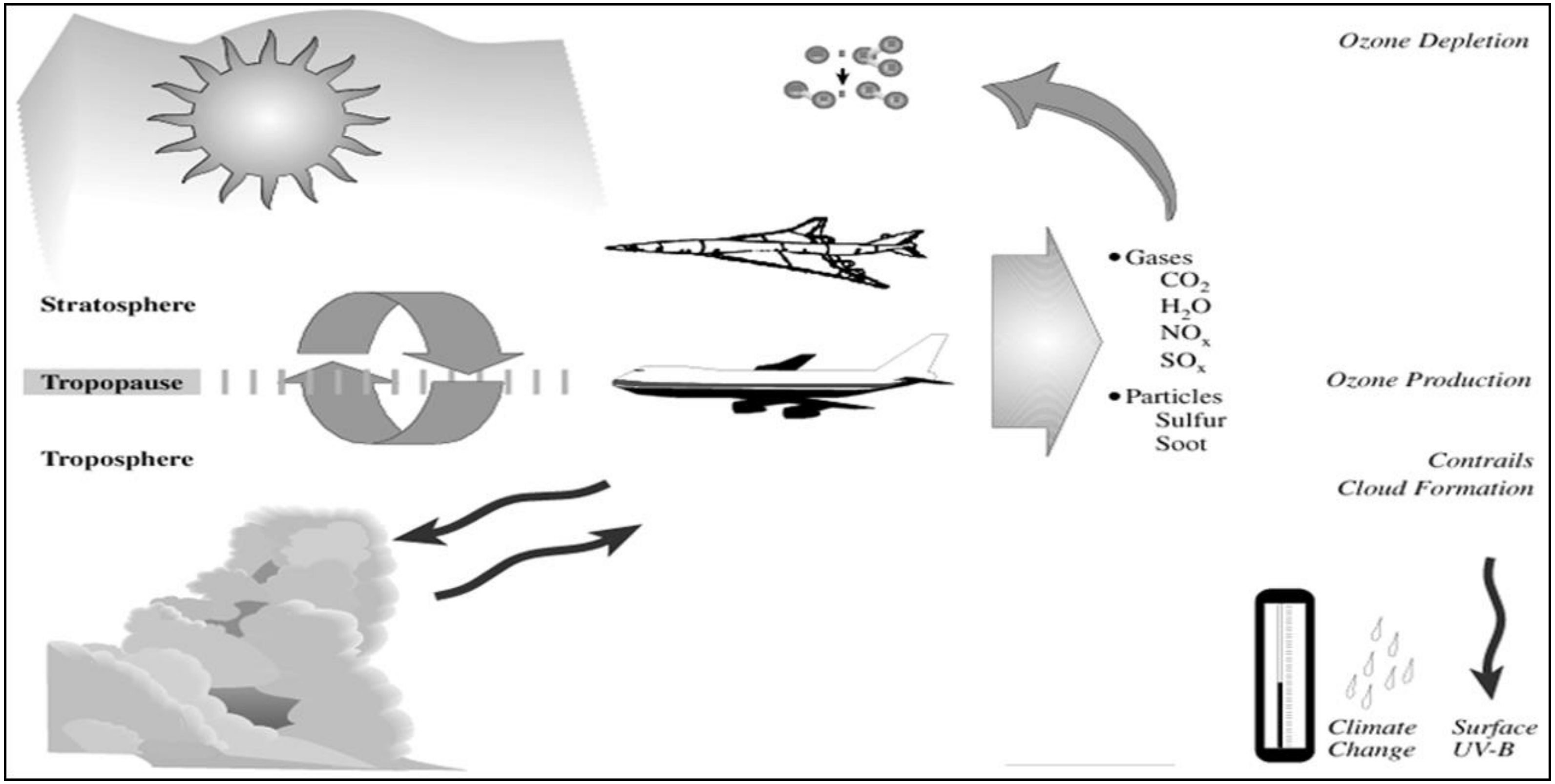
1. Background (1) Scientific Facts



Source: IPCC Special Report Aviation and the Global Atmosphere, 1999.

In 2005, aircraft-induced CO_2 contributed 1.6% to the total radiative forcing (RF). If the non-CO_2 climate effects are also considered, aviation's contribution to total anthropogenic RF is about three times as large, i. e., 4.9% (Lee et al., 2009).

1. Background (2) Political Facts

- Whilst aviation’s **carbon dioxide** emissions have been regulated in a number of countries by market-based measures (European Union, New Zealand) or will soon be regulated (China, South Korea), this is not the case for most of aviation’s **non-CO_2 climate impacts**.

- To complicate matters, the **international character** of aviation renders national approaches relatively ineffective and requires lengthy political negotiations on the international level. Here, both the International Civil Aviation Organisation (ICAO), as well as any supranational/international political institution of great regional importance such as the European Union will have to be involved.

- With regard to estimated average **future annual growth rates** of 4 – 5 per cent (Airbus, 2012), the implementation of a global scheme for the reduction of international aviation’s non-CO_2 impact on climate change seems to be necessary expeditiously.

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2. Objectives of research

In October 2011, the German Aerospace Center (DLR) started a three-year research project with the **overall goal**:

To explore the feasibility for addressing aviation's CO_2 and non-CO_2 climate impacts (aviation-induced clouds, NO_X emissions, water vapour emissions, etc.) by regulatory measures and to study the associated economic impacts. Especially the effects of aviation-induced clouds and NO_X emissions on high altitudes have not been investigated with this goal at this point.

Within the interdisciplinary research project **AviClim** (Including Aviation in International Protocols for Climate Protection) three DLR institutes are involved:

Institute of Air Transport and Airport Research, Institute of Propulsion Technology and Institute of Atmospheric Physics.

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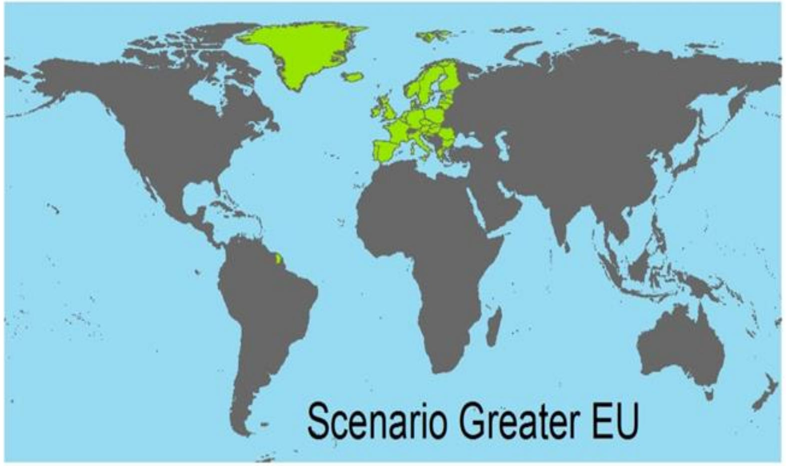
3. Modelling approach (1): Regulatory measures

Best options for **market-based and operational measures** for the reduction of all climate relevant species from aviation include:

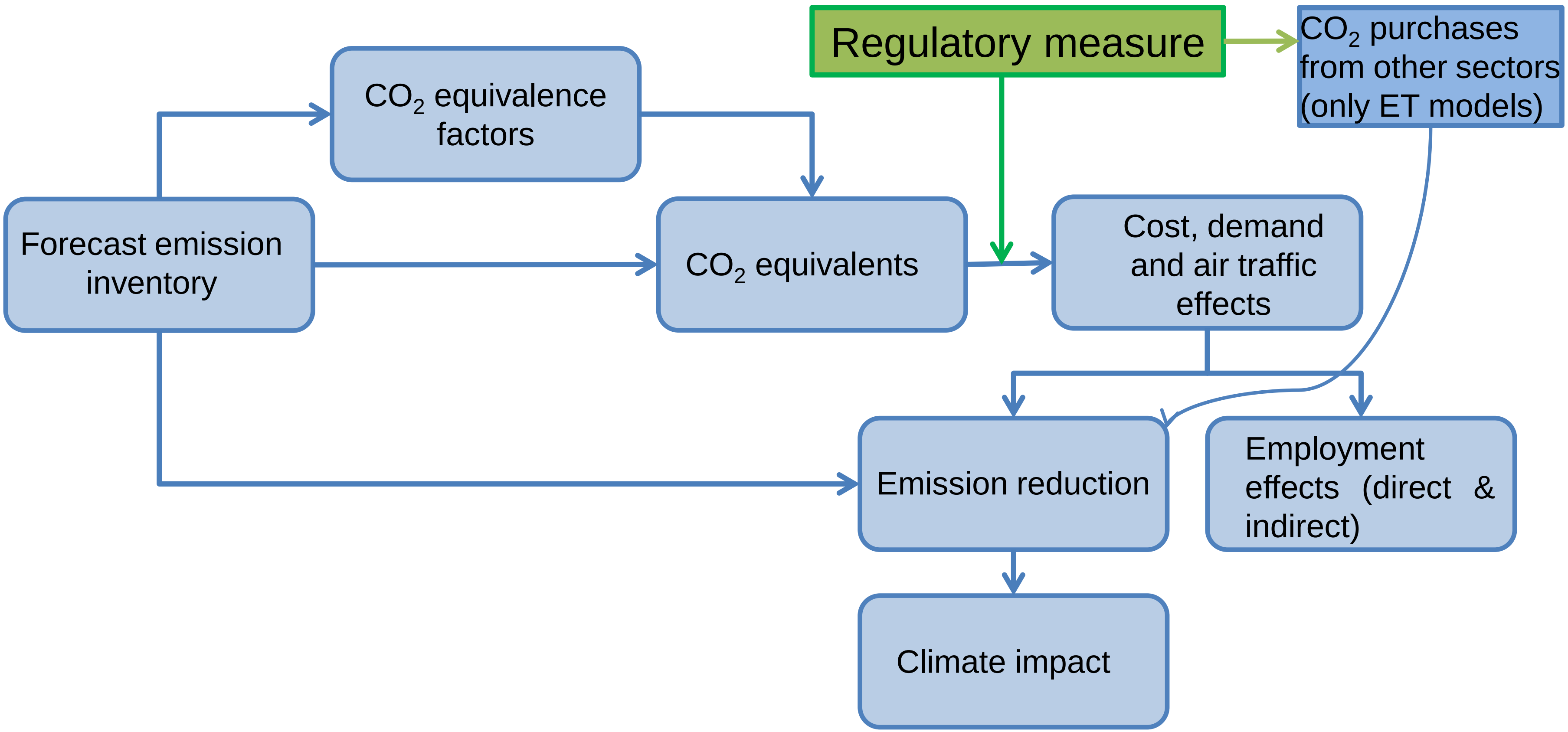
- **Climate tax** on all climate relevant species from aviation;
- **Climate charge** on NO_X emissions plus CO_2 emissions trading scheme combined with **climate-optimal flight trajectories** for the minimization of contrails (applied on 50% of flights between 30 and 60°N on an altitude between 9 and 12 km);
- Open **emissions trading** scheme on CO_2, NO_X, H_2O and contrails.

These measures have been selected in respect to economic efficiency, environmental benefits and practicability. They have been combined with **4 scenarios** which differ concerning the level of international support for these climate protecting measures.

3. Modelling approach (2): Scenario overview



3. Modelling approach (3): Model overview



3. Modelling approach (4): CO_2 prices and metrics

As the future development of prices for CO_2 equivalent is difficult to foresee, **three different price development paths** have been assumed alternatively:

1. Low Price Scenario: USD 10 (2010) to USD 30 (2030) per ton CO_2 equivalent;
2. High Price Scenario: USD 10 (2010) to USD 80 (2030) per ton CO_2 equivalent;
3. Mixed Price Scenario: USD 10 (2010) to USD 30 (2030) (ET models); respectively USD 80 (2030) (climate tax and NO_X charge) per ton CO_2 equivalent.

Also, **two different metrics** for quantifying aviation’s full climate impact have been considered alternatively: Average Temperature Response ‘atr 20’ and ‘atr 50’; ‘atr’ is the mean change in near surface temperature averaged over 20 and 50 years, respectively.

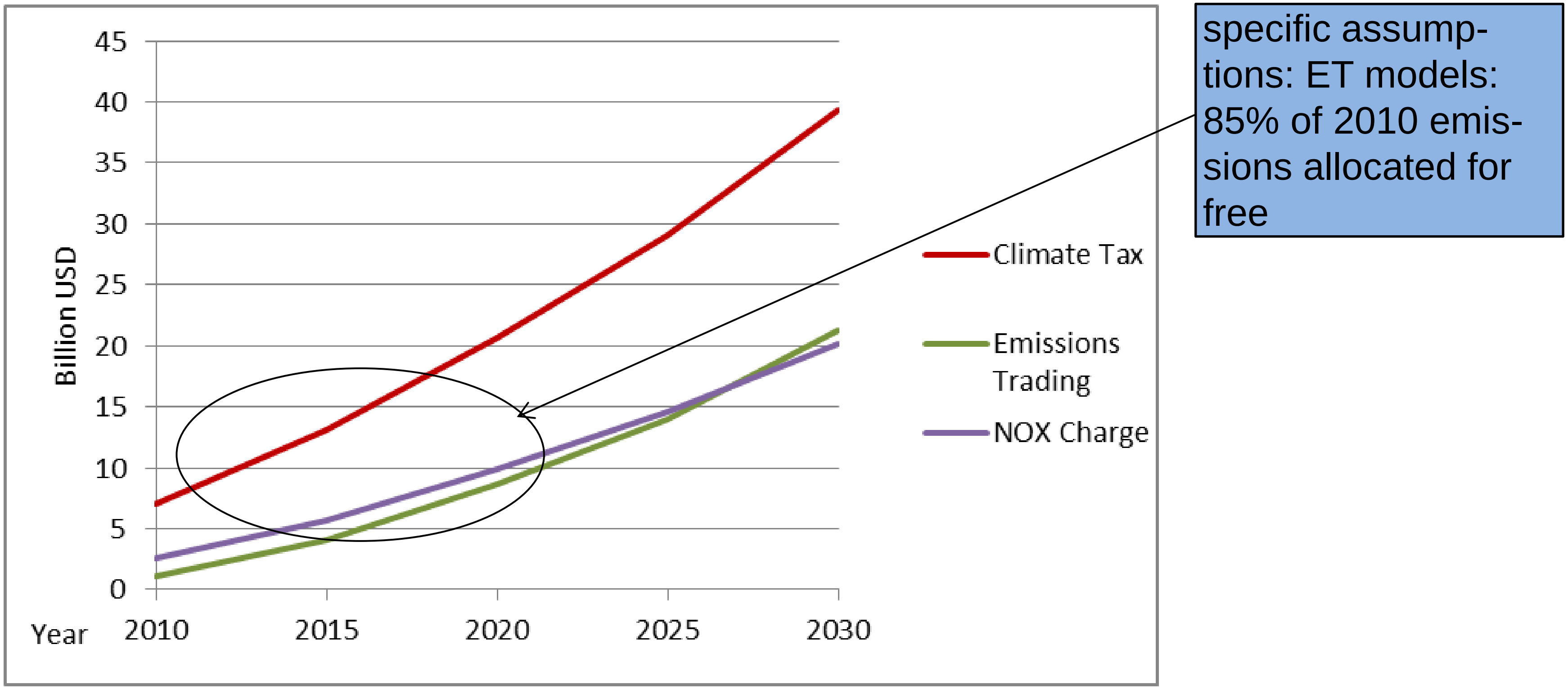
3. Modelling approach (5): Change in revenues

The costs for the market-based measures will lead to a **production cost increase** of the airlines regulated. Under the assumption that the airlines will try to pass-on the full cost increase to their customers, and will therefore act as profit maximizers, **prices for air services** will **increase**.

In general, the **demand reaction** to this price increase depends on the **price elasticities** of demand. As empirical data of the price elasticities of demand for air services shows a broad range of possible figures (Oum et al., 1990; Oum et al., 1992; Lu, 2009), **three cases** of price elasticities (E_D) have been analysed alternatively: case 1: $E_D = 1$; case 2: $E_D = -0.8$; case 3: $E_D = -2.1$.

3. Main results (1): Costs impact of political measures in USD billion

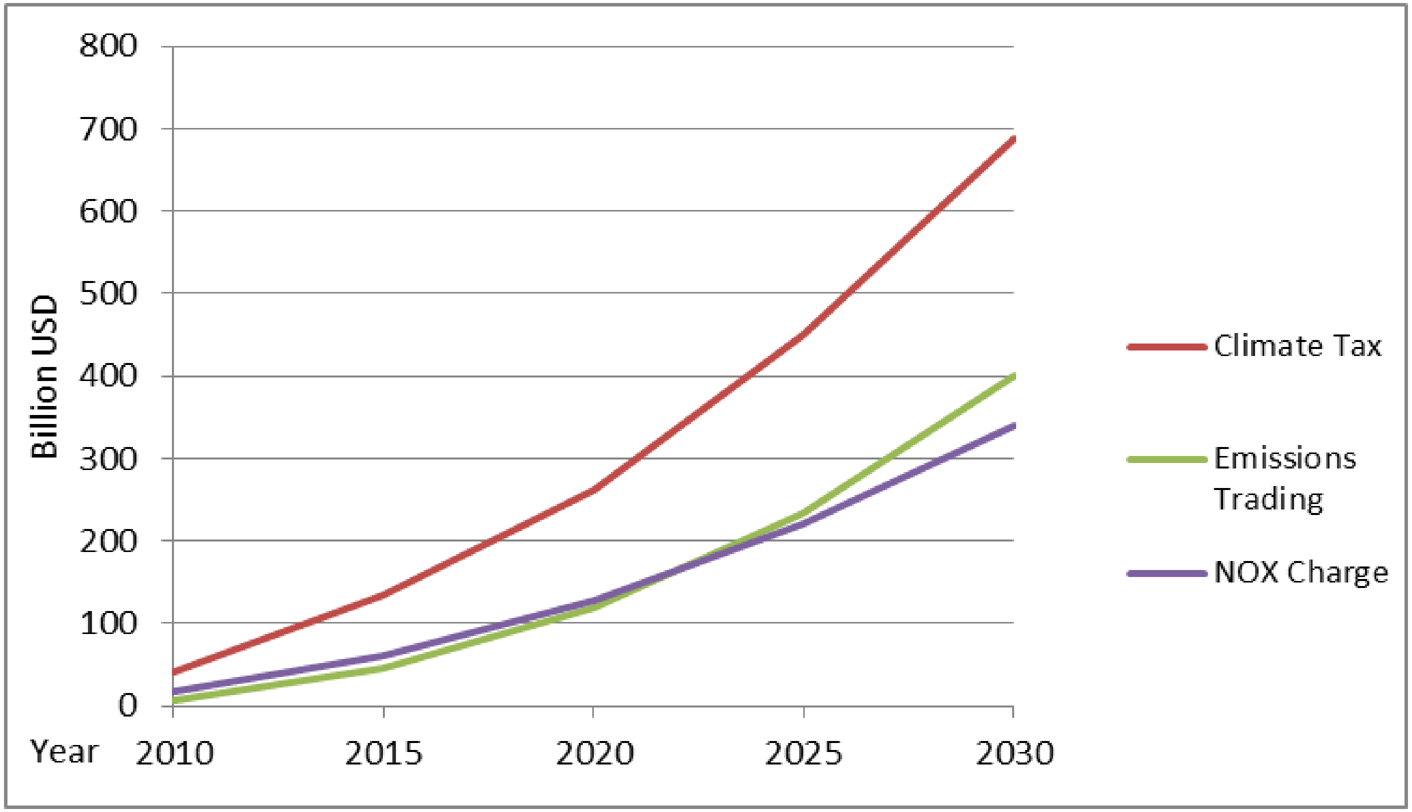
Scenario „Greater EU“, atr 50, Low Price Scenario



NO_X Charge includes CO_2 trading and operational measures.

3. Main results (2): Costs impact of political measures in USD billion

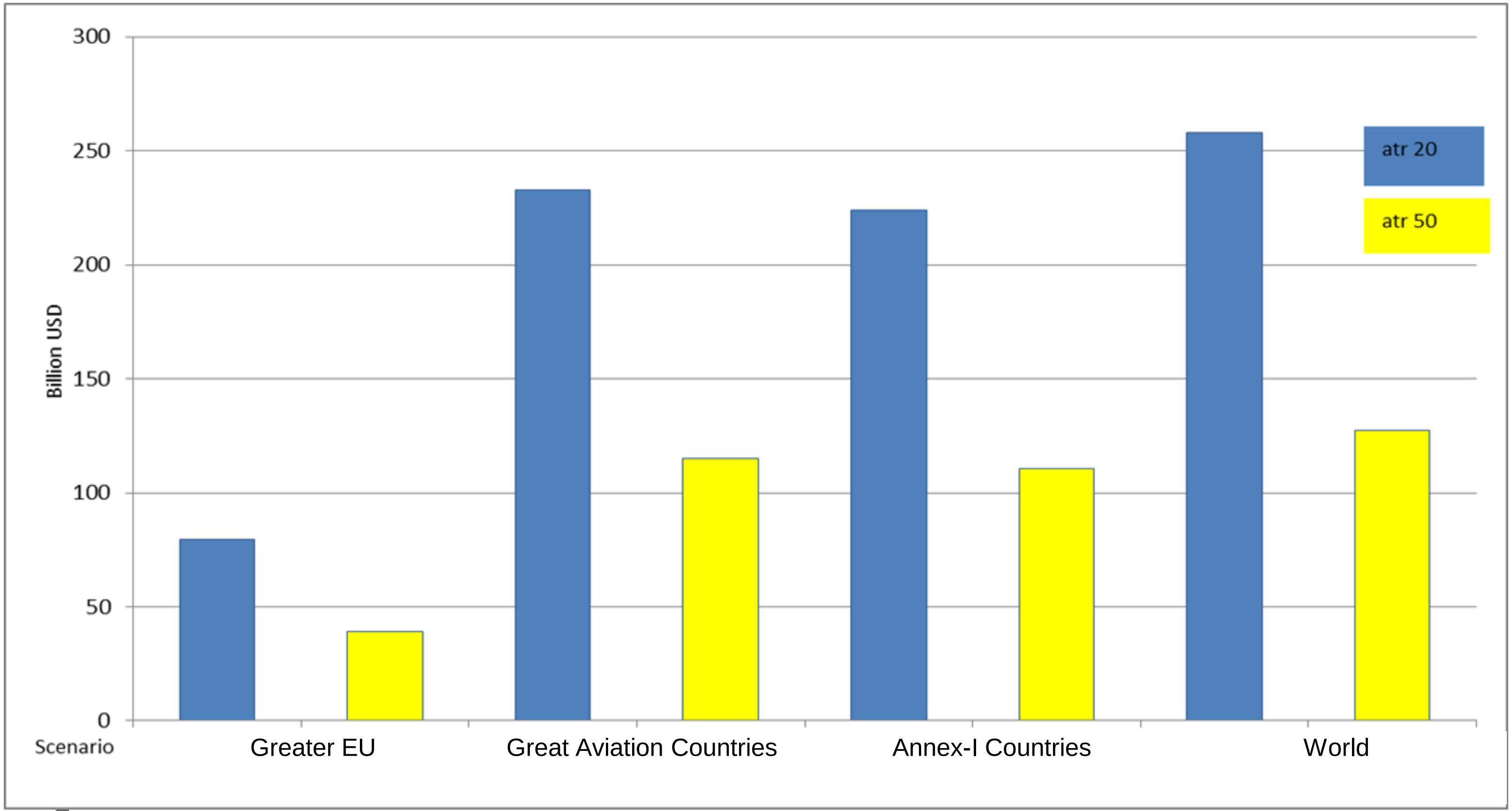
Scenario „World", atr 20, High Price Scenario



NO_X Charge includes CO_2 trading and operational measures.

3. Main results (3): Influence of metrics chosen on costs of climate tax in USD billion in 2030

Different geographical scenarios, Low Price Scenario



3. Main results (4): Competitive impacts – Total costs for selected airline groups, atr 50, Low P

LH: 90% RTK under MBM; UA: 18% RTK under MBM

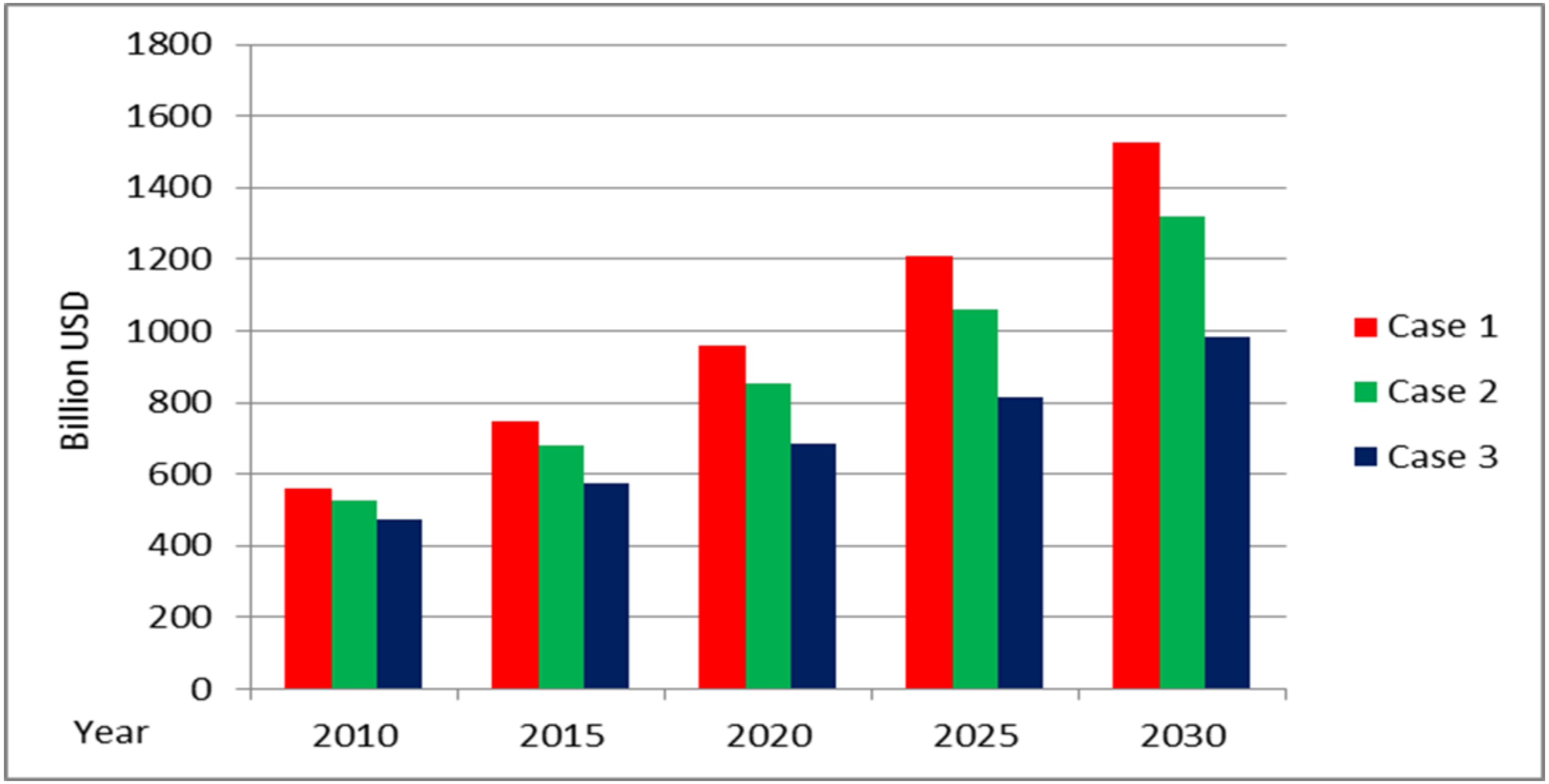
Scenario / Group of Airlines	Low Price Scenario, Costs i			
Emissions Trading all species	**2010**	**2015**	**2020**	**2025**	**2030**
Top 10 "Greater EU" Network Carrier	399	1696	3677	6513	8753
Top 10 Non-"Greater EU" Network Carrier	152	669	1451	2378	3647
Top 10 "Greater EU" LCC/Holiday Carrier	141	487	1001	1526	2193
Top 10 "Great Aviation Countries" Network Carrier	1040	3363	7753	12835	19600
Top 10 Non-"Great Aviation Countries" Network Carrier	155	816	1862	3143	4777
Top 10 "Great Aviation Countries" LCC/Holiday Carrier	242	819	1631	2481	3578
Top 10 "World" Network Carrier	982	4158	8892	14342	21533
Top 10 "World" LCC/Holiday Carrier	249	843	1680	2145	3693
Scenario / Group of Airlines	**Low Price Scenario, Costs in USD million**				
Climate Tax	**2010**	**2015**	**2020**	**2025**	**2030**
Top 10 "Greater EU" Network Carrier	2658	5085	8195	12160	15530
Top 10 Non-"Greater EU" Network Carrier	1013	1960	3173	4530	6230
Top 10 "Greater EU" LCC/Holiday Carrier	938	1682	2595	3518	4584
Top 10 "Great Aviation Countries" Network Carrier	6934	12204	19541	27569	37282
Top 10 Non-"Great Aviation Countries" Network Carrier	1036	2137	3622	5344	7418
Top 10 "Great Aviation Countries" LCC/Holiday Carrier	1613	2875	4372	5908	7690
Top 10 "World" Network Carrier	6546	10683	20020	28252	38225
Top 10 "World" LCC/Holiday Carrier	1661	2962	4504	5160	7929

3. Main results (5): Competitive impacts – Percentage of free allocation of emission permits for selected airline groups, atr 50

Scenario/Group of Airlines	2010	2015	2020	2025	2030
Top 10 "Greater EU" Network Carrier	85 %	67 %	56 %	49 %	45 %
Top 10 Non-"Greater EU" Network Carrier	85 %	64 %	52 %	46 %	40 %
Top 10 "Greater EU" LCC/Holiday Carrier	85 %	71 %	62 %	57 %	53 %
Top 10 "Great Aviation Countries" Network Carrier	85 %	69 %	58 %	51 %	46 %
Top 10 Non-"Great Aviation Countries" Network Carrier	85 %	63 %	50 %	43 %	37 %
Top 10 "Great Aviation Countries" LCC/ Holiday Carrier	85 %	71 %	63 %	58 %	54 %
Top 10 "World" Network Carrier	85 %	66 %	55 %	49 %	43 %
Top 10 "World" LCC/ Holiday Carrier	85 %	71 %	63 %	58 %	54 %
Average	85 %	68 %	57 %	51 %	47 %

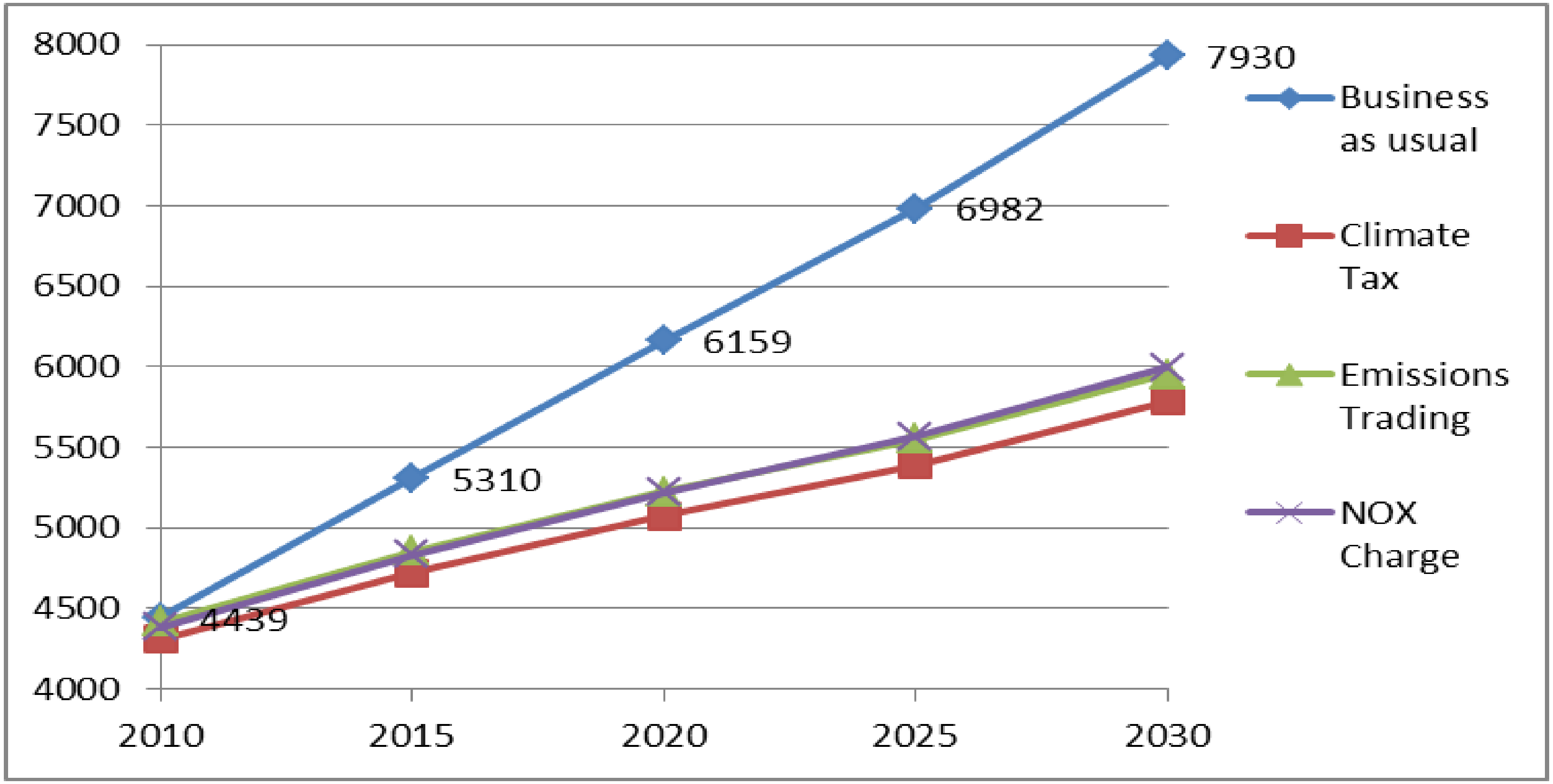
3. Main results (6): Revenue impact of climate tax in Scenario "World", atr 20, Low Price Scenario

Demand reaction according to cases 1 – 3; case 1 is identical to Business-as-usual development



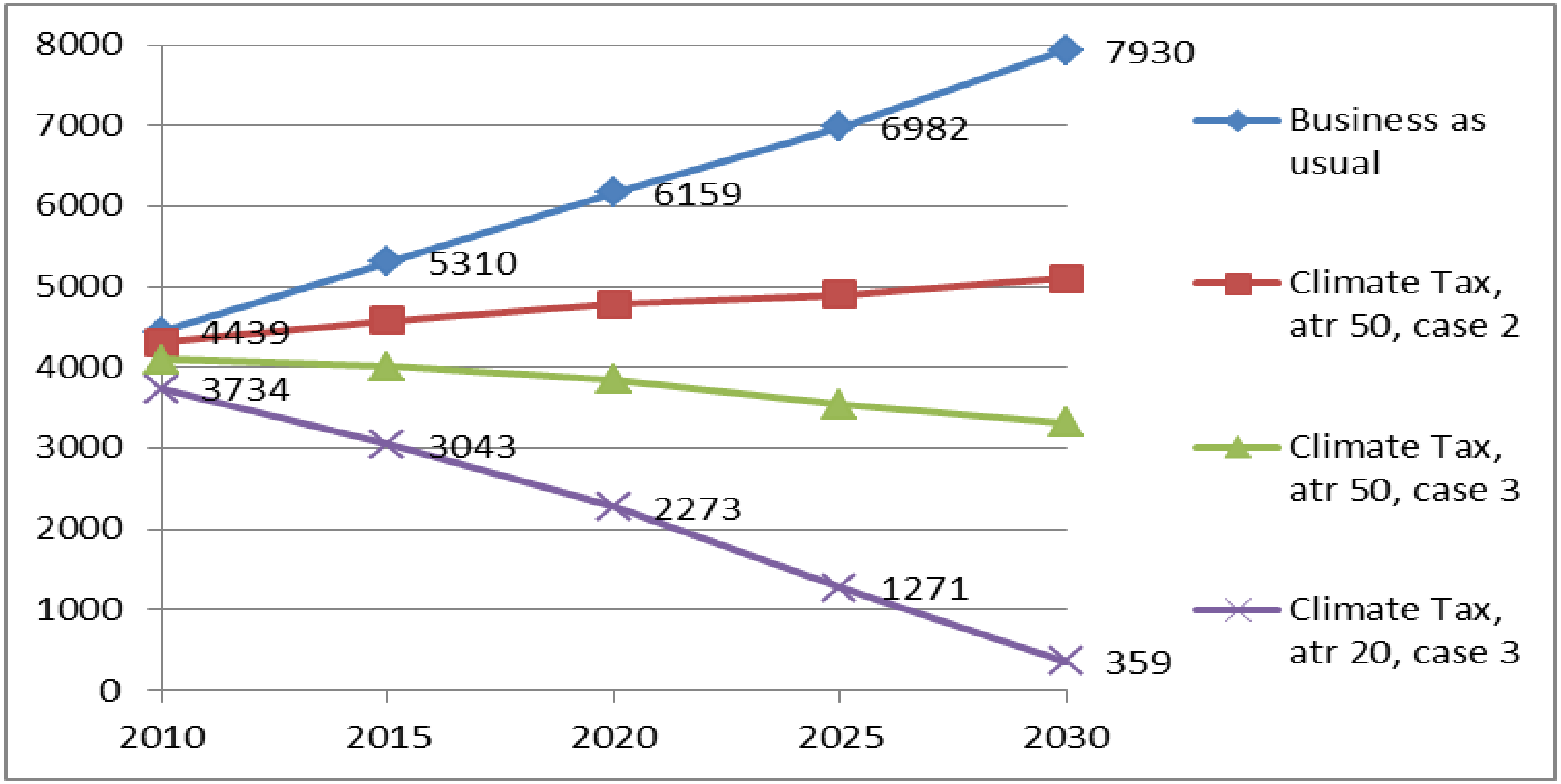
3. Main results (7): Employment impact, Low Price Scenario

Development of direct and indirect employment in the aviation sector, Scenario "World", atr 50, Low Price Scenario, moderate price elasticity of demand (case 2), in 1,000 employees



3. Main results (8): Employment impact, High Price Scenario

Development of direct and indirect employment in the aviation sector, Scenario "World", atr 50 and atr 20, Climate Tax, High Price Scenario, price elasticities of demand case 2 and case 3, in 1,000 employees



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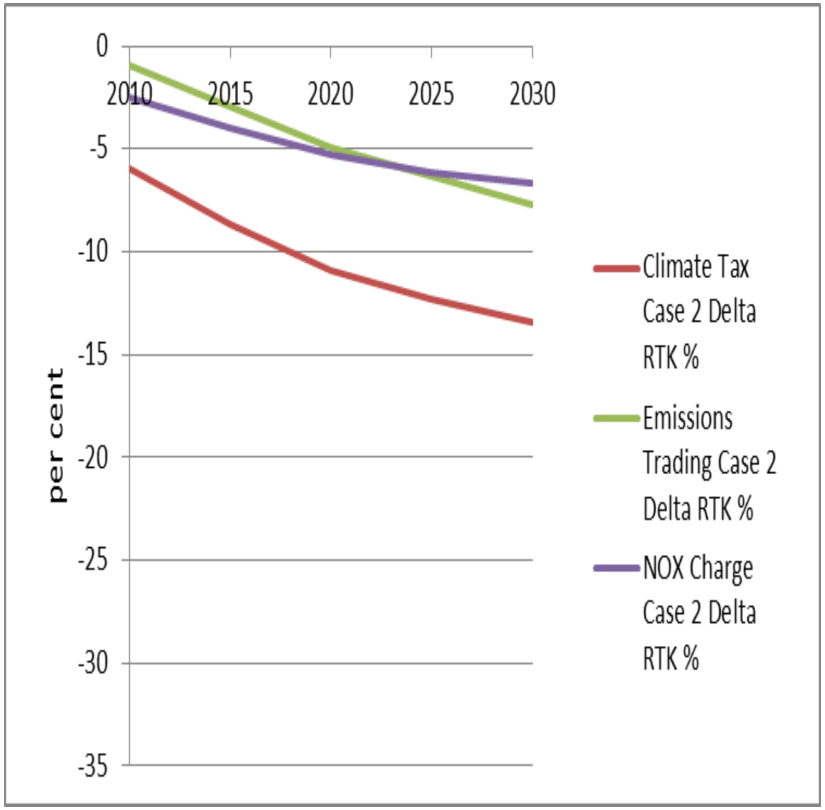
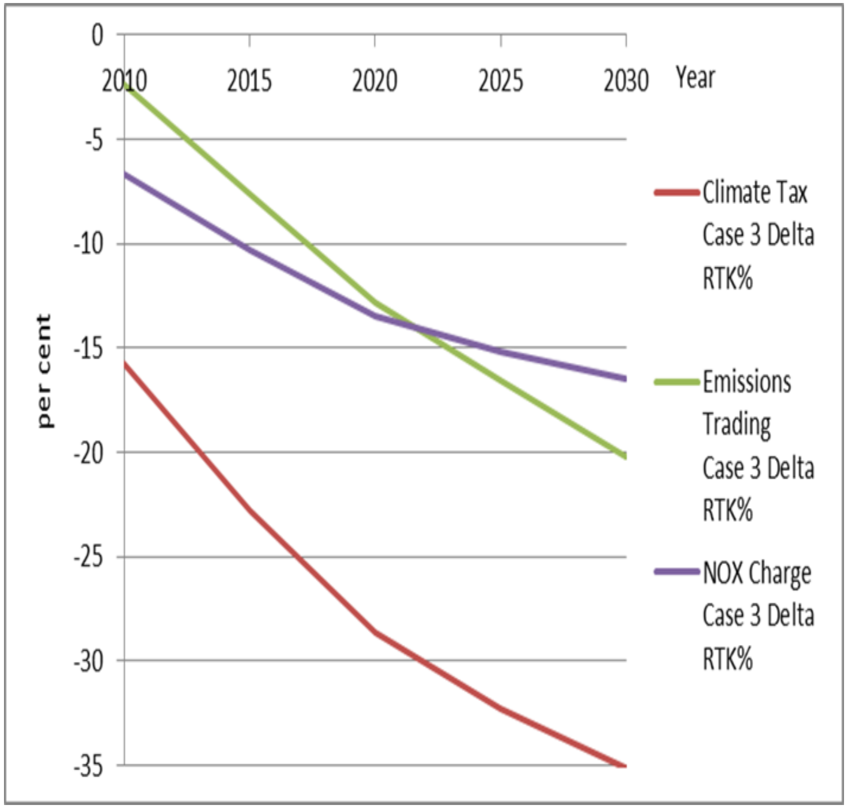
3. Main results (9): Development of air traffic

Scenario „Great Aviation Countries“, atr 20, Low Price Scenario, Case 2 and Case 3 demand reaction, in per cent compared to Business-as-usual Scenario





NO_X Charge includes CO_2 trading and operational measures.

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3. Main results (10): Change in fuel consumption

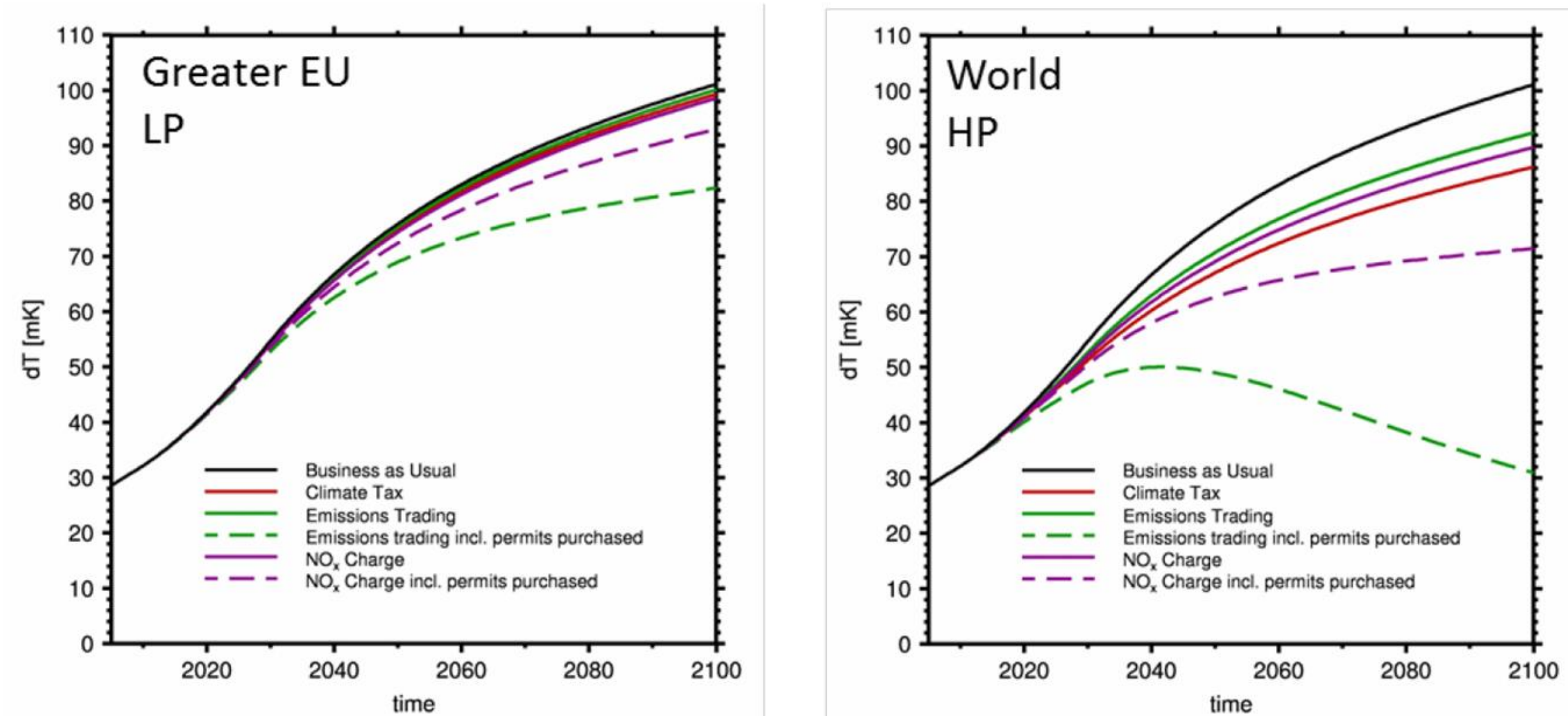
Change in global fuel consumption in per cent compared to Business-as-usual Scenario, Case 2 demand reaction, atr 50, in the year 2030

Low Price Scenario	„Greater EU“	„Great Aviation Countries“	„World“
Climate Tax	-1.8%	-5.9%	-6.7%
Emissions Trading	-0.9%	-3.4%	-3.9%
NO_X charge	-0.6%	-1.9%	-2.2%
High Price Scenario	**„Greater EU“**	**„Great Aviation Countries“**	**„World“**
Climate Tax	-5.1%	-15.8%	-17.8%
Emissions Trading	-2.7%	-9.2%	-10.4%
NO_X charge	-2.4%	-6.5%	-7.4%

NO_X Charge includes CO_2 trading and operational measures.

3. Main results (11): Development of temperature change

Scenario „Greater EU“, Low Price Scenario, and Scenario „World“, High Price Scenario, demand reaction case 2, metric atr 50, compared to Business-as-usual Scenario temperature development



NO_X Charge includes CO_2 trading and operational measures.

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4. Conclusions (1)

From an **environmental point of view**, the limitation of aviation's both CO_2 emissions and non-CO_2 species seems to be necessary urgently. The climate impact from the non-CO_2 species is in the range of the impacts from CO_2. Depending on the timeframe under consideration, the impact from the non-CO_2 species can even be greater.

AviClim modelling results indicate that under the assumptions explained above, a **global emissions trading scheme** for the political regulation of both CO_2 and non-CO_2 emissions from aviation would be the best solution from an economic and environmental point of view. The second-best solution would be the combination of both marked-based and operational measures.

4. Conclusions (2)

Under a **global emissions trading scheme, costs and impacts on competition** could be minimized and effects on employment are moderate. At the same time, **environmental benefits** are significant. The possibility to purchase emission permits from other sectors (so-called “open emissions trading scheme”) is important for the positive outcome.

Even though the introduction of a global measure would be the best solution, AviClim results show that the introduction of such measures by the “**Great Aviation Countries**” or the “**Annex-I-Countries**” would lead to almost the same environmental and economic results. This approach would probably be much easier to implement on a political level.

Thank you very much for your attention!