Institute for Transport Studies
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Emission trading and other incentives for reducing climate impacts from aviation

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WCTRS International Conference “Climate Change and Transport”,
Karlsruhe, 9th, 10th October 2014

ITS

Content

- Background – The Problem of Aviation Emissions
- Emission Reduction Potentials
- Emission Trading & Aviation
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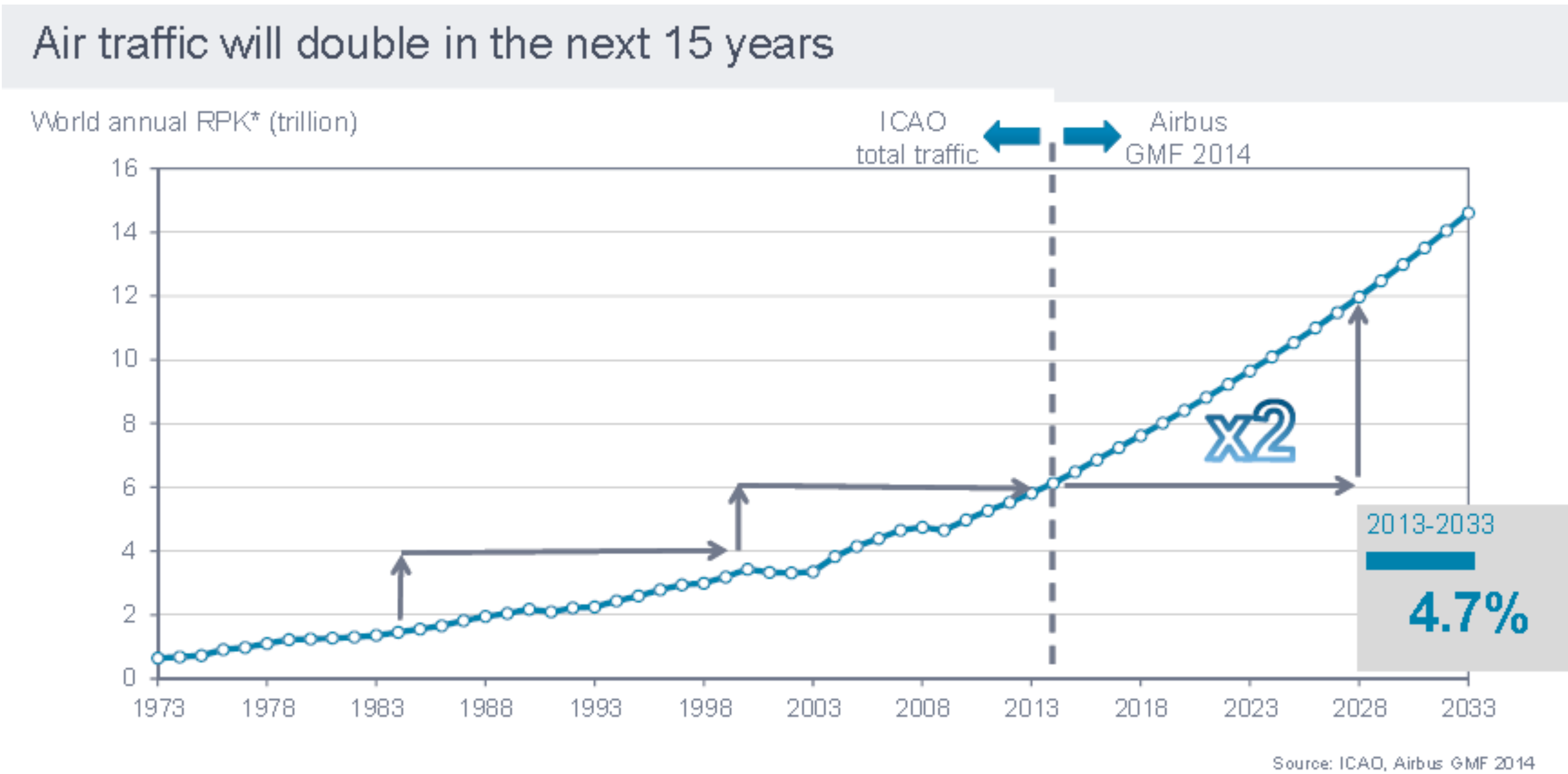
- Evaluation & Conclusions

GHG Emissions from Aviation

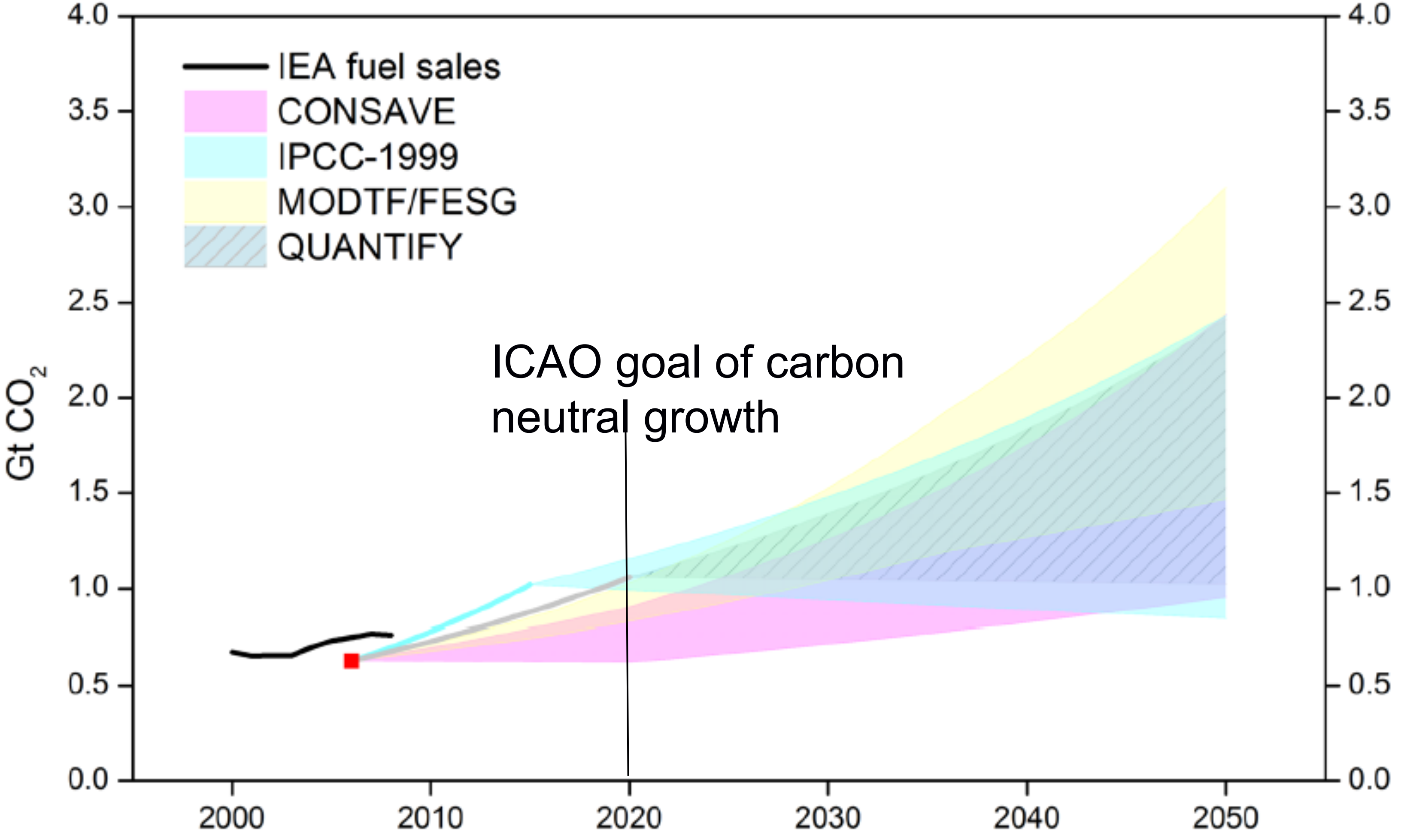
- 2.3 % of global anthropogenic CO_2 emissions (Lee et al., 2009)
- further climate impacts from other GHGs (NO_x, PM, CH_4, contrails) ~ 4.9% of total anthropogenic radiative forcing (Lee et al., 2009)
- major part from international aviation (> 60%); as a 'country', would be 17th largest emitter of CO_2 (CDIAC data, Boden et al., 2013, cited in Lee et al. 2013a)
- previous gains in fuel efficiency have been offset by strong growth in air transport demand
- further strong growth expected

Air Traffic Growth Forecasts



Source: Leahy 2014, p. 13

Future CO_2 Emissions from EU Aviation



Lee et al., 2013b, p. 3

Will improvements happen? The Policy Gap

- Emissions from international aviation not included in Kyoto protocol
- These fall under responsibility of ICAO "to limit or reduce"
- ICAO targets (37th Assembly 2010):
  - 2% fuel efficiency improvement until 2020
  - 2% p.a. fuel efficiency improvement 2021-2050
  - carbon neutral growth from 2020
- Other proposed targets:
  - stabilisation at 2005 levels from 2050
  - -10% of 2005 levels by 2050

How should this be accomplished? 'Four Pillar' approach

- **Technological improvements:**
  - Aircraft renewal and replacement
  - Retrofitting aircraft
  - Alternative fuels
- **Infrastructure** for improved ATM and airport operations
- Improved (more efficient) air **operations**
- **Market-based measures**

Technological Measures Renewal and Retrofit

- Technological measures for improvements to **energy efficiency** (fuel burn per ASK) of new aircraft
- **Restrictions**: Product life cycles 20-30 years; Efficiency improvements 15-20% above previous generation to be worthwhile for investment
- **Past improvements** to energy efficiency ~1.4% to 3% p.a.
- Includes measures to **Airframe** (Aerodynamics, Materials / Weight, Size / Seating) & **Engines** & **Auxilliaries**

Best case:

- Availability of **new designs** such as open rotor engines deployed 2020
- **Radically new designs** such as Blended Wing Body, use of fuel cells available ready for deployment past 2030 and largely complete by 2050

Reduction Potentials for Renewal and Retrofit of Aircraft

Timelines and examples of technologies	Impact
Retrofits	**7-13%**
▪ Winglets mounted on the wingtips of aircraft improve aerodynamics and reduce fuel burn ▪ More advanced engine components for better combustion and airflow ▪ Lighter materials for furnishing in the cabin ▪ Less energy-consuming lighting and in-flight entertainment	
Production Updates	**7-18%**
▪ More airframe structure components made of lightweight composite material instead of aluminium ▪ Advanced engines for current aircraft production series	
New aircraft design before 2020	**25-35%**
▪ Geared turbofan engine will reduce fuel burn 10-15% ▪ Open rotor engine will reduce fuel burn around 25% ▪ Counter-rotating fan will reduce fuel burn 10-15% ▪ Advanced turbofan will reduce fuel burn around 15% ▪ Laminar flow reduces aerodynamic drag by reducing turbulence on aircraft surface, 10-15% less fuel burn	
New aircraft design after 2020	**25-50%**
▪ Blended wing body, rather than the classical tube-and-wing architecture ▪ Revolutionary engine architectures ▪ Fuel cell system for on-board energy	

IATA, 2009, p. 4

Sustainable Fuels: Biofuels

- Fuels must be **sustainable** and **compatible** with **existing** aircraft technology, no radically new systems by 2050
- Based on **top down** estimates:
  - **Sustainable Aviation**: Lower carbon sustainable biofuels deployed from 2020, full market penetration by 2030, then 10% life cylce reduction
  - **IATA**: Biofuels from 2^{nd} / new generation biomass; use as drop-in already possible; assumes availability of a 6% mix 2^{nd} generation 2020; target of using 10% alternative fuel by 2017
- **Reduction Potential:** 2020: **5%**; 2050: **10%**

Improved ATM and Airport Operations

- **Aim** to reduce delays, shorten routes and reduce inefficiencies,
- Includes measures improving the **infrastructure** for air traffic management and at airports allowing more efficient operations e.g.
  - **ATM**: Reducing (restricting) flight altitudes (+CO_2), reduced vertical separation minimum (RSVM), optimisation of cruise altitudes, Reduction of delays and holding patterns, Earlier climb to higher altitudes, **SESAR** (more flexibility in route choice and reduction of delays)
  - **Airport**: Airport CDM; Reduction of taxiing / idling: (potential rebound effect); Increased use of ground power units for aircrafts parked at airports; Clean fuel operated ground support equipment; Avoidance of delays through more efficient planning and use of airport capacities / terminals
- **Reduction Potential**: 2020: **4%**; 2050: **12%**

Improved Air Operations

- **Air operators** apply measures to reduce fuel burn through improved operational procedures
- **Aim**: reduce fuel burn per RPK
- **Measures included**:
  - reduced APU usage,
  - more efficient flight procedures (flight planning)
  - reduction of weight (minimise embarked/ contingency fuel, optimisation of voluntary extra fuel transportation, optimal configuration of the fuel system (aircraft Centre of Gravity optimisation), avoidance of excess weight
  - increase of load factors (steady increase in past; 75% Passenger LF in 2008)
- **Reduction Potential:** 2020: **3%**; 2050: **6%**

And what about MBM

- Proposed Market-based mechanisms
  - Carbon offsetting (with / without revenue generation)
  - Emission trading
- Voluntary, open emission trading system or carbon offsetting favoured
- Lack of agreement on a global measure

⇨ EU decided to include aviation in EU ETS

The European Emission Trading Scheme

EU ETS operational since 2005, now in third phase 2013-2020

Covers currently six key industries – energy, steel, cement, glass, brick making and paper/cardboard (around 45% of GHG emission); aviation in EU airspace included

Cap and trade system; EU Member states issue National Allocation Plans

Uses mix of free allocation based on benchmarking and auctioning (now 40% and increasing)

Aviation and European ETS – Original Proposal

- Aviation in **European ETS** from 2012;
- All flights with origin or destination in EU included
- **Allocations** for emissions from the aviation sector capped at 97% of historical emissions (2004-2006), from 2013 falling to 95% onwards till 2020
- 82% of aviation allowances **freely allocated**, 15% **auctioned** off (rest 'special reserve')
- **Open** system; **CO_2** only

‘Stop the Clock’ and Renegotiations

- International opposition due to perceived infringements on sovereignty
- Progress at ICAO towards a global measure in 2012

⇨ EU suspended enforcement for non intra-EEA flights for 1 year: **‘Stop the Clock’**

- ICAO 2013 decision to develop a global MBM for aviation, for decision at the next meeting of the ICAO Assembly in 2016 and to be implemented from 2020
- After renegotiations now an intra-EEA scheme, review in 2016, potential fall back to original proposal

Future: A Global ETS for Aviation?

Three options explored by ICAO

A. Offsetting scheme (baseline and credit system)
B. Offsetting with revenue generating element (additional charge to support environmental mitigation projects)
C. A global ETS (‘non-discriminatory’, ‘non-distortive’)

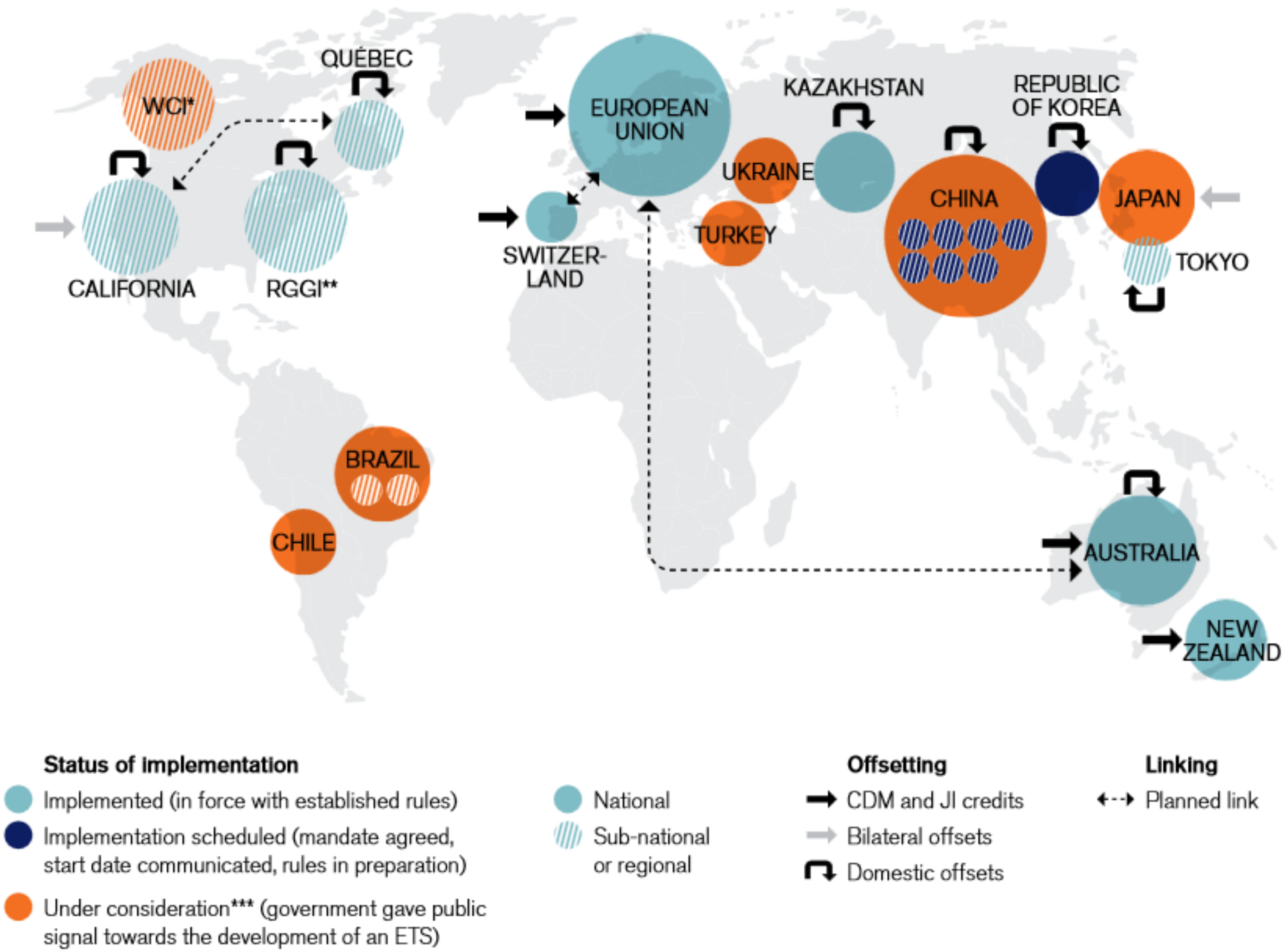
A.) considered easiest to implement, but least environmentally effective

Implementation Issues for Tradable Permits

- Market configuration (should be deep and competitive)
- Transaction costs to trading companies
- Abatement options (short / long term, availability)
- Monitoring and enforcement costs
- Timelines of decision making (Banking / Borrowing allowed)
- Interaction with other regulation instruments, e.g. existing carbon taxes
- Availability of revenues for governments

Proposed and Existing Trading Schemes

Source: World Bank. 2013. *Mapping carbon pricing initiatives 2013 : developments and prospects*. Washington DC ; World Bank Group. http://documents.worldbank.org/curated/en/2013/05/17924477/mapping-carbon-pricing-initiatives-2013-developments-prospects



Linking of / with Regional Schemes ?

Potential benefits

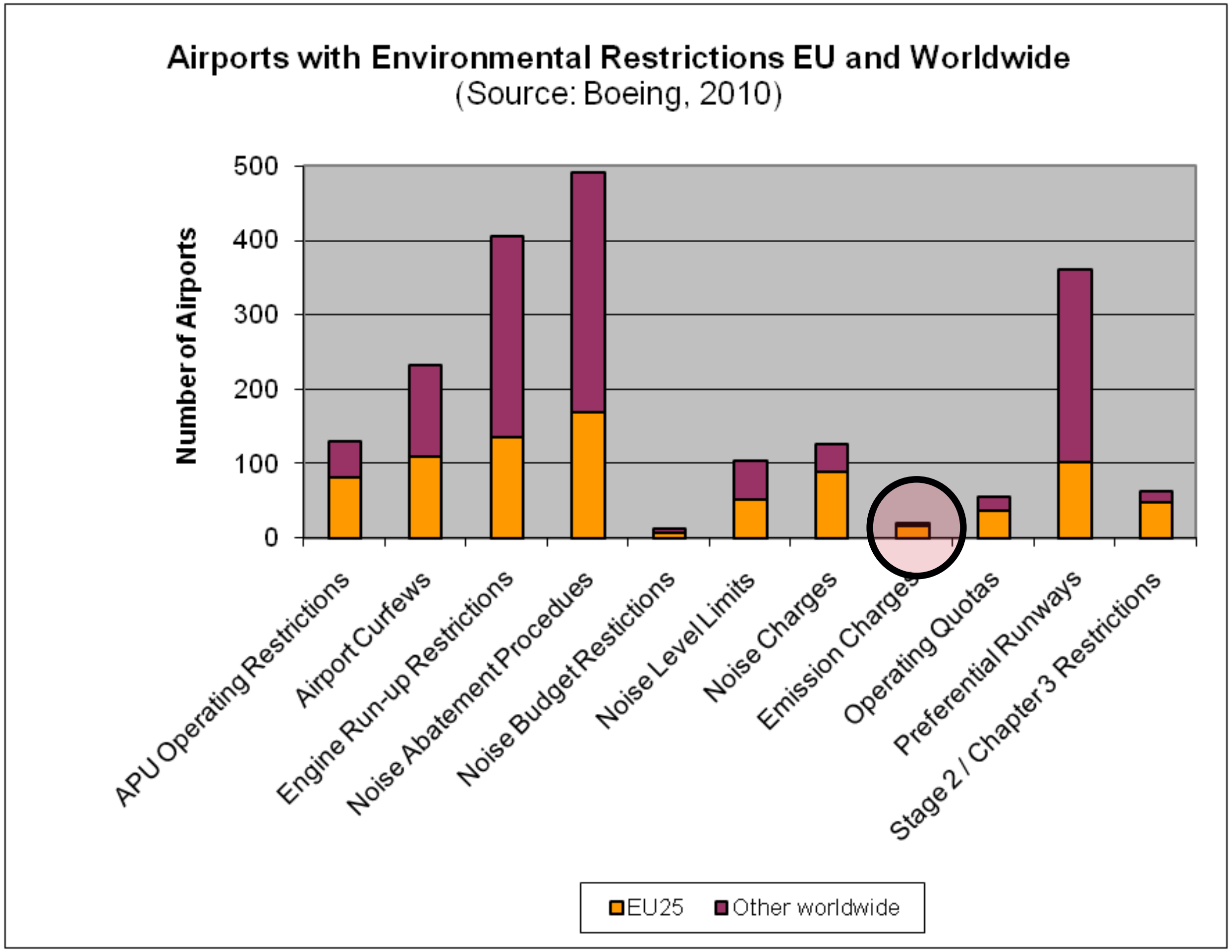
- Greater stability and predictability
- Higher economic efficiency (reduced abatement costs)
- Reduced potential for economic distortions
- Reduced transaction costs & complexity for participants

- **Obstacles**
  - Different political ambitions
  - Different enforcement provisions
  - Different sectoral coverage
  - Different allocation mechanisms
  - Political control / governance

Alternatives:
Environmental Charges & Carbon Taxation

- Increasing number of airports apply emissions or noise differentiated charges
- Some countries apply air passenger duties (e.g. UK, Germany) or removal of VAT tax exemptions on domestic flights
  - fixed by type / destination of flight
- Needs to be cost-effective, non-discriminatory
- Regional equity impacts if applied unilaterally
- Could be used to fund mitigation measures
  (e.g. fleet replacement, Dray et al., 2014)

Existing Environmental Regulations at Airports



Tradable Permits versus Carbon Taxation

Under some idealised conditions, ‘polluter-pays’ taxes can lead to equivalent level of pollution as tradable permits (Baumol and Oates)

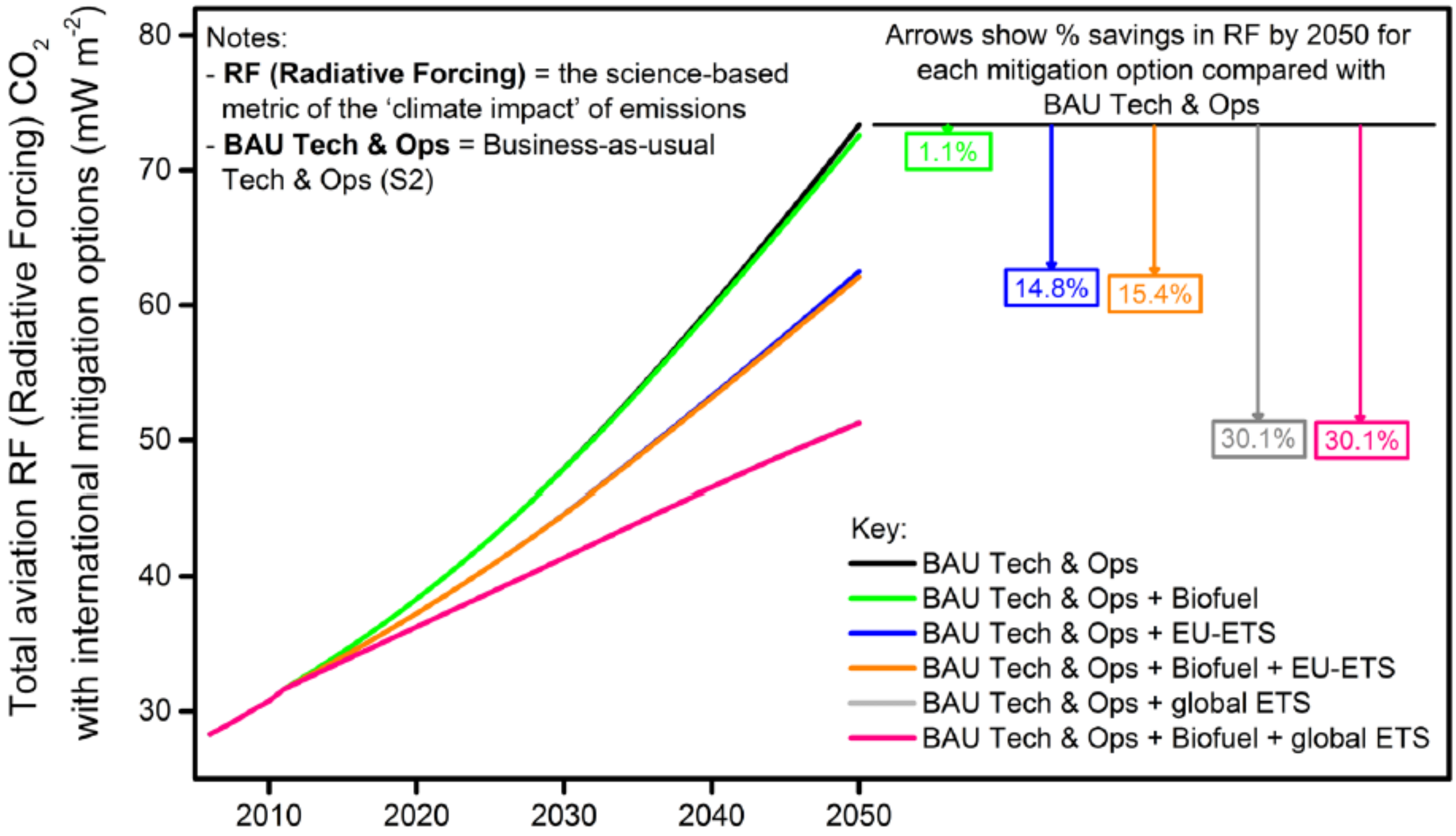
Advantages of taxes

- Less administrative costs as mechanisms often in place
- Revenue can e.g. be used to invest in low carbon technologies

Difficulties of taxation:

- hard to predict the level of taxes required to achieve emission target
- taxes difficult (impossible?) to implement internationally
- taxes don’t respond quickly to changing conditions
- taxes need to be adjusted regularly

Environmental Effectiveness



Source: Lee, Lim, Owen, 2013a, p. 18

Economic Impacts

- efficiency (welfare impacts)
  - cost of environmental measures (least costly solutions)
  - monitoring costs (potential to pass back revenues to companies)
  - extend of internalisation of externalities
- macroeconomic impacts of revenues raised
- impacts on competition / distributional impacts

Parameters Determining Economic Impacts

- Business models
  - ‘Pass-through” rates
  - Share of international / long-haul flights
  - Type of passengers
- Demand growth
- Fuel price expectations

Implementation Barriers

Institutional and policy barriers

- Strong differences between country interests, see ‘stop the clock’ (compensation?)
- Tendency of industrial representative organisations to take the position of weakest member (opposite to ‘top runner’)

Legal barriers

international treaties (Chicago Convention) make implementation of taxes on international flights difficult

Conclusions / Questions

- Need to address aviation's global emissions
- Emission trading important instruments to achieve significant reductions at least cost
- Political will to address the issue patchy, outlook for a global system bleak?
- Can EU put sufficient pressure on other countries?
- Might US role change in light of EPA decision?

And finally

- Does aviation have a 'license to grow'? (Tony Taylor, IATA 2013)

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