First Order Economic Impacts of ICAO’s GMBM Scheme

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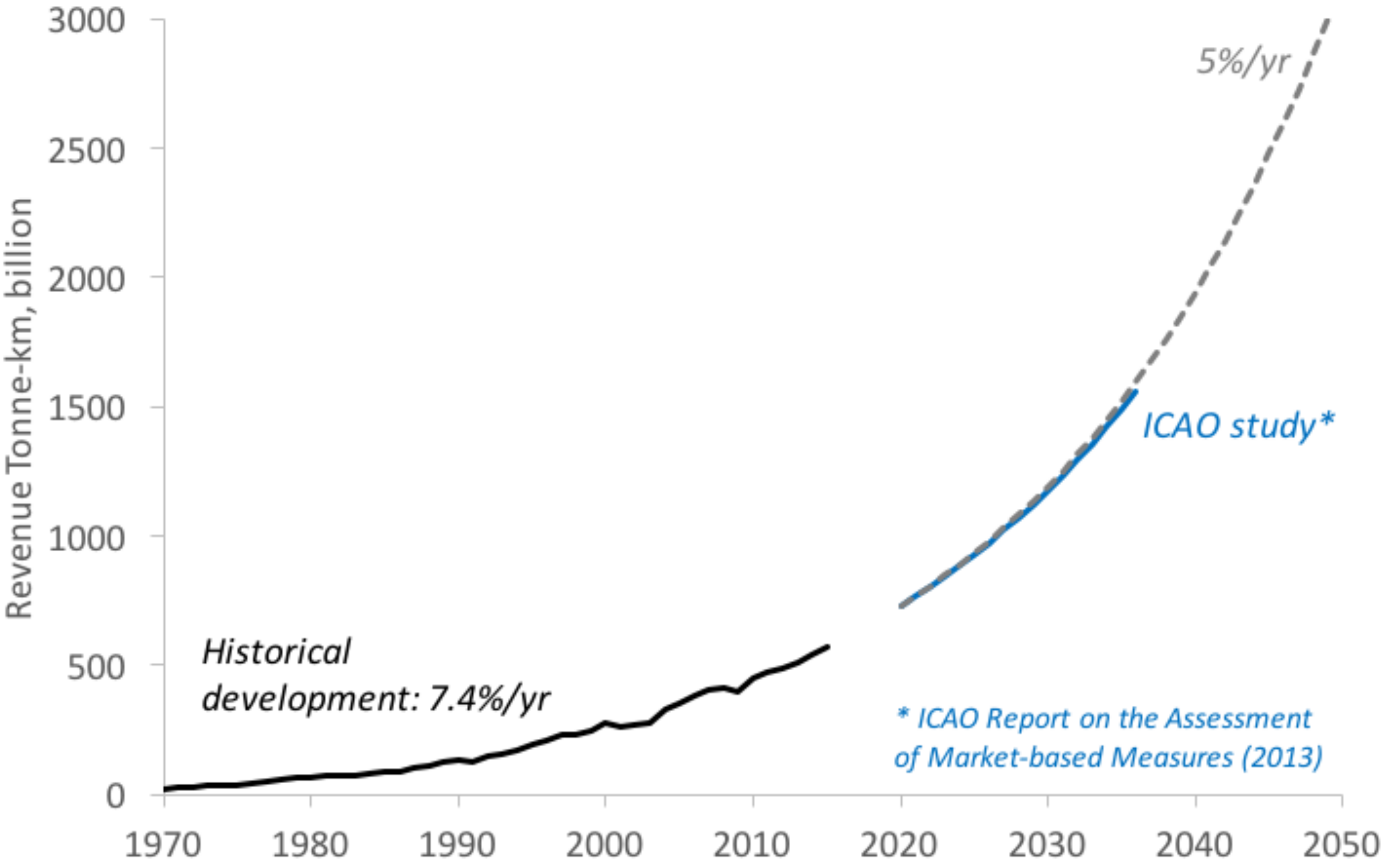
Content

- Assessing economic impacts requires understanding of
  - Demand for air transportation
  - Low-cost fuel burn reduction potential of aircraft fleet
  - Carbon price development
  - Assignment of carbon cost burden, i.e., how much of the carbon cost can be passed through to consumers
- No need for an integrated model to derive 1. order impacts

Growth in international aviation RTK



* ICAO Report on the Assessment of Market-based Measures (2013)

Lifecycle CO_2 intensity from the US NB fleet

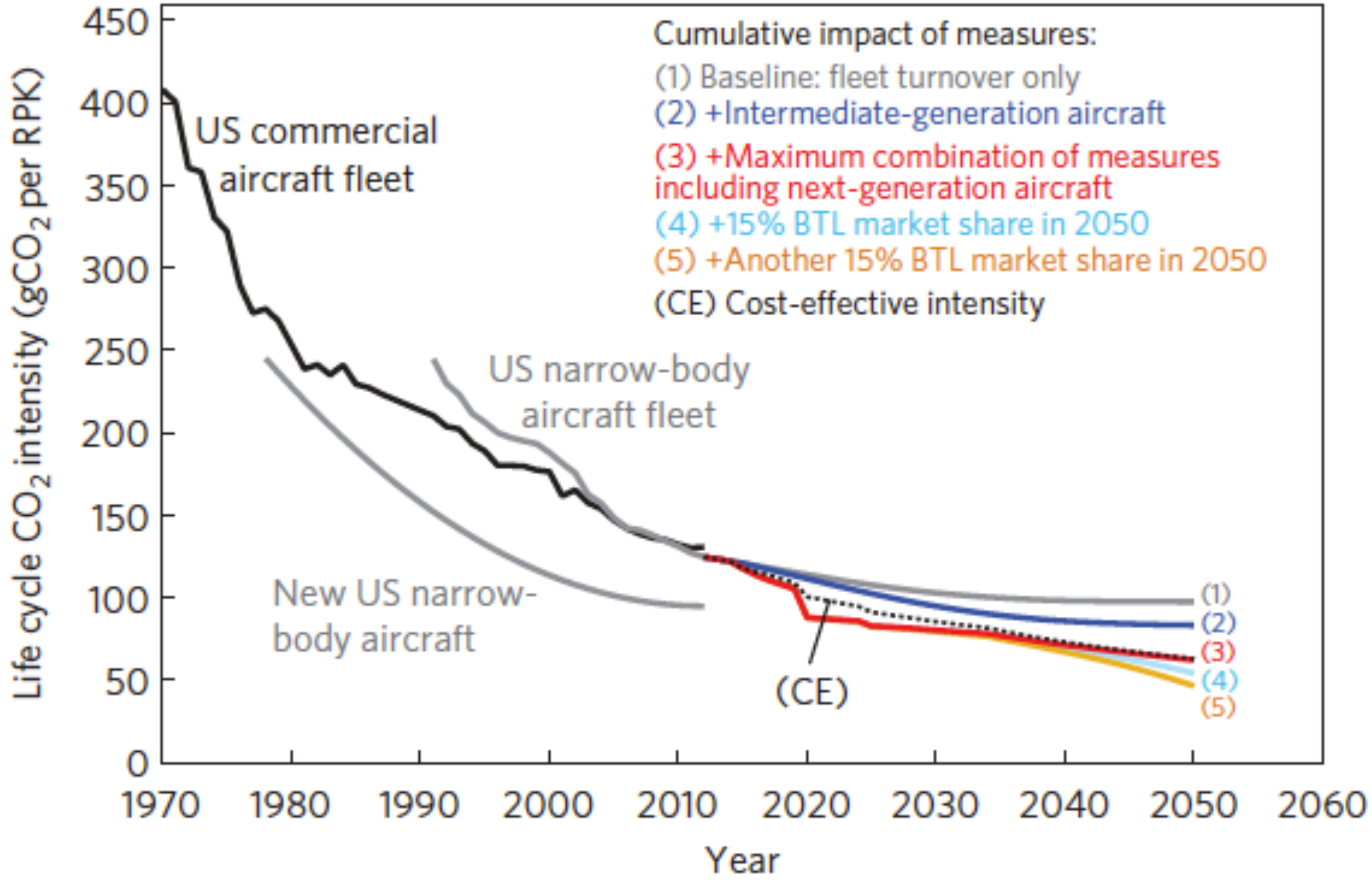


Figure 1 | Life cycle CO_2 emissions intensity of the US commercial passenger aircraft fleet operating in domestic service (black) and of the narrow-body fleet (grey), historical development (1970–2012) and projections (2013–2050). Owing to increases in aircraft fuel efficiency

Source: Schäfer A.W., Evans A.D., Reynolds T.G, Dray L., Costs of mitigating CO_2 emissions from passenger aircraft, *Nature Climate Change* 6, 412–417 (2016)

Costs for reducing CO_2 emissions from US NB fleet

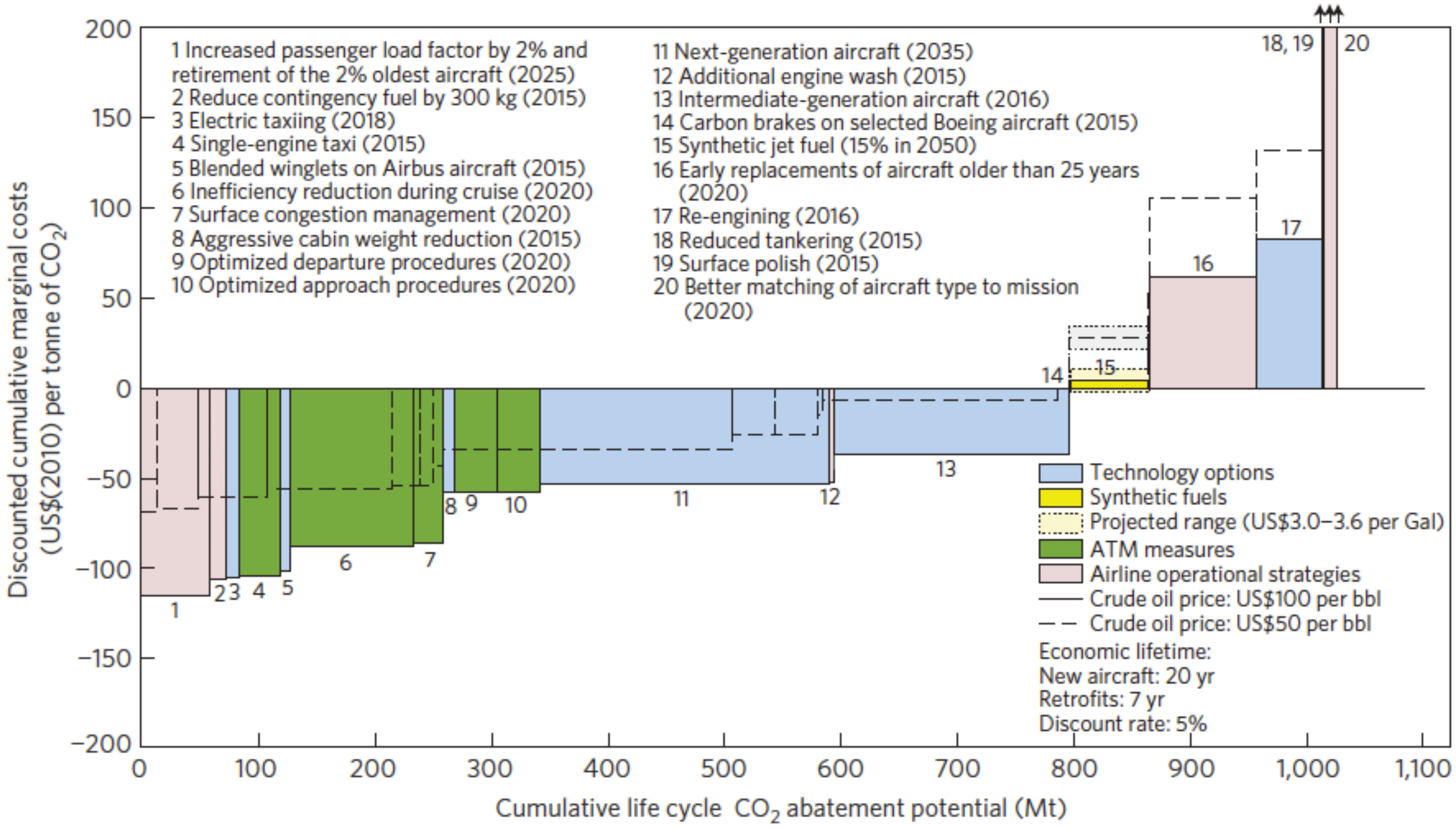


Figure 2 | Discounted marginal abatement costs for cumulative (2012–2050) life cycle CO_2 emissions from narrow-body aircraft in US domestic passenger service. Mitigation options are ranked in sequence of declining cost-effectiveness. Around one-quarter of the cumulative CO_2 emissions of 4.0 billion tonnes that are based on fleet turnover and growth (1.5% per year) could be mitigated if employing all options. At least 75% of that potential could be reduced at zero marginal costs.

Source: Schäfer A.W., Evans A.D., Reynolds T.G, Dray L., Costs of mitigating CO_2 emissions from passenger A/C, *Nature Climate Change* 6, 412–417 (2016)

CO_2 emission reduction from US NB fleet

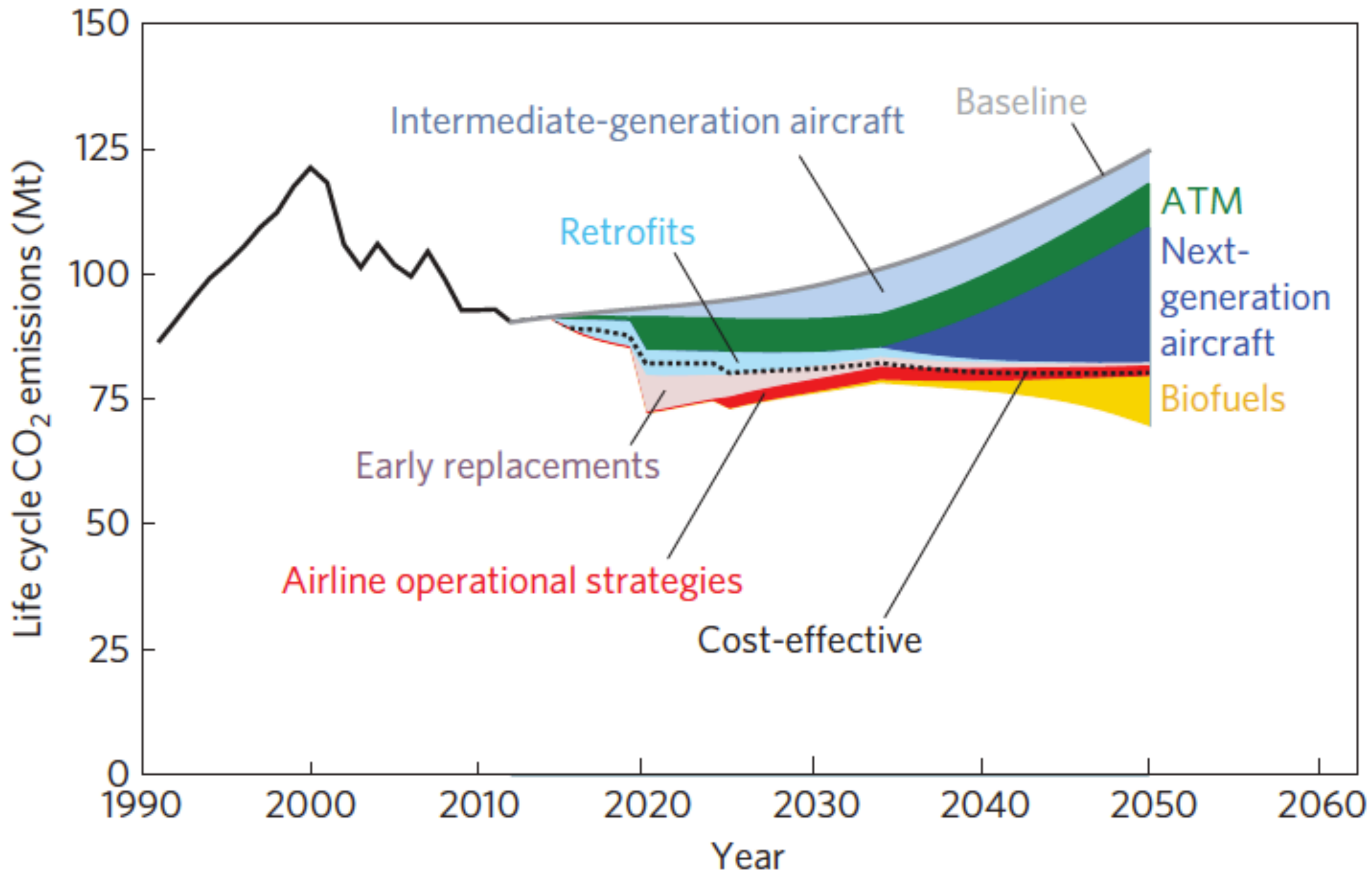
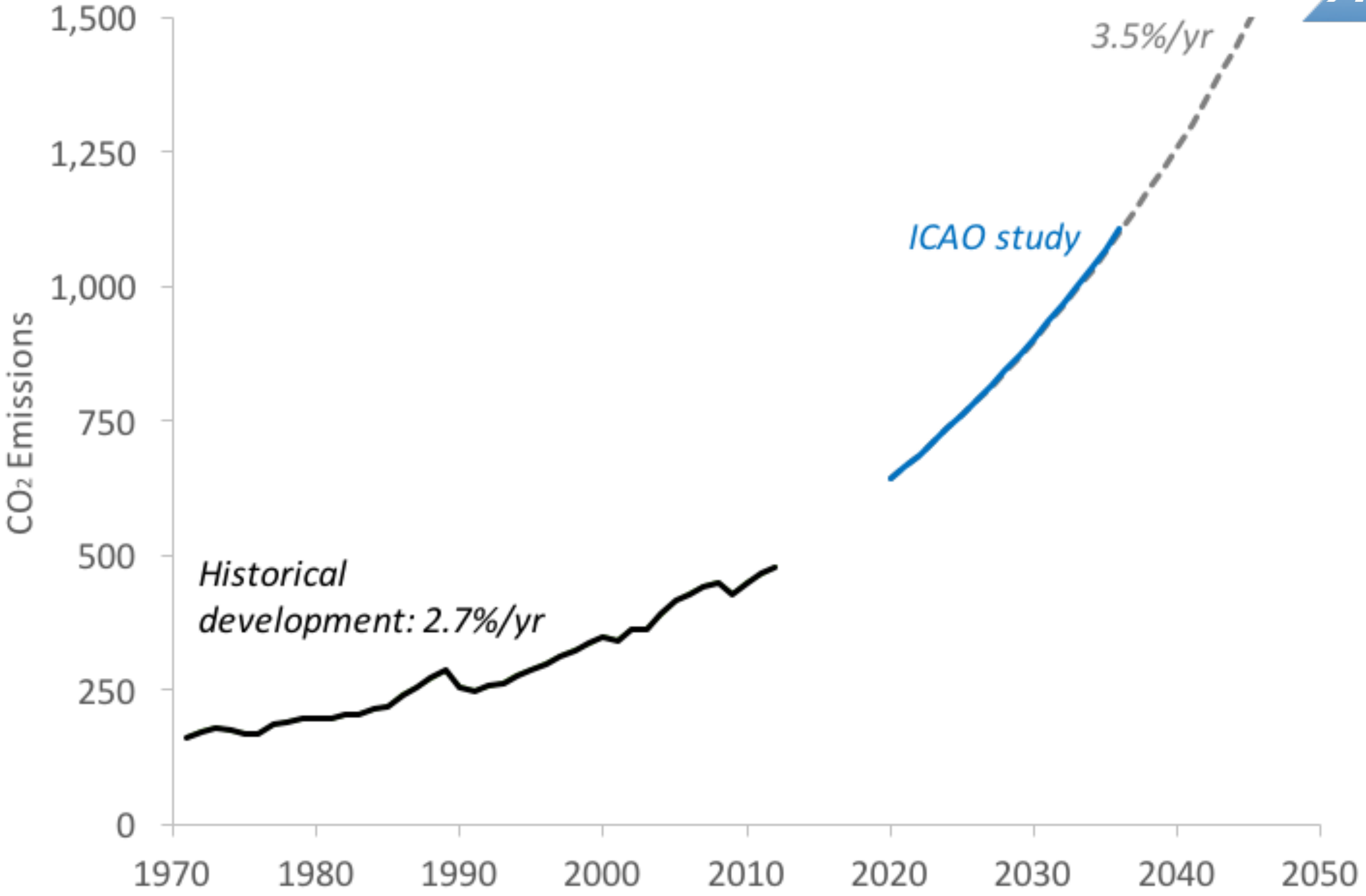


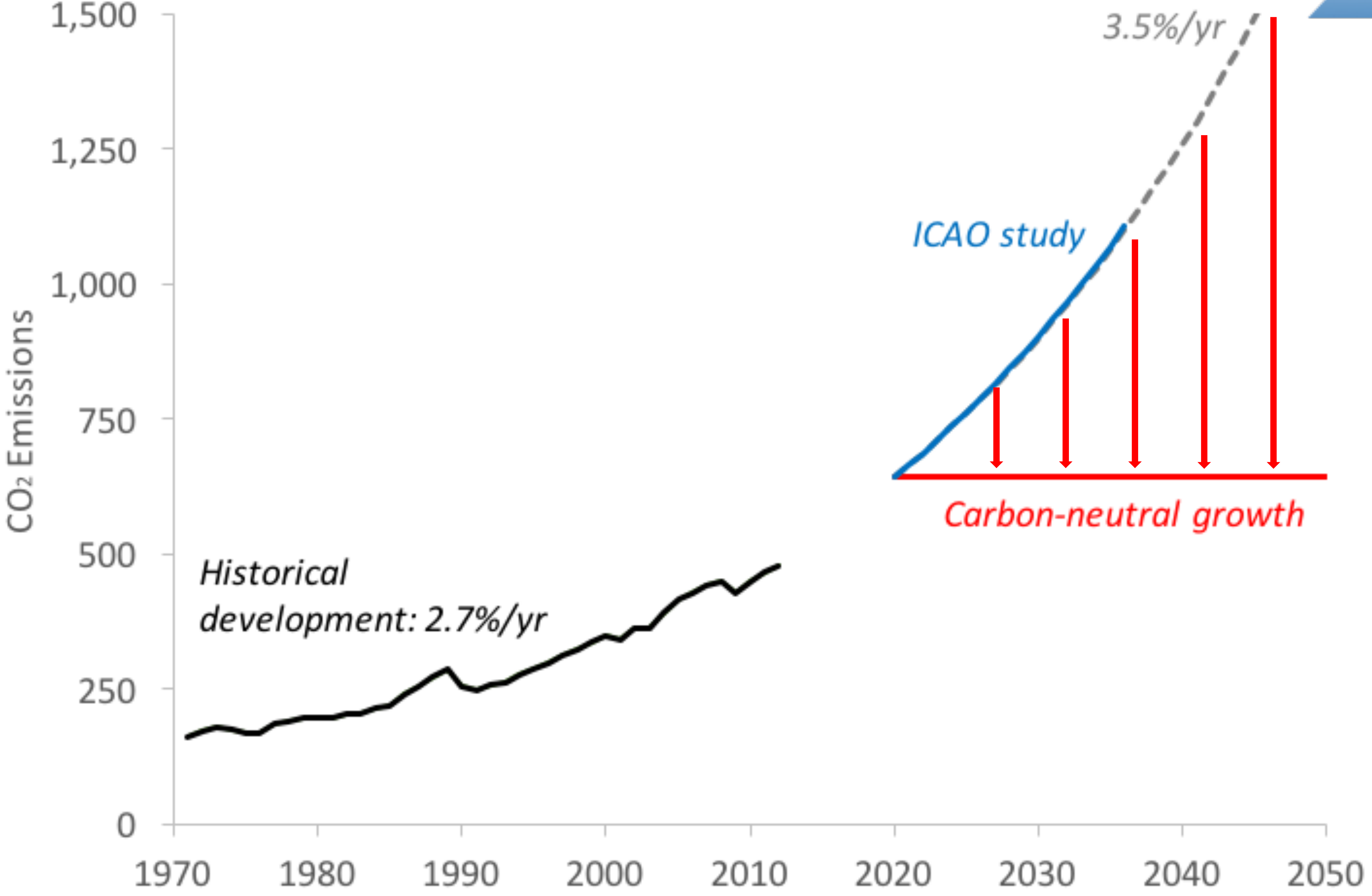
Figure 3 | Life cycle CO_2 emissions, historical trend (1991–2012) and future projections (2013–2050) of the mitigation potential by category of measures. In light of the anticipated fleet growth rate of 1.5% per year, life

Source: Schäfer A.W., Evans A.D., Reynolds T.G, Dray L., Costs of mitigating CO_2 emissions from passenger aircraft, *Nature Climate Change* 6, 412–417 (2016)

Growth in international aviation CO_2 emissions



Growth in international aviation CO_2 emissions



Very high carbon prices in a closed trading system

L. Dray et al. / Transport Policy 34 (2014) 75–84

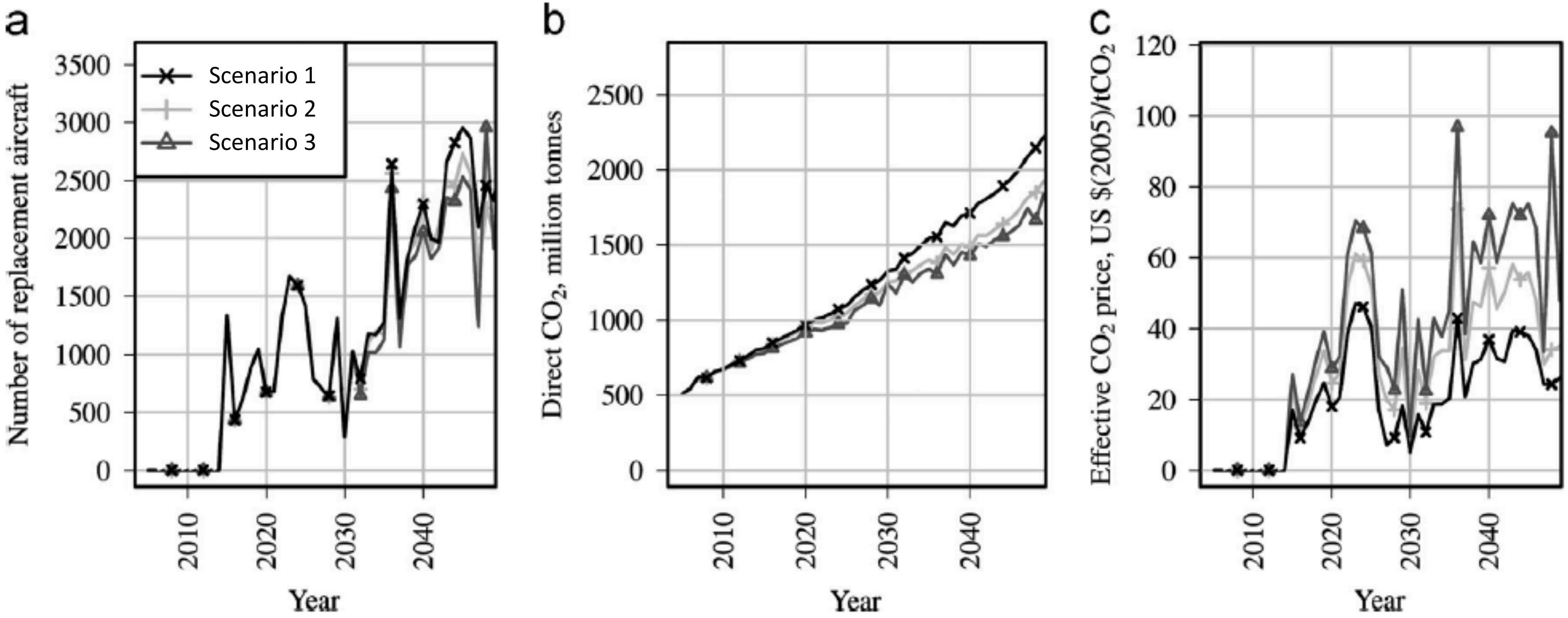
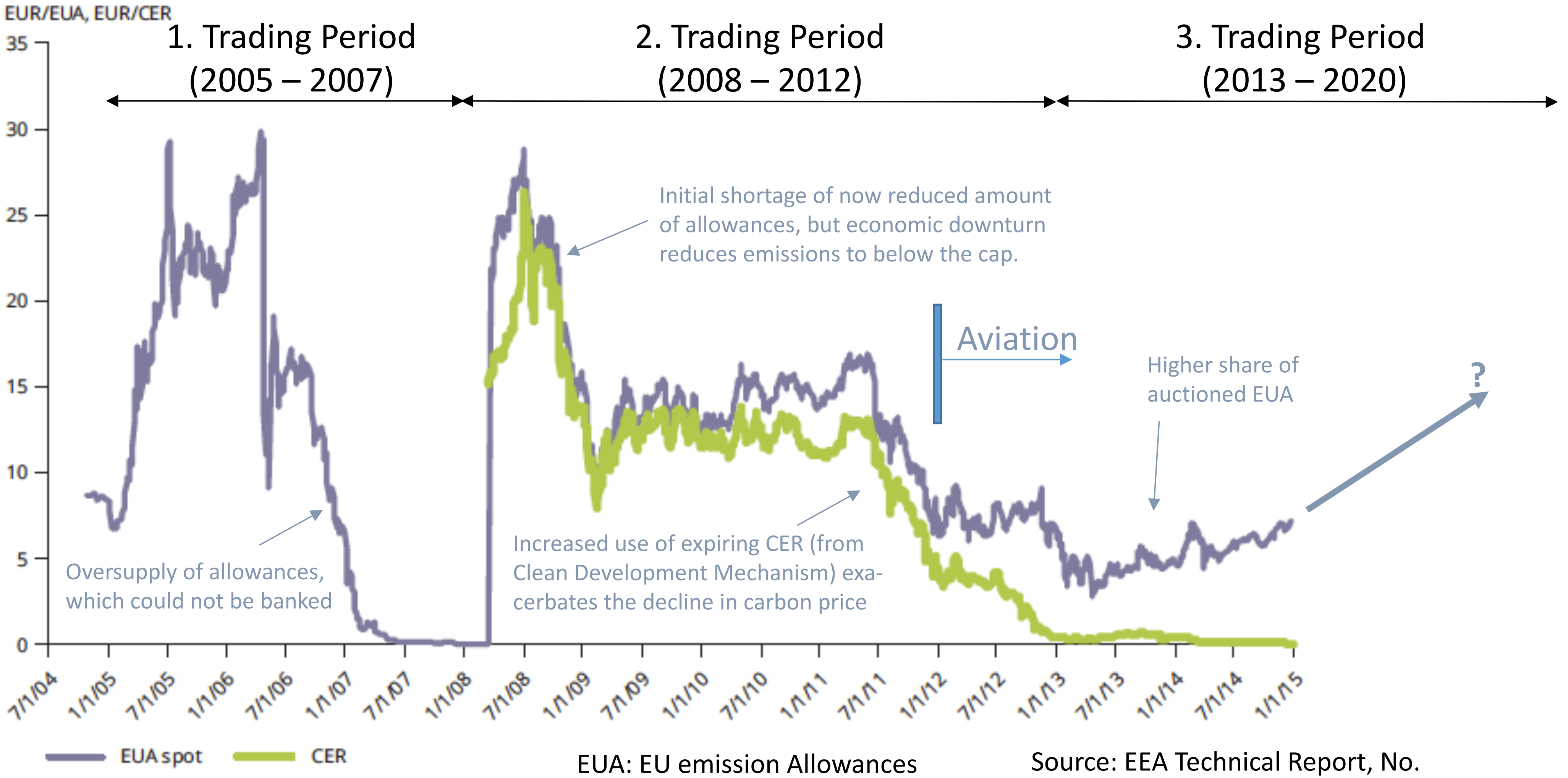


Fig. 3. Global fleet replacement policy: number of aircraft replaced (a), direct CO_2 emissions (b), and effective carbon price by year and scenario (c).

Carbon prices are currently low

Figure 2.9 **Price trends for EUAs and CERs, 2005–2014**



Initial shortage of now reduced amount of allowances, but economic downturn reduces emissions to below the cap.

Higher share of auctioned EUA

Oversupply of allowances, which could not be banked

Increased use of expiring CER (from Clean Development Mechanism) exacerbates the decline in carbon price

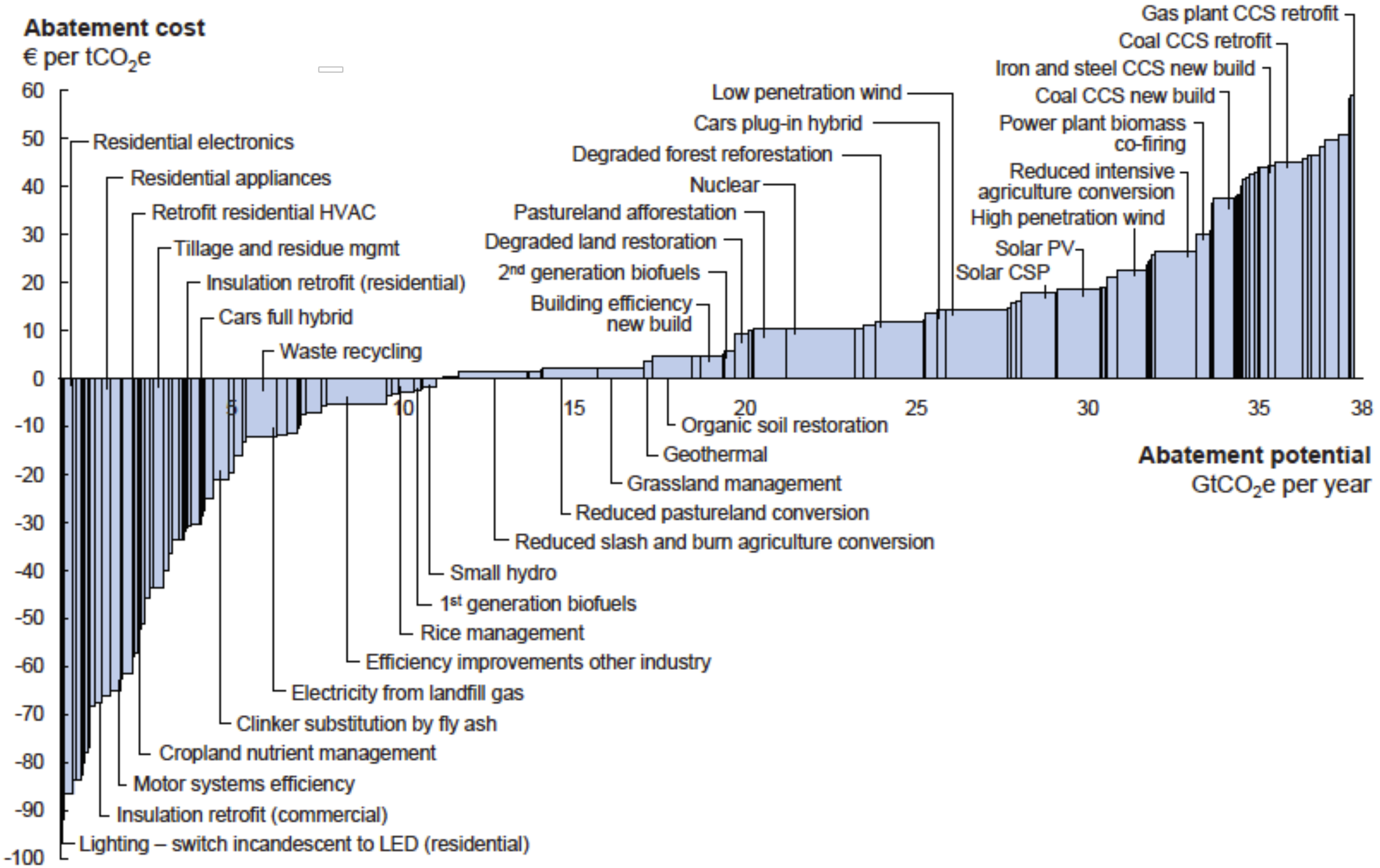
Source: EEX (EUA price), 2015; ICE ECX (CER price), 2015.

EUA: EU emission Allowances
CER: Certified Emission Reductions

Source: EEA Technical Report, No. 14/2015 Trends and Projections in the EU ETS in 2015

Future carbon prices are likely to be higher …

ACCLAIM



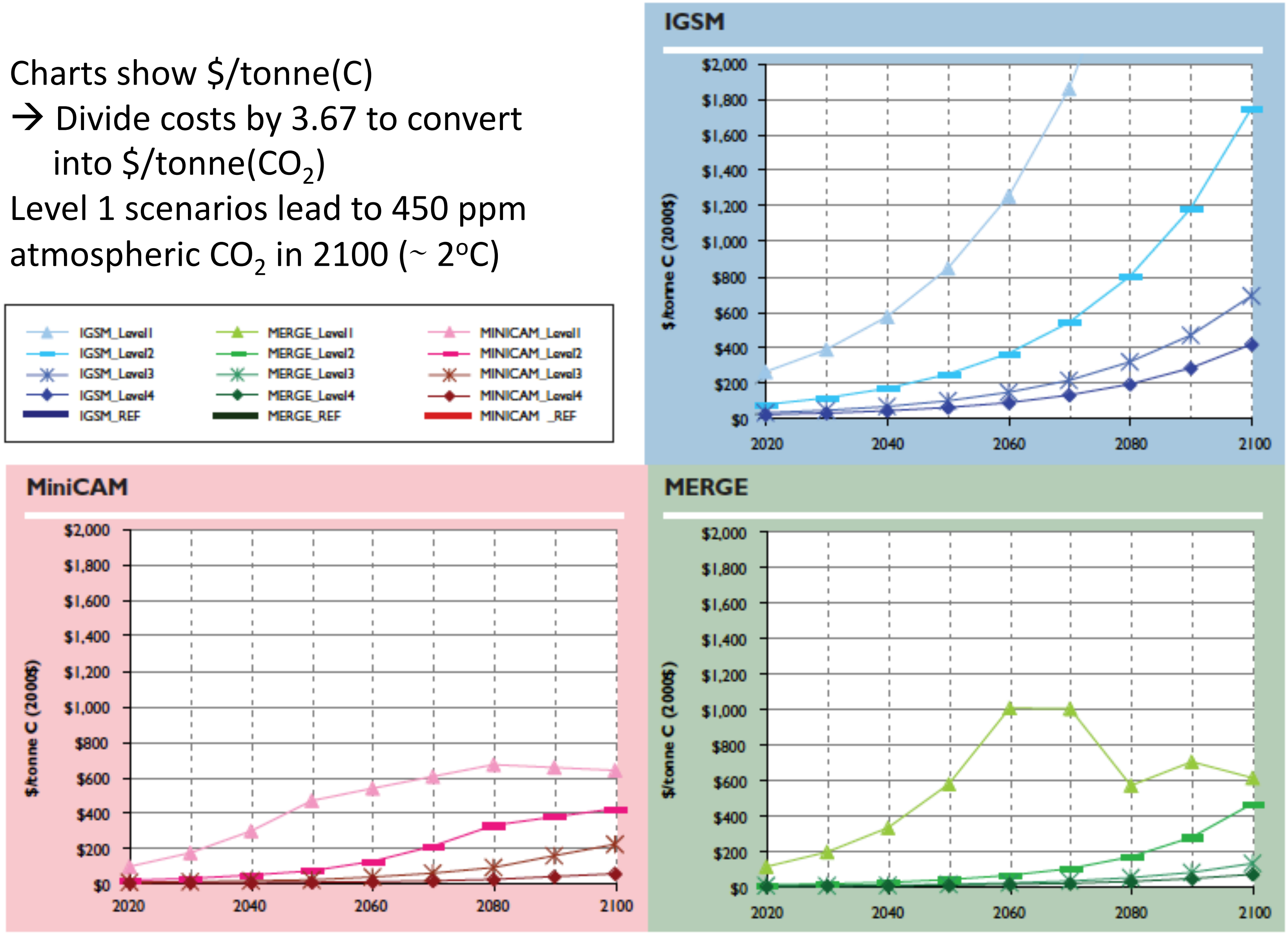
Global GHG abatement cost curve beyond business-as-usual – 2030

Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

… or much higher!

Figure 4.20. Carbon Prices Across Stabilization Scenarios ($/tonne C, 2000$).

Charts show \$/tonne(C)
→ Divide costs by 3.67 to convert
into \$/tonne(CO_2)
Level 1 scenarios lead to 450 ppm atmospheric CO_2 in 2100 (~ 2°C)



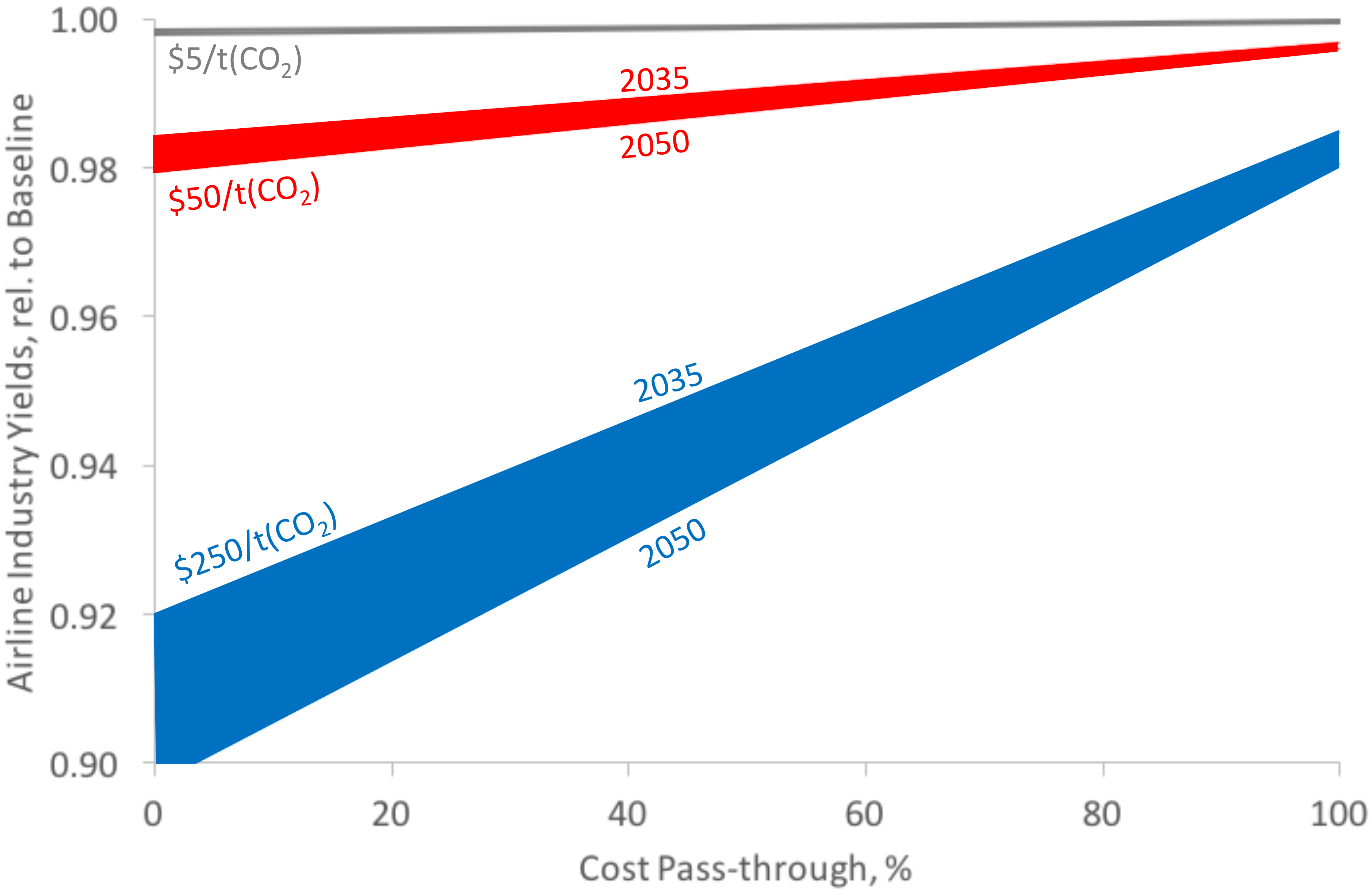
Differences in marginal abatement costs across models due to different baseline development, representation of technology incl. substitution elasticities, sector resolution, etc.

Source:
U.S. Climate Change Science Program, Synthesis and Assessment Product 2.1a, Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations, July 2007

CO_2 cost pass-through fraction

- 2 Extremes
  - 100% cost pass-through → suppressed demand, no carbon costs to airlines (price elasticity = -0.2)
  - 0% cost-pass-through → unchanged demand, but airlines bear full carbon costs
- Ultimately depends on relative slope of demand and supply curve in a competitive market
- Carefully modeled in next version of AIM / ACCLAIM

Costs to airlines



Summary

- Carbon price initially low, suggesting very minor economic implications
- However, carbon price likely to increase strongly over time in light of Paris Agreement →
  - R&D into advanced, low-carbon air transportation systems imperative
  - Carbon offsets buy precious time
- More precise and detailed analysis requires integrated model
  - Feedbacks between supply and demand to determine new market equilibrium
  - Impact of GMBM on particular airlines / alliances (DOC structure, level of route competition, carbon cost pass-through, etc.)
  - One of many capabilities of the updated Aviation Integrated Model (AIM) / ACCLAIM (www.AIMproject.aero)
- There are larger threats to air transportation over medium (e.g., oil price volatility, terrorism, automated vehicles vs. short-haul air travel, etc.)

www.AIMProject.aero

Carbon price in proportion to jet fuel price