APMT Capability Demonstration Problems: *Economic Modelling*

Presented to: TRB AEDT/APMT Workshop #4

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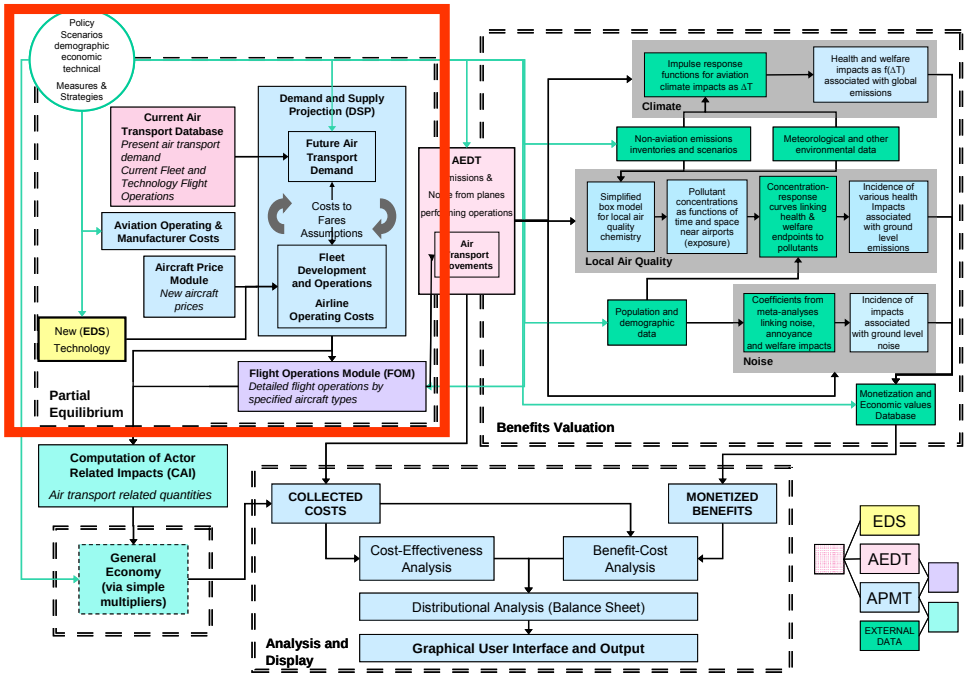
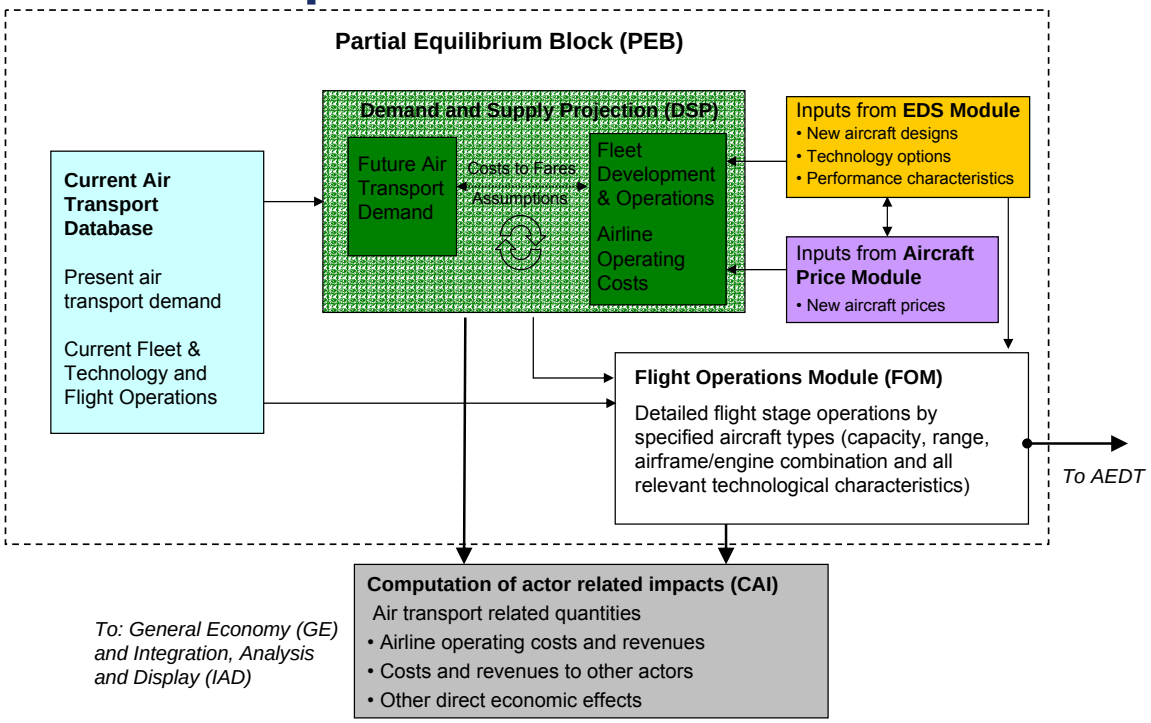
Discussion Objectives and Structure

- How are we analysing the range of potential environmental policy problems in economic terms?
- Outline the key inputs and outputs
- What are the key assumptions?
- Demonstrate some initial projections
- Next steps in the model development

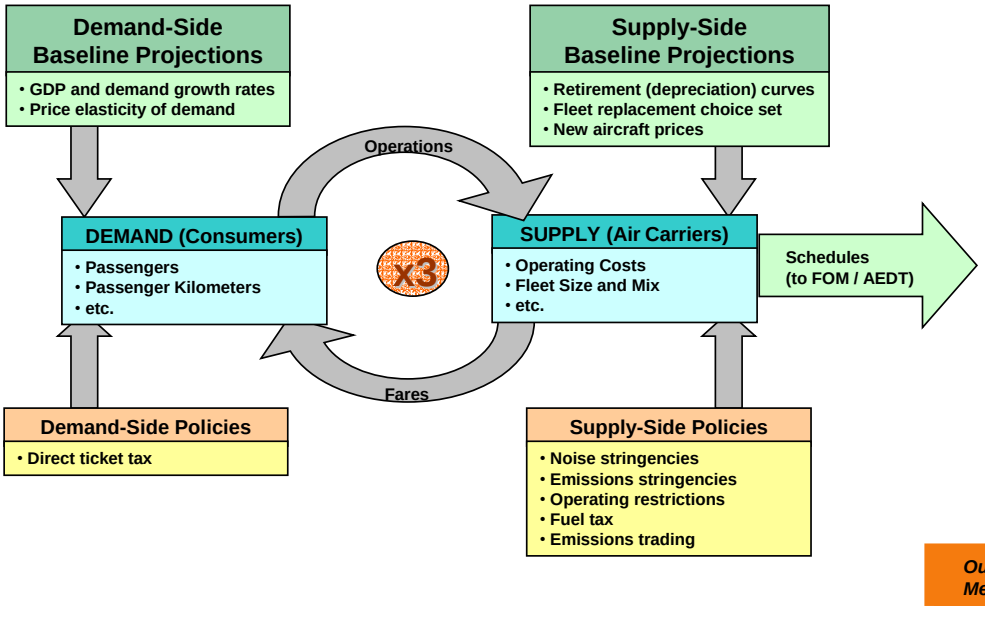
APMT Architecture



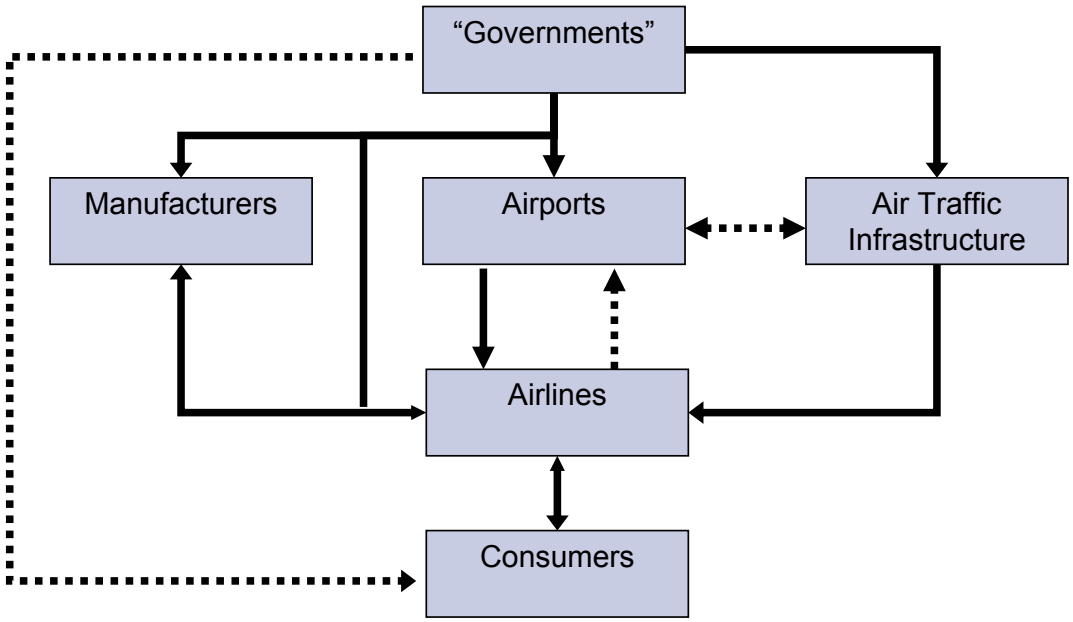
Partial Equilibrium Block Architecture



Demand and Supply Projection Module



Interactions between Actors



Scope:
Global Coverage with Regional Detail

Key Modelling Units

Schedule: ICAO Routegroup and Distance Range Band		
Demand*	Capacity* (Requirements)	Costs and Revenues

Operations: Schedule, Named Aircraft Type, Carrier Type	
Number of Flights*	Direct Operating Costs per Flight

Fleet: Named Aircraft Type, Carrier Type, Age			
Numbers of Aircraft*	Fleet Characteristics	Aircraft Prices and Values	Unit Capital and Operating Costs

Temporal: All of the above are forecast on an annual basis

* Passenger-related only in Prototype

Modelled Scenarios

Datum Year

– Currently 2002, but with plans to update to more recent data

Database of "Known":
- Demand
- Supply (Fleet and Operations)
- Aircraft Operating and Capital Costs

Baseline Forecast

– Business-as-usual situation on an annual basis from 2003 – 2022*

User defined inputs for:
- Forecast Demand, GDP, Demographics
- Aircraft Operating and Capital Costs
- Rates of Aircraft Retirement
- Aircraft Available for Purchase/Delivery

Policy Forecast

– With-measures forecast on an annual basis from 2003 – 2022*

User defined measure specifications:
- Financial Measures
- Regulatory Measures
- Operational Measures
- Year of Announcement and Enforcement

* Forecasting period is, in principle, more flexible, but 20 years chosen for prototype to match available data

Principal Inputs and Outputs

Inputs

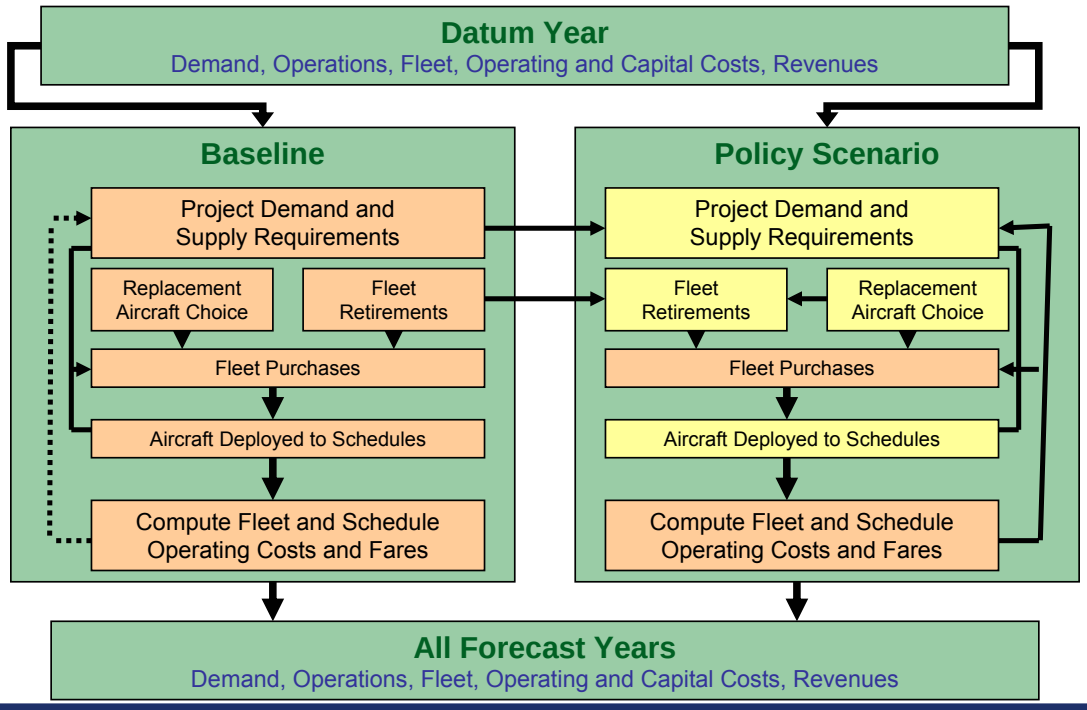
- Consumers
  - Datum year air passenger* demand
- Airlines
  - costs and revenues for the Datum year and projected changes
  - operations for the Datum Year
  - fleet for the Datum year
- Manufacturers
  - price of new units
- Governments
  - policy measure specification

Outputs

- Consumers
  - air passenger* demand forecasts
  - change in consumer surplus
- Airlines
  - costs and revenues
  - operations
  - Fleet
- Manufacturers
  - new units sold
- Governments
  - changes in taxation revenues

* Passenger-related only in Prototype

Modelling Steps



Fleet Replacement Options

- **Existing Aircraft Types**
  - **New purchase aircraft of existing type *(types still entering service in Datum year)***
  - Second-hand purchase of existing type or with close 'commonality' ie same engine and variant in airframe or same airframe and alternative engine
  - Types currently in production which have yet to enter service (A380 etc)
  - Re-engineered or re-certificated existing aircraft
- **New Aircraft Types**
  - **Future types defined by industry or from EDS**
  - Other sources (if required)

Key Structural Assumptions

- **Model forecasts year-by-year**
- **Demand and Supply and Fares and Airline Costs are in equilibrium**
  - The Baseline and Policy Scenarios assume airlines will adjust fares in line with cost changes
  - the extent of this adjustment can be controlled by the model user
- **Size type mix is not (yet) adjusted automatically based on changes in cost**
- **The costs imposed by Policy measures may increase the rate of aircraft retirement**

Key Data Assumptions

All are parameters and can be varied by the model user

- **Elasticity of demand with respect to fare changes**
- **The time period for future aircraft production and delivery**
  - Existing aircraft types in the Datum fleet – how long will these continue to enter service?
  - Future aircraft types – when will they first enter service and for how long?
- **Sensitivities of the replacement choice and retirement adjustment models**
- **The extent to which airlines will pass-on cost changes as changes in fares**

Initial Projections: Results Presented

- Baseline
- Policy Scenarios
  - Fuel Levy (range 15% to 100%)
  - Noise Phase-out (Chapter 3 - 3EPNdB, minus 6EPNdB, minus 9EPNdB as a cumulative measure)
  - NOx Stringency (CAEP 4 minus 20%, minus 40%

Presenting changes through time:

- **Demand and Supply**
- **Fleet**
- **Capital and Operating Costs**
- **Fuel Use**
- **Cost and revenue (per RTK)**
- **Fuel Use per RTK**

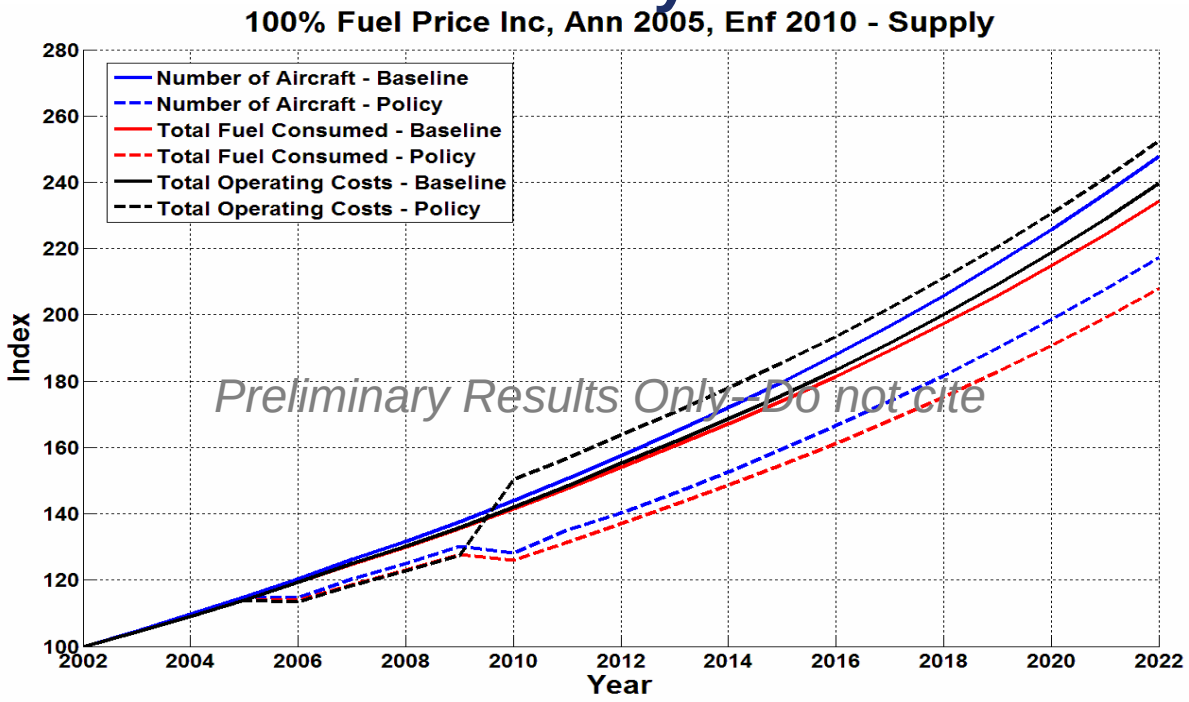
A sample of results only

Initial Projections: Key Points

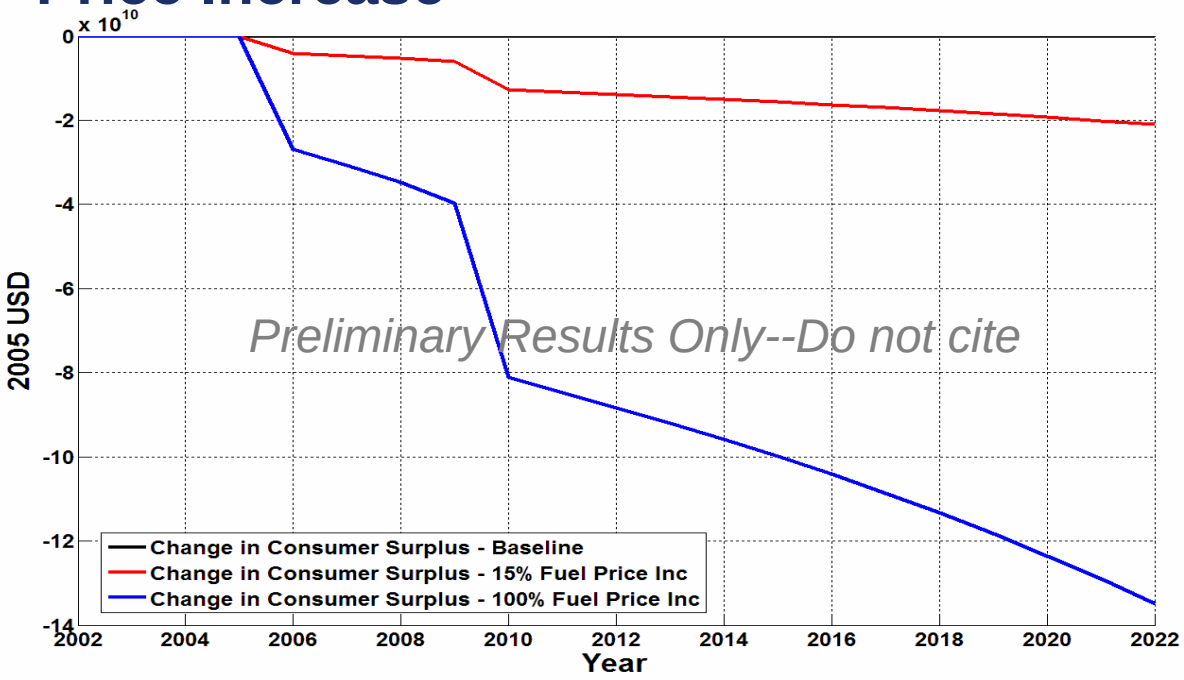
- **The Baseline is one of many potential "Business-as-Usual" scenarios that the "User" could construct**
- **We show the impact of Policy measures as changes from that Baseline for a given set of Assumptions**
- **We are not yet saying we have the "right" Assumptions**

We are illustrating of our capability only and range of outputs

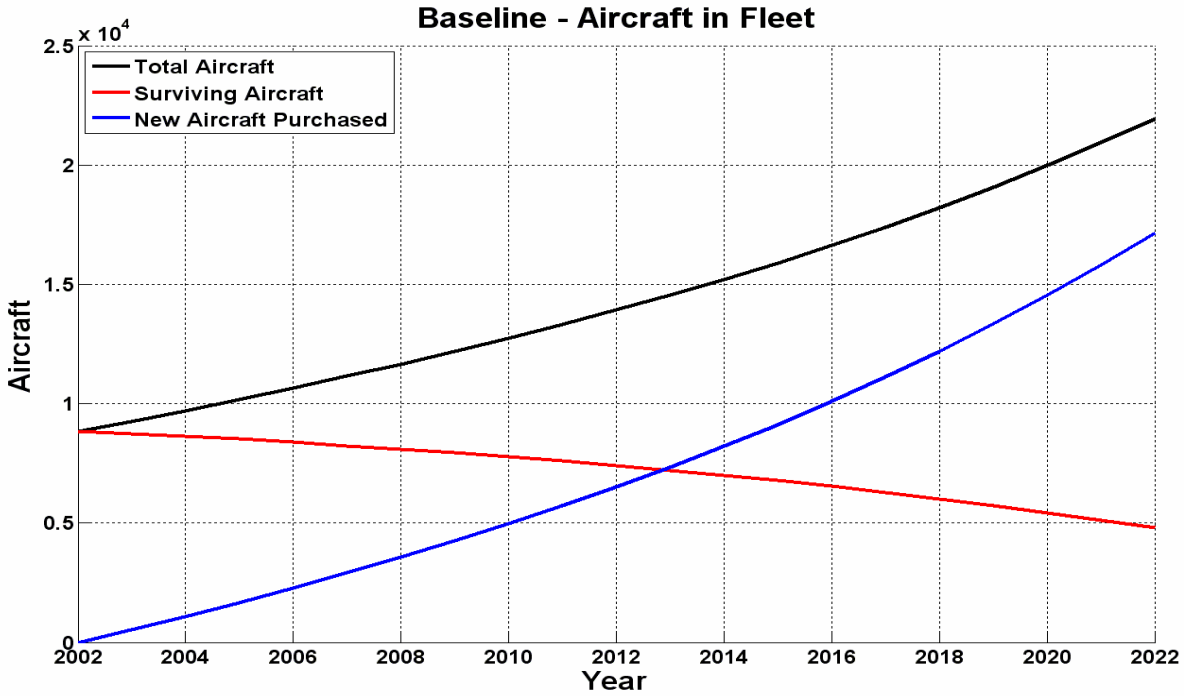
FP: PEB Preliminary Results



Consumer Surplus Changes: Fuel Price Increase



FP: PEB Preliminary Results

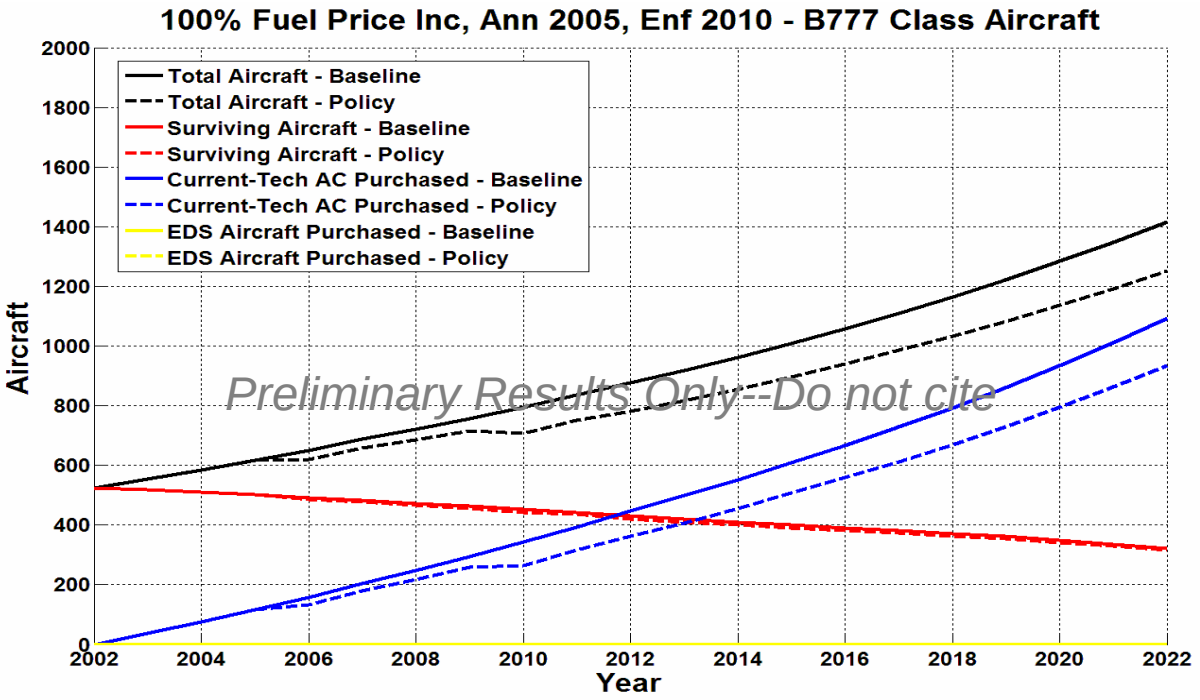


The Results: Fleet Impacts Compared

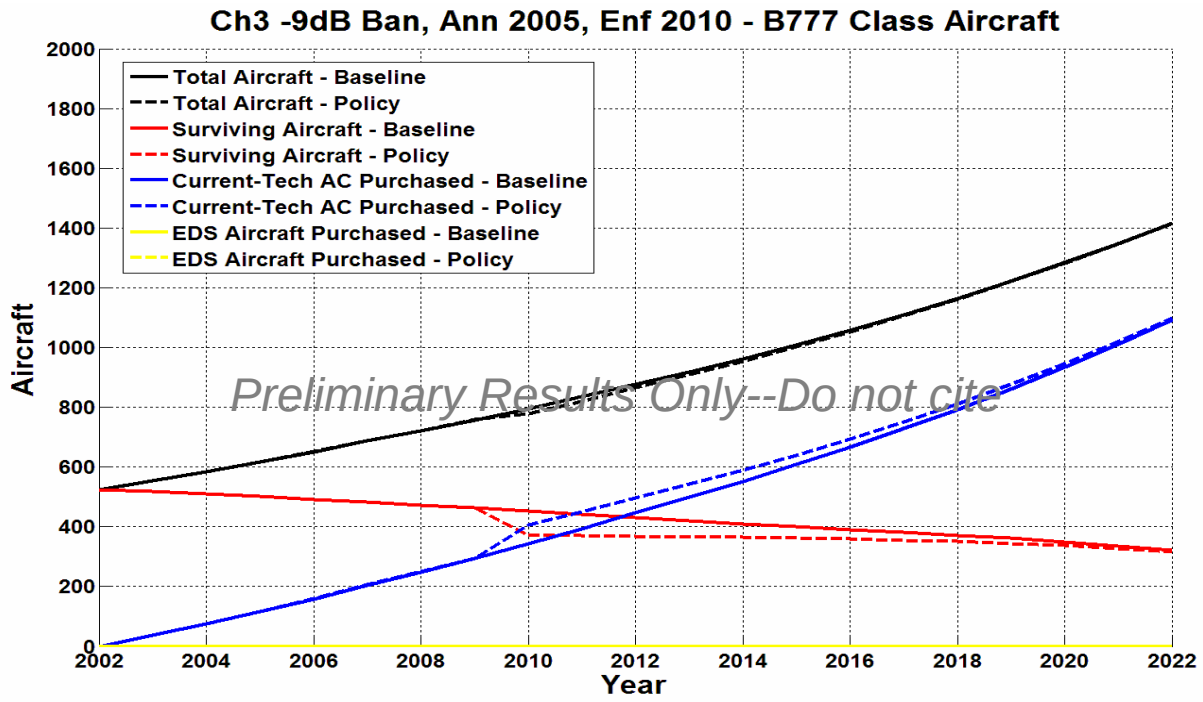
- **Fuel Price Increase:**
  - 100% increase ie from Baseline level of fuel cost of USD 0.5 per kg to USD 1.0 per kg
- **Noise Phase-out:**
  - -9EPNdB from Chapter 3 standard
- **NOX Certification Stringency:**
  - 20% reduction from CAEP4 standard for new purchases

- **Illustrated for B777 seat class (300-400 seat) aircraft**

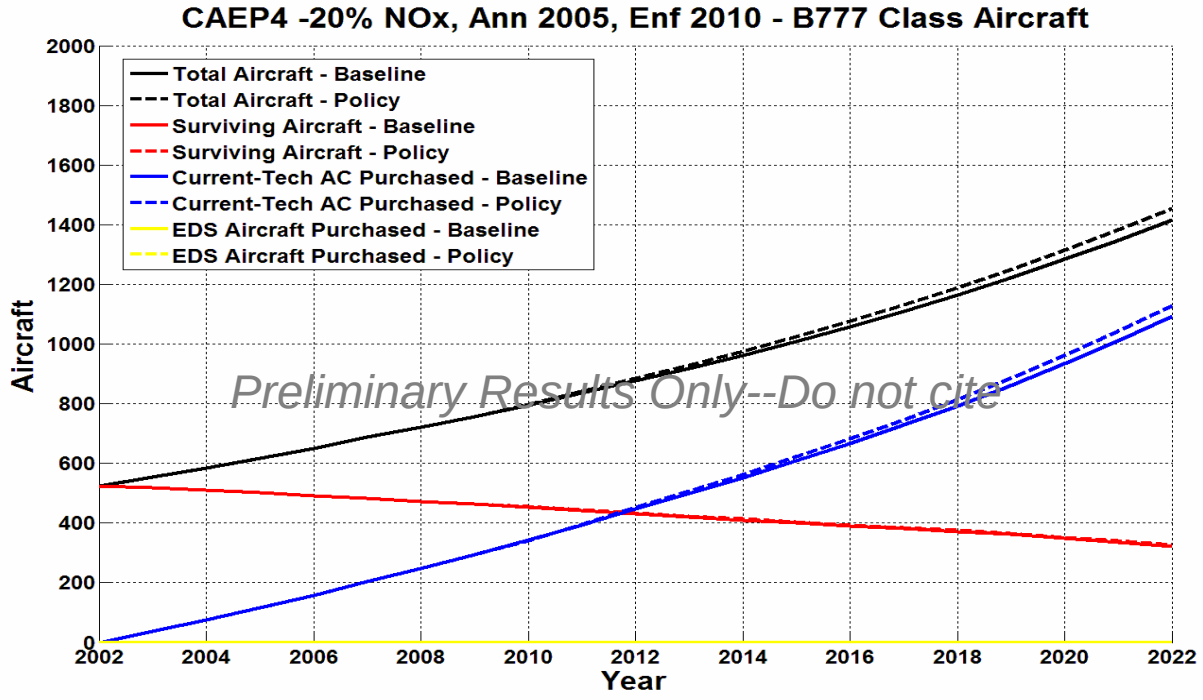
FP: PEB Preliminary Results



NB: PEB Preliminary Results



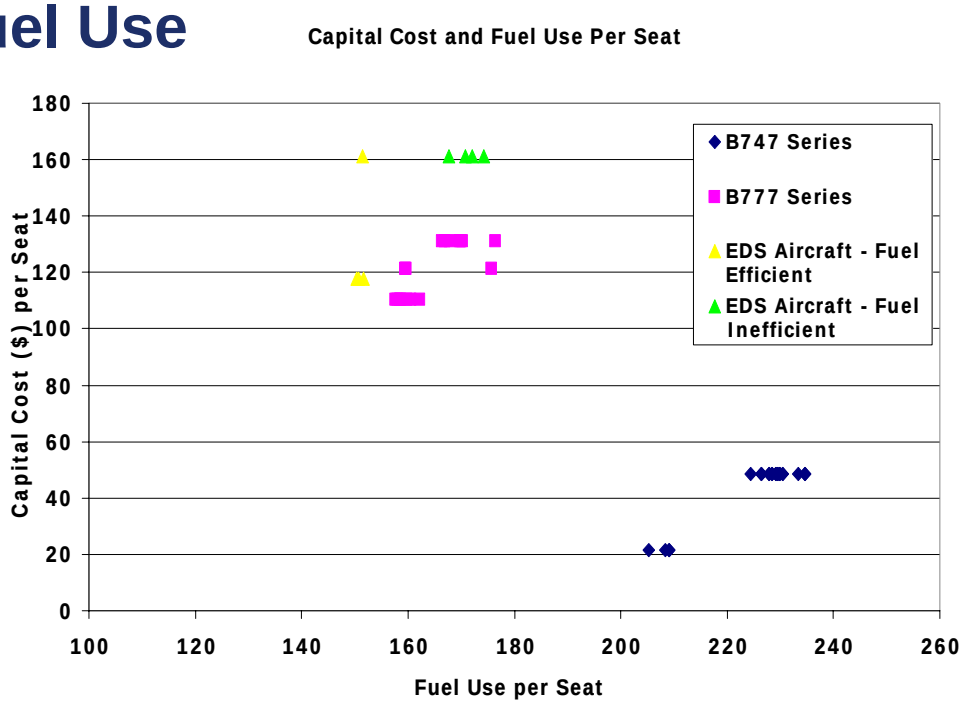
NX: PEB Preliminary Results



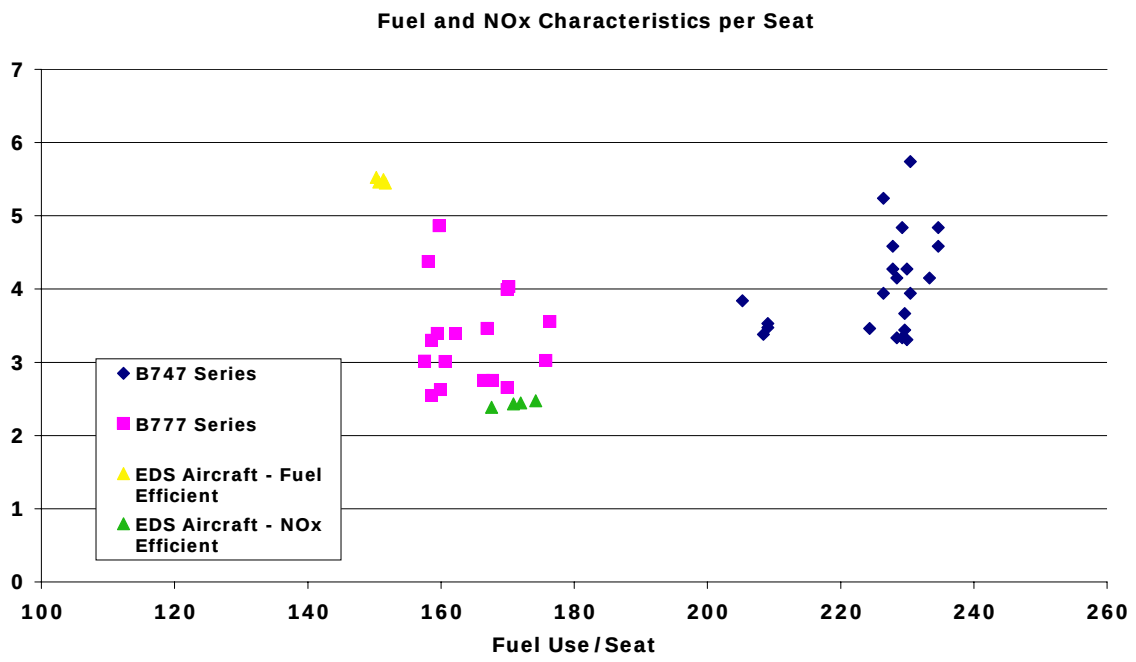
Incorporating EDS Aircraft

- **EDS Design Space used to provide biased designs towards**
  - Improved noise
  - Reduced NO_x
  - Reduced Fuel Use
- **Aircraft of varying and capacities and capital cost provided within the B777 seat class (300-400 seat) aircraft**
- **No EDS aircraft from this set selected in the Baseline but aircraft are introduced under policy scenarios**
  - Fuel Price Increase
  - NO_x Stringency

B777 Class Inputs: Capital Cost and Fuel Use



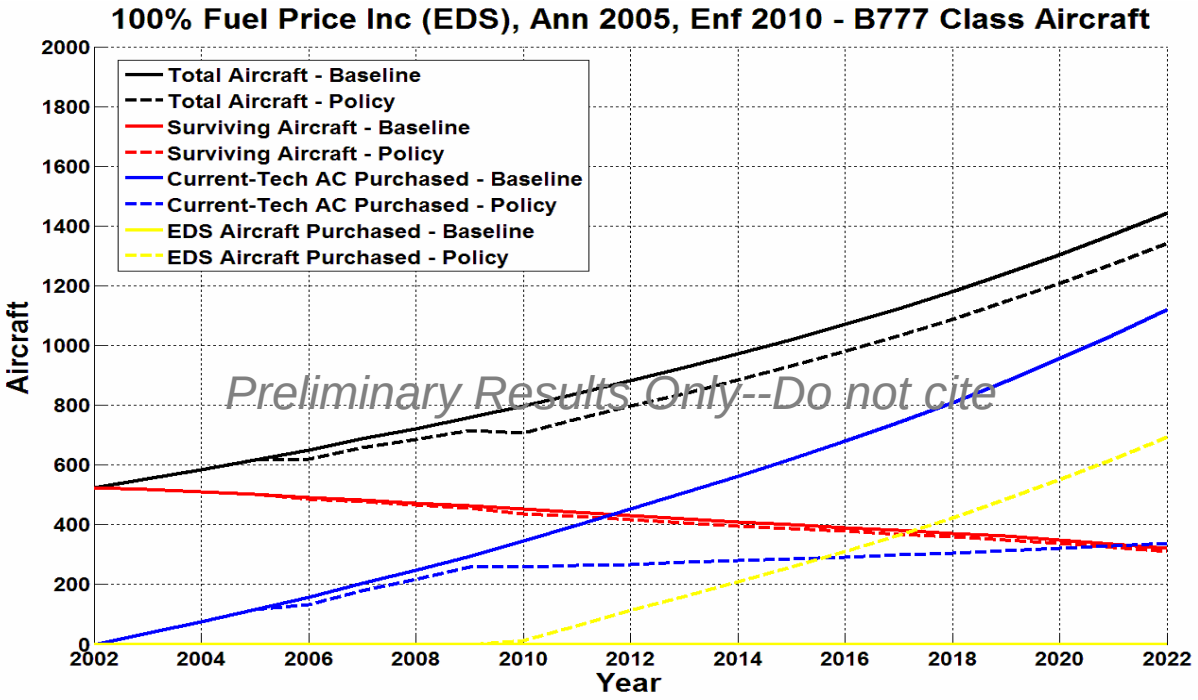
B777 Class Inputs: NOx and Fuel Use



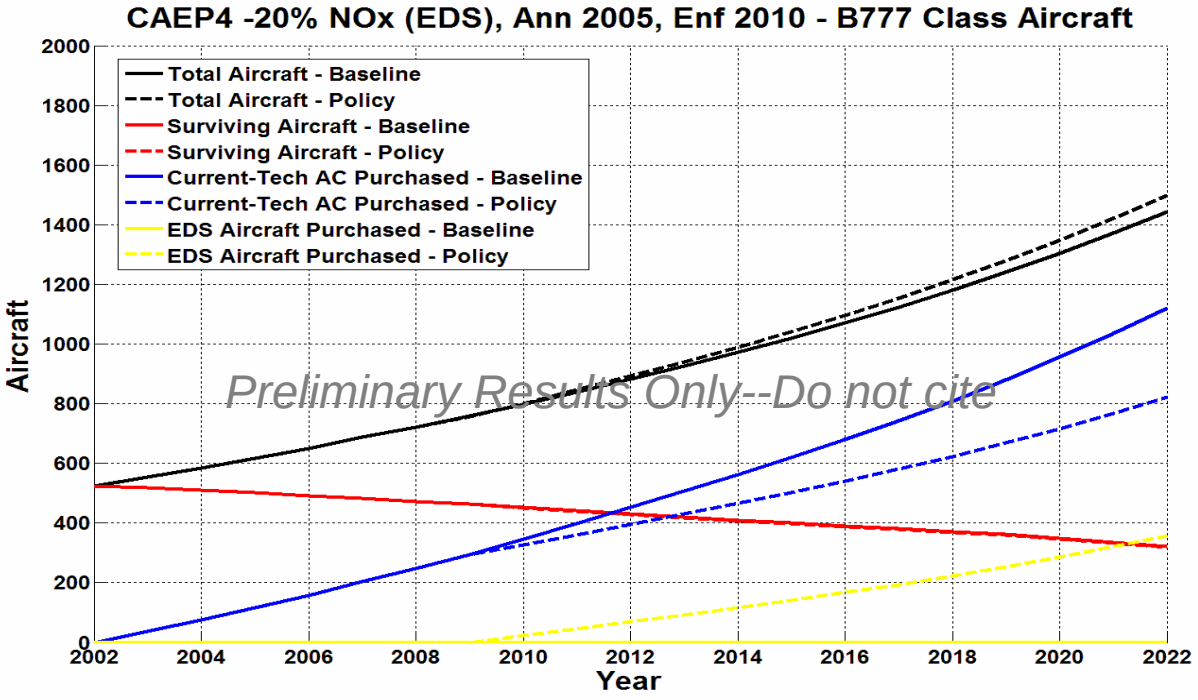
Results: Impacts of EDS Aircraft on Fleet Selection

- **Results Relative to the Baseline**
- **Fuel Price Increase:**
  - 100% increase ie from Baseline level of fuel cost of USD 0.5 per kg to USD 1.0 per kg
- **NOx Certification Stringency:**
  - 20% reduction from CAEP4 standard for new purchases
- **Illustrated for B777 seat class (300-400 seat) aircraft**

NX: PEB Preliminary Results

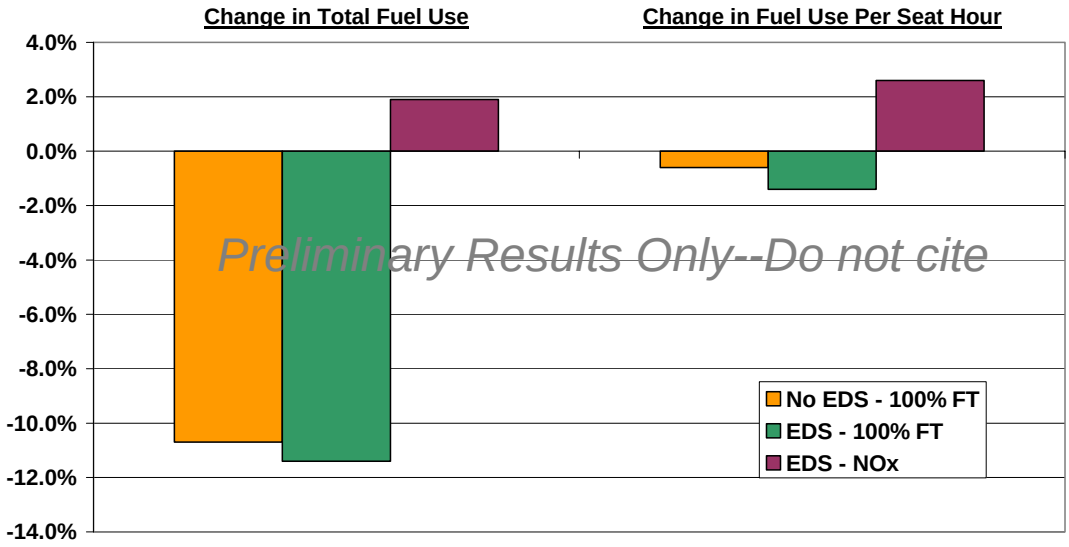


NX: PEB Preliminary Results



EDS: B777 Class Outputs

Change in Fuel Use from the Baseline for B777 Size Class Aircraft (300-400 seats)



Summary

- **We have achieved a significant amount with the Prototype**
  - The model already has significant complexity
  - Some assessment of capabilities made during the testing and analysis phase
- **We are currently undertaking assessment of the**
  - Model sensitivity
  - Quantification of uncertainty
  - Ability to handle other problems
- **What needs to be tackled next… a better representation of**
  - Changes in capital costs resulting from measures
  - Changes in airline costs resulting from a Phase-out or Stringency
  - Disaggregation of the schedule to country-pair from routegroup
  - Using more recent demand, supply and cost input data for the Datum year
  - Calibration and Validation of input data and model forecasts

??? Questions ???

FAA Environmental Tools web site:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/