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ICAO Colloquium on Aviation and Climate Change

Aviation alternative fuels

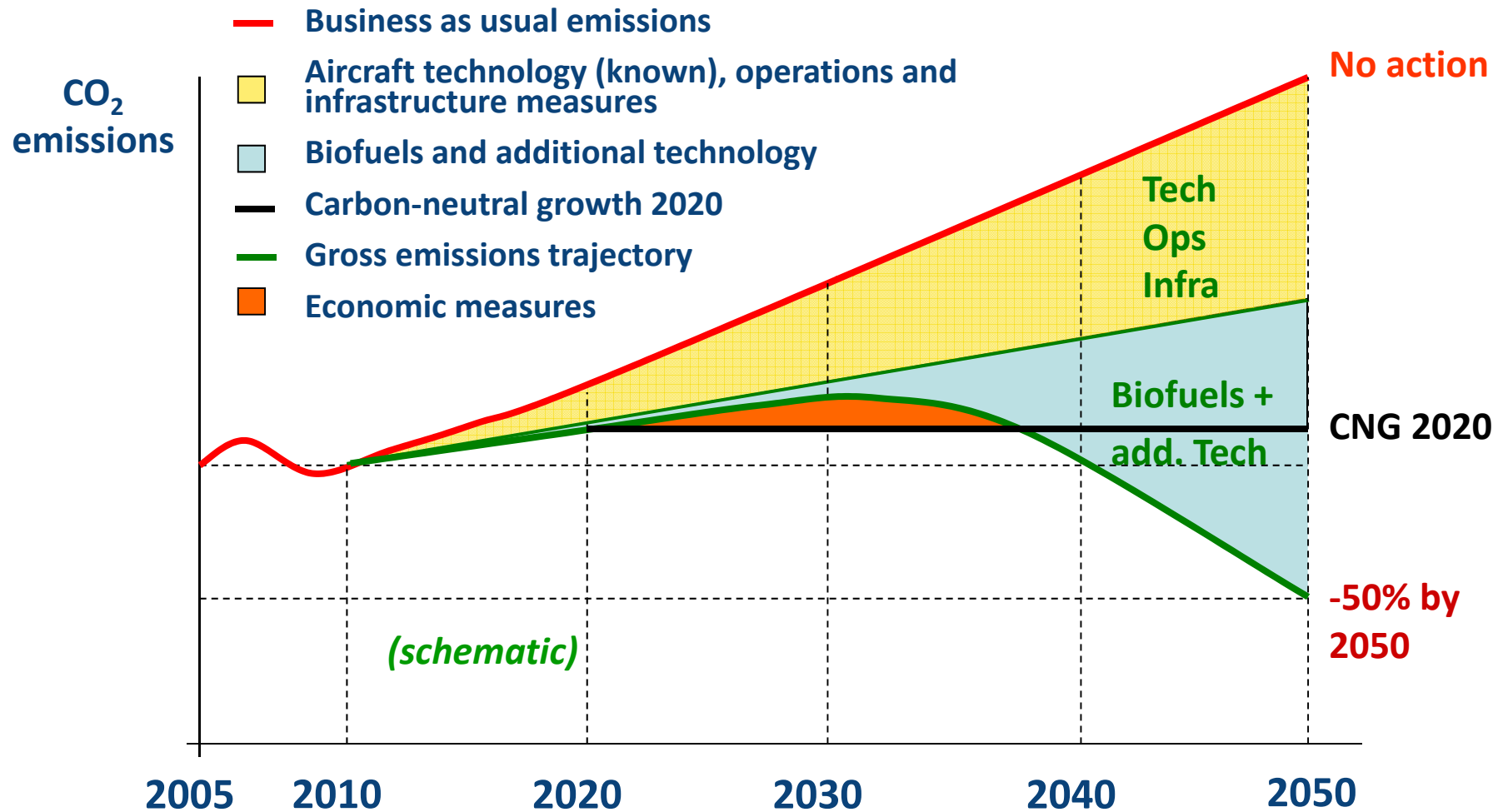
Paul Steele

Executive Director, Air Transport Action Group



ICAO Headquarters, Montréal, Canada, 11- 14 May 2010

Why turn to alternative fuels?





Stringent performance specifications

- Safe
- Drop-in
- High energy density
- High flash point / low freeze point
- Net benefit on full carbon lifecycle basis

The above excludes many first generation fuels
e.g. Biodiesel, Ethanol made from food crops



Alternative fuel types

Fuels from Fossil Sources

	Energy Source	Process	Benefits /Issues
Jet Kerosene	Oil	Refining	Compact/High Energy Fuel
Coal-to-Liquid (CTL)	Coal/Shale	Fischer-Tropsch	Reduces oil-dependency Needs CCS* to reduce CO ₂
Gas-to-Liquid (GTL)	Gas/Coal/Shale	Fischer-Tropsch	Reduces oil-dependency Needs CCS* to reduce CO ₂



*Carbon Capture & Storage



Alternative fuel types

Fuels from Renewable Sources

	Energy Source	Process	Benefits /Issues
Biomass-to-Liquid (BTL)	Camelina/Jatropha Halophytes/Algae/ Urban Waste	Gasification/ Fischer-Tropsch	CO ₂ Lifecycle benefits/ Sustainability
Hydrotreated Renewable Jet (HRJ)	Camelina/Jatropha Halophytes/Algae/	Hydrogen treatment	CO ₂ Lifecycle benefits/ Sustainability
Fermented Renewable Jet (FRJ)	Sugars	Fermentation	CO ₂ Lifecycle benefits/ Sustainability



Sustainability requirements

- Aviation determined not to repeat the experience with first-generation biofuels

CO ₂	Land use	Food security	Water and air quality	Society	Soil and biodiversity
Has a net reduction in carbon emissions over its full lifecycle	Do not use land previously used for food Do not cause deforestation	Do not impact food supplies Do not compete with food crops for water supplies	Do not negatively impact water and air quality	Provide benefits to communities growing feed sources	Do not negatively impact soil quality or introduce invasive species

- The industry is working with the **Sustainable Biofuels Roundtable** on sustainability criteria









We've come a long way

- **2006:** biofuels for aviation thought “unlikely”
- **2010:** 5 x biofuels test flights have taken place, 2 x gas to liquid flights
- The industry has driven development of this exciting initiative
- ASTM certification for biofuels within a year
- Commercial flights on biofuels 3-5 years away







Alternative fuels test flight programme

Carrier	Aircraft	Partners	Date	Alternative fuel	Blend
	B747-400	Boeing, GE Aviation	23 Feb 2008	Coconut & Babassu	20% one engine
AIR NEW ZEALAND	B747-400	Boeing, Rolls-Royce	30 Dec 2008	Jatropha	50% one engine
	B737-800	Boeing, GE Aviation, CFM, Honeywell UOP	7 Jan 2009	Algae and Jatropha	50% one engine
	B747-300	Boeing, Pratt & Whitney, Honeywell UOP	30 Jan 2009	Camelina, Jatropha, Algae blend	50% one engine
	A340-600	Airbus, Shell	12 Oct 2009	Gas to liquid (not biofuel)	50% four engines
	B747-400	GE, Honeywell UOP	23 Nov 2009	Camelina	50% one engine
	A319	Rentech	30 April 2010	Gas to liquid (not biofuel)	40% two engines





Test flight programme, scheduled flights

Carrier	Aircraft	Partners	Date	Alternative fuel	Blend
	A320	Airbus, CFM	2H 2010	Jatropha	TBC
	A320	Airbus, IAE, Honeywell	2010	TBC	TBC
	A320	CFM, Safran, EADS, Airbus, Honeywell	2011	Salicornia	TBC
	E190	Embraer, Amyris, GE	1H 2012	Sugars	TBC



Key findings from test flight programme

- Efficiency

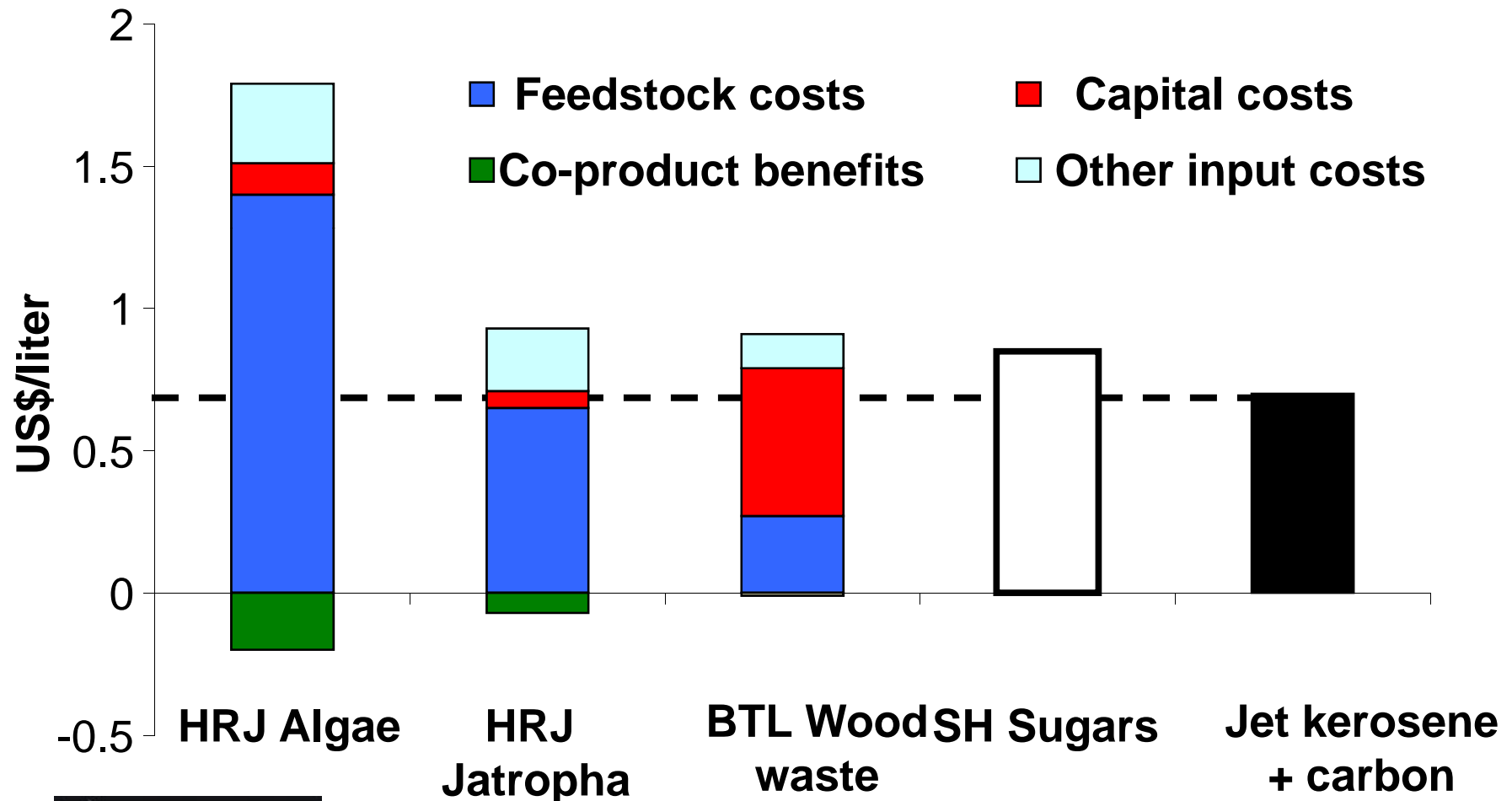
- Energy density up to 48 MJ/kg (more than JetA1 average of around 43 MJ/kg)(Continental)
- Saving of 1.4 tonnes fuel on a 12 hour 747-400 flight (Air New Zealand)

- CO₂ gas savings

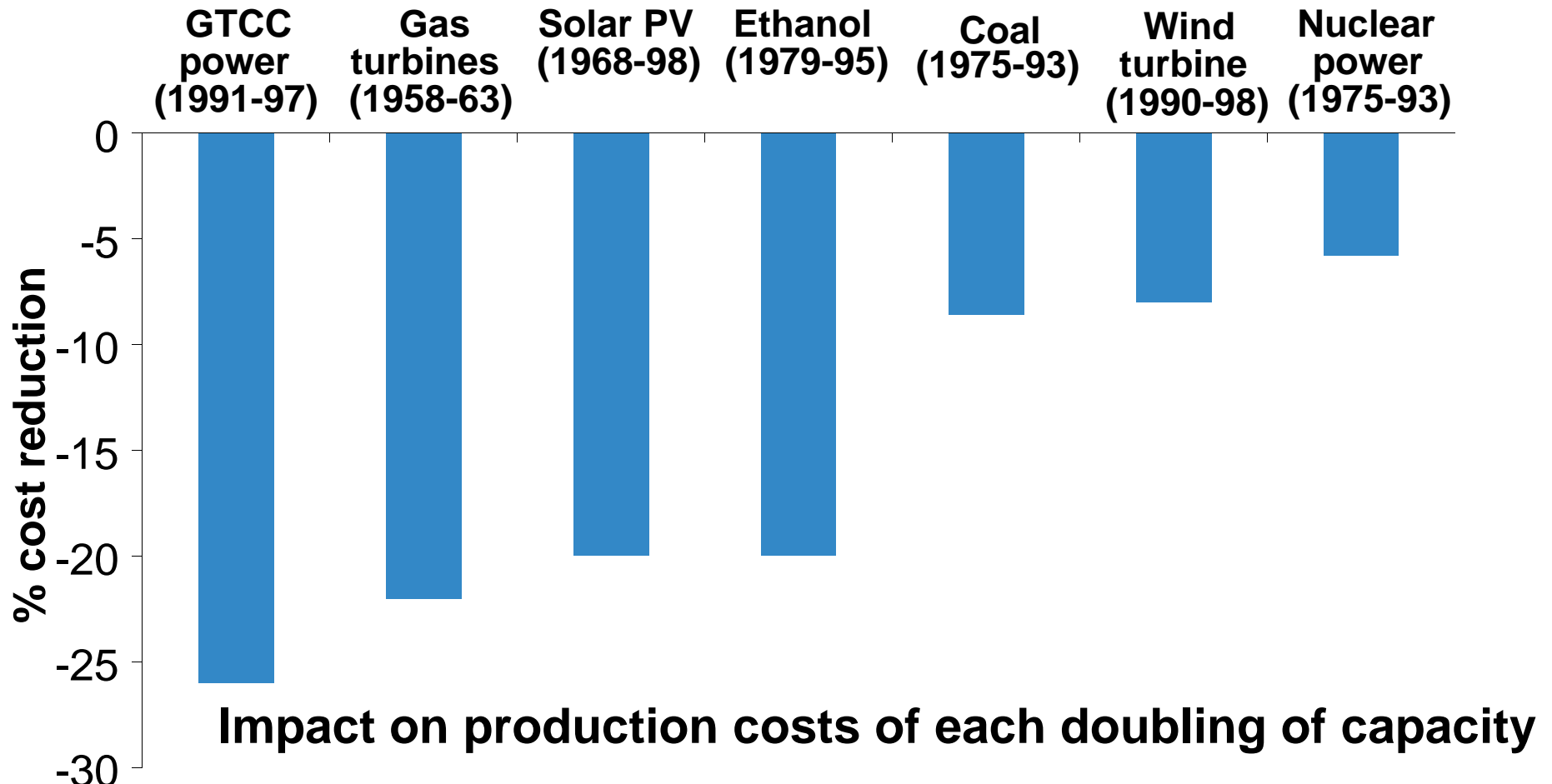
- Camelina, up to 85% (Michigan Technological University)

Need to support several types of biofuel

Near term supply costs of aviation biofuels vs jet kerosene

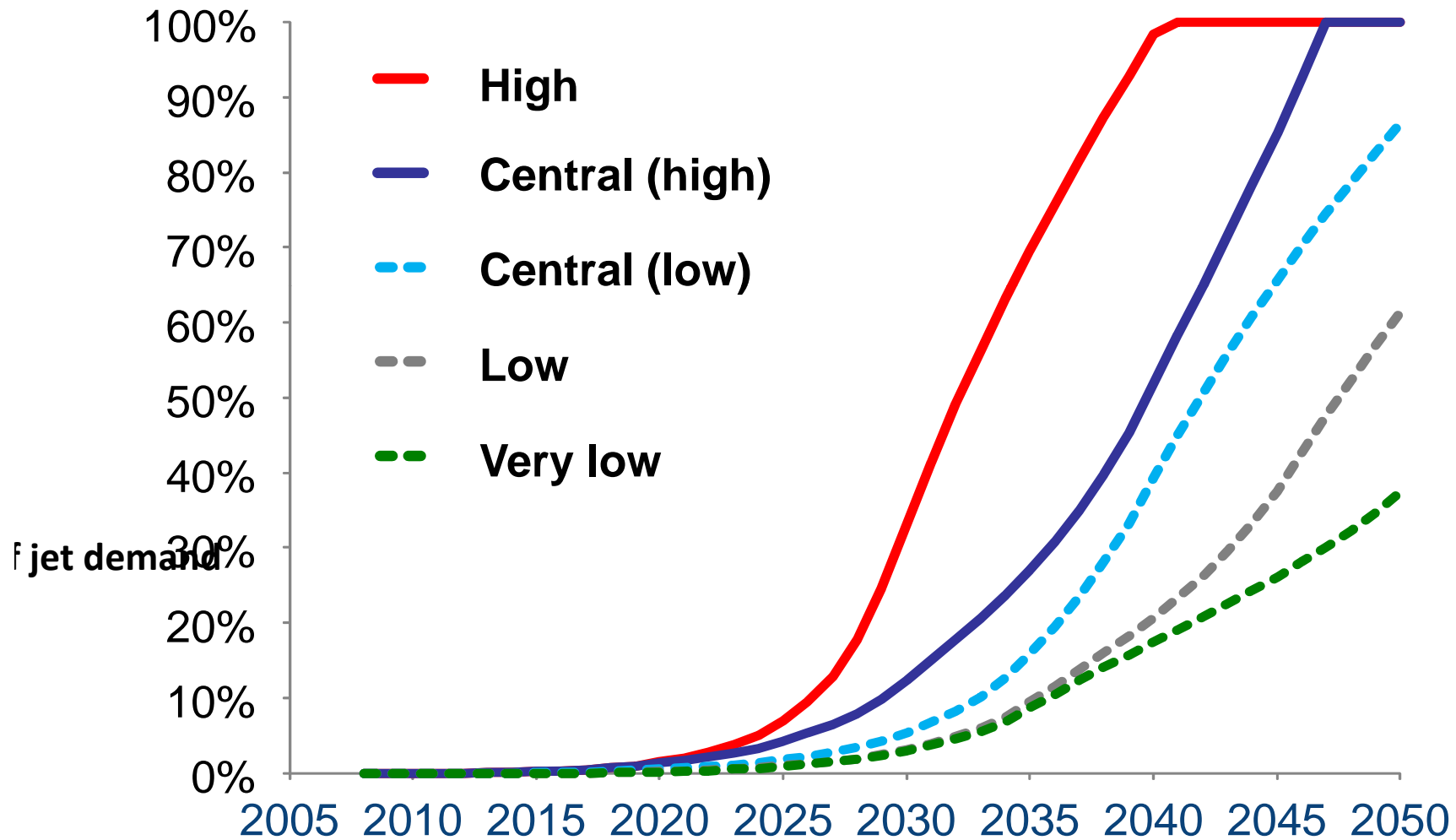


Scaling up could reduce costs substantially





Biofuels could completely replace Jet A-1



Source: E4tech

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The way forward

- Consolidate aviation business case
- Agree common sustainability standards
- Agree standard methodology for carbon lifecycle calculations
- Support development of diversity of biofuel feedstock
- Improve biomass productivity – more R&D
- Scale up capacity
- Demonstration plants – World Bank
- Commercialisation / implementation support from governments