Aviation Sustainable Biofuels: An Asian Airline Perspective

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Aviation Biofuels in Asia: Current Status

- Focus on “2nd generation” sustainable biofuels
  - candidate feedstocks - jatropha, camelina, halophytes, sugar palm, algae
  - Cathay Pacific member of SAFUG, providing support to RSB, IATA etc

- Exploring potential of biofuels which:

  - are appropriate to Asia, and can be mass grown in marginal locations (e.g. deserts and salt water);
  - do not compete with resources for food supplies (i.e. sustainable);
  - can be used in conventional jet engines with existing fuel (“drop-in”);
  - requires no changes to existing aviation infrastructure;
  - can be developed to scale and meet aviation’s needs; and
  - could lead to more stable supplies/ fuel prices in the long term.

2nd Generation Biofuels – key advantages

• Environmental – reduced CO2 emissions throughout the lifecycle
  - will play a significant role in reducing aviation's carbon footprint
  - sustainable biofuels are needed as technology will only take us so far

• Diversified supply – can substitute traditional jet fuel with a more diverse geographical supply base

• Economic and Social – can reduce price volatility if market becomes mature
  - provide populations in emerging Asian economies with a source of livelihoods

• Financial – Biojet will have a premium above market price of Jet-A/A1
  - there are risks, but there are rewards for those carriers entering upstream opportunities and investments early.

Challenges & Opportunities

Viability

- price
- return on investment

+

Sustainability

- environmental
- social/livelihoods

+

Scalability

- mass production
- supply chain

Adapted from: Boeing Commercial Airplanes

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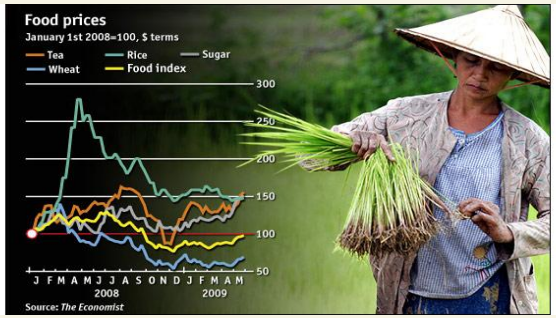
Environmental Sustainability

- Impact on land use change
  - Forests to grasslands
- Impact on Biodiversity
  - Deforestation of rainforests
  - Species invasion
- Food vs fuel
  - Price hikes
- Water resources
  - Pollution due to pesticides/fertiliser

Social/Livelihoods Sustainability

- Biofuel production can benefit local communities
  - Employment
  - Infrastructure
  - Power
  - Animal feed as a by-product
  - Development of markets at local level



- But can be negative:
  - Increasing agricultural product prices
  - Negative impact on countries importing food –poorest hit hardest
  - Large scale investors buying up/speculating on land for biofuel production
  - Forces small scale subsistence farmers to marginal land

Economic Sustainability

Security of supply:

- At what point will biofuels be cheaper to produce compared to conventional fossil fuels?
  - $90 USD per barrel price cross-over point?
  - Aviation will have to compete with other sectors
  - Biofuels will be used in sectors with best economic returns (currently diesel/gasoline)
  - Aviation may get up to 15% of global production by 2030
  - Logistics/transportation

Scale:

- If industry is to produce 225bn litres of biojet by 2030 to meet IATA target, 225 plants of Neste Oil's Singapore facility scale are needed – that's one a month from now on
- From lab, to pilot plant, then commercial plant?
  - Huge risk and investment challenge

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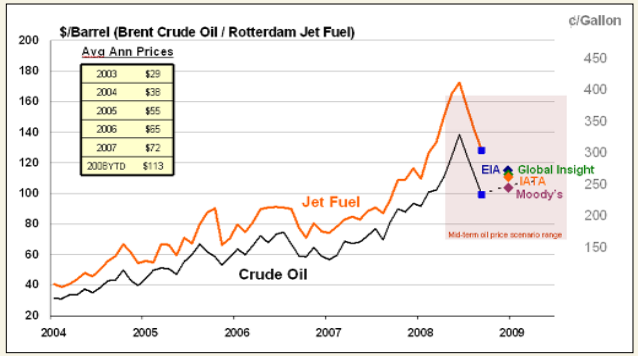
Scalability & Economic Challenges/Opportunities



Challenge: Fuel price and availability

- fuel suppliers – aviation competing with road transport
- no significant supply chain exists yet

Opportunity:

- No major changes to aviation fuel distribution infrastructure needed
- Secure advantaged position
- Mitigate price volatility
- Mitigate risk from heavy crudes
- Scalability, first mover advantage
- Supply chain establishment and control

Challenge: Greenhouse Gas Emissions

Opportunity:

- Reduce emissions cost-effectively
- Position with stakeholders, customers
- Mitigate exposure to regulation

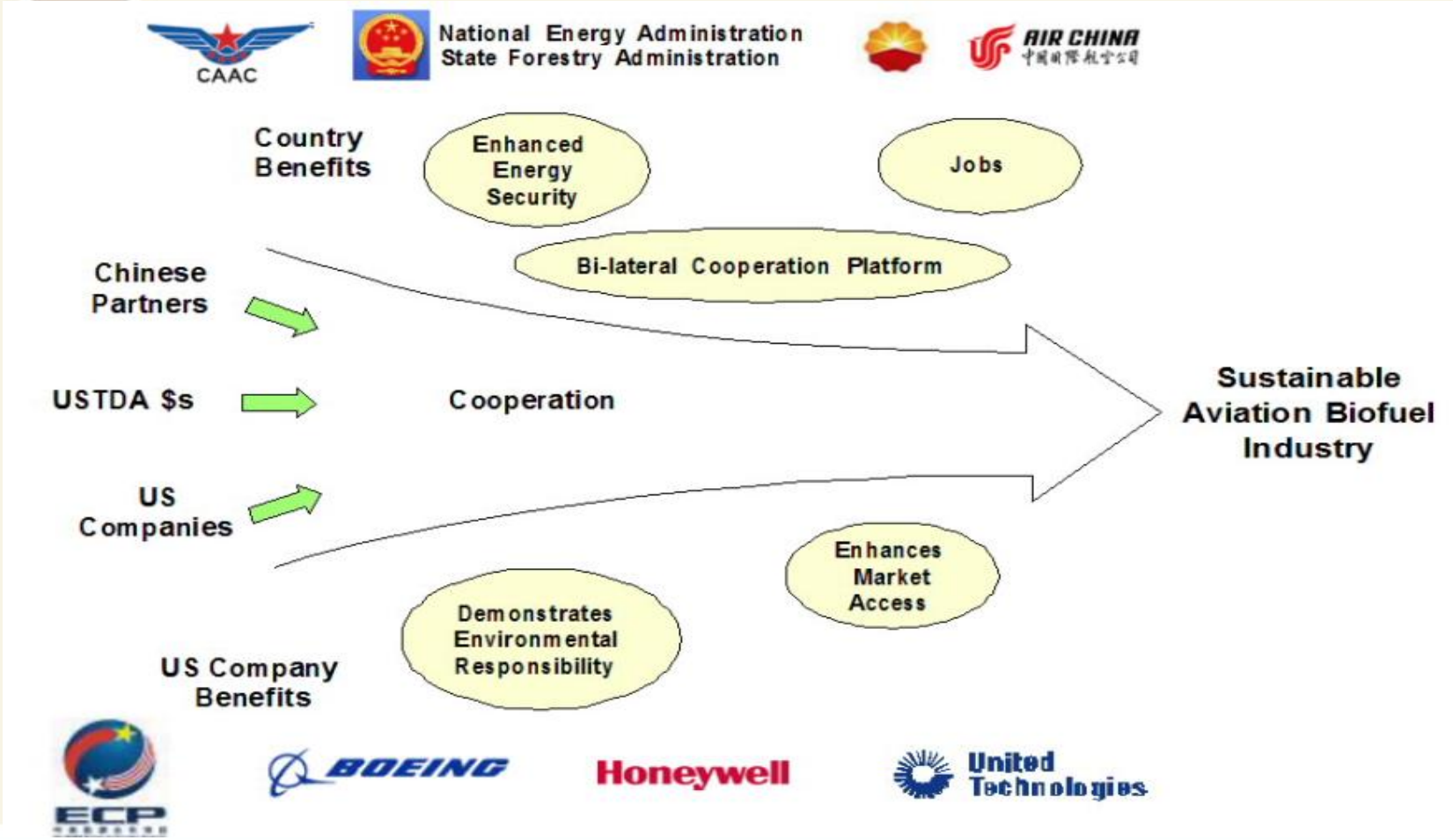
From Field to Wing

- Producing sufficient feedstocks to meet aviation's requirements is a major challenge
- 2nd generation biofuels can be grown in harsh environments, but very significant amounts of land will be required to meet the global demand for replacing jet fuel
- The production of aviation biofuel is complex:
  - Extracting oil from harvested biomass by pressing process
  - Refining bio-oil to Jet fuel using conventional hydro-processing technology used today
  - Further refinement via isomerisation (cracking/re-arranging molecules)
  - Blending of fuels and delivery to aircraft
    - Drop-in
    - Dedicated refinery (e.g. UOP/Houston) or airport fuel facility (e.g. PAFF/HKG)
- The process is expensive, given the small scale of production at present

Key Biofuel Drivers for Major Airlines

- Regulatory
  - EU ETS - Commences 1 January 2012
  - Airlines will need to cover the cost of emissions above a pre-determined cap
  - Legislation provides potential for biofuels to be 'zero-rated' (i.e. no carbon cost or reduced cost)
  - Potential cost savings from reduced ETS Allowance requirements
  - Other emerging regional schemes may have similar clauses
- Reputational
  - The "right thing to do" - social, economic and environmental benefits
  - Industry leadership - support for IATA's climate change targets
  - Investors looking to support responsible airlines
- Return on Investment
  - High and volatile jet fuel prices and need to manage cost of carbon
  - Emissions control – airlines could significantly reduce future Scope I emissions by utlising biofuel
  - Supply chain – security of supply and price stability

Aviation Biofuel Development in China



Courtesy: Boeing Commercial Airplanes

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Air China undertaking biofuel test flight

- Air China plans a domestic flight powered by biofuel, likely June 2011
- Using a Boeing 747-400 aircraft powered by 4 x Pratt & Whitney engines
- 1 engine - 50/50 blend Jet A-1 + jatropha from Yunnan Province, other 3 using 100% Jet A-1

- Highly significant:
  - Feedstock grown, harvested and processed by PetroChina
  - PetroChina involvement indicates importance of supply chain in China
  - Further test flight planned, trans-Pacific, using biofuel from USA and China
  - First steps towards commercialisation

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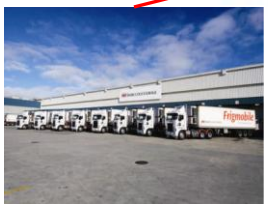
Cathay Pacific's focus on Supply Chain

Property	Aviation	Agribusiness & Food Chain	Marine Services	Trading & Industrial










SWIRE

HK Intl Airport has potential to store/supply biofuels

- New Permanent Aviation Fuel Facility (PAFF) adjacent to HKIA – state of the art
- Dual undersea pipelines to airport
- 2 supertanker berths
- Potential for dedicated biofuel storage tanks
- 8 tanks over 2 farms, 264,000m^3 fuel storage capability, with room for expansion

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Cathay Pacific & Sustainable Biofuels: Summary of Current Situation

- 2nd generation biofuels derived from biomass represent an exciting proposition for CX and a key element in our strategy to address our future environmental impacts as part of the group's commitment to sustainability

- CX has already engaged in relevant industry groups and has learned a great deal from this

- There are significant challenges and risks involved in going further, but key opportunities too

- Ability to store and supply biofuels to HKIA, strategic partnerships in the region and our linkages with the overall Swire Group provide a strong basis for moving forward

- We are actively examining the scale and extent of our involvement

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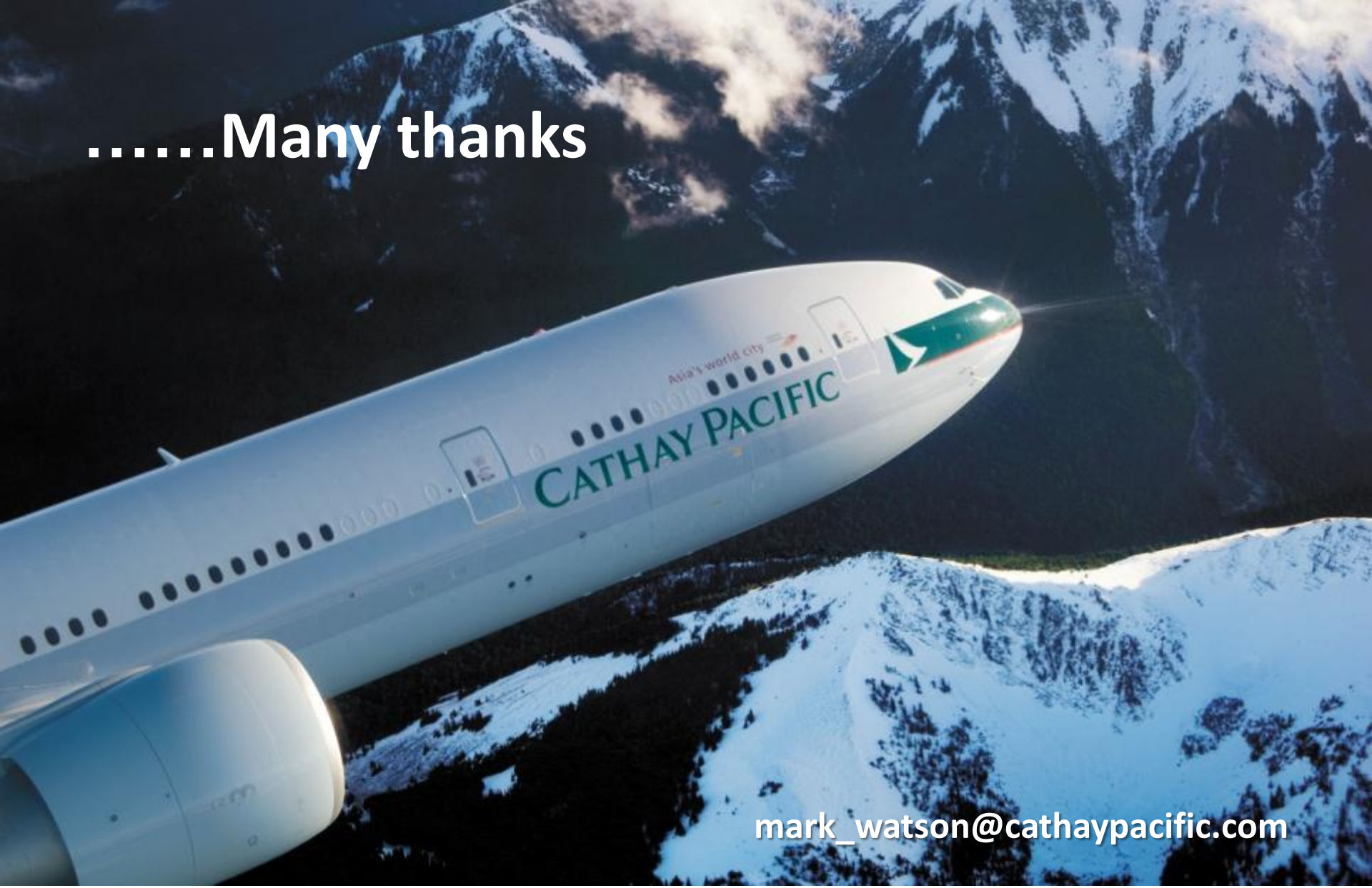
Sustainable Biofuels for Aviation: Next Steps

What do airlines want?:

- A steady supply of feedstock is grown and processed into biofuel
- Facilities are in place to refine and blend biofuel into jet fuel
- Costs are feasible, to compete with petroleum based jet fuel
- Aviation is allocated its share of biofuel despite competition from other forms of transport
- Governments provide incentives to suppliers to bring sufficient biofuel to the market (e.g. building facilities, hiring labour, buying seeds, irrigation)
- Positive fiscal and legal frameworks implemented to support airlines using biofuels



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