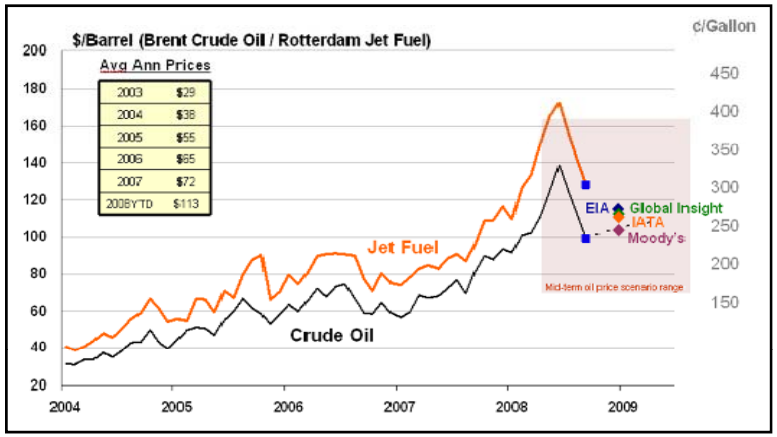
Why sustainable biofuels? Challenges and opportunities

Challenge:
Fuel price and availability



Challenge:
Greenhouse gas emissions

Source: 2008 average annual oil price forecasts as of Sept 2008 (Global Insight, EIA) and June 2008 (Moody's, IATA)

Pursuing alternative fuels initiatives

The industry is pursuing different alternative fuels initiatives to address these challenges…and that's ok!

AIRBUS

Air Transport Association

IATA

BOEING

CAAFI

Sustainable Aviation Fuel Users Group

AIR NEW ZEALAND

JAL

cargolux

Virgin atlantic

ANA All Nippon Airways

AIR FRANCE

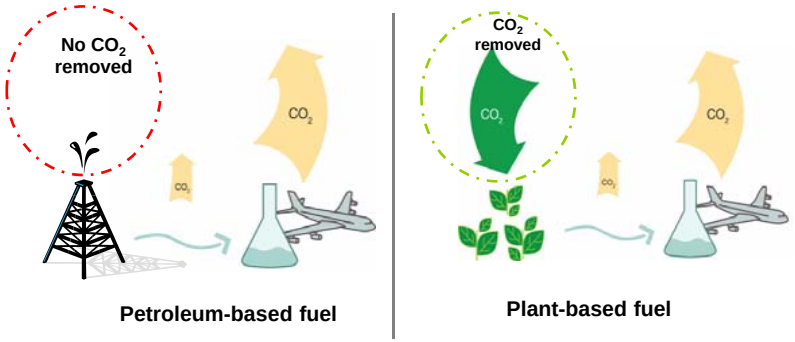
KLM

GULF AIR

SAS Scandinavian Airlines


Focus on Sustainability
Are all biofuels equal? What are the best and worst sources?

Sustainability considers: environmental, economic and social impacts



Lower CO_2 lifecycle

Does not compete with food or promote deforestation

Promotes local and regional solutions and economies

Commercial efforts underway via Sustainable Aviation Fuel User Group

GOAL: To help speed the creation of a viable market mechanism for sustainable biofuels.

Members are:

- Driving commercial viability requirements
  - ☑Sustainability principle and monitoring in place
  - ☑Technology/agronomy in place
  - ☑Fuel processing technology in place
  - ☑Viable feedstock and processing developers in place
- Using the power of their fuel spending dollars to ensure sustainability is a real requirement in the development of future aviation fuels

Ensuring a sustainable approach to aviation biofuels

The user's group pledges to consider only renewable fuel sources that –

- ☑ require minimal land, water and energy to produce
- ☑ minimize biodiversity impacts
- ☑ don't complete with food or fresh water resources
- ☑ provide socioeconomic value to local communities in cultivation and harvest of feedstocks

Group agrees to link with *Roundtable on Sustainable Biofuels* Process

Sustainable Aviation Fuel Users Group
Our Commitment to Sustainable Options

As aviation leaders, our business is to bring people, cultures, and economies together. We recognize the need for dynamic, new innovation to help reduce aircraft greenhouse gas emissions beyond existing advances, while continuing to increase the socio-economic good that air transport provides to the world.

Whilst we recognize the need to drive further efficiency gains through technological solutions and operational efficiencies, we also have an opportunity to deliver significant environmental and social benefits as we seek to lower the carbon intensity of our fuels overall by supporting the development, certification, and commercial use of lower carbon renewable fuels, derived from environmentally and socially sustainable sources.

Therefore, we, the undersigned air carriers and other aviation industry organizations declare our commitment to advance the development, certification, and commercial use of drop-in sustainable aviation fuels. Collectively, we represent, approximately 15% of commercial aviation fuel demand, and in assessing the sustainability and commercial use of a bio-derived aviation fuel, the following considerations at a minimum should be addressed by verifiable means:

1. Jet fuel plant sources should be developed in a manner which is non-competitive with food and where biodiversity impacts are minimized; in addition, the cultivation of these plant sources should not jeopardize drinking water supplies.
2. Total lifecycle greenhouse gas emissions from plant growth, harvesting, processing, and end-use should be significantly reduced compared to those associated with jet fuels from fossil sources.
3. In developing economies, development projects should include provisions or outcomes that improve socio-economic conditions for small-scale farmers who rely on agriculture to feed them and their families, and that do not require the involuntary displacement of local populations.
4. High conservation value areas and native eco-systems should not be cleared and converted for jet fuel plant source development.

These criteria should be consistent with, and complementary to emerging internationally-recognized standards such as those being developed by the Roundtable on Sustainable Biofuels.

We agree to work with leading organizations and individuals in the biofuels arena, not limited to the aviation industry, to develop a world leading fact base on sustainable aviation fuels, which will:

1. Provide a body of peer-reviewed research and best practices, including fuel lifecycle emissions assessments, which will support the practical application of common sustainability criteria to the development, certification, and commercial use of sustainable aviation fuels
2. We will work in conjunction with the Version Zero report of the Roundtable on Sustainable Biofuels as a basis for sustainability research and certification efforts. The Working Group will identify and research feedstock-specific sustainability indicators and criteria to contribute to the Roundtable.
3. Support the development of government policies which promote the development, certification, and commercial use of sustainable, lower carbon aviation fuels.

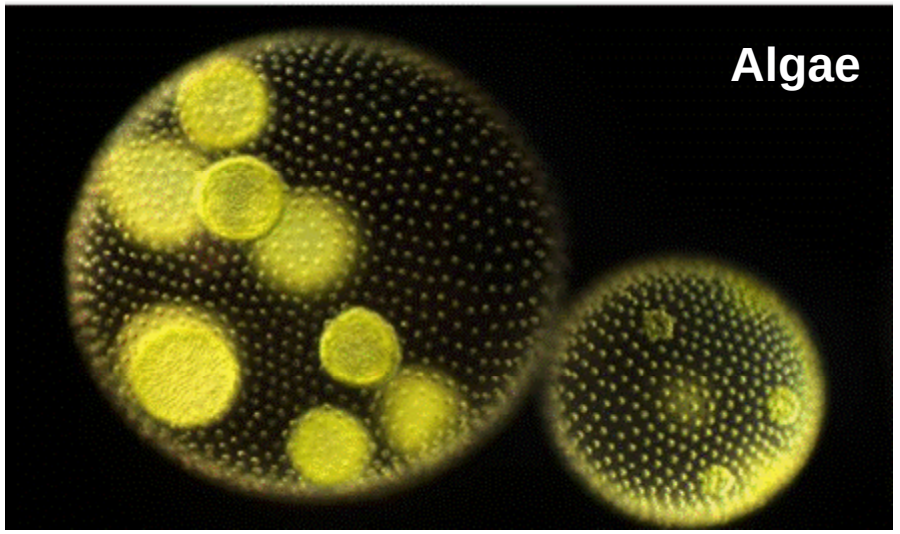
We are committed to working in partnership where appropriate with governments, other industries and representatives of civil society on credible and feasible actions in response to global climate change concerns and other socio-economic challenges.

We strongly encourage other aviation industry participants to join us in working together to help accelerate the development, certification, and commercial use of environmentally and socially sustainable aviation fuel.

AIR FRANCE · KLM · UOP A Honeywell Company · ANA · AIR NEW ZEALAND · cargolux · JAL · GULF AIR · SAS Scandinavian Airlines · BOEING · Virgin atlantic

Sustainability Pledge

Viable and sustainable feedstock alternatives

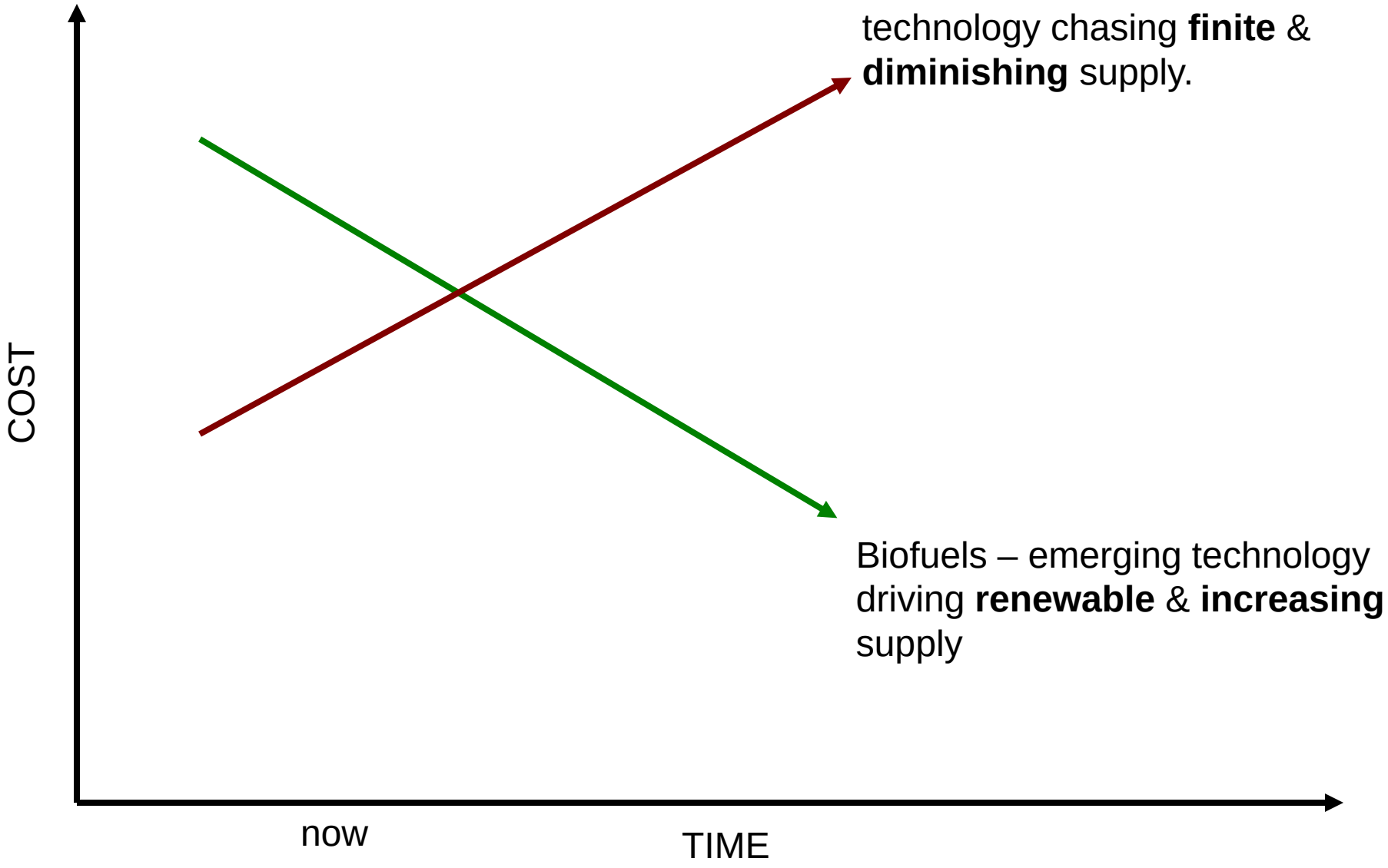


Viability is based on timing, technology and local resources

Commercially Viable

The business case for sustainable aviation fuel

Long term trajectory of cost is important



Fossil Fuels – mature technology chasing **finite** & **diminishing** supply.

Biofuels – emerging technology driving **renewable** & **increasing** supply

New fuel supply models increase aviation fuel supplies

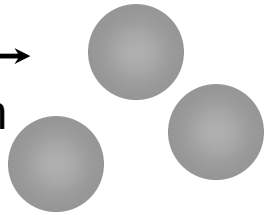
Fossil Fuel Model

Integrated Oil Production

Individual Airline Fuel Demand →

Sustainable Fuel Model

Sustainable Biofuel Production →



Individual Airline Fuel Demand →

Scale of biofuel production allows for new opportunities for air carriers

Aviation is uniquely structured to maximize benefits of sustainable biofuels

- Tens of thousands fueling stations
- Hundreds of millions of vehicles

- Several hundred fueling stations (airports)
- 20,000 vehicles

Technical and Fuel Requirements

Sustainable biofuels must provide near-term replacement solution

Sustainable biofuels work in existing aviation infrastructure

- Meets fuel performance requirements
- Requires NO change to airplanes or engines
- Requires NO change to infrastructure
- Can be mixed or alternated with Jet-A fuel

Sustainable biofuels can exceed current jet fuel specification

Fuel requirements:

- ☑ Freezing point
- ☑ High temperature thermal stability
- ☑ Energy density
- ☑ Storage stability
- ☑ Elastomeric compatibility
- ☑ Must be a replacement solution
- ☑ Meet ASTM fuel specs
- ☑ Have a low CO_2 footprint

Synthetic Paraffinic Kerosene (SPK) from a bio-derived source*					
Property		***Jet fuel specification***	***Bio-SPK performance***		***ASTM Test Method***
			Bio-jet A	***Bio-jet A1***	
Fluidity					
Freezing point, degrees Celsius	**max**	**-40 Jet A -47 Jet A1**	**-63**	**-69**	**D 5972, D 7153, D 7154, or D 2386**
Combustion					
Net heat of combustion, MJ/kg	**min**	**42.8**	**44.4**	**43.2**	**D 4529, D 3338, or D 4809**

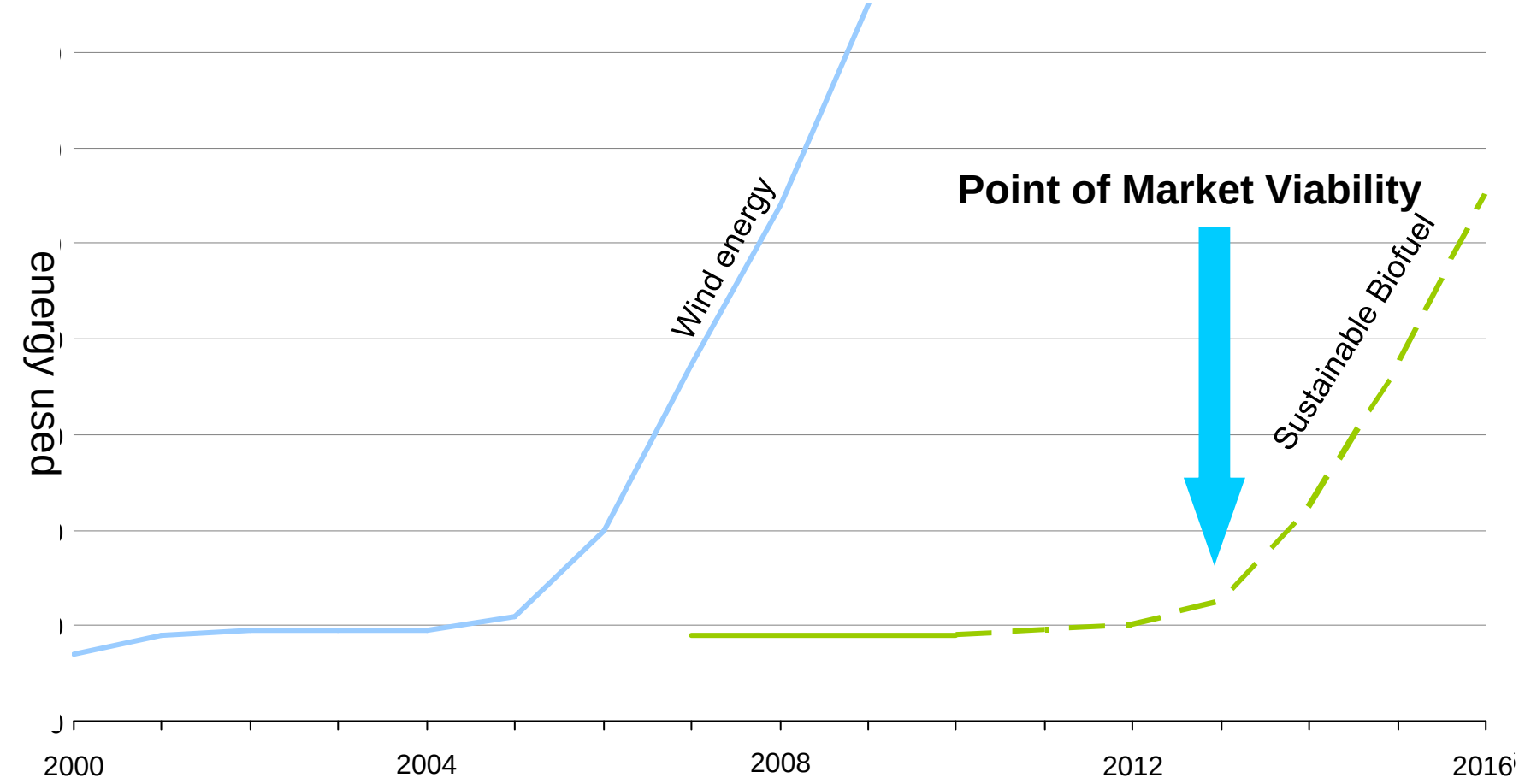
23 degrees C lower freeze point

Nearly 4% more energy content

* Data provided by UOP


Achieving the Goal
Driving a viable market for sustainable aviation biofuels

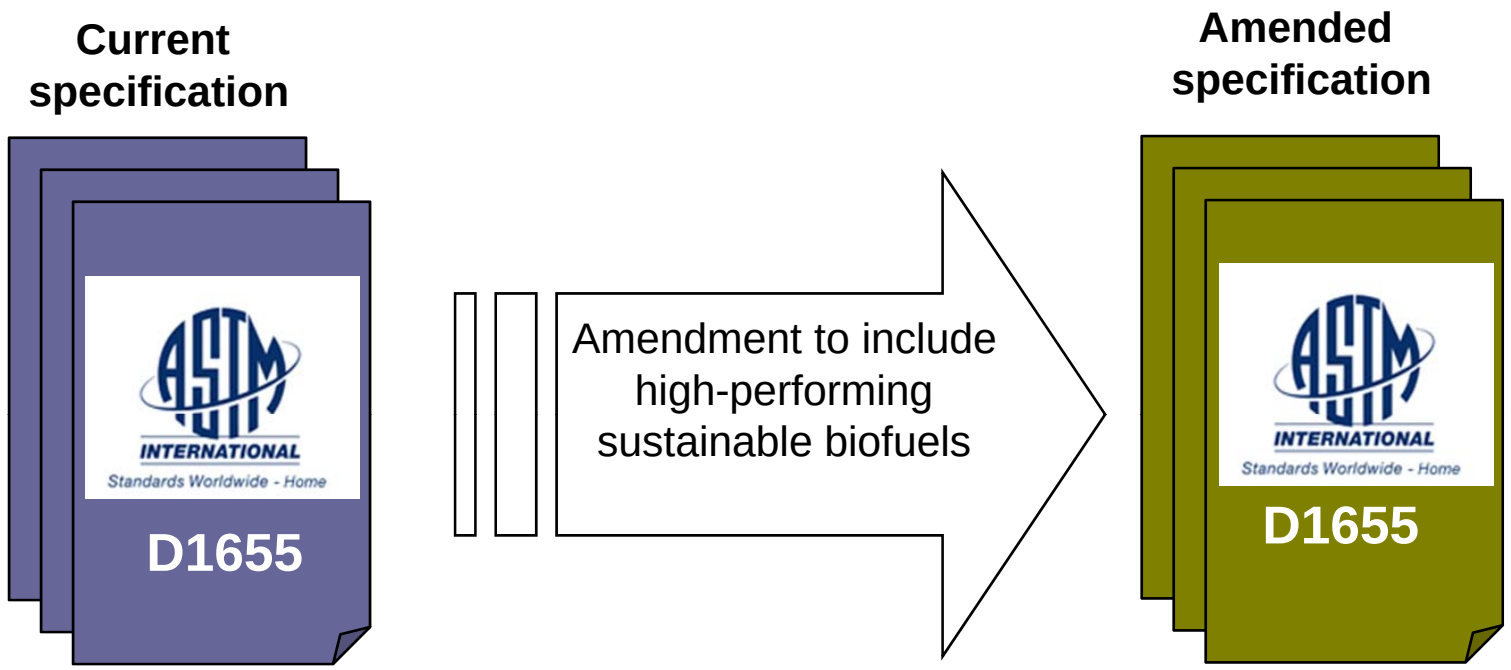
Sustainable biofuels can follow a similar adoption curve to wind energy



** Notional data*

Technology matured; financial markets became comfortable with investing

Accelerating fuel certification



New specification will include high performing biofuels

Boeing is working to achieve certification of bio-spk fuels by 2010 by:

- Increasing airline participation in ASTM
- coordinating flight demos, which generate performance data
- Writing the technical fuel certification report which supports near term certification

Successful flight test program demonstrated biofuel viability

- Demonstrated technical feasibility
- Identified sustainable biofuel sources
- Promoted development of viable commercial markets
- Demonstrated diverse engine / airframe combinations

Focus areas in commercial scale production

Gaps in critical market drivers are being addressed by Sustainable Aviation Fuel Users Group

Driving development of viable feedstocks

- Sponsoring feedstock feasibility studies on jatropha, algae, halophytes
- Connecting feedstock projects with financial community
- Working with industry and NGOs to support sustainable feedstocks through public policy
- Co-founded
  - Algal Biomass Organization
  - Sustainable Aviation Fuel Users Group