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# *Aviation Fuel Costs And Alternatives*

June 5, 2012

TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES

# Today's Speakers

Moderated by James Hileman, Chief Scientific & Technical Advisor of Office of Environment and Energy, FAA

- 1) Overview of *ACRP Report 48: Impact of Jet Fuel Price Uncertainty on Airport Planning and Development*
  - William Spitz of GRA, Inc.
  
- 2) Overview of *ACRP Report 60: Guidelines for Integrating Alternative Jet Fuel into the Airport Setting*
  - Bruno Miller of Metron Aviation
  
- 3) Overview of *ACRP Report 46: Handbook for Analyzing the Costs and Benefits of Alternative Aviation Turbine Engine Fuels at Airports*
  - Fred Morser of CSSI, Inc.



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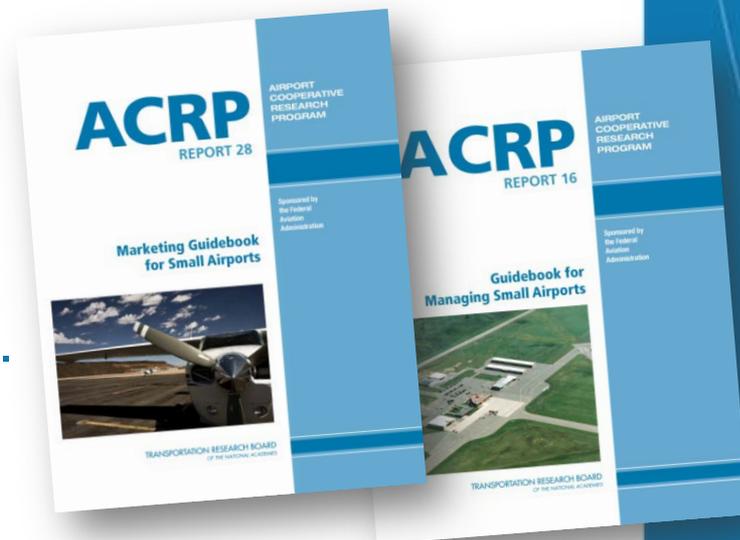
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# What is the Airport Cooperative Research Program (ACRP)?

- Industry-driven, applied research program that develops near-term, practical solutions to problems airport operators face.
- Managed by the Transportation Research Board (TRB) of the National Academies.
- Sponsored by the Federal Aviation Administration.
- Research is conducted by *you*—individuals and firms selected on the basis of competitive proposals.

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# Ways to Get Involved in ACRP

- Submit a research idea, also called a Problem Statement.
- Prepare a proposal to conduct research.
- Volunteer to participate on a project panel. We reimburse for travel.
- Apply to be an ACRP Ambassador or member of the ACRP Speakers Bureau.
- Use our research results.

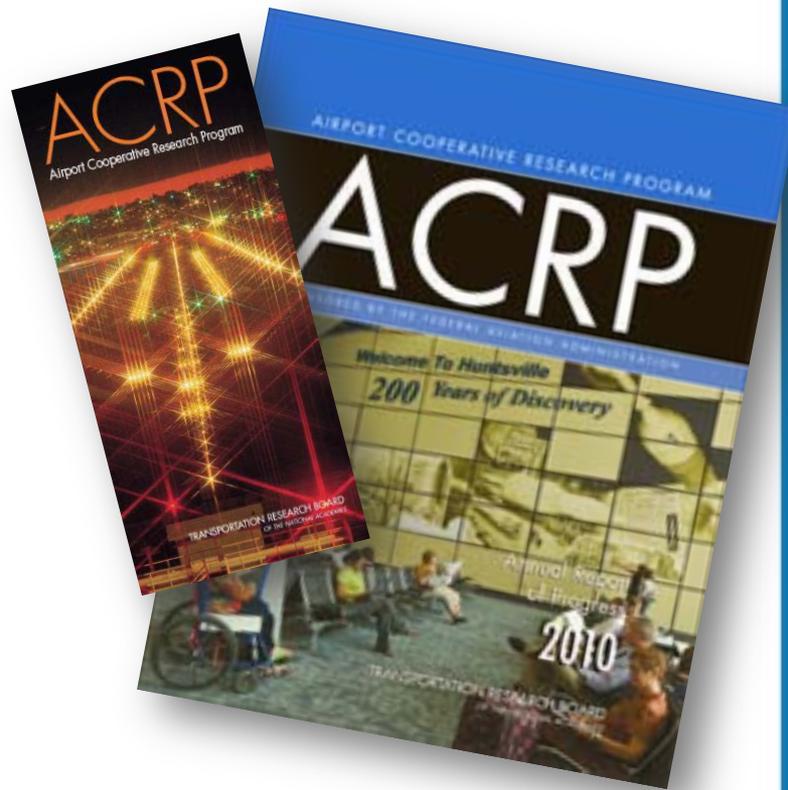
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# ACRP Report 48: Impact of Jet Fuel Price Uncertainty on Airport Planning and Development

William Spitz, PhD  
GRA, Incorporated

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# William Spitz, PhD

## Principal Investigator

- Chief Economist, GRA Incorporated
- Former Economist, Mathtech Inc
- Former Assistant Professor, Rider College



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# ACRP Report 48 Oversight Panel

John K. Duval, Austin Commercial, L.P., Panel Chairman

Michael T. Hackett, Metro Washington Airports Authority

Glenn Hipp, JetBlue Airways

Michael E. Levine, New York University

Barry Molar, Unison Consulting, Inc

Jeff Mulder, Tulsa Airport Authority

Clinton Oster, Indiana University

Carl Burleson, FAA Liaison

Joesph Hebert, FAA Liaison

John P. Heimlich, Airlines for America Liaison

Richard Marchi, ACI-North America Liaison

Melissa Sabatine, AAE Liaison

Christine Gerencher, TRB Liaison

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# ACRP Report 48: Impact of Jet Fuel Price Uncertainty on Airport Planning and Development

- Documents how fuel price uncertainty and volatility can affect aviation markets and activity at airports
- **Connects changes in both macroeconomic conditions and local factors with changes in airport activity projections and development projects**
- Describes the development of a statistical approach to assist airports with anticipating changes in air service due to fuel price and other external changes
- **Provides easy-to-use computer software to allow airport planners and sponsors to do a simplified risk analysis showing how fuel price and other uncertainties may affect their own airport activity forecasts**
- Published April 2011

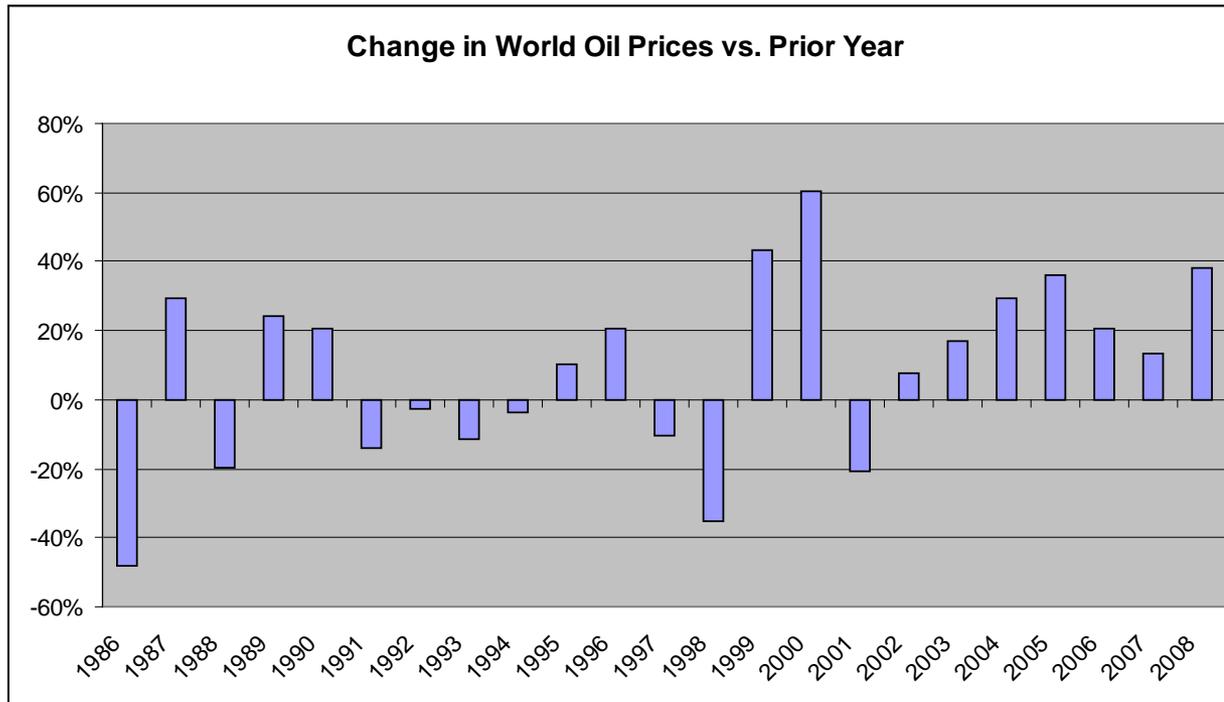
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## Motivation and Overview

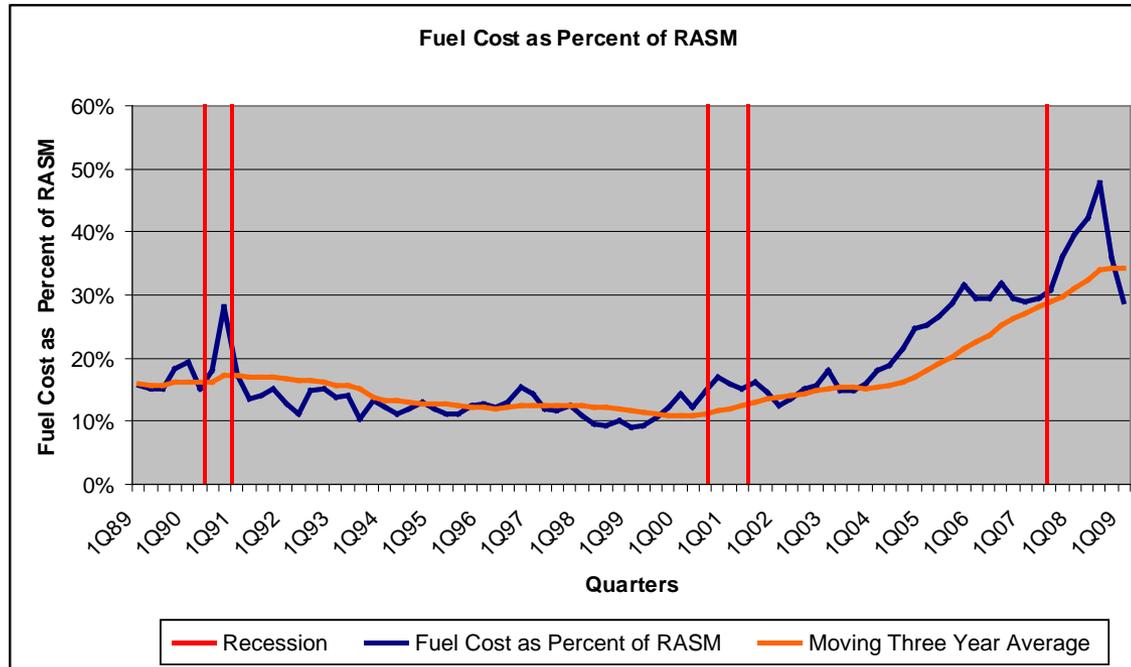
- How can commercial service airport planners account for uncertainty and volatility in fuel prices in their activity forecasts?
- Project involves development of statistical models of airport activity which can then be used to assess uncertainty in airport activity
- Primary output is an Excel-based software program allowing users to assess future forecasts for a specific airport while accounting for future changes in fuel prices, income and other variables

# Historical Volatility in Oil Prices



- Significant increase since 2009 not shown

# Increasing Importance of Fuel Costs on Domestic Commercial Aviation



- Fuel cost as % of RASM shows short-run challenge in accommodating rapid changes in fuel prices
- Trend line shows secular long-run increase

# Reductions in Airport Development Programs and Budgets

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Airport	FAA Hub Category	Project	Action	Budget Change	Change in Seat Offers	
					2008	2009
Atlanta	L	Capital program	Budget cut	-\$225M; may cut \$50M more	-1%	-2%
Butte	N	Additional runway lighting (\$2.5M)	Delayed			
		Terminal renovation to increase energy efficiency (\$5-7M)	Delayed	-30%	-7%	-61%
		Overall capital projects	Budget cut			
Dulles Int'l	L	Terminal replacement (\$2B)	Halted		-3%	-7%
		Car rental center (\$400M)	Halted			
Ft. Lauderdale Int'l	L	Discretionary projects	Delayed		1%	-13%
Green Bay	S	Parking lot and exit road expansion (\$2.2M)	Canceled		-1%	-23%
		Overall capital projects	Budget cut	-11.6%		
Kansas City	M	Overall capital projects	Budget cut	-6.3%	-4%	-15%
Louisville Int'l	S	Some capital projects	Delayed		1%	-13%
McCarran Int'l	L	Capital improvement plan (\$3.7B)	Budget cut			
		Runway reconstruction; new signage, baggage handling upgrade (\$215M)	Delayed	-9.7%	-1%	-15%
		Escalator expansion at baggage claim	Canceled			
Missoula Int'l (Montana)	N	Small capital projects not funded by AIP	Delayed		-3%	-26%
Oakland	M	Overall capital projects	Budget cut	-5.5%	-12%	-24%
		Build third terminal, cargo and passenger airline tenant support centers, pavement rehabilitation (\$1B)	Canceled			
Orlando Int'l	L	Expansion including ticket lobby overhaul	Delayed		-1%	-15%
Pensacola	S	New gates and boarding bridges	Delayed		0%	-15%
Reno-Tahoe	S	Capital projects	Budget cut		-6%	-21%
Richmond	S	Capital program	Budget cut		-4%	-2%
San Luis Obispo	N	Capital projects	Delayed		-4%	-34%
Sioux City	N	Overall capital projects	Budget cut			
		Terminal renovation (\$1.8M)	Delayed	-5%	75%	-34%
		Runway reconstruction (\$12M)	Delayed			
Toledo	N	Overall capital projects	Budget cut	-12.5%	-11%	-54%
Tucson	S	Overall capital projects	Budget cut	-0.4%	6%	-23%
		Gate expansion	Canceled			

Sources: Trade and General Press Reports

# Accuracy of Airport Forecasts

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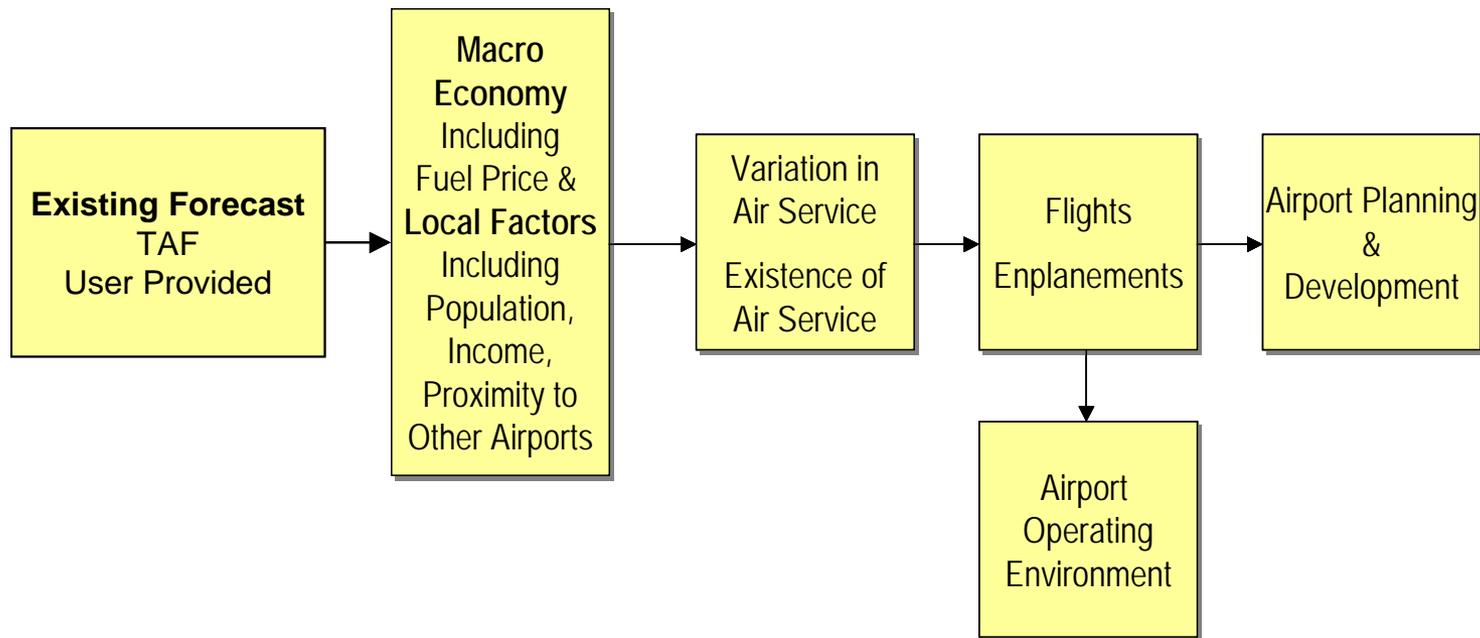
2003-2008 TAF forecasts one to five years out  
(Mean Absolute Percentage Error)

Hub Type	Domestic Operations				
	Years Ahead Forecast				
	1	2	3	4	5
Large	3.4%	10.2%	13.9%	18.4%	25.5%
Medium	5.3%	12.5%	17.3%	22.0%	25.7%
Small	8.0%	13.9%	17.9%	22.7%	26.0%
Non-Hub	14.0%	20.4%	25.3%	31.9%	38.7%
All	10.4%	16.8%	21.4%	27.1%	32.8%

Hub Type	Enplanements				
	Years Ahead Forecast				
	1	2	3	4	5
Large	3.9%	9.3%	12.4%	15.7%	20.4%
Medium	5.5%	11.3%	14.5%	17.9%	19.3%
Small	8.7%	12.3%	14.4%	17.1%	18.6%
Non-Hub	15.6%	20.2%	23.9%	26.3%	27.9%
All	11.5%	16.1%	19.3%	22.0%	23.9%

- Given the uncertainty, can we put confidence bands on specific airport forecasts given what we know about fuel price volatility?

# How it all ties together: Relationship Between Fuel Prices and the Economy, Airport Forecasts and Planning and Development



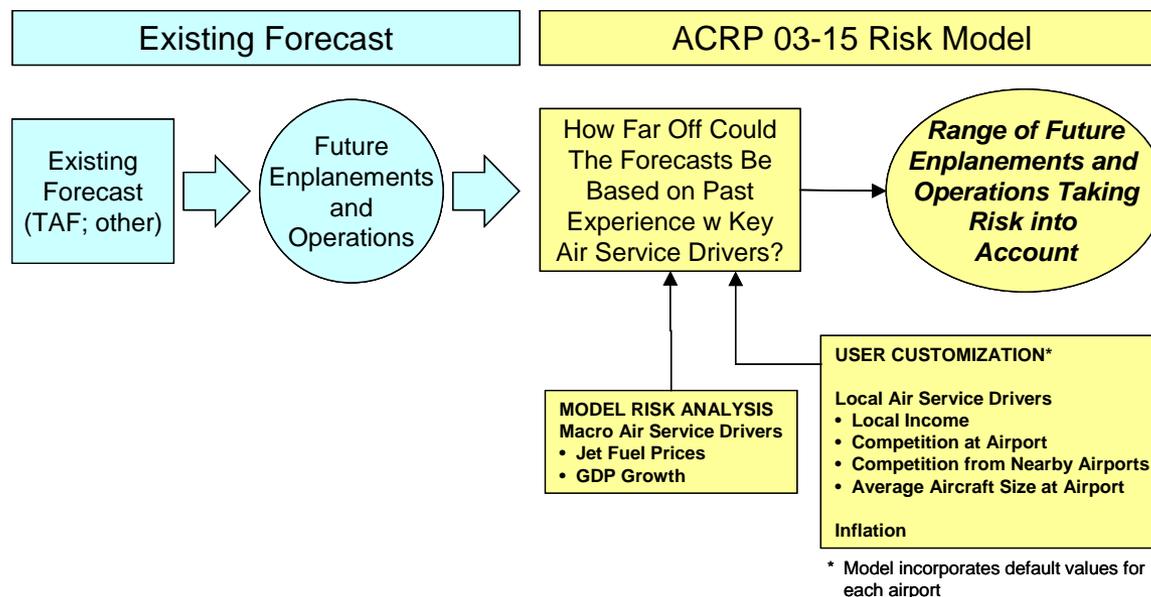
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## Modeling Approach

- Separate statistical models for airport domestic seat-departures developed for:
  - Large Connecting Hubs
    - Local Traffic
    - Connecting Traffic
  - Other Large/Medium Hubs
  - Small Hubs
  - Non-Hubs
- Seat-Departures then translated into Operations and Enplanements
- Operations and Enplanements used to help estimate airport operating revenues

# Combining Existing Airport Forecasts with the Statistical Models



- From the models: Key drivers of future activity are jet fuel prices and local income.

# Combining Existing Airport Forecasts with the Statistical Models

- In order to use the models to get a handle on the uncertainty in airport forecasts, we need to *project* future values of the key model drivers
- For fuel prices, we can use heating oil futures prices
- For income, we can use the national GDP forecasts (or local forecasts if available)

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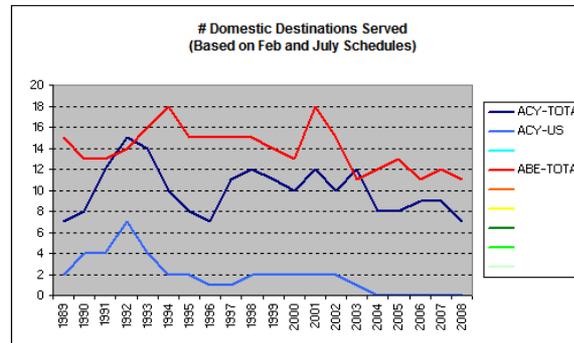
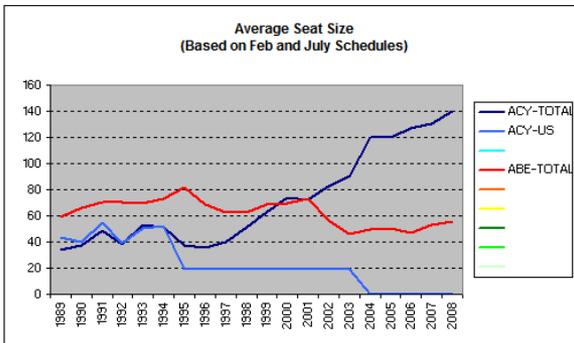
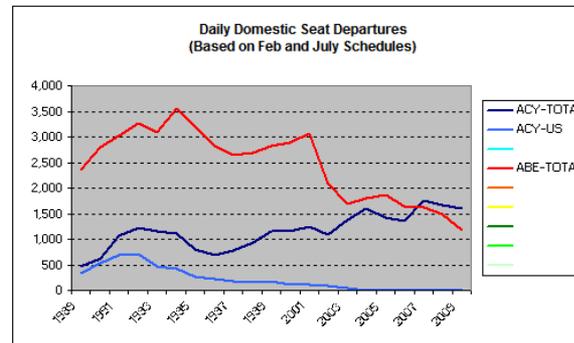
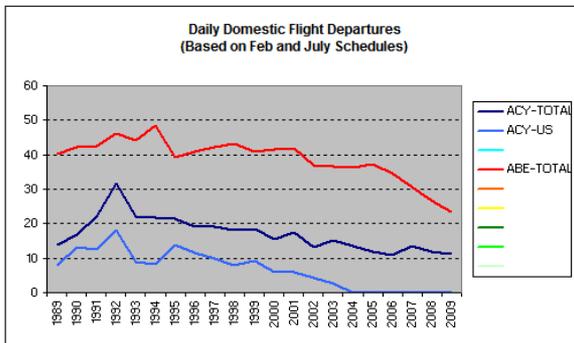
## Using the Software

- Excel spreadsheet model handles all of the calculations and has preloaded data on over 270 US airports
- User can review current and historical activity at selected airport, including:
  - 20-year OAG air service history
  - Current scheduled service (user-updateable)
  - Recent TAF forecasts
- User may use TAF forecast or provide their own
- Simplified risk analysis can then be created by specifying +/- ranges for key drivers of air service
- Software produces charts showing the results of the risk analysis using confidence bands

# Using the Software – Service History

Here you can compare scheduled service at ACY with other airports over the past 20 years.

Locid	Carrier #1	Carrier #2	Carrier #3
ACY - ATLANTIC CITY-INTL, NEW JERSEY (Small Hub)	TOTAL	US - US AIRWAYS	(blank)
ABE - ALLENTOWN, PENNSYLVANIA (Small Hub)	TOTAL	(blank)	(blank)
(blank)	(blank)	(blank)	(blank)



# Using the Software – Baseline Forecast

Year	<i>Default Baseline Domestic Forecast</i>		<i>User Updates (changes in red)</i>	
	Domestic Operations	Domestic Enplanements	Domestic Operations	Domestic Enplanements
2009	14,406	520,470	14,406	520,470
2010	14,548	527,543	<b>15,275</b>	<b>553,920</b>
2011	14,692	534,712	<b>15,427</b>	<b>561,448</b>
2012	14,836	541,979	<b>15,578</b>	<b>569,078</b>
2013	14,983	549,350	<b>15,732</b>	<b>576,818</b>
2014	15,133	556,821	<b>15,890</b>	<b>584,662</b>

# Using the Software – Forecasts for Key Drivers

[View the latest Heating Oil futures prices by clicking here](#)

Set Jet Fuel Scenarios based on Futures Uncertainty

Year	Baseline Price of Jet Fuel (Current Yr \$/gal)	Scenario 1	Scenario 2
2005	\$1.622		
2006	\$1.906		
2007	\$2.025		
2008	\$2.938		
2009	\$1.844		
2010	\$2.174	\$1.500	\$4.000
2011	\$2.258	\$2.258	\$2.258
2012	\$2.499	\$2.499	\$2.499
2013	\$2.719	\$2.719	\$2.719
2014	\$2.888	\$2.888	\$2.888

(Default baseline from 2010 forward based on change in projected price of jet fuel from EIA Annual Energy Outlook 2010.)

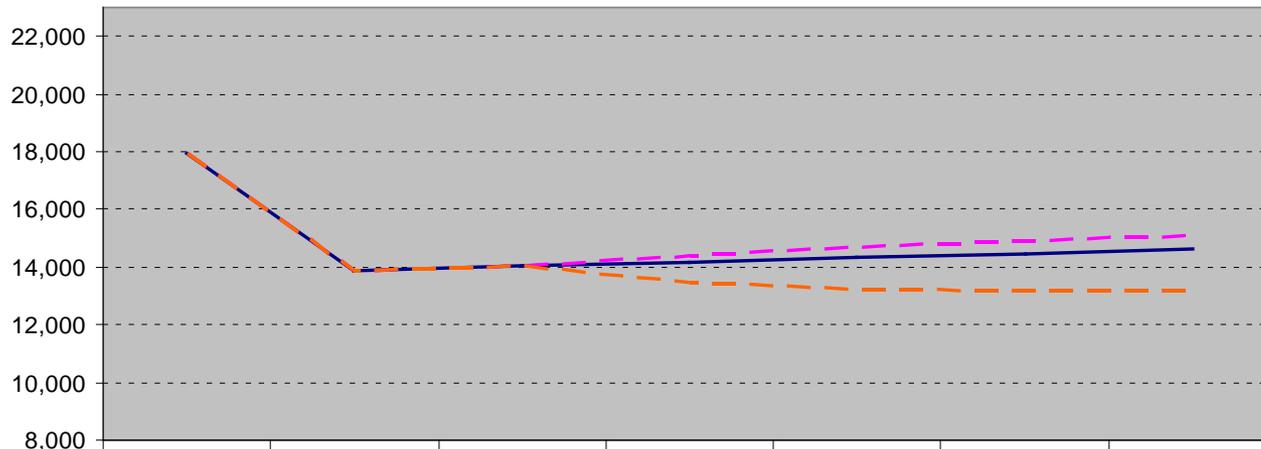
Set Income Scenarios based on EIA GDP Uncertainty

Year	Baseline Local Real Income Growth	Scenario 1	Scenario 2
2005	0.43%		
2006	0.73%		
2007	0.27%		
2008	0.34%		
2009	-2.83%		
2010	1.07%	4.00%	-1.00%
2011	3.52%	3.52%	3.52%
2012	3.64%	3.64%	3.64%
2013	2.80%	2.80%	2.80%
2014	2.46%	2.46%	2.46%

(Default baseline from 2010 forward based on projected US GDP from EIA Annual Energy Outlook 2010; 2009 value equal to US GDP growth.)

# Using the Software – Risk Assessment for Operations Forecast

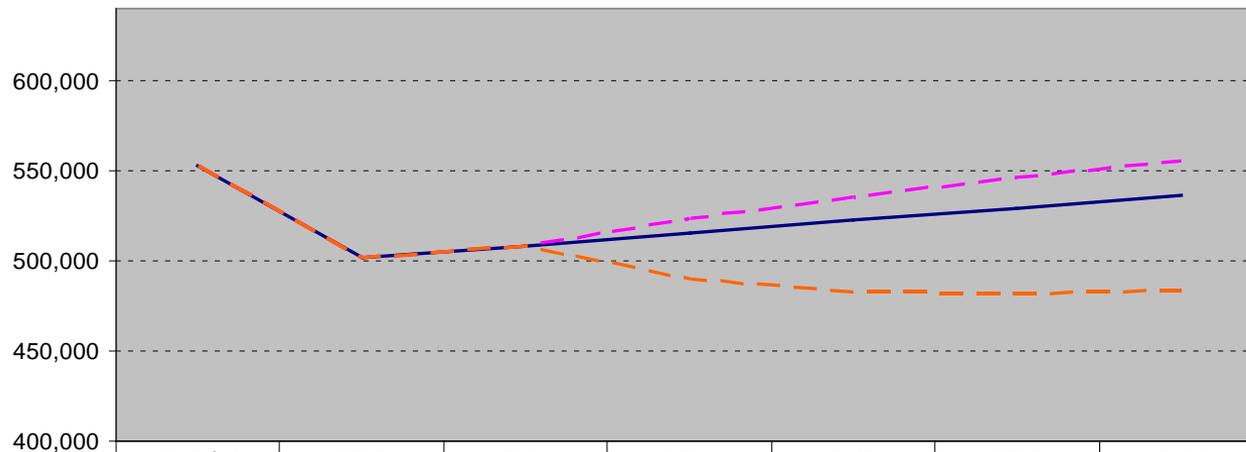
Projected Annual Operations for ACY



	2008 Act	2009	2010	2011	2012	2013	2014
Baseline	17,962	13,898	14,035	14,174	14,313	14,455	14,600
Scenario 1	17,962	13,898	14,035	14,392	14,670	14,905	15,120
Scenario 2	17,962	13,898	14,035	13,481	13,234	13,148	13,148

# Using the Software – Risk Assessment for Enplanements Forecast

Projected Annual Enplanements for ACY



	2008 Act	2009	2010	2011	2012	2013	2014
Baseline	553,177	501,686	508,504	515,415	522,419	529,524	536,726
Scenario 1	553,177	501,686	508,504	523,346	535,431	546,023	555,847
Scenario 2	553,177	501,686	508,504	490,225	483,024	481,628	483,342



## ACRP Report 48:

### *Impact of Jet Fuel Price Uncertainty on Airport Planning and Development*

<http://www.trb.org/main/blurbs/165241.aspx>

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# ACRP Report 60: Guidelines for Integrating Alternative Jet Fuel Into the Airport Setting

Bruno Miller, Ph. D.

Metron Aviation



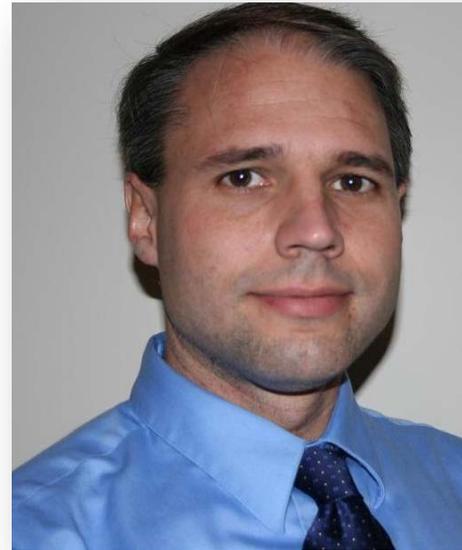
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# Bruno Miller, Ph. D. Principal Investigator

- Principal, Energy and Environment, Metron Aviation
- Former Strategic Fuel Sourcing Manager for Delta and Northwest airlines
- Co-chairman, Business Team, Commercial Aviation Alternative Fuels Initiative (CAAFI)



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# ACRP Report 60 Oversight Panel

- Mary Vigilante, Synergy Consultants, Inc., Panel Chairman
- John B. Ackerman, Denver International Airport
- John “Jack” Lavin, National Petroleum Management Association
- Lisa D. Loftus-Otway, University of Texas – Austin
- Michael Lufkin, Port of Seattle
- Debra K. Wilcox, Bye Energy, Inc.
- Nathan Brown, FAA Liaison
- Chris Hugunin, FAA Liaison
- Sabrina Johnson, EPA Liaison
- Chris Oswald, ACI-NA Liaison
- Tim Pohle, A4A Liaison
- Christine Gerencher, TRB Liaison
- Sia Schatz, ACRP Senior Program Officer

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# ACRP Report 60 Research Team



- Bruno Miller (PI), Terry Thompson, Michael Johnson, Meghan Brand, Alan MacDonald



- Don Schenk, Judith Driver, Larry Leistriz, Arlen Leholm, Nancy Hodur, David Plavin



**Integration Strategy**

- Diana Glassman



**A Honeywell Company**

- Amar Anumakonda

RCB ALTMAN  
ASSOCIATES  
L.L.C

- Richard Altman

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# ACRP Report 60: *Guidelines for Integrating Alternative Jet Fuel Into the Airport Setting*

- Presents 3-step framework to identify and evaluate alternative jet fuel projects at airports
  - Stakeholder analysis
  - Initial screening of options
  - Comparative evaluation of screened options
- Includes supporting material:
  - Frequently asked questions
  - Worksheets
  - Primer on alternative fuels
  - References and Bibliography
- Published January 2012

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# How to use this Handbook

- **Handbook tailored to readers with different levels of familiarity and interest in alternative jet fuels, e.g.:**
  - Limited prior knowledge but interested in learning basics
    - Sections 1 (Introduction), 2 (Main characteristics of alt. fuels), and 4 (FAQs)
  - Some prior knowledge and interest in more detailed information
    - Appendices (Primer on alternative fuels), Sections 4 (FAQs) and 6 (Bibliography)
  - Comfortable with alternative fuels and interested in evaluating opportunities
    - Sections 3 (Evaluation framework) and 4 (Supporting docs.)
    - Even if the reader is not intending to develop an alternative jet fuel project, Handbook provides support to evaluate proposals from third parties

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**Today's  
focus**

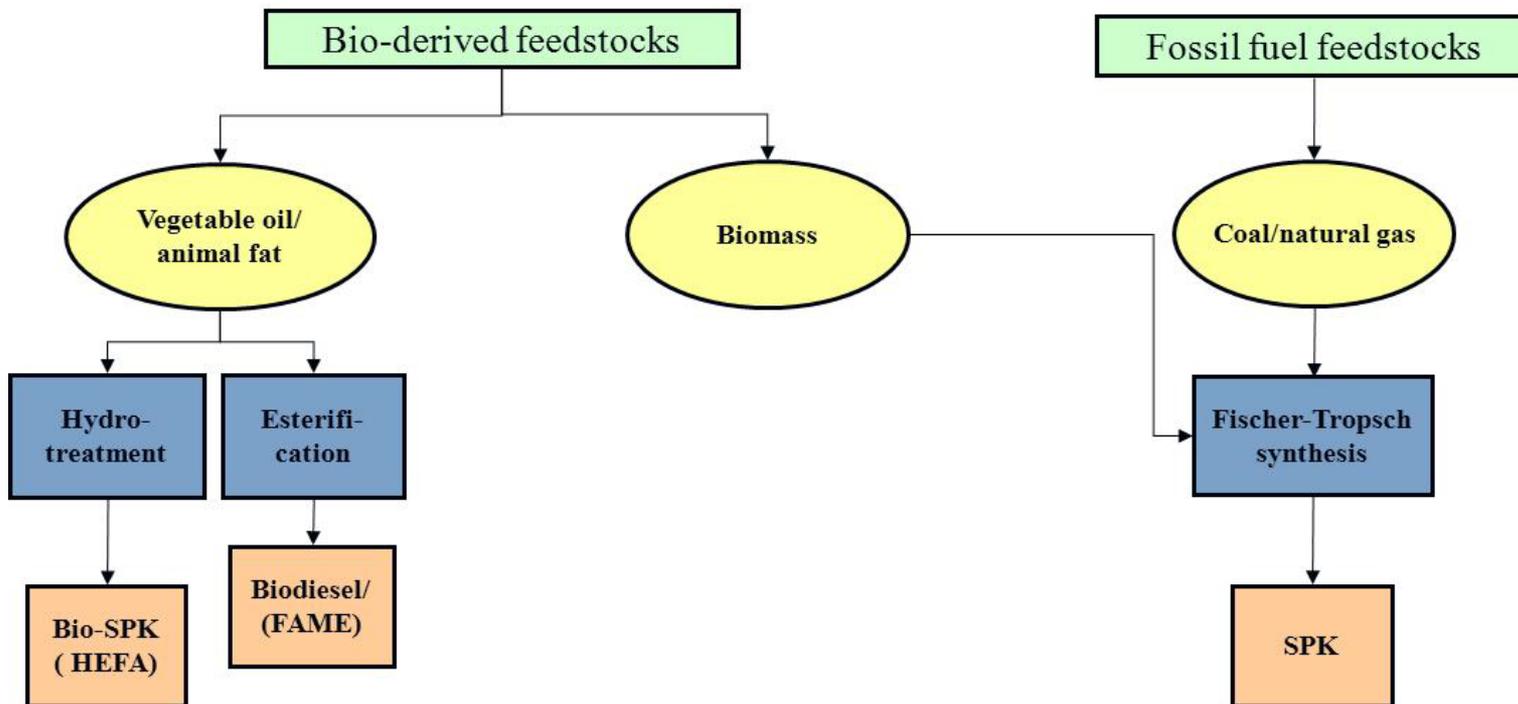
# Introduction to research approach

- **Develop framework for assessing implementation of alternative jet fuel projects**
  - Includes all steps along the supply chain
  - Emphasis on identifying main factors for project success:
    - Regulatory
    - Environmental
    - Logistical
    - Financial and business case
  - Initially focused on alternative jet fuel but can be extended to alternative fuels for ground use

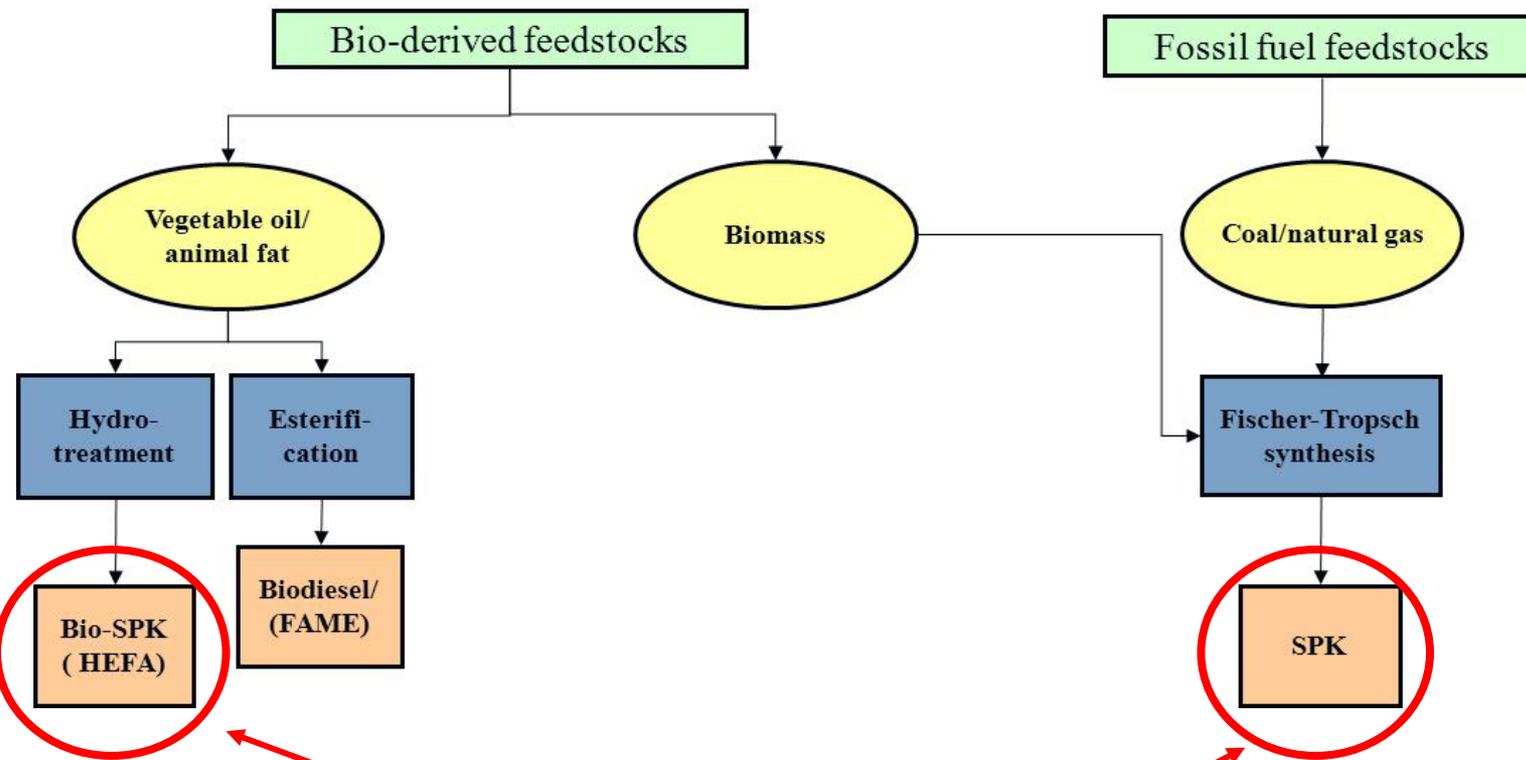
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# Alternative fuel pathways



# Alternative fuel pathways



**Focus of Handbook**

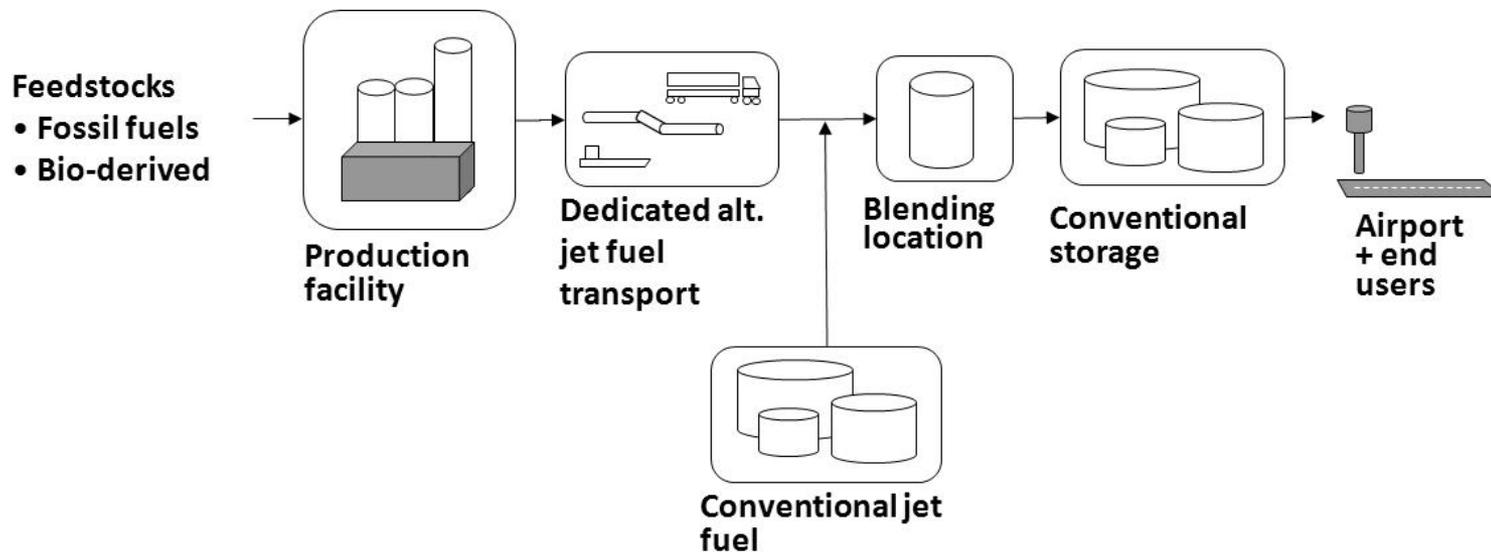


# Integrated Analysis Along the Supply Chain

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- **Critical to consider the entire supply chain**
  - Industry in development
  - All links in the chain need to be successful for projects to occur
- **Airports play a key role**
  - Hubs of demand for aviation and surface transportation fuels
  - Can be a catalyst and participate in projects



# Overview of evaluation framework

- Framework consists of three main elements:

## 1. Pre-assessment of implementation readiness

- Basic questions to identify what alternative fuel projects are of interest



## 2. Assessment of implementation readiness

- 3-step framework to identify promising alternative fuel projects



## 3. Detailed feasibility study

- In-depth evaluation of down-selected alternative fuel projects (not covered here)

# Pre-Assessing Implementation Readiness

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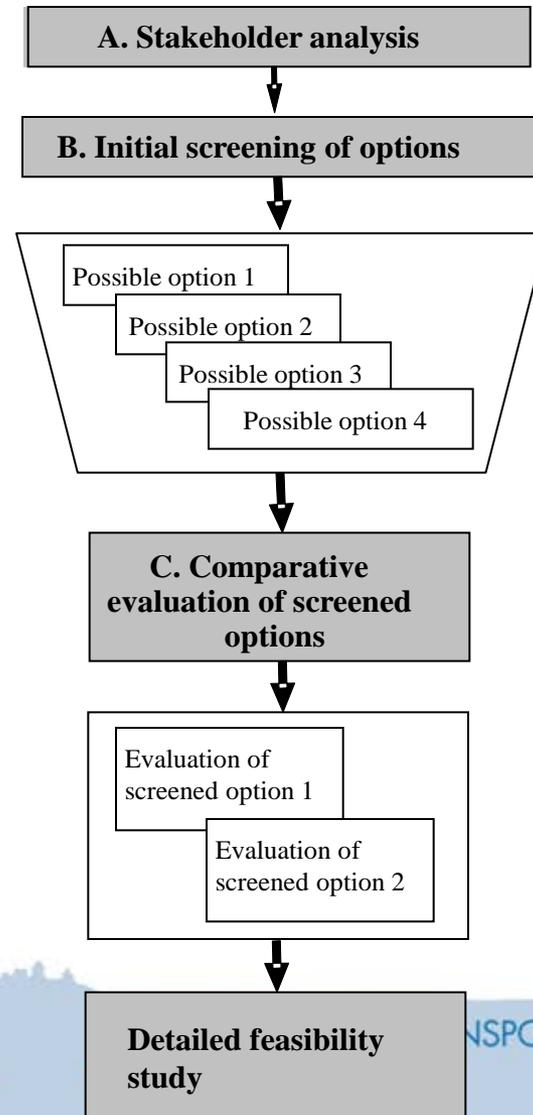
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- **Factors to consider regarding alternative fuel projects:**

- 1. Alternative fuel type:**
  - What feedstock and processing technology can be implemented at my site?
- 2. Safety:**
  - Has the alt. fuel been certified for use on aircraft and existing jet fuel infrastructure?
- 3. Environmental goals:**
  - How can the environmental characteristics of the alt. be used to meet your goals?
- 4. Logistics:**
  - How will the alt. fuel be delivered to the airport at no or minimal incremental cost?
  - How is the need for additional facilities (e.g., storage, blending) being minimized?
- 5. Business case:**
  - How can public and private sector programs be utilized to strengthen the project?
- 6. Overall evaluation:**
  - Are you satisfied with the answers above?

# Assessment of Implementation Readiness

- Intended to down-select from multiple options to a few for further evaluation



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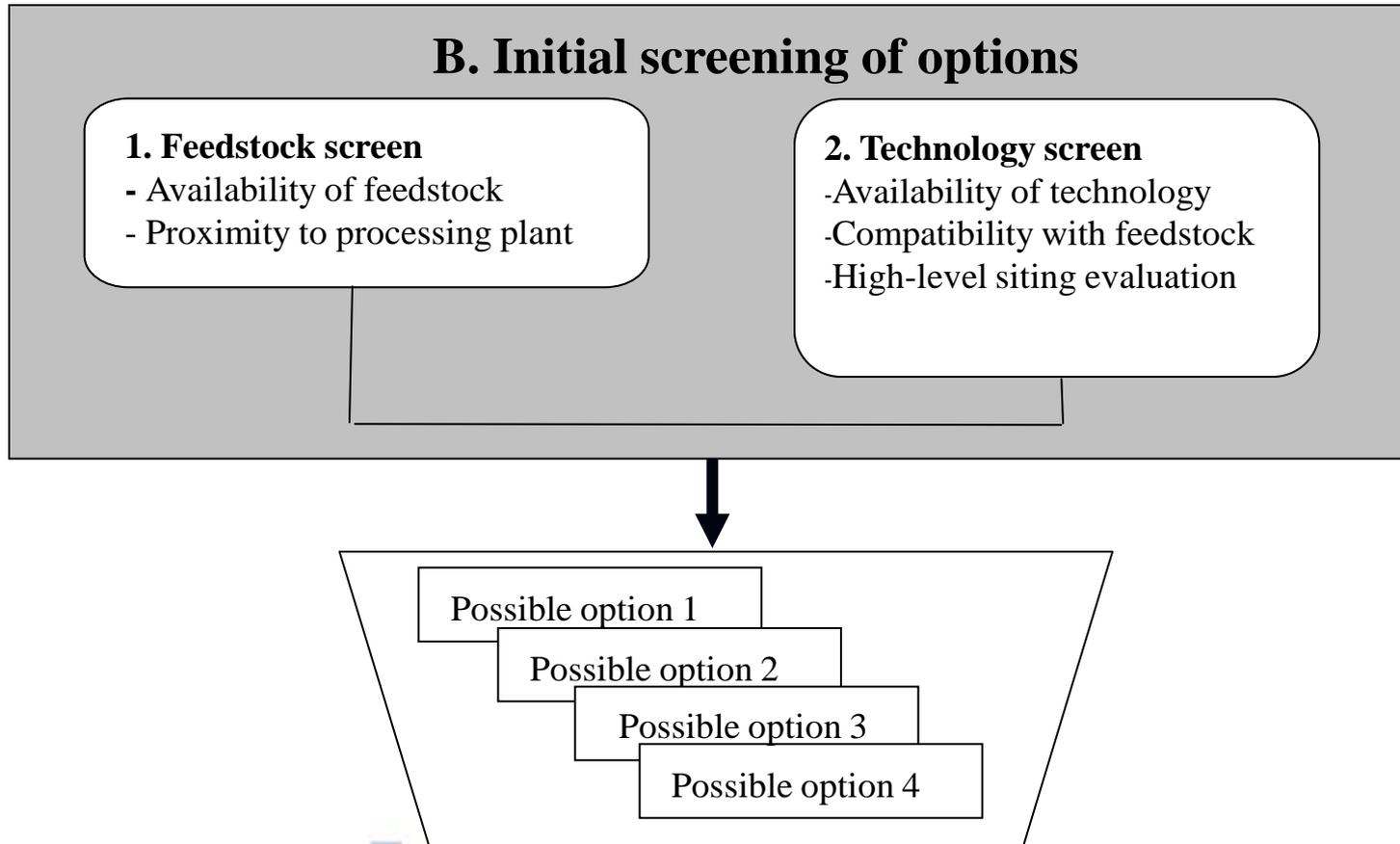
# A. Stakeholder analysis

- Identify key supporters and their needs:

<b>Stakeholder Information</b>	
Stakeholder (Name of entity):	
Role in project: (e.g., airport, airline, feedstock supplier, fuel producer, municipality/local government, public/private sector funder)	
<b>Stakeholder mission:</b>	
Economic	
Non-economic	
Is project consistent with mission? (yes, maybe/not sure, no)	
Explanation	
<b>"Hurdle rate"—describe specific minimum requirements that project must meet to obtain stakeholder's participation</b>	
Economic	
Non-economic	
Does project meet hurdle rate? (yes, maybe/not sure, no)	
Explanation	
<b>Stakeholder concerns and risks</b>	
Economic	
Non-economic	
Has mitigation strategy been developed? (yes, maybe/not sure, no)	
Explanation	

# B. Initial screening of options

- Two major screens:



# Examples of possible options

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All Wheat 2008  
Production by County

## Pacific NW:

- HEFA – camelina
- FT – woody biomass

## Northeast:

- FT – Municipal Solid Waste (MSW)
- FT – woody biomass

## Northern Plains:

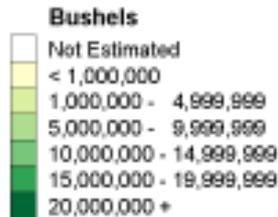
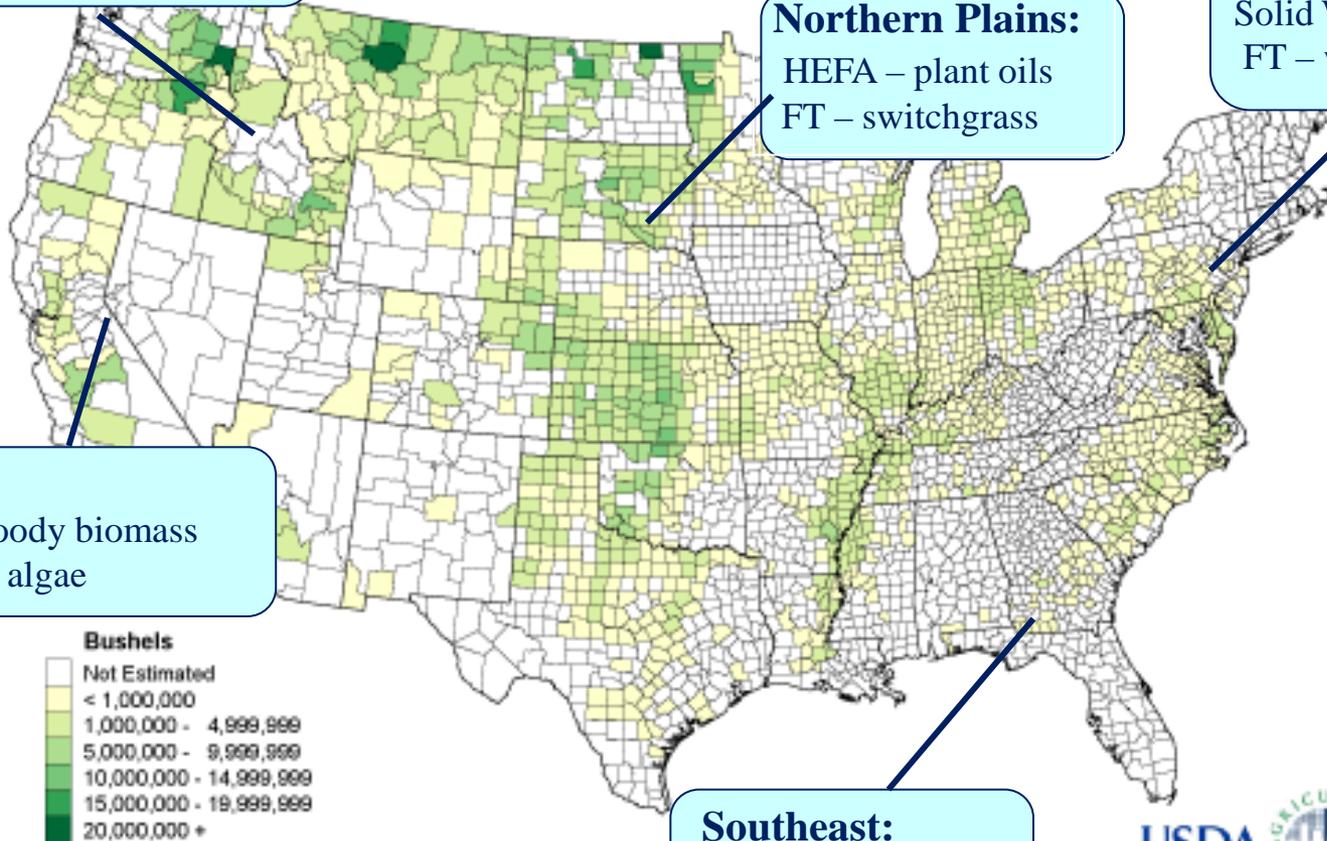
- HEFA – plant oils
- FT – switchgrass

## West:

- FT – woody biomass
- HEFA - algae

## Southeast:

- HEFA – jatropha
- FT – switchgrass

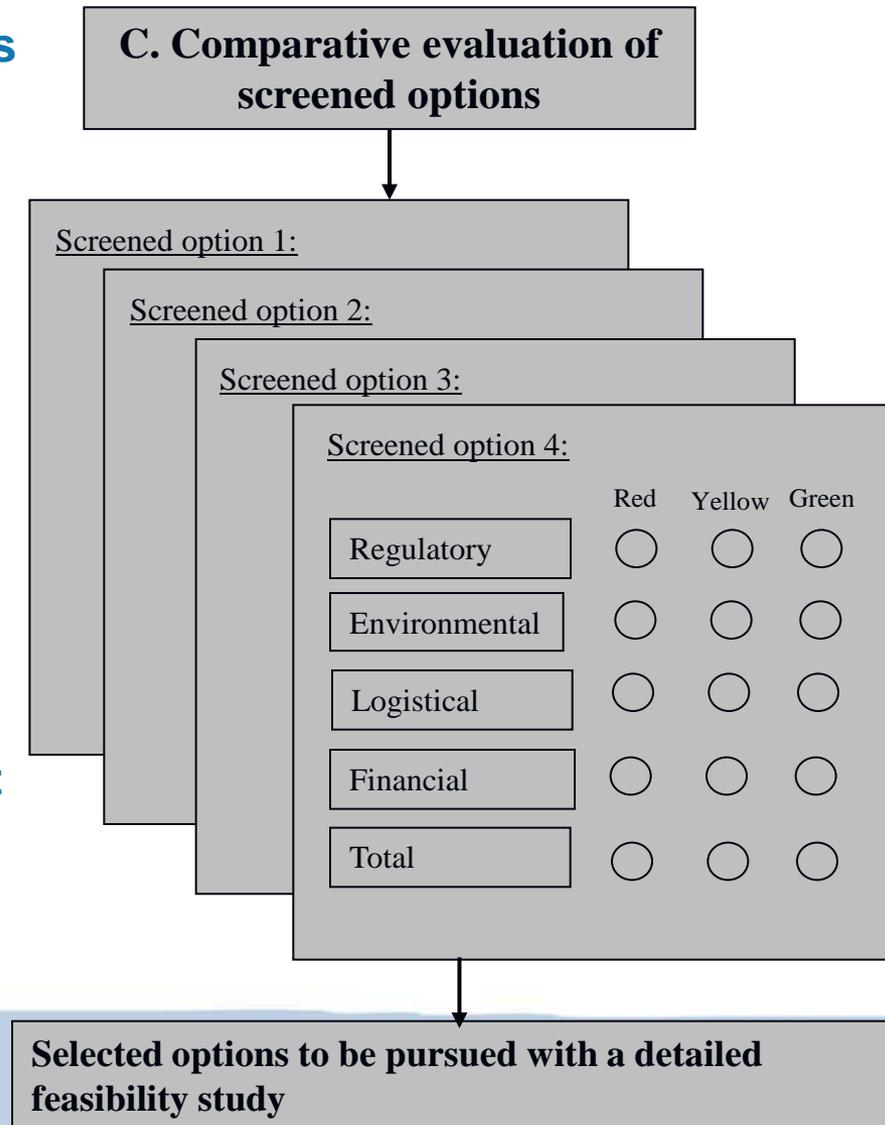


U.S. Department of Agriculture, National Agricultural Statistics Service



# C. Comparative Evaluation

- Comparative evaluation is meant to rank screened options relative to each other
- Factors considered:
  1. Regulatory
  2. Environmental
  3. Logistical
  4. Financial
- Goal is to select the most promising few for a detailed feasibility study



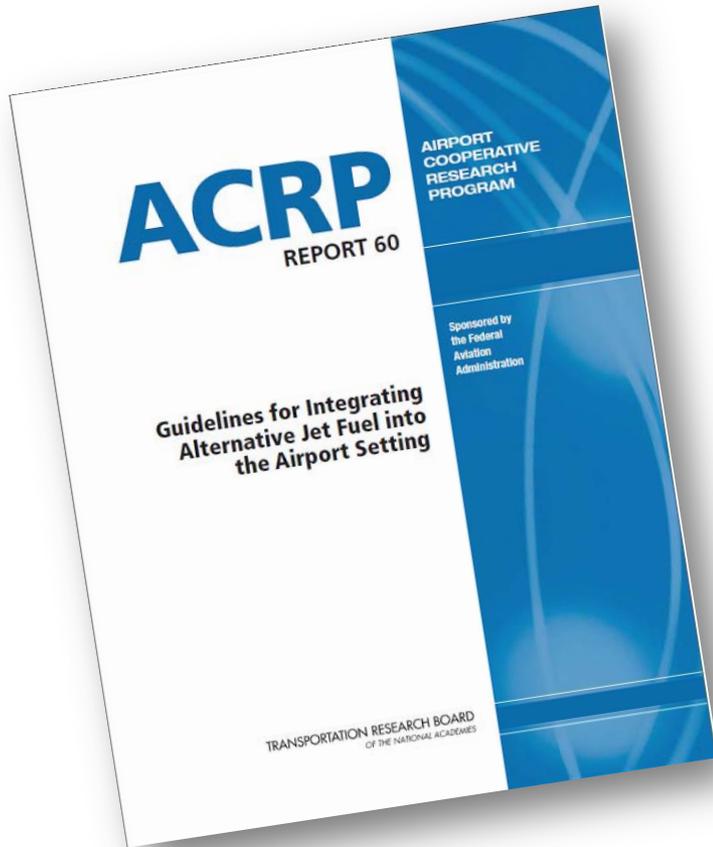
# Supporting material

- **Frequently asked questions**
- **Worksheets:**
  1. Stakeholder analysis
  2. Regulatory considerations
  3. Energy policy considerations
  4. Logistical considerations
  5. Financial considerations
  6. Evaluation summary
- **Primer on alternative fuels**
  1. Feedstocks
  2. Conversion technologies
  3. Environmental and economic characteristics

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# For additional information:



## ACRP Report 60: *Guidelines for Integrating Alternative Jet Fuel into the Airport Setting*

<http://www.trb.org/ACRP/Blurbs/166622.aspx>

- Bruno Miller
  - [Bruno.miller@metronaviation.com](mailto:bruno.miller@metronaviation.com)

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# ACRP Report 46: Handbook for Analyzing the Costs and Benefits of Alternative Aviation Turbine Engine Fuels at Airports

Fred Morser, PMP  
CSSI, Inc.

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TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES

# Project Team

- Philip Soucacos, CSSI
- Jim Hileman, FAA (then MIT)
- Sandy Webb, ECG
- Peal Donohoo, MIT
- Fred Morser, CSSI
- Ted Thrasher, CSSI\*
- Souad Behnroumie, CSSI\*

\* No longer employed by CSSI at the end of the project

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# ACRP Report 46 Oversight Panel

- Bryan C. Wagoner, Wayne County (MI) Airport Authority, Detroit, MI (Chair)
- Richard Altman, Commercial Aviation Alternative Fuels Initiative, Wethersfield, CT
- Roger A. Johnson, Los Angeles World Airports, Los Angeles, CA
- Darrin L. Morgan, Boeing Company, Seattle, WA
- Virgil M. Regoli, Jr., US Air Force, Wright Patterson AFB, OH
- Russ Simonson, Seattle-Tacoma International Airport, Seattle, WA
- Steve Sletten, PBS&J, Madison, WI
- Lourdes Maurice, FAA Liaison
- Jessica Steinhilber, Airports Council International–North America Liaison
- Lawrence D. Goldstein, ACRP Senior Program Officer

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# **ACRP Report 46: *Handbook for Analyzing the Costs and Benefits of Alternative Aviation Turbine Engine Fuels at Airports***

- Assess what is involved in bringing alternative fuels to airports
- Determine how alternative fuels will fit into current system including: movement from production facilities, onsite storage, delivery to aircraft and ground support equipment
- Provide information on viable alternative fuels and what airports need to accommodate them
- Offer cost comparison to conventional fuels and environmental benefits
- Gauge airport readiness through field studies and interviews
- Provide a handbook and software tool to enable aviation community to evaluate costs and benefits
- Published July 2010

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# Research Problem and Approach

- **Petroleum-based Jet A fuel powers turbine engines in the industry, diesel powers most GSA**
- **Pressure from environmental concerns will necessitate substitute fuels**
- **Need a near-term “drop-in” SPK substitute made from sustainable feed stocks**
- **2 Phased approach**
  - Phase 1
    - Research fuels science, chemistry to determine viable fuels, environmental impact and deployment methods
    - Determine airport readiness
  - Phase 2
    - Develop stand-alone software tool AFIT (Alternative Fuel Investigation Tool)
    - Provide handbook on AFIT use

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# Viability Fuels

- **Potentially viable fuels – must meet ASTM D1655 (aircraft suitability) and GSE diesel use**
  - ULS (ultra low sulfur) Jet Fuel and SPK (synthetic paraffinic kerosene) fuels
  - Others failed specifications because of high vapor pressure, low flash point, cold temperature decomposition and freeze point, energy content, or practicality
  - GSE diesel use considers emissions and engine wear

Fuel	Thermal Stability	Freeze Point	Vapor Pressure or Flash Point	Energy Content	Aircraft and Airport Compatible
ULS Jet Fuel	✓	✓	✓	✓	✓
SPK	✓	✓	✓	✓	✓
FAME	✗	✗	✓	✗	✗
Ethanol	✓	✓	✗	✗	✗
Butanol	✓	✓	✗	✗	✗
Liquid Hydrogen	✓	✓	✗	✓	✗
LNG	✓	✓	✗	✓	✗

# Airport Fuel Handling

- **Airports surveyed: BOS, DTW, CMH (Columbus), ONT, RIC (Richmond), LCK (Rickenbacker), VNY (Van Nuys)**
- **Typical fuels on site include:**
  - Jet A – aircraft
  - Diesel – GSE, maintenance vehicles, on/off airport shuttles and buses
  - Unleaded gasoline – GSE, fleet vehicles, on/off airport shuttles and buses
  - Aviation gasoline – piston engine aircraft
  - Compressed natural gas – GSE, fleet vehicles, on/off airport shuttles
  - Propane – some GSE, forklifts

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# Airport Fuel Handling (cont.)

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- **Fuel purveyors and management**
  - Fueling consortia – typically found at large airports are formed by tenant airlines and they manage fueling systems and procedures
  - Airlines – handle fueling needs for fleet and GSE
  - Airports – in some cases fueling system operations for tenant airlines especially for fuel other than Jet fuel
  - FBO – fixed based operators are private companies onsite that offer a variety of services in addition to fuel, such as oil, parking, hangar space, maintenance and repair, etc.
  - Third-party service companies – hired by tenant airlines to perform fuel and related activities

# Airport Readiness

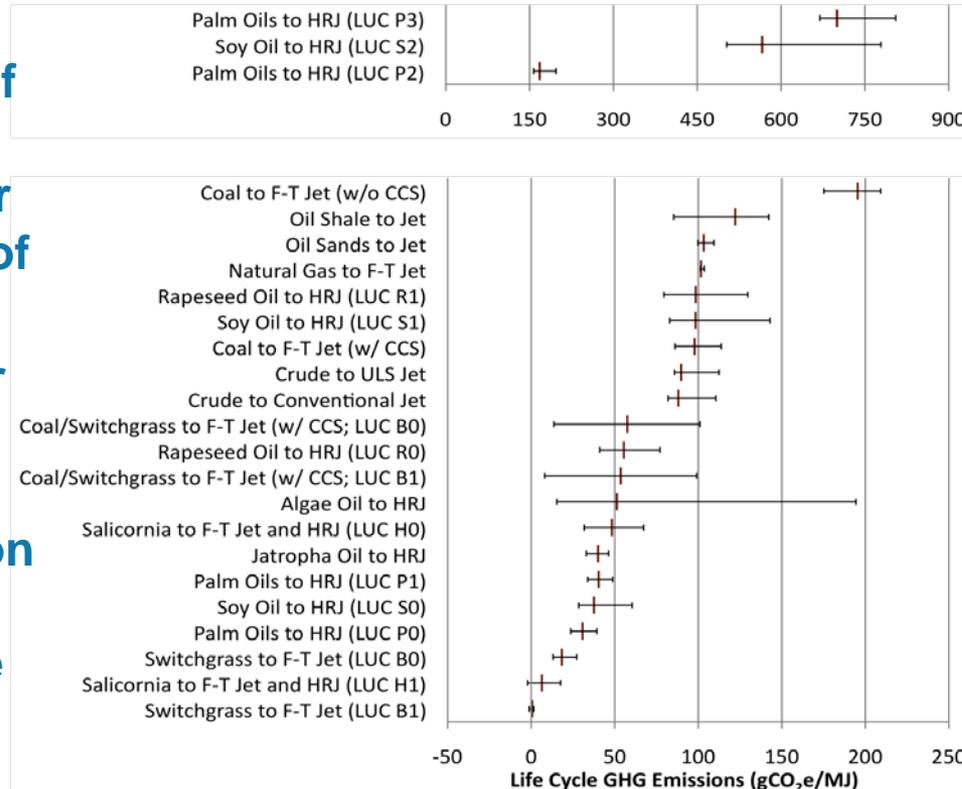
- Airports can readily convert to a drop-in alternative if supplied
- Drop-in fuel must be pre-blended as cost from laboratory support and equipment, holding tanks, etc. too high
- Fueling systems require no modifications for drop-in fuels and seals remain effective for fuels studied here
- Fueling equipment and vehicles remain unchanged (not cost savings associated)
- Drop-in conversion to a single fuel for aircraft and GSE cost savings to come from avoided construction where applicable

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# Environmental Factors

- **Accurate assessment of GHG impact must consider full life cycle of the fuel**
- **Bio fuels offer significant potential to reduce aviation impact on global climate change**



PARTNER Report has complete details

<http://web.mit.edu/aeroastro/partner/reports/proj28/partner-proj28-2010-001.pdf>

# Handbook and AFIT Model

- **Costs**
  - Fuel
  - Delivery or transfer to terminal and airport
  - Off airport and on airport
  - Storage, blending, throughput, filtering, excess throughput, delivery to vehicles
  - Conversion, decommissioning, GSE filters and pumps warrantee labor, etc.
  - Avoided diesel construction costs
  - Cost per gallon and annual
- **Benefits**
  - For aircraft and GSE: CO, NO<sub>x</sub>, SO<sub>x</sub>, PM, GHG
  - Uses airport EDMS study results for emission inventory changes

# AFIT

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- Stand-alone native application that runs on a PC
- Provides cost and benefit estimates of introducing alternative fuels, but not a cost/benefit metric.....
- GUI with 5 tabs
- Default setting provided to user for reference

Alternative Fuels Investigation Tool (AFIT)

File

Setup | Fuel Economics | Equipment Cost | Emissions | Report

**General Options**

	Yes	No
Would you like to calculate costs associated to the fuel?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Would you like to calculate costs associated to the equipment?	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Would you like to calculate the emissions?	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Monthly fuel usage in gallons      Jet A: 2,000,000      Diesel: 110,000

**Fuel Settings**

Current fuel price per gallon in dollars      Jet A: \$2.191      Diesel: \$2.130

**Equipment Cost Settings**

Which equipment costs would you like to calculate?      Finance?

<input checked="" type="checkbox"/> Existing System (GSE conversion)	
<input checked="" type="checkbox"/> Decommission Costs	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> New construction (Avoided construction cost)	<input checked="" type="checkbox"/>

**Emission Settings**

Select Alternative Fuel

Fuel: Jet A and SPK      % of SPK: 30

Usage

<input checked="" type="checkbox"/> Aircraft	<input checked="" type="checkbox"/> GSE
--	---

Default      Help

# AFIT

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- Fuel economics input costs
- Cost per gallon and annual total estimates
- Off airport
  - fuel price
  - Transfer to terminal
  - Transfer to airport
  - Storage and fuel management
- On airport
  - Storage, flowage throughput, delivery to equipment, etc.

Fuel	Cost per Gallon	Annual Total Cost
Jet A	\$2.191	\$52,584,000.00
Diesel	\$2.130	\$2,811,600.00
Alternative	\$2.203	\$55,779,960.00

Change in Cost	Cost per Gallon	Annual Total Cost
Jet A	\$0.012	\$288,000.00
Diesel	\$0.073	\$96,360.00

Off airport fuel component cost	Cost per gallon:	Value
Neat fuel at production facility		\$1.971
Transfer to terminal via: barge		\$0.050
Delivery to airport via: dedicated pipeline		\$0.020
Storage		
Blending cost per gallon: \$0.001	Filtering cost per gallon:	\$0.005
Throughput cost per gallon: \$0.001	Monthly terminal storage cost per gallon:	\$0.008
	Excess throughput cost per gallon:	\$0.002
	Total off airport cost per gallon:	\$2.058

On airport fuel component cost	Cost per gallon:	Value
Storage		\$0.010
Flowage		\$0.060
Monthly throughput: low		\$0.040
Hydrant to gate		\$0.005
Into wing delivery		\$0.020
Into GSE delivery		\$0.010
	Total on airport cost per gallon:	\$0.145

# AFIT

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- Equipment cost input
- Cost per gallon and annual total estimates
- GSE conversion
  - Filters, fuel pump, lost warrantee, labor
- Decommissioning cost
  - Removing old diesel system
- Greenfield cost savings from single fuel system

Alternative Fuels Investigation Tool (AFIT)

File

Setup Fuel Economics **Equipment Cost** Emissions Report

### Equipment Cost

	Cost per Gallon	Annual Total Cost
GSE Conversion Cost	\$0.151	\$199,900.00
Decommission Cost (total)	\$2.273	\$3,000,000.00
Decommission Cost (monthly)	\$0.331	\$36,398.28
Avoided Construction Cost (Total)	\$0.556	\$733,696.00
Avoided Construction Cost (monthly)	\$0.081	\$8,901.76

### GSE conversion cost to accomodate the alternative fuel

Filter replacement	Filters replaced:	<input type="text" value="600"/>	Cost per filter:	<input type="text" value="\$26.00"/>
Fuel pump replacement	Pumps replaced:	<input type="text" value="19"/>	Cost per pump:	<input type="text" value="\$350.00"/>
Warrantee loss on engine parts	Number of repairs:	<input type="text" value="125"/>	Cost per repair:	<input type="text" value="\$250.00"/>
Conversion labor	Labor hours:	<input type="text" value="1,600"/>	Cost per hour:	<input type="text" value="\$75.00"/>

### Decommissioning costs

Tank decommission	Number of tanks:	<input type="text" value="1"/>	Cost per tank:	<input type="text" value="\$1,000,000.00"/>
Other decommission			Other cost:	<input type="text" value="\$2,000,000.00"/>

### Avoided diesel fueling system construction cost

Diesel fuel storage tank	Tank capacity:	<input type="text" value="1,008,000"/>	Installation cost:	<input type="text" value="\$296,000.00"/>
Fuel transfer piping	feet of pipe:	<input type="text" value="10,000"/>	Cost per foot:	<input type="text" value="\$8.45"/>
Pumps, valves, filters	Stations:	<input type="text" value="2"/>	Cost per station:	<input type="text" value="\$34,898.00"/>
Fueling island	Square ft:	<input type="text" value="1,200"/>	Cost per sq. ft.:	<input type="text" value="\$19.50"/>
Diesel fuel truck(s)	Number of trucks:	<input type="text" value="4"/>	Cost per truck:	<input type="text" value="\$65,000.00"/>

### Project Financing Options

Loan period (yrs):	<input type="text" value="10"/>	Interest rate (%):	<input type="text" value="8.00"/>
--------------------	---------------------------------	--------------------	-----------------------------------

Default Help

# AFIT

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- Emissions input
- EDMS study file upload for comparison
- Lifecycle calculation options
- Sample EDMS data

Alternative Fuels Investigation Tool (AFIT)

File

Setup Fuel Economics Equipment Cost Emissions Report

### Annual Emissions

	Source	CO	NOx	SOx	PM
Current Fuel (kg)	Aircraft	3300	4600	510	57
	GSE (Diesel)	760	3300	420	180
	Total	4000	7900	930	240
% Change with Alternative Fuel	Source	CO	NOx	SOx	PM
	Aircraft	0.66	0.66	29	46
	GSE (Diesel)	100	100	100	100
Total	20	42	61	87	

### Green House Gas Emissions

	Current Fuel (metric tons)		Alternative Fuel (metric tons)	
	L-CO2	C-CO2	L-CO2	C-CO2
Aircraft	1400 - 1900	1200	960 - 1300	1200
GSE (Diesel)	340 - 430	280	340 - 430	280
Total	1700 - 2300	1500	1300 - 1700	1500

### Lifecycle CO2 Options

Jet A Fuel

Production Pathway  User-defined emission factors

Crude to Conventional Jet Fuel 0.00 g CO2 / kg Fuel

Alternative Fuel

Production Pathway  User-defined emission factors

Switchgrass to F-T Jet (LUC B1) 0.00 g CO2 / kg Fuel

### EDMS Study Location

C:\Users\vmorser\Desktop\AFIT 0.2.6\Sample EDMS Study

Calculate Help

# AFIT

- Comparison reporting
- Cost estimates
- Benefit estimates
- User discretion on trade-off between

Alternative Fuels Investigation Tool (AFIT)

File

Setup Fuel Economics Equipment Cost Emissions Report

### Fuel Cost

Fuel	Cost per Gallon	Annual Total Cost
Jet A	\$2.191	\$52,584,000.00
Diesel	\$2.130	\$2,811,600.00
Alternative	\$2.203	\$55,779,960.00

### Change in Cost

Fuel	Cost per Gallon	Annual Total Cost
Jet A	\$0.012	\$288,000.00
Diesel	\$0.073	\$96,360.00

### Equipment Cost

	Cost per Gallon	Annual Total Cost
GSE Conversion Cost	\$0.970	\$1,279,900.00
Decommission Cost (total)	\$9.848	\$13,000,000.00
Decommission Cost (monthly)	\$1.434	\$157,725.87
Avoided Construction Cost (Total)	\$0.556	\$733,696.00
Avoided Construction Cost (monthly)	\$0.081	\$8,901.76

### Annual Emissions

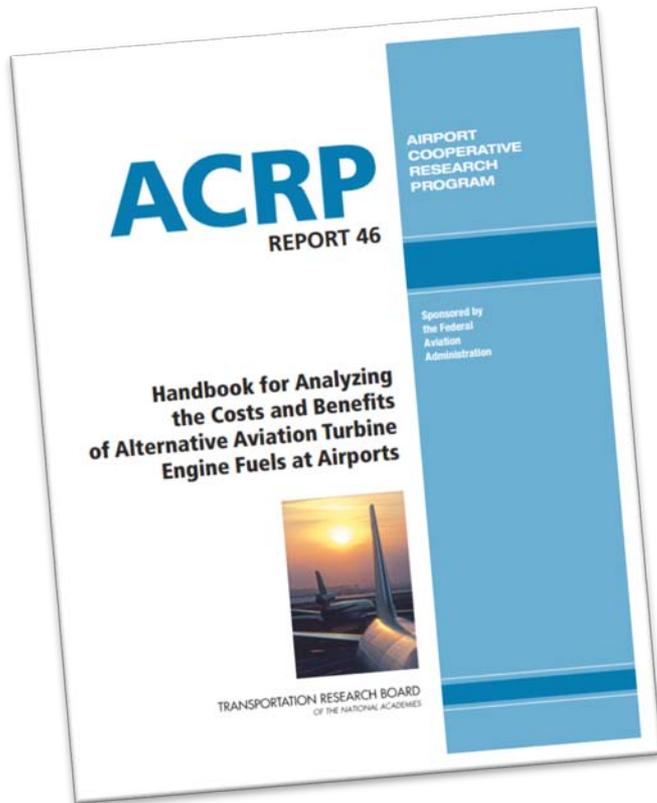
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Aircraft	0.66	0.66	29	46
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Total	20	42	61	87

### Green House Gas Emissions

	Current Fuel (metric tons)		Alternative Fuel (metric tons)	
	L-CO2	C-CO2	L-CO2	C-CO2
Aircraft	1400 - 1900	1200	960 - 1300	1200
GSE (Diesel)	340 - 430	280	340 - 430	280
Total	1700 - 2300	1500	1300 - 1700	1500

Print Help

# For additional information:



## ACRP Report 46: *Handbook for Analyzing the Costs and Benefits of Alternative Aviation Turbine Engine Fuels at Airports*

<http://www.trb.org/Aviation1/Blurbs/165496.aspx>

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