Topic Paper #1

Air Transportation Demand

On August 1, 2012, The National Petroleum Council (NPC) in approving its report, *Advancing Technology for America's Transportation Future*, also approved the making available of certain materials used in the study process, including detailed, specific subject matter papers prepared or used by the study's Task Groups and/or Subgroups. These Topic Papers were working documents that were part of the analyses that led to development of the summary results presented in the report's Executive Summary and Chapters.

These Topic Papers represent the views and conclusions of the authors. The National Petroleum Council has not endorsed or approved the statements and conclusions contained in these documents, but approved the publication of these materials as part of the study process.

The NPC believes that these papers will be of interest to the readers of the report and will help them better understand the results. These materials are being made available in the interest of transparency.

Future Transportation Fuels Study - Air
Introduction

The Air Travel Demand subgroup[1] was tasked by the National Petroleum Council (NPC) to review the long-term outlook for jet-fuel (i.e., aviation turbine fuels) demand in the United States out to 2050[2]. We used the U.S. Energy Information Administration (EIA) 2010 Annual Energy Outlook (AEO 2010) as the basis for our evaluation. The AEO provides a forecast for U.S. energy supply, demand and prices through 2035, and within this forecast resides an Air Travel Module, which incorporates future macroeconomic assumptions and an aircraft fleet stock submodule that, when combined, calculates future traffic and capacity, and consequent demand for aviation fuels. In particular, we took a close look at the AEO base-case scenario with a few key considerations in mind:

1. What are the key macroeconomic assumptions that drive future air traffic demand?
2. What are the long-term traffic and capacity growth projections for both domestic and international operations from U.S. airports, and how would any change in energy prices impact these projections?
3. How do the model outputs (traffic demand, fuel demand, etc.) compare with the industry's own expectations?
4. What issues might materially impact future jet-fuel demand?

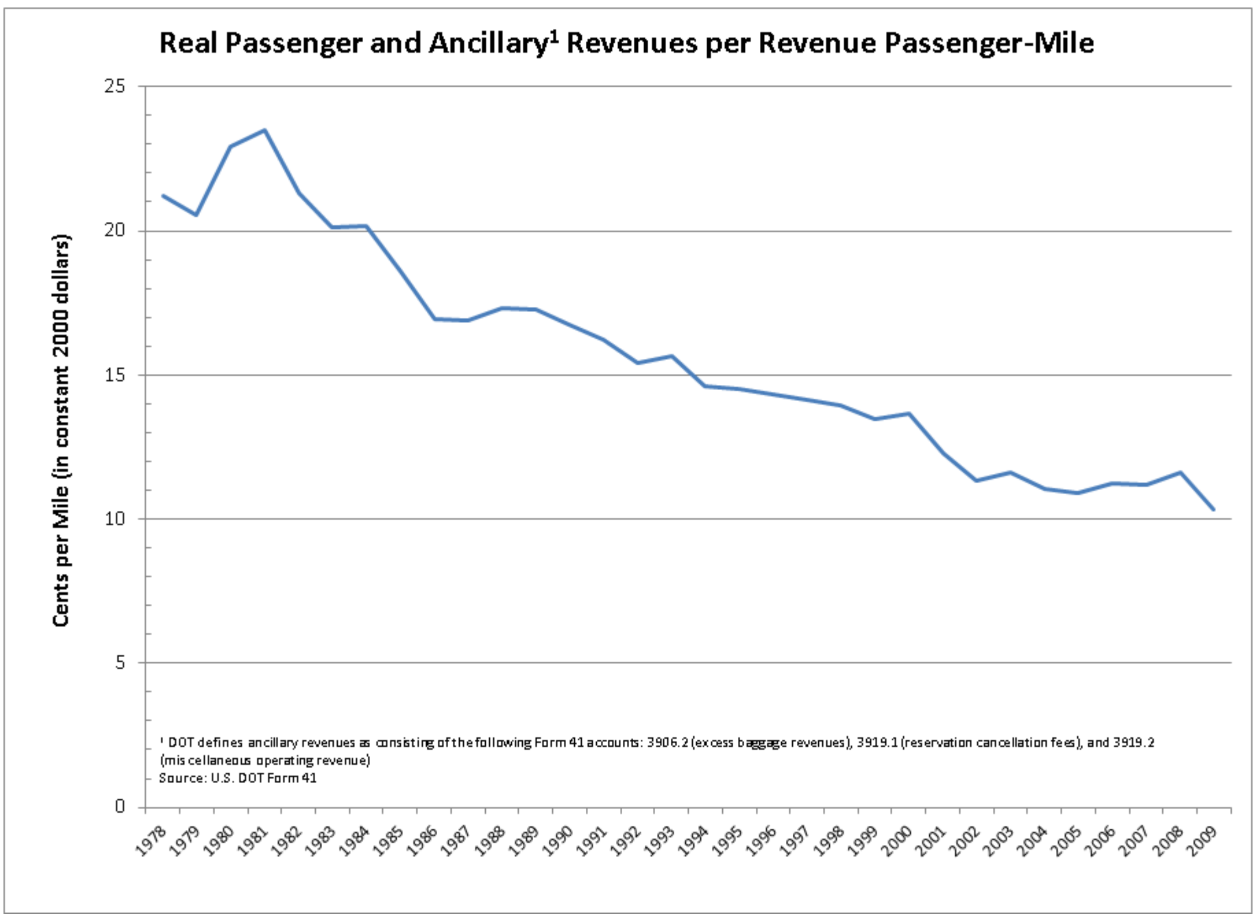
Review of EIA's AEO 2010 Base-case

Ultimately, our team had concerns with the EIA model and base-case results, as our respective outlooks on future demand differed. Our first take on the base-case scenario looked closely at the model, assumptions, and data inputs. While a quick review of the macroeconomic assumptions did not raise any significant issues, we had some concerns with the underlying industry source data and some aspects of the model. Specifically, given the global nature of commercial aviation and the scope of this demand outlook – any forecast was to be limited to jet fuel uplifted in the United States. – the model's use of U.S. Department of Transportation (DOT) Form 41 financial and traffic data was of particular concern, as this dataset is populated by U.S. airlines, whose operations span the globe. The data does not include foreign-carrier operations – for example, there is no coverage for fuel uplifted in the United States by a Lufthansa or Air China, whose route networks include U.S. cities. Despite these concerns, having discussed the issue at length, our group determined that using Form 41 data for this purpose (forecasting future demand) was not an unreasonable approach. Because foreign flag carriers currently account for roughly 50 percent of the international traffic and capacity to and from the United States, U.S. carriers' entire international traffic and

[1] The subgroup consisted of United Airlines, the Air Transport Association of America, the Boeing Company, the Federal Aviation Administration Office of Policy and Plans, and GE Aviation
[2] The scope of this subgroup's outlook on jet-fuel demand was strictly limited to commercial users and does not incorporate projected demand by other users of aviation turbine fuels such as general/corporate aviation and the operations of military and civilian (federal/state/local) government aircraft. Non-commercial use was considered to be outside the expertise of this team.

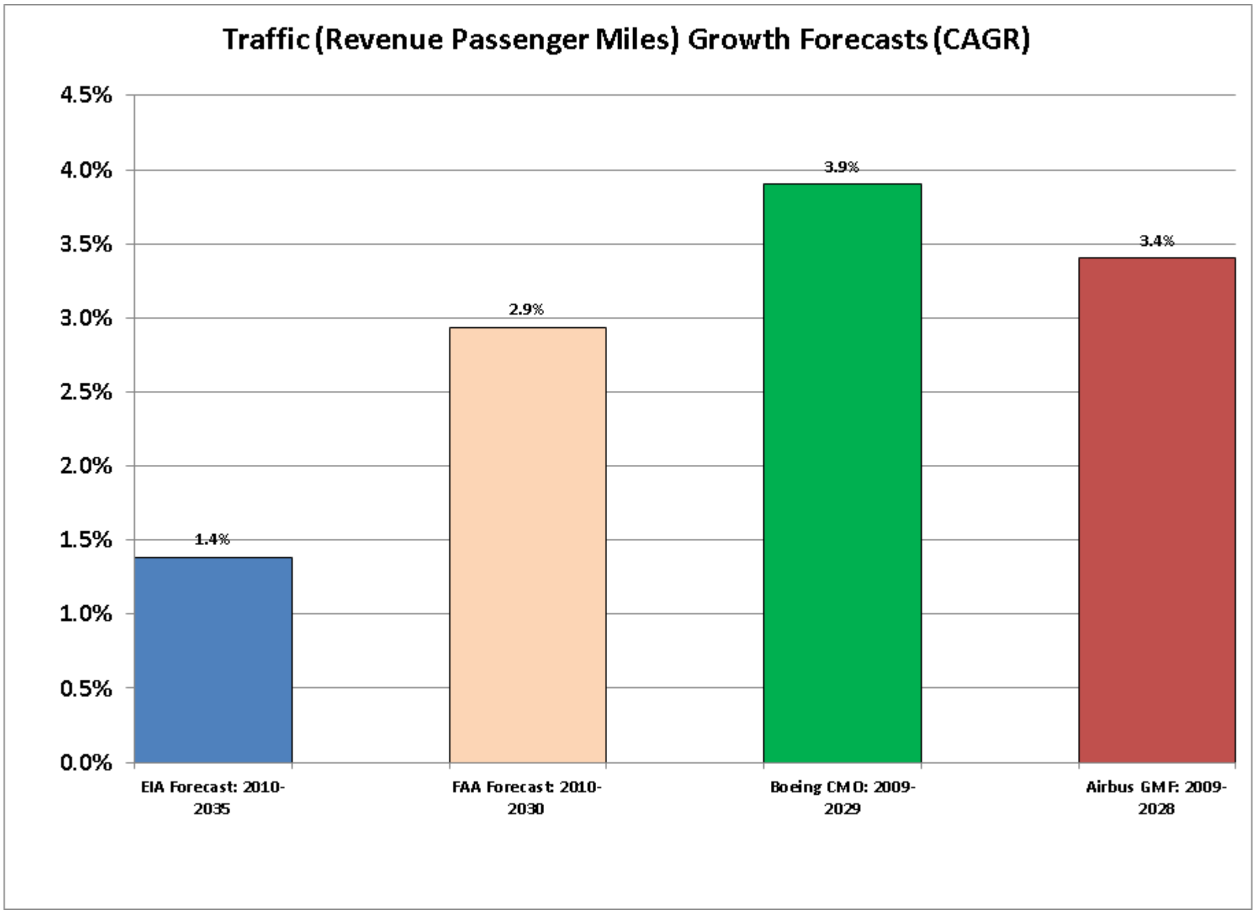
jet-fuel consumption should suffice as a reasonable proxy for total U.S.-based jet fuel consumption (i.e.,U.S. and foreign operators' jet-fuel demand uplifted in the U.S.). Further, our group did not find a better source of data to estimate foreign carrier uplift in the U.S.

There were a few aspects of the model that sparked specific comments. In particular, the base-case model's estimation of future ticket prices appeared to be tied exclusively to future movements in jet-fuel price, which was assumed to grow modestly into the future in real terms by an average of 2.4 percent per annum.[3] It is worth noting that, in the most recent 12-month period of available data, fuel accounted for roughly 25 percent of total industry operating expense, so the notion of linking fuel expense with ticket prices might inadvertently neglect other cost factors that ultimately translate into ticket price. Moreover, the base case shows both domestic and international passenger traffic yields growing annually in real terms by 1.6 percent and 1.7 percent, respectively, from 2010 to 2035. As shown in the chart below, this does not reconcile with either the empirical evidence of the past three decades or the expectations of industry observers looking forward.



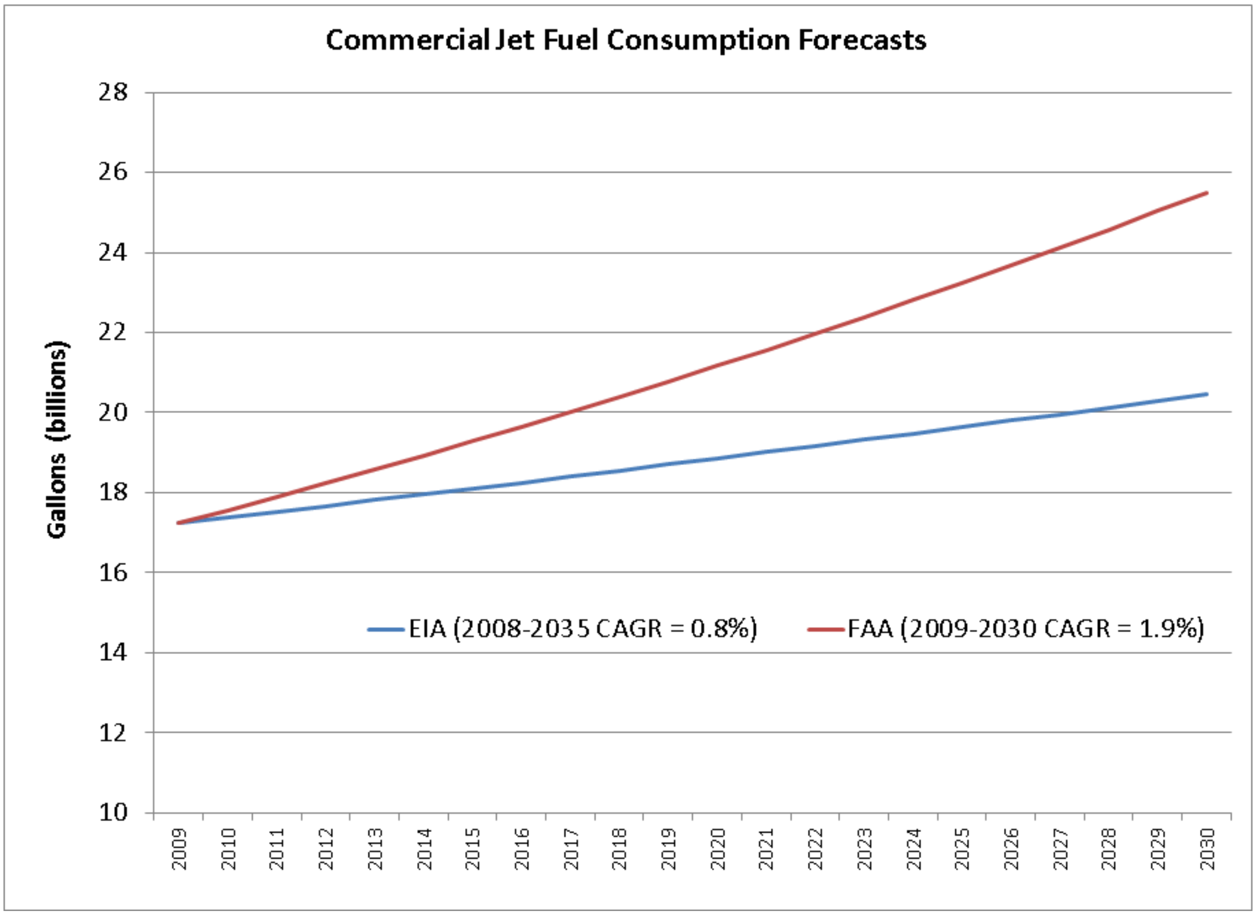
[3] The EIA AEO 2010 shows fuel costs rising 2.4 percent annually from 2010 to 2035 (in $1987 dollars)

Similarly, but more importantly, the EIA base-case projects passenger traffic to grow materially less than historically has been the case or than anticipated via industry forecasts. For example, EIA expects system passenger traffic as measured in revenue passenger miles (RPMs) to grow at an annual rate of 1.4 percent from 2010 to 2035, well short of the 3.9 percent growth experienced from 1978 to 2009. While historic growth rates are not necessarily expected to continue due to capacity constraints and other limiting factors, current forecasts from industry stakeholders range from 2.9 percent to 3.9 percent.



Ultimately, the variance between the industry and EIA base-case traffic forecasts has a material impact on the outlook in jet-fuel demand. For example, EIA projects jet-fuel consumption to increase 0.8 percent per year out to 2035, whereas FAA is projecting 1.9 percent growth. Based on current consumption levels, the variance between the two forecasts from 2009-2030 is roughly 51 billion gallons, or three times the amount of fuel consumed by industry in 2009.

Finally, different assumptions on fleet composition have contributed to the variance in jet-fuel demand forecasts. The EIA base-case relies on a mix of aircraft that is more dependent on smaller regional jets, which mirrored the U.S. airline industry fleet profile when energy prices were low. However, the economics of regional jet operations have been negatively impacted by high oil prices. Labor cost and revenue management developments together with the expectation of continued rising and volatile oil prices lead industry stakeholders to expect smaller regional jets, the 50-seat market in particular, to have a materially smaller share of the market in the future. At the same time, the 70- to 90-seat aircraft market is expected to grow. Traditional single- and twin-aisle aircraft are also expected to grow as passenger trip lengths increase and as international markets continue to flourish. Accordingly, the combination of larger average aircraft size and longer average flight stage lengths implies greater aggregate fuel consumption than anticipated by the base case.



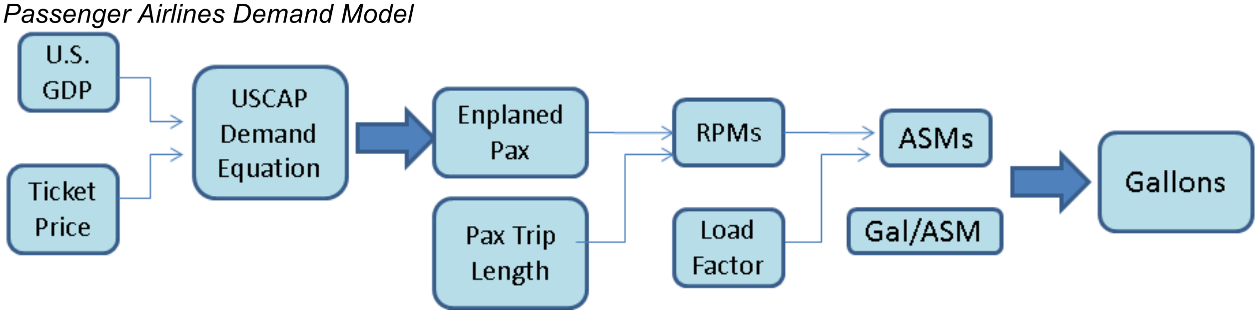
NPC Air Travel Demand Group Model

Given the group's review of the EIA base-case, the team elected to develop a forecast model of its own to better reflect industry's outlook on jet-fuel demand. We elected to use the demand equation developed by the U.S. Commercial Aviation Partnership (USCAP)[4] in its work with the Transportation Security Administration (TSA) to evaluate

[4] USCAP was led by Boeing and the Transportation Security Administration and relied on the active participation of the Air Transport Association of America, Airports Council International-North America, the Department of Transportation and the Department of Homeland Security. The USCAP model has been peer-reviewed and recognized – in 2006, USCAP was a finalist in the 2006 Franz Edelman Award for

the effects of various proposed security measures. The key parameters in the demand equation for passenger airlines are the U.S. economy (real GDP) and ticket price, as represented by the average fare for a 1,000-mile trip plus government-imposed taxes and fees. We assumed an income elasticity coefficient of 0.94 and a price elasticity coefficient of -0.625.[5] The demand equation produces a forecast for enplaned passengers, which is then applied against an assumed average distance of a passenger journey[6] to derive RPMs. A load factor assumption[7] is applied against forecast RPMs to arrive at a forecast of capacity, as measured in available seat miles (ASMs). The model then projects future jet-fuel demand by taking the capacity outlook and applying a fuel-efficiency factor[8].

Passenger Airlines Demand Model



The key parameters in the demand equation for all-cargo airlines were akin to the passenger model and used real GDP and cargo price (cargo revenue per revenue ton mile). For the cargo model, we assumed an income elasticity coefficient of 2.0 and a price elasticity coefficient of -0.21. The demand equation produces a forecast for cargo revenue ton miles which is then applied against a load factor assumption[9] to compute capacity, as measured in available ton miles. Forecasted capacity applied against a fuel-efficiency factor subsequently yields an estimate of cargo jet-fuel demand.

Cargo Airlines Demand Model

Achievement in Operations Research and the Management Sciences. See http://www.informs.org/Recognize-Excellence/Award-Recipients/USCAP and http://interfaces.journal.informs.org/cgi/content/abstract/37/1/52

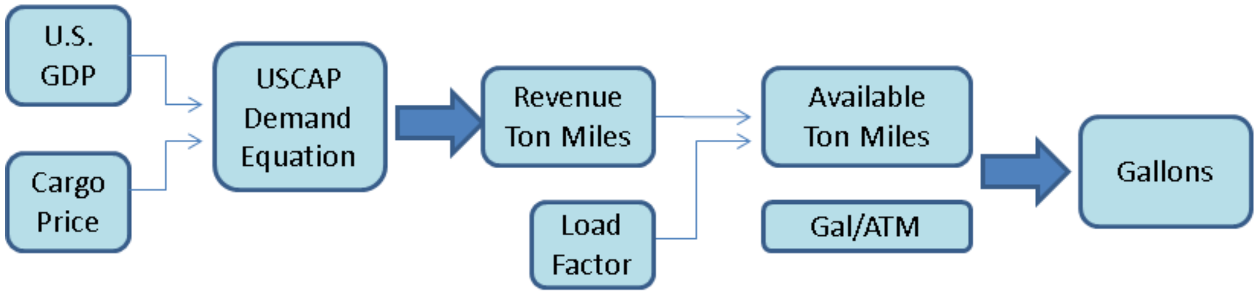
[5] Baseline assumption inputs in the USCAP demand equation

[6] Assumed to increase 0.7 percent per annum in the forecast period.

[7] Load factors are assumed to increase by 0.1 percentage points annually and are capped at 85 percent.

[8] A critical model assumption is future improvements in industry fuel efficiencies:. The industry has committed to improve its fuel use by 1.5 percent annually from 2009 to 2020 and the model incorporates this factor for the duration of the forecast period. See http://www.airlines.org/Environment/ClimateChange/Pages/FactSheet_CommercialAviationsEnvironmentalEfforts.aspx

[9] Cargo load factors are assumed to increase by 0.1 percentage points annually.



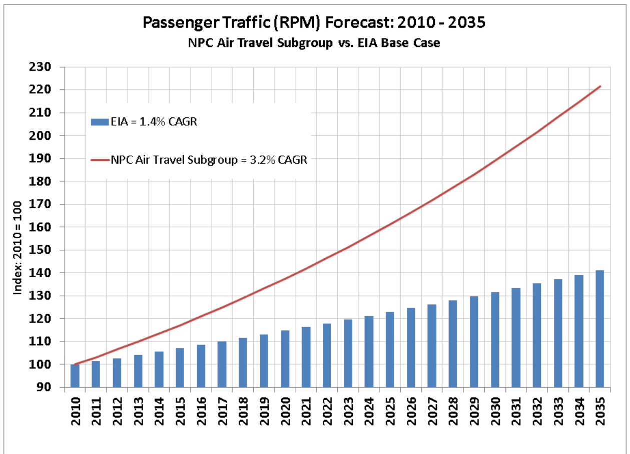
Model Results and Review

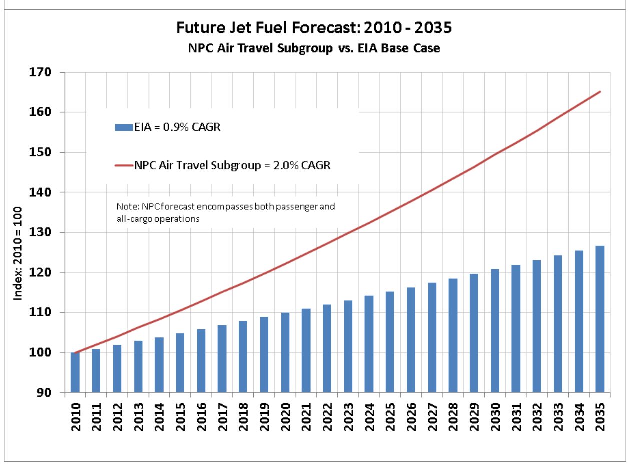
As expected, our team's model produced results that were in line with industry stakeholder expectations. The forecasted average annual RPM growth rate was 3.2 percent, which fell in line with expectations[10] and was materially higher than the EIA base-case forecast of 1.4 percent growth: by 2035, EIA forecasts that annual traffic levels will have increased by only 40 percent over 2010 levels while we expect traffic to more than double.

Higher traffic levels ultimately translate into greater jet fuel demand, although that effect is dampened by expected fuel efficiency gains. By 2035, EIA projects that annual jet-fuel demand will increase 27 percent compared to 2010 while our model sees demand growing by 48 percent over the same time span. The variance between the two fuel forecasts is not nearly as distinct as the respective passenger forecasts because EIA assumes that annual fuel efficiency will improve by only 0.5 percent per year compared to the 1.5 percent annual improvement assumed in our model.[11] Fuel consumption projections from our subgroup's modeling are shown in Table 1 (in aggregate), Table 2 (passenger), and Table 3 (cargo) at the end of this report.

[10] As referenced earlier, the industry's long-term RPM growth projections range from 2.9 percent to 3.9 percent annually.

[11] U.S. passenger carriers have improved fuel efficiency (on an ASM-per-gallon basis) by an average of 1.8 percent per year since 1978. While industry analysis suggests that meeting this historic average may not be economically or technologically feasible going forward (for example, load factor improvements cannot continue at the same rate forever), as part of its proposal for a global framework for aviation and climate change the aviation industry has committed to a goal of an annual average 1.5% improvement in fuel efficiency through 2020.





This prospective improvement will require the realization of a number of factors including, but not limited to, airline operational improvements, the evolution of airline route structures, advancements in airframe and engine technologies, and next-generation air traffic management practices and procedures, without being specific as to the respective contribution of each.

In support of use of the anticipated 1.5 percent annual improvement in industry fuel efficiency, the group considered each of the known components separately. Airlines have made great progress in recent years improving the fuel efficiency of existing fleets by retrofitting equipment to reduce aircraft weight or adding winglets. Airlines also have introduced more fuel-focused operational processes such as single-engine taxiing, precision fueling, and fuel-optimized routings using sophisticated software. These actions can be expected to continue to increase the fuel efficiency of existing airline operations, albeit possibly at a reduced rate from that achieved in the past few years.

Several commercial trends underway in the airline industry also will serve to improve fuel efficiency. Notably, over time the average length of a passenger trip has increased for multiple reasons, including the fact that growth in demand for international air transportation has been outpacing domestic growth. As this trend is expected to continue, and more industry capacity is provided by twin-aisle aircraft on longer routes, the average fuel efficiency factor will improve.

Airlines typically refresh their aircraft fleets on a 20- to 25- year cycle. Historically each new generation of aircraft, with current airframe and engine technology, has generated an approximately 15 percent improvement in fuel efficiency over the previous generation. As such, to the extent that airlines' financial stability is restored and maintained in coming years, airlines can expect to gradually improve the average fuel efficiency of their fleet at an average annual rate of 0.6 percent to 0.75 percent as older aircraft are replaced with new models. Future aircraft models such as the Boeing 787, Airbus 350, and Bombardier C-series will make use of carbon-fiber technology, new engine types and other design improvements that can be expected to continue this trend with sufficient investment by government and industry in relevant research and development programs.

The Federal Aviation Administration (FAA) has initiated a program known as NextGen, which is an umbrella term for the ongoing, wide-ranging transformation of the National Airspace System. NextGen encompasses a number of improvements in ground and airspace operations, including transforming the current ground-based system of air traffic control into a satellite-based system of air traffic management. It will include the development of aviation-specific applications for existing, widely used technologies, such as the Global Positioning System and technological innovation in areas such as weather forecasting, data networking and digital communications. NextGen is expected to yield many benefits, including improved safety, increased capacity and enhanced efficiency, as well as superior environmental performance, by allowing more aircraft to safely fly closer together on more direct routes. Airspace redesign and Performance Based Navigation procedures are already saving fuel and reducing emissions in demonstrations with various air carriers. FAA expects NextGen to cumulatively save over 1.4 billion gallons of jet fuel from air traffic operations between 2009 and 2018, representing about 0.8 percent of projected fuel consumption.

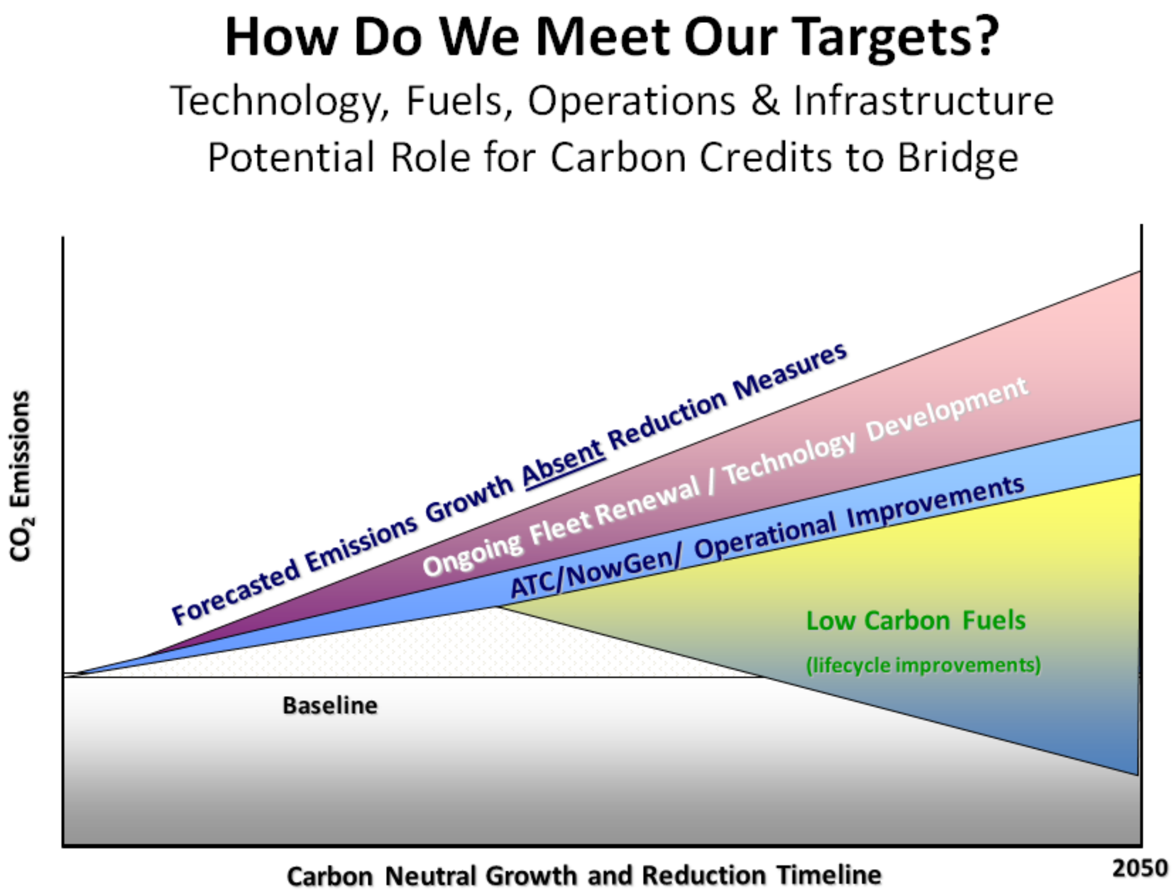
Potential Future Impacts

Alternative Fuels. The development of commercially viable alternative jet fuels is expected to have a significant impact on the future fuel profile of commercial aviation. Alternative fuels should complement the available supply of conventional fuels while reducing the net carbon output of the industry. The Air Transport Association, the Aerospace Industries Association, Airports Council International-North America and FAA co-founded the Commercial Aviation Alternative Fuels Initiative (CAAFI) to hasten the development and deployment of jet fuel from non-petroleum sources (see www.caafi.org). CAAFI, which includes many supporters beyond the original founders, has been instrumental in facilitating the flow of information between potential fuel suppliers and the airlines with the goal of achieving agreements between the parties that will enable the commercial production of economically viable, environmentally preferred alternative jet fuels. Airlines have generally held to the position that alternative fuels should meet the following criteria: they should be “drop in” fuels capable of being commingled with conventional jet fuel, transported via existing pipelines and used in existing aircraft engines; they should be commercially viable, meaning available in sufficient quantities and priced competitively; and lastly, they should have life cycle emissions equal to or better than conventional jet fuel.

In 2009, ASTM International, the relevant standard-setting organization, approved a new fuel specification for fuels produced from the Fischer-Tropsch (FT) process up to a 50 percent blend with conventional jet fuel. FT fuels can be made from coal or natural gas, but may also be made from biomass feedstocks. Because of the potential to use readily available coal as a feedstock, the FT process is capable of commercial-scale production of fuels in considerable quantities. However, such fuels will not significantly reduce carbon output and may even increase lifecycle carbon versus conventional jet fuel unless biomass feedstocks and/or carbon sequestration are introduced to the process.

Pure bio-jet fuels, on the other hand, have the potential to reduce life cycle emissions by as much as 80 percent, depending on the feedstock and process, but it may take longer to develop commercially viable quantities as crop production processes must be scaled up and costs driven down. However, efforts underway to achieve ASTM approval for Hydrotreated Renewable Jet (HRJ) fuels are expected to stimulate the market viability of these fuels. Life cycle emissions from HRJ fuels are highly dependent on the feedstock and the land-use change associated with it. Current studies suggest that fuels made from palm or soy oil can reduce emissions considerably, assuming no land use change, but HRJ fuels made from high-yield feedstocks that do not require arable land, such as jatropha, camelina and some algae oils display even lower life-cycle emissions. However, land-use change can be critical with any biomass, as converting tropical or peatland rainforest to biomass production can increase life cycle emissions by several orders of magnitude over that of conventional jet fuel.

The U.S. Air Force plans for its entire fleet to operate on fuels that are at least 50 percent synthetic by 2016, but it remains to be seen if this goal is achievable. The airline industry is dependent on the successful implementation of commercially viable low carbon fuels in the future to enable the reduction of green house gas (GHG) emissions beyond improvements expected from other known sources such as aircraft technology and NextGen.



Industry Targets and the Prospect for Carbon Taxes on Jet Fuel. The U.S. airline industry has joined with the worldwide aviation industry in supporting a global sectoral approach to aviation and climate change. As part of this, the industry has proposed a series of GHG emissions goals, including a 1.5 percent annual average fuel efficiency improvement through 2020, carbon neutral growth from 2020 and a 50 percent net reduction in aviation's CO2 output in 2050, relative to 2005 levels. Meeting these goals relies on the full array of measures noted above and on governments making the necessary supportive investments in technology research and development, operational and infrastructure improvements and alternative fuels. Additional taxes and charges, including potential carbon taxes or emissions trading as applied to jet fuel, that siphon away from aviation the funds it needs to invest in new aircraft, efficiency-enhancing retrofits like winglets and alternative fuels will detract from the industry's ability to continue to improve its fuel and carbon efficiency from within the sector. Instead, the aviation industry approach calls for the implementation of an international framework under the International Civil Aviation Organization (ICAO), the United Nations body charged with setting standards and recommended practices for international aviation, to support appropriate targets and measures for aviation GHGs. This approach also provides that if any carbon credits are needed to help industry close the gap in meeting its targets, any revenues collected should be reinvested into aviation environmental improvements. In October of 2010, ICAO adopted an Assembly Resolution with the essential outlines for such a framework, with more work continuing on details.

Table 1

Commercial Airline Jet Fuel Forecast: 2010-2050

		Jet Fuel Gallons (mil)		
Year	**Real GDP (2005 - bil))**	**Passenger**	**All-Cargo**	**Total**
2010	13,221	14,909	3,034	17,942.6
2011	13,511	15,077	3,117	18,193.5
2012	13,914	15,359	3,251	18,609.8
2013	14,286	15,601	3,371	18,972.0
2014	14,732	15,914	3,525	19,438.7
2015	15,175	16,215	3,678	19,893.0
2016	15,609	16,499	3,828	20,327.0
2017	16,045	16,778	3,978	20,755.6
2018	16,478	17,047	4,127	21,174.0
2019	16,930	17,327	4,284	21,611.9
2020	17,384	17,603	4,443	22,045.9
2021	17,865	17,897	4,616	22,512.4
2022	18,380	18,214	4,805	23,018.8
2023	18,890	18,520	4,992	23,511.7
2024	19,405	18,821	5,181	24,002.6
2025	19,948	19,141	5,385	24,526.5
2026	20,475	19,437	5,580	25,017.7
2027	20,997	19,723	5,773	25,495.5
2028	21,517	19,998	5,963	25,961.6
2029	22,046	20,274	6,158	26,431.5
2030	22,615	20,577	6,374	26,951.3
2031	23,190	20,878	6,593	27,470.2
2032	23,760	21,165	6,808	27,973.1
2033	24,353	21,464	7,035	28,498.9
2034	24,973	21,779	7,277	29,055.2
2035	25,614	22,101	7,529	29,630.4
2036	26,274	22,431	7,793	30,224.2
2037	26,945	22,760	8,062	30,822.4
2038	27,622	23,086	8,334	31,419.4
2039	28,317	23,417	8,615	32,031.9
2040	29,038	23,759	8,911	32,670.3
2041	29,772	24,103	9,215	33,317.5
2042	30,526	24,451	9,529	33,980.1
2043	31,298	24,805	9,853	34,658.4
2044	32,090	25,164	10,189	35,352.9
2045	32,902	25,528	10,536	36,064.0
2046	33,734	25,898	10,895	36,792.2
2047	34,587	26,272	11,266	37,538.0
2048	35,463	26,653	11,649	38,301.8
2049	36,360	27,038	12,046	39,084.2
2050	37,280	27,429	12,456	39,885.7
2010-2050				
CAGR	2.6%	1.5%	3.6%	2.0%

Table 2

Commercial Passenger Airline Jet Fuel Forecast: 2010-2050

Year	Real GDP (2005 - bil))	Passenger Enplanements (mil)	Passenger Trip Length (miles)	Revenue Passenger Miles (mil)	Load Factor	Available Seat Miles (mil)	Fuel per ASM	Jet Fuel (mil gallons)
2010	13,221	718.5	1,098	789,283	80.5%	980,138	0.0152	14,908.7
2011	13,511	733.3	1,106	811,150	80.6%	1,006,286	0.0150	15,076.9
2012	13,914	753.9	1,114	839,748	80.7%	1,040,723	0.0148	15,358.9
2013	14,286	772.8	1,122	866,860	80.8%	1,073,250	0.0145	15,601.4
2014	14,732	795.5	1,130	898,572	80.9%	1,111,402	0.0143	15,913.6
2015	15,175	818.0	1,137	930,440	80.9%	1,149,668	0.0141	16,214.6
2016	15,609	840.0	1,145	962,150	81.0%	1,187,661	0.0139	16,499.2
2017	16,045	862.0	1,153	994,291	81.1%	1,226,110	0.0137	16,777.9
2018	16,478	883.9	1,162	1,026,671	81.2%	1,264,774	0.0135	17,047.3
2019	16,930	906.7	1,170	1,060,492	81.3%	1,305,133	0.0133	17,327.4
2020	17,384	929.5	1,178	1,094,837	81.3%	1,346,056	0.0131	17,602.7
2021	17,865	953.7	1,186	1,131,208	81.4%	1,389,384	0.0129	17,896.8
2022	18,380	979.5	1,194	1,169,964	81.5%	1,435,549	0.0127	18,214.0
2023	18,890	1,005.1	1,203	1,208,922	81.6%	1,481,869	0.0125	18,519.7
2024	19,405	1,030.9	1,211	1,248,571	81.7%	1,528,941	0.0123	18,821.4
2025	19,948	1,058.0	1,220	1,290,407	81.7%	1,578,592	0.0121	19,141.1
2026	20,475	1,084.2	1,228	1,331,665	81.8%	1,627,436	0.0119	19,437.4
2027	20,997	1,110.2	1,237	1,373,158	81.9%	1,676,469	0.0118	19,722.6
2028	21,517	1,136.1	1,245	1,414,964	82.0%	1,725,783	0.0116	19,998.2
2029	22,046	1,162.3	1,254	1,457,761	82.1%	1,776,205	0.0114	20,273.8
2030	22,615	1,190.6	1,263	1,503,619	82.2%	1,830,251	0.0112	20,577.3
2031	23,190	1,219.0	1,272	1,550,336	82.2%	1,885,231	0.0111	20,877.5
2032	23,760	1,247.2	1,281	1,597,247	82.3%	1,940,335	0.0109	21,165.4
2033	24,353	1,276.4	1,290	1,646,119	82.4%	1,997,707	0.0107	21,464.4
2034	24,973	1,307.0	1,299	1,697,348	82.5%	2,057,820	0.0106	21,778.6
2035	25,614	1,338.5	1,308	1,750,443	82.6%	2,120,071	0.0104	22,100.9
2036	26,274	1,370.9	1,317	1,805,438	82.6%	2,184,495	0.0103	22,430.9
2037	26,945	1,403.8	1,326	1,861,703	82.7%	2,250,322	0.0101	22,760.2
2038	27,622	1,437.0	1,335	1,918,992	82.8%	2,317,252	0.0100	23,085.6
2039	28,317	1,471.0	1,345	1,978,125	82.9%	2,386,272	0.0098	23,416.6
2040	29,038	1,506.2	1,354	2,039,639	83.0%	2,458,020	0.0097	23,758.9
2041	29,772	1,542.0	1,364	2,102,763	83.1%	2,531,561	0.0095	24,102.7
2042	30,526	1,578.6	1,373	2,167,841	83.1%	2,607,301	0.0094	24,451.4
2043	31,298	1,616.2	1,383	2,234,932	83.2%	2,685,308	0.0092	24,805.2
2044	32,090	1,654.6	1,393	2,304,100	83.3%	2,765,649	0.0091	25,164.2
2045	32,902	1,694.0	1,402	2,375,408	83.4%	2,848,393	0.0090	25,528.3
2046	33,734	1,734.3	1,412	2,448,923	83.5%	2,933,613	0.0088	25,897.7
2047	34,587	1,775.5	1,422	2,524,714	83.6%	3,021,382	0.0087	26,272.4
2048	35,463	1,817.7	1,432	2,602,850	83.6%	3,111,777	0.0086	26,652.6
2049	36,360	1,861.0	1,442	2,683,404	83.7%	3,204,877	0.0084	27,038.2
2050	37,280	1,905.2	1,452	2,766,451	83.8%	3,300,763	0.0083	27,429.4
2010-2050								
CAGR	2.6%	2.5%	0.7%	3.2%		3.1%	-1.5%	1.5%

Table 3						
Commercial Cargo Airline Jet Fuel Forecast: 2010-2050						
Year	**Real GDP (2005 - bil))**	**Revenue Ton Miles (mil)**	**Load Factor**	**Available Ton Miles (mil)**	**Fuel per ATM**	**Gallons (mil)**
2010	13,221	26,892	56.9%	47,244	0.0642	3,033.9
2011	13,511	28,074	57.0%	49,272	0.0633	3,116.6
2012	13,914	29,758	57.0%	52,176	0.0623	3,250.8
2013	14,286	31,356	57.1%	54,922	0.0614	3,370.6
2014	14,732	33,326	57.1%	58,314	0.0605	3,525.1
2015	15,175	35,340	57.2%	61,777	0.0595	3,678.4
2016	15,609	37,372	57.3%	65,264	0.0587	3,827.8
2017	16,045	39,468	57.3%	68,855	0.0578	3,977.8
2018	16,478	41,611	57.4%	72,520	0.0569	4,126.7
2019	16,930	43,903	57.4%	76,438	0.0561	4,284.4
2020	17,384	46,269	57.5%	80,478	0.0552	4,443.2
2021	17,865	48,846	57.6%	84,874	0.0544	4,615.6
2022	18,380	51,673	57.6%	89,698	0.0536	4,804.7
2023	18,890	54,559	57.7%	94,612	0.0528	4,992.0
2024	19,405	57,547	57.7%	99,695	0.0520	5,181.3
2025	19,948	60,786	57.8%	105,201	0.0512	5,385.4
2026	20,475	64,010	57.8%	110,669	0.0504	5,580.3
2027	20,997	67,293	57.9%	116,230	0.0497	5,772.8
2028	21,517	70,643	58.0%	121,895	0.0489	5,963.4
2029	22,046	74,131	58.0%	127,784	0.0482	6,157.7
2030	22,615	77,980	58.1%	134,286	0.0475	6,374.0
2031	23,190	81,966	58.1%	141,008	0.0468	6,592.6
2032	23,760	86,014	58.2%	147,825	0.0461	6,807.7
2033	24,353	90,324	58.2%	155,077	0.0454	7,034.5
2034	24,973	94,951	58.3%	162,857	0.0447	7,276.6
2035	25,614	99,846	58.4%	171,083	0.0440	7,529.5
2036	26,274	105,023	58.4%	179,774	0.0434	7,793.3
2037	26,945	110,412	58.5%	188,809	0.0427	8,062.2
2038	27,622	115,986	58.5%	198,142	0.0421	8,333.8
2039	28,317	121,851	58.6%	207,954	0.0414	8,615.3
2040	29,038	128,086	58.7%	218,376	0.0408	8,911.4
2041	29,772	134,599	58.7%	229,252	0.0402	9,214.9
2042	30,526	141,444	58.8%	240,669	0.0396	9,528.7
2043	31,298	148,637	58.8%	252,655	0.0390	9,853.2
2044	32,090	156,196	58.9%	265,238	0.0384	10,188.8
2045	32,902	164,139	58.9%	278,448	0.0378	10,535.8
2046	33,734	172,486	59.0%	292,316	0.0373	10,894.6
2047	34,587	181,257	59.1%	306,874	0.0367	11,265.6
2048	35,463	190,474	59.1%	322,157	0.0362	11,649.3
2049	36,360	200,161	59.2%	338,202	0.0356	12,046.0
2050	37,280	210,339	59.2%	355,045	0.0351	12,456.2
2010-2050						
CAGR	2.6%	5.3%		5.2%	-1.5%	3.6%