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Methodologies to monetize the variations in load factor and GHG emissions per passenger-mile of airlines

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ABSTRACT

Global GHG emissions from air travel are currently at 3% and it could increase to 15% of the total GHG emissions by 2050. To curb the growth of GHG emissions from air travel, the U.S. Federal Aviation Administration (FAA) has created a policy to achieve carbon neutral growth by 2020 relative to the 2005 baseline. If the airline industry is to both grow and meet the objectives set by this policy, new and innovative aircraft designs, operational efficiencies, and widespread use of alternate fuels are required. To accomplish this would require large research and development investment. The federal government and state governments have passed legislations that provide tax breaks and other incentives to encourage investments in new technologies. One such tax policies is cap and trade system. This had partial success in reducing GHG emissions in certain industries but was not successful in the airline industry. This paper presents alternate methods to raise capital to invest in GHG emissions reduction projects in the airline sector. The four methodologies presented here monetizes the GHG emissions resulting from differences in load factor (ratio of number of passengers to number of seats) and GHG emissions per passenger-mile among different airlines, among different flight sectors, etc. to raise the capital. Based on 2012 air travel data, these methodologies could raise more than $300 million dollars annually to invest in GHG emissions reduction projects.

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Introduction

The United Nations Intergovernmental Panel on Climate Change reported that there is a 95–100% likelihood that human activities are causing global warming (IPCC press release on human influence on climate, 2013). The primary contributor to global warming is increase in the amount of Greenhouse Gases (GHG) released into the atmosphere. In 2010, the global GHG emissions was approximately 31,780 Tg (CO_2 Eq.) and the United States accounted for 5586 Tg of GHG emissions (Inventory of U.S. greenhouse gas emissions sinks: 1990–2011, 2013) (approximately 18%). During the same period, the transportation sector in the United States added approximately 1857 Tg GHG emissions through the combustion of fossil fuels and of which the commercial airlines accounted for 114 Tg of GHG emissions (Inventory of U.S. greenhouse gas emissions sinks: 1990–2011, 2013) (approximately 6%). The relative contribution of GHG emissions from air travel is expected to increase in the future due to growth in air as well as an expected reduction in GHG emissions from other sectors. Globally, GHG emissions from air travel is currently at 3% and the 1999 IPCC report (Sgouridis et al., 2011) states that it could reach as high as 15% by 2050. To curb the expected growth in GHG emissions and to reverse the direction of GHG emissions trajectory, the U.S.

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Federal Aviation Administration (FAA) has created a policy to achieve carbon neutral growth by 2020 relative to the 2005 baseline and net reduction from all aviation emissions over the longer term (by 2050) (Aviation Environmental and Energy Policy Statement, 2013).

If the airline industry is to both grow and meet the objectives set by the policy, new and innovative aircraft designs, operational efficiencies, and widespread use of alternate fuels that lower the GHG emissions are required (Hileman et al., 2013). Large research and development investments are required to convert the innovative concepts to be production feasible designs, increase operational efficiencies, and lower the cost of alternate fuels to be competitive with fossil fuel.

In general, the federal government and state governments pass legislations that provide tax breaks and other incentives to encourage investment in new technologies and bring new competitors to the market. One such tax policy is the cap and trade system that had partial success in reducing GHG emissions. In a typical cap and trade system, the government sets the mandatory limit (cap) for GHG emissions for a sector and allows businesses within that sector to bank and borrow among them or buy carbon offsets from the open market to meet the target (trade). One of the successes is California's cap and trade program established for electric utilities and large industrial facilities. In a recent auction (California Air Resources Board Quarterly Auction 5-Summary Results Report, 2013) conducted on August 4, 2013 to trade GHG emissions, the auction settled price ($12.22) for one MT of GHG emissions was $1.51 higher than the reserved price ($10.71), a 14% premium.

What worked for utility companies and large industrial facilities in California did not work with airline industry in Europe. The European Union (EU) tried to set a cap and trade program (http://ec.europa.eu/clima/policies/transport/aviation/, 2013) for airlines and it resulted in a large protest from the airline industry and from various governments including the US and China that the EU has to delay the implementation of the program. If the European Union restricts the cap and trade mechanism of taxation to the local airline industry, they would be negatively impacted compared to their foreign competitors (Yuen and Zhang, 2001).

Are there any other mechanisms that governments can resort to in order to raise capital from the airline sector to invest in GHG emissions reduction projects? What about from air travelers?

This paper proposes four methodologies to monetize the GHG emissions. These methodologies were developed based on the differences in load factor (ratio of number of passengers to number of seats) and GHG emissions per passenger-mile among different airlines, among different flight sectors, etc.

Data and model validation

Historical air travel data such as distance between the originating and the destination airports (non-stop flights), number of passengers, numbers of seats, etc., for each flight are available at the Department of Transportation (DOT) website (http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=309, 2014).

There is a little consistency in calculating the total GHG emissions using the air travel data. Different methodologies would provide different levels of GHG emissions for the same trip (Miyoshi and Mason, 2009). Therefore, prior to analyzing the GHG emissions data from air travel, a methodology to calculate the GHG emissions is presented and the values calculated from this methodology were compared against the published data from airlines.

GHG emissions factor per passenger-mile (E_i) is determined based on emissions from GHG gases such as carbon dioxide (CO_2), methane (CH_4), and Nitrous oxide (N_2O). Emissions from CO_2 are calculated by applying an appropriate emissions factor (accounting for carbon content and fraction of carbon oxidized) to the fuel quantity consumed per passenger-mile traveled. Emissions from CH_4 and N_2O are calculated based on performance of emissions control equipment such as catalytic converter.

The GHG emissions factors have different values based on distance traveled: long (>700 miles), medium (between 300 and 700 miles), and short hauls (<300 miles). The longer haul airplanes will have less GHG emissions per passenger-mile due to extended steady state flight time compared to those of shorter hauls (<300 miles). The equation (Optional emissions from commuting, 2008) (Eq. (1)) for calculating GHG emissions (in kg) per passenger-mile is shown below:

$$E_i = \mathrm{EF}_{CO_2} + \mathrm{EF}_{CH_4} \times 0.021 + \mathrm{EF}_{N_2O} \times 0.310 \quad (1)$$

where E_i – GHG emissions factor, kg/passenger-mile, EF_{CO_2} – CO_2 emissions factor, kg/passenger-mile, EF_{CH_4} – CH_4 emissions factor, g/passenger-mile, EF_{N_2O} – N_2O emissions factor, g/passenger-mile, 0.021 – conversion factor, 0.310 – conversion factor.

Table 1 shows the overall GHG emissions factor (in kg) for short, medium, and long haul trips per passenger-mile calculated using Eq. (1).

To calculate the GHG emissions for each flight, the GHG emissions factor (E_i) is multiplied by the trip distance (D_{trip}) and the number of passengers (N_{pass}), Eq. (2). Therefore, a flight carrying 100 passengers on a short haul trip ($E_i = 0.280$) of 250 miles, the total GHG emissions is equal to 7000 kg (250 × 100 × 0.28). Similarly, a flight carrying 100 passengers on a long haul trip ($E_i = 0.188$) of 1000 miles, the total GHG emissions is equal to 18,800 kg (1000 × 100 × 0.188).

$$\mathrm{GHG}_{flight} = E_i \times D_{trip} \times N_{pass} \quad (2)$$