

Original article

Modelling and forecasting the demand for jet fuel and bio-based jet fuel in Turkey till 2023



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ARTICLE INFO

Article history:

Received 15 October 2015

Revised 21 October 2016

Accepted 18 November 2016

Keywords:

Bio-based jet fuel

Demand

Forecasting

Jet fuel

Vision 2023

ABSTRACT

Turkey's ambitious Vision 2023 agenda foresees a significant growth in the country's aviation sector. However, forecasts for Turkey's jet fuel demand in the view of Vision 2023 are not available in the published literature. Also, there is no information about the country's potential bio-based jet fuel demand after 2020, when it is plausible to become a mandatory supplement to kerosene. As a result, for the first time in this study, semi-empirical models were generated to provide Turkey's jet fuel and bio-based jet fuel forecasts based on the country's Vision 2023 energy targets. These models were generated taking current market dynamics, business as usual, and the possibility of enhanced economic growth for Turkey based on Vision 2023 energy and economic targets. As a result, Turkey's jet fuel demand in 2023 was estimated at between 4.230 and 7.880 billion litres. Also, it was calculated that Turkey could need up to 0.307 billion litres of bio-based jet fuel in 2023, if its consumption becomes mandatory after 2020.

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Introduction

Turkey has one of the highest gross domestic product (GDP) growth rate amongst all European Union (EU) member and associate states [1]. The country also has a large young population, who like to travel [2]. Accordingly, both the number of civilian aircraft and passengers carried increased almost exponentially over the last decade as shown in Figs. 1 and 2, respectively [3,4].

It is envisaged that Turkey's economic and population growth will continue in the next decade [5]. Consequently, it is clear that more people will fly over the Turkish skies. However, there is a price for that. Aviation sector around the globe is highly dependent on petroleum. Jet fuel, which is the primary fuel for aviation, is almost exclusively extracted from kerosene fraction of petroleum [6]. Consequently, its increased consumption generates major environmental and economic problems.

Environmental problems occur both at local and global levels. Local atmospheric issues are related to airport contributions to local air quality; whereas at global level aviation emissions have the potential of atmospheric impacts, which could affect climate change [7,8]. Also, there is an economic side, which cannot be

ignored. According to the International Air Transport Association (IATA), global jet fuel market for commercial airlines reached to \$210 billion in 2012 [9].

Alternative aviation fuels are a promising solution to these aforementioned problems. However, the information about the current research in the field of alternative aviation fuels and an up to date review about the economic and environmental problems associated with the reliance of the global aviation sector on jet fuels is scarce in the published literature. Therefore, the first aim of this paper was to provide this information.

In 2012, a series of ambitious growth plans for the economy, energy and transportation sectors were announced by the Turkish government under the Vision 2023 agenda [5,10]. A part of this plan, a significant growth is expected in Turkey's aviation sector [10]. However, detailed analysis of Turkey's jet fuel demand in the view of Vision 2023 is not available in the published literature. Also, there is no information about the country's potential bio-based jet fuel demand after 2020, when it is plausible to become a mandatory supplement to kerosene. Therefore, the second aim of this paper was to provide this crucial information.

This paper was written with a global to local perspective to provide the aforementioned important information for the academia, aviation industry and policy makers.

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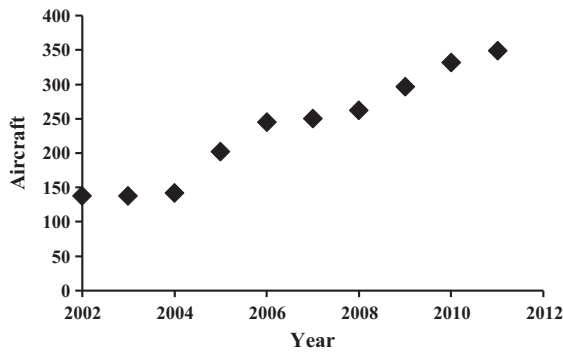


Fig. 1. Number of aircrafts under Turkish registers (passenger and cargo combined), between 2002 and 2012 [4].

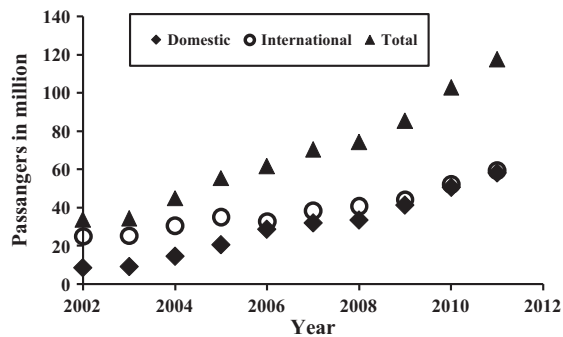


Fig. 2. Air passenger statistics for Turkey, between 2002 and 2012 [3].

Problems associated with global aviation sector and analysis of alternative aviation fuels as a possible solution to these problems

Concise information about global aviation sector

Aviation sector has made the world truly global, and aviation is the fastest means of transportation for goods, services and people around the world [11,12]. Globally, aviation sector has been growing over the last two decades [7]. Between 1989 and 2009, total scheduled air traffic grew at rate of 4.4% per annum in terms of revenue passenger kilometres (RPK) [7]. The IATA estimated that airlines around the world carried nearly 2.8 billion passengers and 48 million metric tons of cargo in 2012 [13]. Consequently, the aviation industry supported 56.6 million jobs and \$2.2 trillion in economic activity in the same year [13].

In 2012, the total value of goods transported by aviation was \$5.3 trillion or nearly 35% of all annual global trade [13]. The IATA estimated that the airlines would carry nearly 3.6 billion passengers around the world in 2016 [14]. This is 800 million more than the 2.8 billion passengers carried by airlines in 2012. Finally, it is projected that the total scheduled air traffic will continue to grow at an average rate of 4.8% per annum in terms of RPK till 2036 [7]. However, there would be a price to be paid for this growth. There are serious economic and environmental problems associated with the global aviation sector. These problems will be analysed in the following subsections.

Economic problems

Global jet fuel demand has been growing over the last three decades [15]. At local level, this increase has been much steeper for Turkey [16]. Jet fuel consumption statistics for the World and

Turkey, between 1984 and 2010, are shown in Fig. 3 [15] and Fig. 4 [16], respectively. It is believed that Turkey's jet fuel demand grew much faster than the global average due to the country's economic growth, population rise, and aggressively expanding civil aviation sector.

Globally, fuel expenses of airlines increased as the market grew [17]. Annual aviation fuel expenses of commercial airlines based on IATA data, between 2003 and 2013, in billion US\$ is shown in Fig. 5 [17]. Increased consumption also increased jet fuel's share in the total operating expenses over the last decade [17]. Annual aviation fuel expenses of commercial airlines based on IATA data, between 2003 and 2013, % of total annual operating expenses is shown in Fig. 6 [17].

As can be seen from Fig. 6, the fuel costs accounted for only 14% of the total operating expenses in 2003, whereas it rose to 33% by the end of 2012. As a note of caution, the sudden drop in 2009 was due to the global financial crisis in 2008 and the sectors jet fuel spending returned to this level in 2012.

Even though the global commercial aviation sector has a vast economic turnover (estimated at \$2.2 trillion in economic activity in 2012 [13]), the sector has relatively meagre profits. In 2012, global sector profit was estimated at \$3.0 billion [9]. This was equal to 1.4% of the sectors jet fuel expense in the same year. This shrinking profit margins was related to climbing jet fuel prices [18]. From January 2003 to July 2008, jet fuel price increased 462%, reaching \$3.89/gallon [19]. However, it dropped to \$1.26/gallon in February 2009 due to the global economic crisis of 2008, and rose to \$3.09/gallon in January 2012 [19]. On 08 February 2013 (Friday value), the price of jet fuel was recorded at \$3.33/gallon or \$139.8/bbl [20], which was still lower than its price back in 2008.

Petrol prices increased in the first decade of the 21st century [21]. Jet fuel is produced from petroleum. As a result, the price of jet fuel increased in the meantime. The basket price of oil reached to \$123.5/bbl in March 2012 [22]. However, it was \$17.5/bbl in the year 1999 [23]. This simply means a 600% increase in a 13 year time span.

Our increasingly globalized world's hunger to jet fuel for aviation is increasing every day. As a result, a transition to an eventual sustainable replacement seems to be rather difficult [24]. It is believed that as time passes the changeover would have much greater economic and social costs [24]. But sadly, this would only be the tip of the iceberg. Because, the bigger problem actually lies with the associated environmental impacts of the aviation. This is explained in detail in the next subsection.

Environmental problems

Aircrafts emit a variety of greenhouse gases and particles into the atmosphere. Carbon dioxide (CO₂), nitrogen oxides (NO_x),

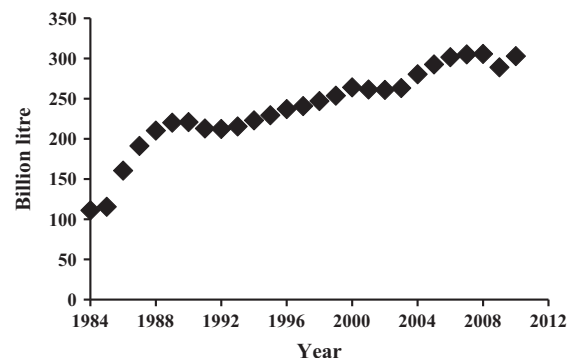


Fig. 3. Jet fuel consumption statistics for the World, between 1984 and 2010 [15].

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