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An eco-friendly aircraft taxiing approach with collision and conflict avoidance

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ABSTRACT

Among several crucial objectives of the air transportation system, minimization of fuel consumption has a profound impact on the economic viability of airline companies and their effect on the environment. Given that many large airports around the world are located in the heart of residential areas such as Chicago's O'Hare, New York's JFK, and Montreal's Pierre Elliott Trudeau, the Greenhouse Gas Emissions (GGE) released by aircraft flying through such urban airports directly impacts the health of nearby residents. In this paper, we propose a hybrid taxiing solution to reduce the airports' impact on GGE where part of the taxiing operations is handled by tow-trucks powered by renewable energy while some other aircraft continue using their engines to complete taxiing. The main contribution of the work presented in this paper is the inclusion of collision of conflict avoidance in the formulation of taxiing operations planning with an objective to minimize fuel consumption and to maximize the desired service quality. The conflict-free taxing operations planning model is tested on Montreal's Pierre Elliott Trudeau airport. Furthermore, the detailed economic analysis on the adoption of electric-powered tow-trucks is provided.

1. Introduction

Demand for civil aviation has been steadily increasing for many decades. According to the International Civil Aviation Organization (ICAO), passenger traffic has grown an average of 5.2% per year between 1995 and 2012. ICAO estimates demand for aviation to continue to increase at an annual rate of 4.6% until 2032 and 4.5% until 2042 (ICAO, 2016). Despite its current contribution to global GGE being estimated to be only around 3–6%, increasing demand on air travel suggests that, in near future, aviation's contribution to the global GGE will increase significantly. In recent years, both automobile and rail industry have introduced several alternative power sources with potentials to reduce their CO_2 emission. Unlike for the automobile and rail industry, advances in technology is not promising a breakthrough alternative power-source for the aviation industry. Both increasing demand on air-travelling and lack of alternatives for the fossil fuel-powered engines will only increase the contribution of aviation industry for the CO_2 emission.

The objective of airline companies is to transport passengers or cargo from an origin to destination with minimum deviations from the schedule, safely and comfortably while sustaining a profitable business. In the literature, the Air Traffic Management (ATM) problem is mostly tackled as an operations research problem with an objective to minimize flight delays. Outputs of such mathematical models include departure times from origins (gates or runways), set of air sectors to be visited during flight, and the arrival and

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