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Low-carbon measures for Fiji's land transport energy system

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ABSTRACT

Road transport in Fiji is fully dependent on petroleum fuels. This study is a first for Fiji where fuel demand for land transport is studied under some clean transportation strategies. Long-range Energy Alternatives Planning (LEAP) tool is used with 2016 as the base year and 2040 as the end year. In 2016, approximately 337 million litres of fuel was used with an associated GHG emission of around 864 Gg of CO_{2e}, which increases to 1158.4 Gg by 2040 in Business as usual (BAU) scenario. Several measures are explored to reduce the fuel consumption in the land transport sector in Fiji.

1. Introduction

Almost 20% of the world energy consumption is by the transport sector, Fig. 1 and the sector is heavily dependent on motor gasoline and diesel fuels, Fig. 2. For Fiji's case, the transport sector accounts for 60% of the total petroleum consumption in the country (ECA, 2013). Fiji being an island country with around 900000 population is committed to reducing its fossil fuel consumption as noted in its Nationally Determined Contributions (NDC) to GHG reductions (GoF, 2015). Fiji's transport sector is growing as evidenced by the increasing number of vehicles, number of passengers and tonnes of goods transported, Fig. 3.

To the best of authors' knowledge, there has not been any study conducted in Fiji on the current and future projects on energy consumption of land transport. A number of studies have been done globally, nationally and regionally to study how different strategic interventions are affecting fossil fuel consumption and GHG emissions. It was noted by Sadri et al. (2014) that energy-environment planning for transportation requires extensive data for energy carriers, production, consumption and vehicle technologies. While (Liu et al., 2015) mentions that emission reduction measures for urban passenger transport in Beijing can be divided into two categories (i) a clean vehicle strategy which encompasses technical improvement in vehicle or fuel and (ii) a mobility management strategy which reduces traffic volume through a variety of measures.

For Delhi city, the passenger transport fuel demand and environmental emissions were studied using scenario analysis in LEAP by Bose and Srinivasachary (1997). They have discussed strategies of improving efficiency of buses and how to reduce congestion of roads. China's freight transport sector's energy demand and GHG emissions was studied by Hao et al. (2015) where they concluded that China needs aggressive efforts to reduce GHG emissions by almost 30% compared to BAU scenario. In addition, road freight transport for heavy goods vehicle in Spain was studied by Andrés and Padilla (2015) for its energy intensity and concluded that alternative mode of transport such as rail would achieve higher energy efficiency.

Recently, Dhar and Shukla (2015) had studied low carbon scenarios for transport in India using ANSWER MARKAL from 2010 to 2050 and found that although vehicle fleet efficiency increases in BAU scenario, rapidly increasing transport demand, population and income levels tend to overwhelm the energy savings from efficiency measures. ANSWER MARKAL is a Microsoft Windows interface specifically developed for working with IEA/ETSAP's MARKAL energy system model (NS, 2018). Dhar and Shukla (2015) recommended that low carbon policies such as CNG, battery electric vehicle, hybrid gasoline, hybrid diesel, fuel cell electric vehicle, ethanol-gasoline blended, bio-diesel blended vehicles tend to reduce emissions.

A similar study has been done for Thailand for the same time horizon but a different tool AIM/Enduse is used, (Selvakkumaran and Limmeechokchai, 2015). They have studied emission taxes and low carbon society scenarios. These researchers (Dhar and Shukla, 2015; Selvakkumaran and Limmeechokchai, 2015) also discuss about co-benefits of low carbon society (an economy with minimum GHG emissions). The co-benefits are necessary to look at because technology to reduce GHG emissions require huge capex investments. The co-benefits include energy security for a country and better air quality (Selvakkumaran and Limmeechokchai, 2015).

Yeh and Sperling (2010) in their paper conclude that reducing transportation fuel use and GHG emissions require a portfolio of

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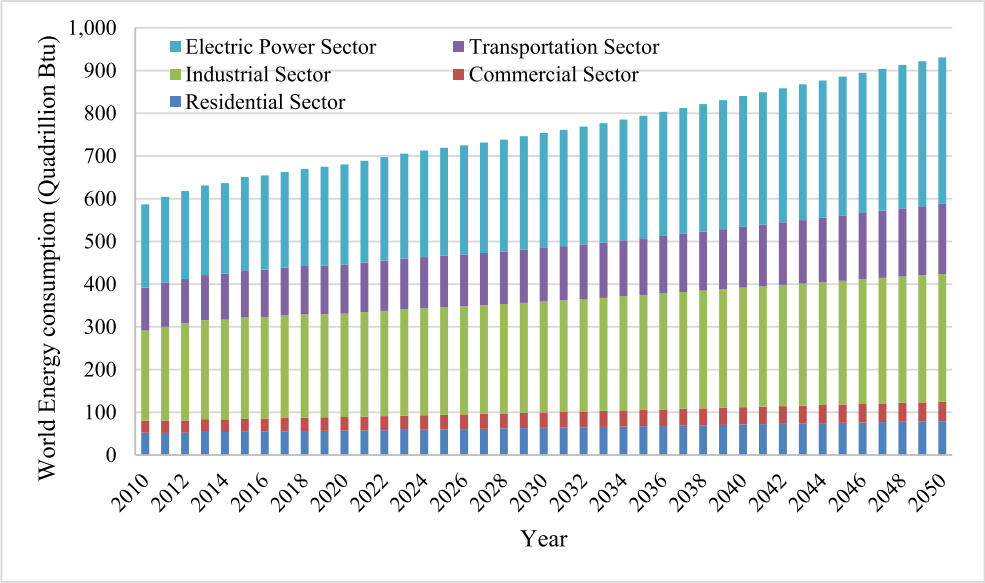

Fig. 1. World energy consumption by different sectors.
Data Source: (IEA, 2017).

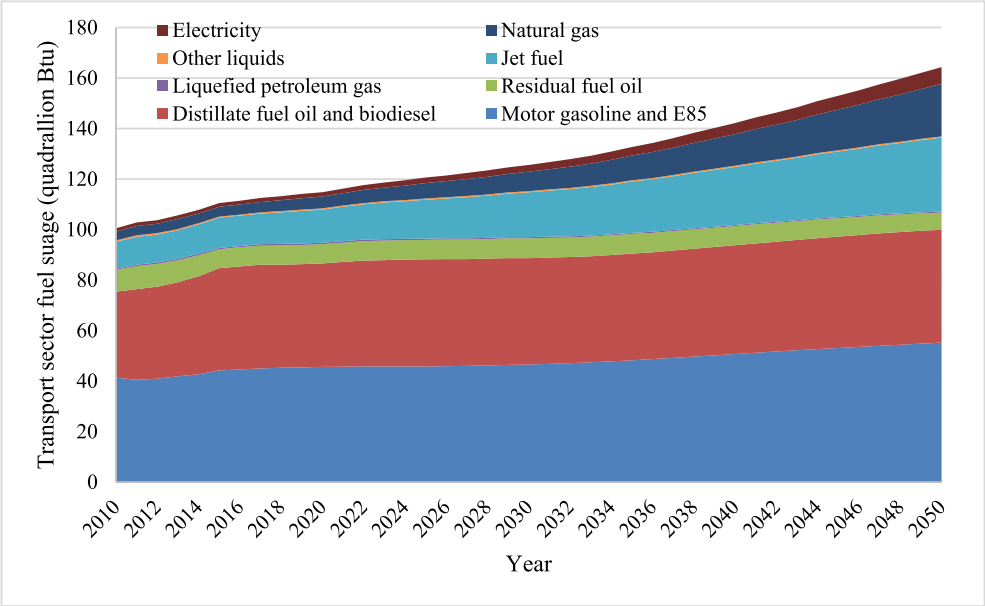

Fig. 2. World transport sector energy consumption in reference case.
Data source: (IEA, 2017).

policies and programs. This is supported by Guttikunda and Mohan (2014) who emphasize that policies should not be implemented in isolation but be supplemented by providing high quality fuel, stringent fuel efficiency standards and enforcing them to reduce pollution levels. Improvement in traffic management, vehicle pollution checking procedures and promotion of behavioral change to use more public and non-motorized transport are also some additional actions to be undertaken to reduce pollution (Guttikunda and Mohan, 2014).

In addition, Mraihi et al. (2013) in their study of factors affecting energy consumption for road transport found that vehicle fuel intensity (energy demand per vehicle), vehicle intensity (number of vehicles per GDP), per capita GDP, urbanized kilometers and national road network are principal drivers of the change in road transport related energy consumption.

The present study aims to study different low carbon measures in Fiji's land transport for the period 2016–2040. Two types of strategies as mentioned by Liu et al. (2015) are studied for Fiji's case; clean vehicle strategy and mobility management strategy to explore path to sustainable land transport. The aim of this study is to quantify fossil fuel consumption as a function of strategic interventions and its related GHG emissions in land transport sector using LEAP tool.

Next section of this paper presents an overview of Fiji's land transport system. Section 3 presents the method and model framework used in this study followed by result presentation. Section 5 discusses policy implications of low carbon strategies studied in land transport. Finally, some conclusions are made.

2. Fiji land transport

There has been almost 70% increase in total number of vehicles over the past 15 years reaching 101,425 registered vehicles in 2015