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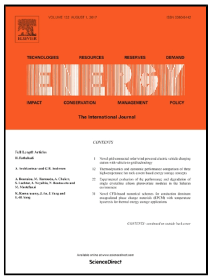

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MODELLING THE IMPACT OF ROAD NETWORK CONFIGURATION ON VEHICLE ENERGY CONSUMPTION

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Abstract

The paper shows that road geometry has a great impact on overall fuel consumption and emissions. Some roads connect traffic origins and destinations directly, while some take winding, indirect routes. Indirect connections result in longer distances driven and increased fuel consumption. A similar effect is observed on congested roads with stop and go traffic and on mountain roads with many changes in elevation. In this light, we propose a methodology for analysis of road networks based on energy consumed by the vehicles and the energy needed to build more efficient connections. This framework takes into consideration traffic volume, shares of vehicle classes, road geometry and energy needed for road operation and construction. Its application was illustrated through two case studies, one with macroscopic traffic data and one with microscopic traffic simulation that can also be applied for urban road network optimization.

Keywords: traffic energy, vehicle emissions, road network configuration, road geometry

INTRODUCTION

Sustainable energy is a target of energy development strategy in EU countries. The term refers to energy sources that are expected not to be exhausted in a time frame relevant to the human race and do not compromise the ability of future generations to meet their needs [1, 2]. The transport sector is one of the largest and fastest growing contributors to energy demand and greenhouse gas emissions [3–5]. The ambition of the EU-Strategy for Low-Emission Mobility is to reduce greenhouse gas emissions from transport at least 60% than in 1990 by mid-century and be firmly on the path towards zero [6].

The transport sector contributes nearly a third of CO_2 emissions and energy consumption within the EU [7]. Efforts to achieve greater energy efficiency in transport have resulted in diverse approaches worldwide. The European Union focuses a great deal on policies for energy efficiency which should result in lower emissions [8]. Most efforts to combat this problem are directed towards traffic mode shift, use of energy-efficient vehicles and alternative fuels [9]. As a result, there was a decline of overall emissions by 3% in 2012 and by 2014 average light vehicle emissions were below the targets set for 2015. These values were obtained in part as the EU requires member states to record data on registering new vehicles [10]. Similar policies are being practiced elsewhere in the world, such as in the USA and China [11, 12]. Some transport policies focus on limiting road traffic in cities, increasing use of public transport and shifting from road to other modes of transport. Such approaches work well in densely populated areas, but in sparsely populated areas road traffic is still, necessarily, the transportation mode of choice. A study on emissions reduction in London notes effective measures directed towards traffic mode shift [13]. An alternative to such approaches can be better traffic management or road network configuration that could result in less congestion and lower emissions.

In sparsely populated areas, where roads are preferred and necessary, some focus should be put on the relation between greenhouse emissions and traffic management. Traffic simulation and emissions models are tools that can be applied for such analyses. This paper will include a review of traffic

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