Research in Transportation Business & Management 12 (2014) 11–19

Contents lists available at ScienceDirect

Research in Transportation Business & Management

Road freight energy efficiency and CO_2 emissions in the Nordic countries

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ARTICLE INFO

Article history:
Received 11 November 2013
Received in revised form 14 May 2014
Accepted 13 August 2014
Available online 4 September 2014

Keywords:
Road freight transport
CO_2 intensity
Transport intensity
Energy efficiency

ABSTRACT

Nordic countries have committed to improve the energy efficiency and decrease the CO_2 emissions of freight transport. The aim of this paper is to compare the energy efficiency and CO_2 emissions in the road industry for the Nordic countries in 2010, in order to identify the key factors and their impact on energy efficiency and CO_2 emissions. A joint analysis method was developed to compare data. Quantitative data was used to conduct a decomposition analysis for several sectors, taking several indicators into account. Statistics from Denmark, Finland, Norway and Sweden include continuous road haulier surveys, national account data and fuel consumption data. The CO_2 emissions of road freight transport in the Nordic countries vary from 1.14 Mt in Denmark to 2.27 Mt in Sweden. While the size of the economy, measured in gross value added (GVA), is a major determinant for the emissions, the differences in transport intensity and energy efficiency also have a significant effect on the total emissions. This study is the first of its kind for the Nordic countries. Our research can be used as a first step in a continuous evaluation of the determinants of road freight CO_2 emissions in the European countries.

1. Introduction

Sustainable development, especially improving energy efficiency and reducing carbon dioxide (CO_2) emissions, has become a highly important global goal during the past few years. This development is mainly related to research findings on global warming caused by human activities (IPCC, 2007), but also to limited sources of fossil oil, increasing the demand and resulting in rising oil prices. Information considering energy use and emissions as well as measures to improve energy efficiency and reduce CO_2 emissions are needed in every sector of society in order to mitigate climate change and to respond to rising energy prices. This trend is also evident in the freight transport and logistics sector. In this paper, energy efficiency is defined as road haulage per energy consumption (tkm/kWh), and it is therefore of interest to analyse the factors that affect this measure.

The transport sector is currently almost entirely dependent on fossil oil and it is also the only sector in which emissions have increased in the last few years. Without determined policy measures to reduce the emissions, they are also forecasted to increase even further (COM/2011/0144; Eurostat, 2011; SEC/2011/0358). The new White Paper for European Transport (COM/2011/0144), launched by the European Commission, sets a target for reducing 60% of transport greenhouse gas (GHG) emissions from the 1990 level by 2050, and a 20% reduction from the 2008 level by 2030. The target for transport is less ambitious than in other sectors (80–95% reduction to keep the global warming below 2 °C), which underlines the challenging role of transport in climate policy. The White Paper also highlights that because freight transport is essential to economic growth, and limiting mobility is not an option, the targets should be achieved without reducing the mobility of goods.

The target is not further allocated to passenger and freight transport. Road traffic emissions dominate transport emissions, and as passenger car emissions per kilometre are in decline (EEA, 2011), addressing road freight emissions becomes increasingly relevant. Estimates for major economies show that road freight is responsible for 30–40% of all road transport emissions (ITF, 2010). More detailed studies in Germany (Léonardi & Baumgartner, 2004) and the UK (McKinnon & Piecyk, 2009) show that the share of freight in road transport emissions has been increasing.

In the Nordic countries, including Iceland, transport accounts for 21% of total greenhouse gas emissions and is thus the largest single sector emitting energy related CO_2 (Fig. 1). Total Nordic energy related CO_2 emissions were in 2010 about 220 Mt, of which around 36% came from transport. The share of transport related CO_2 emissions differs between countries from 50% in Sweden to 23% in Finland, mainly due to differences in emissions from power generation. Road transport emitted around 70% of total Nordic transport CO_2 emissions and around one fourth of road transport emissions came from heavy road freight transport. (IEA, 2013).

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http://dx.doi.org/10.1016/j.rtbm.2014.08.001
2210-5395/

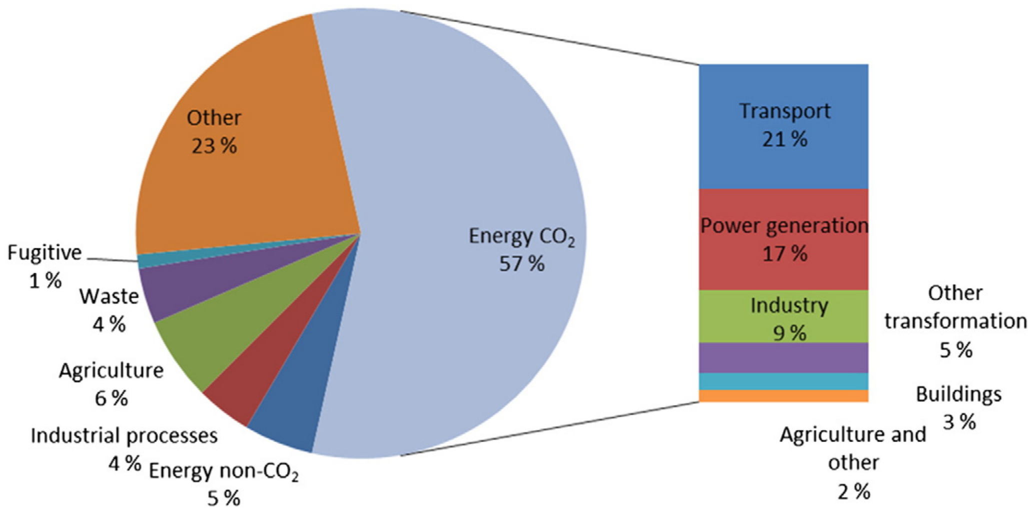

Fig. 1. Nordic greenhouse gas emissions in 2010 (IEA, 2013).

As EU member states Denmark, Finland and Sweden are also committed by the Energy Services Directive (2006/32/EC) to achieve a 9% energy savings target from the 2001–2005 average by 2016. To realise this target, the EU has established an action plan for energy efficiency (COM/2006/0545). This plan identifies the transport sector as central in the ambition of achieving energy efficiency improvements, as it is the fastest growing sector in terms of energy use and heavily dependent of fossil fuels. Several energy efficiency measures are identified in the action plan. However, only a few of the measures are applicable in road freight transport, such as developing markets for cleaner vehicles, maintaining proper tire pressure and promoting co-modality, i.e. efficient use of transport modes on their own and in combination.

In line with the EU target, Norway has also committed to improve energy efficiency and reduce the CO_2 emissions of road freight transport. Although Norway's strategy is less detailed than the EU action plan, the Norwegian master plan for transport, renewed every fourth year (Norwegian Ministry of Transport & Communications, 2009), includes measures for how emission targets can be realised, both for passenger and freight transport.

The aim of this paper is to compare energy efficiency and CO_2 emissions of the road freight transport for the Nordic countries, except Iceland, in 2010. Denmark, Finland, Norway and Sweden have quite similar population, geography and road infrastructure with well connected high quality network of asphalt roads. Iceland is much smaller in population, area and road condition and is thus not included in the research. The four countries are also connected with open border crossings and have similar competitive structure of the logistics market with a vast number of small owner–operator companies with one or two trucks. The study thus highlights various factors affecting these key indicators, and identifies opportunities for policy measures that may improve energy efficiency and reduce CO_2 emissions. For this purpose, an analytic method for comparison was created, with indicators that can be used in data sets for all countries.

2. Literature review

Earlier studies in the field of sustainable development of freight transport have performed development assessment at international and national levels, though the emphasis has generally been at the national level. Historical development has been used to examine the trends of different phenomena. Based on historical development, Liimatainen and Pöllänen (2010) establish that in Finland the energy efficiency of road freight improved during 1995–2002, but has since declined. The same trend was found in the US from 1975 to 2004, where efficiency improvements have been employed to increase a truck's performance and comfort rather than reduce consumption (Lutsey & Sperling, 2005). Ramanathan's (2000) study reveals that in India there has been a slight improvement in the energy efficiency of rail transport, but that road transport was more energy efficient in the late eighties than in the nineties. Ediger and Camdali (2007) argue that in Turkey the energy efficiency of the transport sector over the period from 1988 to 2004 has been cyclical, but improved slightly. Sorrell, Lehtonen, Stapleton, Pujol, and Champion (2012) conclude that the aggregate energy intensity, defined as road freight fuel consumption per GDP (l/£), of the UK road freight sector fell considerably during the period 1989 to 2004, achieving relative decoupling from GDP. They argue, however, that this development was due to current economic trends and cannot be regarded as a direct result of policy actions.

At the international level historical development has enabled the comparison between different countries. Kamakate and Schipper (2009) evaluate the energy intensity (MJ/tkm) of road freight in Australia, France, Japan, the United Kingdom and the United States from 1973 to 2005. This research relies on a bottom-up model, which shows that energy intensity is influenced by geography, transportation infrastructure and truck utilisation. Eom, Schipper, and Thompson (2012) analyse freight CO_2 emissions in 11 IEA countries from 2007 to 2010. According to this study, it is difficult to establish an explicit trend with regards to the energy intensity (MJ/tkm) of trucking, making the limiting of freight CO_2 emissions a challenging project. The whole of Europe is covered in a study by Ruzzenenti and Basosi (2009), which evaluates the reliability of energy efficiency metrics. They are thereby able to argue that the energy efficiency of the European transport sector has improved during 1970–2000, due to technological progress but also because vehicles are more powerful and heavier, i.e. as a result of the ratio properties of efficiency; higher efficiency can either be due to lower input or a higher output.

Other than historical developments in freight energy efficiency, several studies have analysed variations of future trends of energy efficiency in freight transportation. Trucking activity will have doubled by 2050 and grows faster than passenger transport (IPCC, 2007). These trends could lead to a doubling of transport energy use worldwide (IEA, 2009). In a more local context, Zanni and Bristow (2010) have warned that road freight CO_2 emission in London might increase by about 109% by 2050. A study by Hao, Wang, and Ouyang (2012) utilises a bottom-up model to predict future fuel consumption and life cycle GHG emissions of the on-road trucks of China. According to this study,