DECARBONIZING INTRAREGIONAL FREIGHT SYSTEMS WITH A FOCUS ON MODAL SHIFT

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Overview

Road freight transportation accounts for around 7% of total world energy-related carbon dioxide emissions [1]. Energy savings and emissions reductions can be achieved by shifting freight to rail or water modes, both of which are far more energy efficient and emit far less CO_2 per tonne-km than road. We briefly introduce five general strategies for decarbonizing freight transportation, and then focus on the literature and data relevant to estimating the global decarbonization potential through modal shift. We compare freight activity (in tonne-km) by mode for every country where data are available. We also describe major intraregional freight corridors, their modal structure, and their infrastructure needs. We find that the current world road and rail modal split is around 60:40, based on available data. Most countries are experiencing strong growth in road freight and a shift from rail to road. Rail intermodal transportation holds great potential for replacing carbon-intense and fast-growing road freight, but it is essential to have a targeted design of freight systems, particularly in developing countries. Modal shift can be promoted by policies targeting infrastructure investments and internalizing external costs of road freight, but we find that not many countries have such policies in place. We identify research needs for decarbonizing the freight transportation sector both through improvements in the efficiency of individual modes and through new physical and institutional infrastructure that can support modal shift.

Methods

In this paper, we focus specifically on road freight, which has a large and growing share of freight activity in most countries [1, 2], and explore the potential for modal shift as a decarbonization strategy. We begin by introducing five general strategies to decarbonize global freight transport, using the same taxonomy as McKinnon (2016) [3]. These are: 1) reducing the demand for freight; 2) improving vehicle loading; 3) increasing the efficiency of freight transport vehicles; 4) reducing the carbon content of fuel used to transport freight; and 5) shifting freight to low carbon-intensity modes. We provide a brief overview of global freight activity and important trends using a dataset of road, rail, and domestic water freight activities in tonne-km, which we have compiled for 157 countries for the years 2000 to 2017. We analyze compound annual growth rates (CAGR) by mode over the available time frames. We also provide an in-depth review of studies of the theoretical aspects of modal shift. We identify which factors influence shippers' mode choices, and we discuss the greatest barriers to increasing the share of rail, water and intermodal freight transportation. We conclude that discussion with an overview of existing policies to promote modal shift. We then describe freight transportation systems and modal shift policies in specific regions of the world, including major intraregional freight corridors, their modal share, and their infrastructure needs. We conclude the review by summarizing existing estimates of the potential for modal shift.

Results

Road freight activity data are only available for 75 countries, which collectively account for ~83% of global GDP. With the exception of a few countries where rail dominates, such as Russia, Australia and Canada, most countries rely heavily on road freight transportation. While countries with large surface areas tend to have high shares in rail freight activity, some South American countries and China are exceptions. We find that the share of rail freight has decreased in many countries, particularly in China, India, and Eastern Europe. The U.S. has shown a recent increase in the share of rail largely due to an estimated decline in road freight activity. Japan and Australia have increased their rail share. We find that only a few European countries and Japan have experienced an overall decline in land freight activity, while most countries have seen growth in freight with a much higher CAGR for road than for rail. We find that to promote modal shift, governments could use two types of policy approaches: infrastructure investments and incentives. However, policy approaches have been largely underused. For example, the share of

infrastructure investments in the rail sector is small and should be increased, especially in developing countries. Investments should focus on constructing efficient rail and intermodal terminals and facilitating the use of information and communication technologies (ICTs) for example to track shipments and expedite routing. In low-income countries, a freight system with multimodal and low-carbon infrastructure can be a cost-competitive way to promote economic growth. Incentives should discourage the use of road freight by pricing mechanisms such as tolls, fuel or vehicle taxes, or through tighter regulation. At a minimum diesel taxes should be as high as gasoline taxes [4]. Some countries might also consider subsidies and R&D programs to promote intermodal freight.

Conclusions

Modal shift may have the potential to reduce greenhouse gas (GHG) emissions, but a systematic analysis of the possible emissions reductions and costs is yet to be found in the literature. Infrastructure investments are effective approaches to encourage modal shift in less developed freight markets but policies targeting the internalization of external cost should be preferred in well-developed markets in order to maximize welfare [5]. Combining multiple policies (policy packaging) has been emphasized as a valuable approach [6, 7], in particular the combination of cost increases for road transport with decreases in lead time of intermodal transport [8]. The lack of standardized, high-quality data in the freight sector limits informed policy analysis, formulation and validation. The global potential for reducing GHG emissions through modal shift remains unknown, although there are a wide variety of national and regional estimates, targets and assumptions. A rigorously produced, and economically and politically realistic estimate would be valuable. Also missing from the literature is a marginal GHG abatement cost curve for freight that captures mode shifting and intermodal potentials, and that also accounts for ICT strategies. In addition, there are potentially adverse interactions of other decarbonization strategies with modal shift that need to be studied, such as the effect of more efficient and therefore cheaper trucking. It would also be instructive to examine possibly disruptive changes in commodity demands that can result in stranded infrastructure assets, change freight market conditions but also free up rail or water freight capacity. This is particularly relevant as many countries shift away from coal for electricity generation.

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