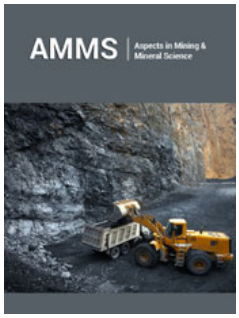
Crimson Publishers
Wings to the Research

Mini Review

Future Demand for Fuels Used in Freight Transportation Considering Sustainability Targets

ISSN: 2578-0255



Jaap M Vleugel*

Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands

Abstract

Climate change mitigation asks for a gradual replacement in the use of fossil fuels in freight transport. This opinion article discusses options for and barriers to such change. It concludes that many options are available to stakeholders and partially already deployed. These can be cost-effective and otherwise financially interesting, in particular if a total cost of ownership perspective is used. They may also have other benefits, in particular a reduction in local air pollution. Some assistance from a favorable policy regime is among the conditions needed.

Keywords: Fossil fuels; Electricity; Freight; Combustion; Energy

***Corresponding author:** Jaap M Vleugel, Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands

Submission: March 01, 2022

Published: March 16, 2022

Volume 9 - Issue 1

How to cite this article: Jaap M Vleugel. Future Demand for Fuels Used in Freight Transportation Considering Sustainability Targets. Aspects Min Miner Sci. 9(1). AMMS. 000701. 2022.
DOI: 10.31031/AMMS.2022.09.000701

The context

Freight transport, a key economic activity, is also a major consumer of fossil fuels. In 2012, this was more than 60 quadrillion btu world-wide. This value may rise to more than 90 quadrillion btu by 2040 [1]. This goes along with a substantial local (NO_x, PM_{xx}) and global (CO_2) emissions to the air world-wide [2,3]. In 2019, 100 billion tonkm of goods were shipped around the world, which translates into 8-11% of global CO_2-emissions [4]. This 50% growth in fuel consumption by freight transport in nearly 30 years' time is a world average. The actual value will be even higher, up to 300% [5] in developing countries. Since energy consumption and CO_2-emissions are directly related, a massive rise in global CO_2-emissions from freight transport is inevitable, making it the largest source of CO_2-emissions. Local air pollution will also grow exponentially, while major cities in developing countries already experience a health-threateningly low air quality.

The world population continues to grow, which translates itself in more consumption, production and freight transport. Recent trends in consumer behaviour, in particular related with internet buying, add their share as well. Popular supply chain management practices, in particular just-in-time, high-frequency and cost-efficient delivery also contribute to the rise in freight transport world-wide [6]. As most goods are produced far away from their (final) consumers (also known as globalization), about 90% of freight transport goes by sea. On land, trucking is the dominant mode of transport in most countries (see for example Figures 1 & 2), with a secondary role for rail or barge depending on the local conditions and the transport distance to be covered. Air freight is mainly used for very time sensitive and more valuable goods, which is a small part of the overall volume transported, but its emissions are disproportionate [7] (see also Table 1).

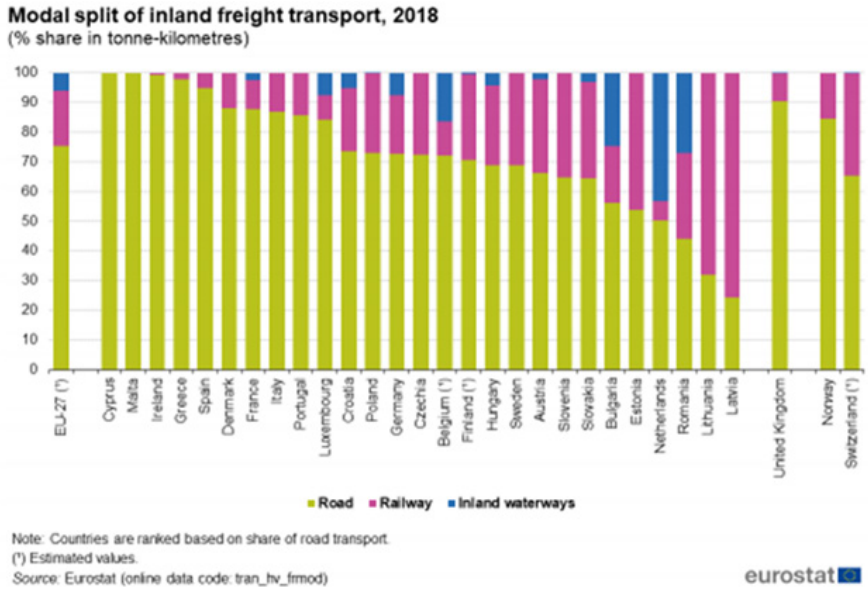


Figure 1: Modal split in freight transport, EU-27 countries, 2018 Source: [7].

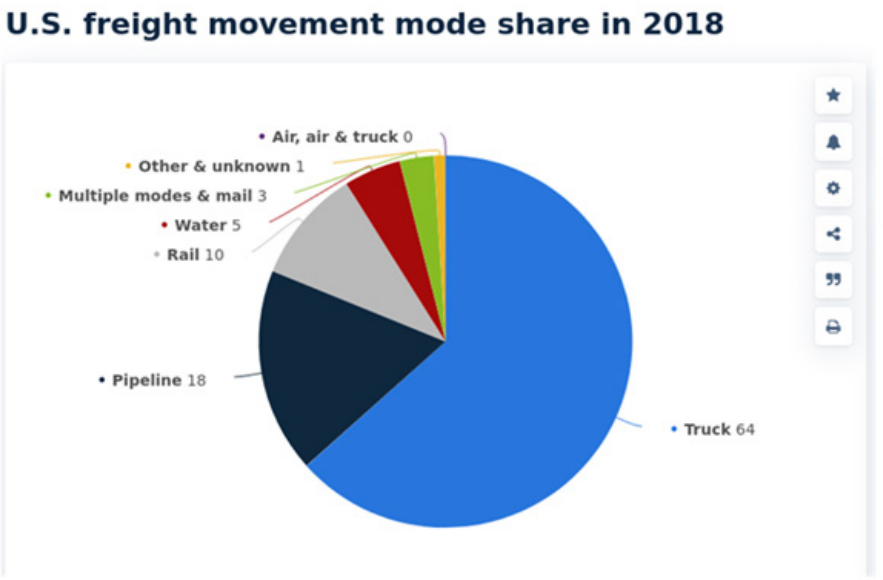


Figure 2: Modal split % in freight transport, USA, 2018 Source: [8].

Table 1: Emissions of CO_2 for 1 metric ton of freight, tonkm Note: B747 planes were mostly replaced by more fuel-efficient types. Source: [9].

Mode	Gram
Air cargo (B747)	500
Lorry, truck	60 – 150
Train	30 – 100
Sea freight	10 – 40

The Climate Issue

Climate change is a long-term process, yet in the past decades its pace is accelerating, according to most scientists due to human activities. Its impact is progressing visible in our daily lives as changes in the weather and more dramatically, as an increase in the frequency of wildfires, aridification, heavy storms and excessive rainfall or flooding. Scientists warn that we are approaching the point of no return [8]. Calls for intervention, also known as climate change mitigation, have led to unilateral as well as multilateral policy initiatives, such as the Paris Agreement of 2015 [9]. There are also actions by multilateral organizations, such as the International Maritime Organization (IMO) in 2018 [10]. What these initiatives aim to achieve is a reduction or at least stabilization of human-related global CO_2-emissions. This asks for measures taken by local stakeholders in all economic sectors, including freight transport.

Practice in Some Parts of the World

Not all countries have committed themselves to these policy goals (to the same extent) or they pursue a different policy per economic activity. This can be due to lack of political agreement, owning large fossil fuel resources, lack of funding opportunities or priorities and path dependencies due to historic investments in fossil fuel vehicles and infrastructure, etc. In Europe with its relatively high spatial density and comparatively short distances, there is tendency to gradually move away from fossil fuels, although the pace is not everywhere the same. Its car and truck manufacturing industry are mainly targeting at electricity as fuel source, although hydrogen is also studied by some manufacturers as an option for the longer-term. In the USA, the situation is quite complex due to a strongly divided political landscape, the lack of a powerful environmental lobby, the powers of the oil and gas industry and the high cost of change. Freight transport by road and rail strongly relies on diesel. Driving range is a much bigger issue than in Europe. This explains the need for larger batteries or another fuel – hydrogen. Electrification of railways is regarded as not cost-efficient, in particular in rural areas, which many trains pass. Use of hydrogen could also replace diesel over time. The complex situation reduces the pace of intervention substantially.

The picture in China is quite diverse. A steeply increasing demand for energy leads the country to invest in both fossil and non-fossil fuel sources. It has built a uniquely large railway network that is also used for freight transport. It promotes use of direct rail services to serve foreign markets, which compete with the much slower, yet less expensive, transport by sea. It subsidizes electric vehicle manufacturers and producers of windmills and PV cells for home and export markets. Other parts of the world, Africa, South America and Australia, are lagging behind, because of political, social or economic reasons. What can we expect in the coming years? It is not necessary to dive into complex scenarios [11] in case of a brief exploration of future developments and mitigation options.

Short-Term Outlook

If the aim is to reduce emissions of CO_2 by fossil fuel combustion, then the following is already practiced:

a. Fuel efficiency improvements [12]: Gradually increase energy efficiency of freight vehicles. Less fuel consumed means less CO_2 emitted and also a lower fuel bill, which translates itself in lower costs (or higher profit) for the logistic provider, the shipper and the final customer. In terms of regulation, this means staying on the bandwagon of air pollution regulation as practiced for decades in several countries.

b. Smart logistics: This includes clever routing of vehicles to reduce mileage, load sharing with other (competing) transport companies, reduce empty driving (15-30% of all truck trips [13]) improved forecasting, customer order and delivery flexibility and frequency. Savings up to

c. (Partially) change transport mode (modal shift): Switching from truck to rail or barge is a means to reduce CO_2-emissions (see Table 1), in particular if trains or barges are powered by electricity. Using short sea to replace trucking is another option, depending on the geographical situation.

By combining these measures, an impressive reduction in CO_2-emissions can be achieved; [14] mentions even 60% less CO_2 in trucking, of which 5% due to a modal shift). A much lower fuel bill is also welcome to fleet owners. If investments are needed, then the payback time can be quite reasonable, especially with rising oil and gas prices. Barriers to change are the following. In case of fuel efficiency improvements, the pace of vehicle fleet replacement plays a key role in the speed of implementation. If the number of vehicles rises, then the impact of a gradual increase in fuel efficiency is by definition mitigated. Smart logistics demands cooperation of all stakeholders, in particular (final) customers. If they have to adapt their logistics too much or at very high costs, then cooperation potential will be small. Unless the 'winner' neutralizes the disadvantages in monetary or contractual terms. A modal shift is not always feasible, in particular if the new mode does not provide the required logistic and operational flexibility or capacity. If you need only one container, then a full train with containers is clearly overdone. This calls for clever combinations and probably also accepting certain logistic consequences, such as minimum order or stock levels.

Longer-Term Outlook

Replacing fossil fuels in freight transport fully takes more time. In this case the following requirements have to be fulfilled:

a. In truck transport, deployment of electric vehicles is dependent on the driving range in relation to the density of the fuel network. In urban areas, latest electric trucks and vans can operate in most applications, even with a low-density charging network. Covering longer distances is still a challenge, but battery technology is evolving and charging facilities can be added, either public or private. Studies into electric highways are also underway [15].

b. If hydrogen would be used as fuel source, then the driving range is not an issue, but the lack of a fuel network could limit long-distance applications.

c. Biofuels (diesel or gas) can also be used with some (minor) technical adaptations in many transport applications.

d. Until now, change of production or consumption locations was not mentioned. But, if these could be brought closer together

('local for local'), then the amount of fuel used in transport could be reduced substantially. Changing production locations is dependent on the local conditions and sunk costs. In a longer-term scenario it should definitely be considered, also because it may help to reduce political dependencies.

Barriers to change are again available. In case of electricity, the source matters. Green electricity has a small market share in most countries. Its availability is also fluctuating and location dependent. In case of hydrogen, nearly all of it is still produced from fossil fuels. Changing to hydrogen makes little sense in such a scenario. Biofuels are a fairly controversial energy source. Their production may compete with the production of food, in terms of resources, use of space and lead to rising food prices. The environmental impact of biofuel production may be negative, especially in forest areas. It not clear if their use reduces CO_2-emissions [16].

Marine Transport and Ports

With roughly 90% of world freight transport going by sea, it is obvious that sea transport will also have to change. But how? Electric propulsion is far from reality for large(r) vessels, but mooring can be done electric. LNG is regarded as a transition fuel by some [17] as is it a gas with 25 times higher global warming potential than CO_2, although it could help to reduce local air pollution from combustion of the cheaper HFO, in particular in coastal areas. Use of LNG in freight transport competes with other applications, in particular in industry and households, which may create scarcity and higher prices, however. Fleet renewal is also slow, which influences the pace of transition. Ports play a vital role in marine transport. Especially the larger ports, such as Rotterdam in the Netherlands, may have large refueling and refinery facilities. A reduction in the use of fossil fuels may not be in their interest, unless they specialised in non-fossil fuels or develop new activities.

Economics

In (business-)economics there is always a tendency to focus on the short-term. Climate change mitigation is a long-term process, hence a different perspective on costs and benefits is needed. It may be needed to forgo some short-term profit in order to not only survive as a human race, but also reduce the accelerating damage to the environment in the longer term. Investments in fossil fuel infrastructure and vehicles have to be written off faster than key stakeholders would like to see. Yet, the alternative(s) may have a lower Total Cost of Ownership (TCO), which may help to reduce the perils of change substantially. As always there are first mover costs and benefits. Those who change early, may reap the benefits and forgo the higher cost of repairing the damages of climate change [18-20]. This holds for investments in vehicle technology, fuel production and distribution.

Policy-agenda

The key role of policymakers should be as follows:

i. To change regulations to speed up the process of climate change adaptation.

ii. To adapt technical standard to allow the use of new fuels in all transport applications.

iii. To create a level playing by removing market distorting elements, like hidden subsidies for fossil fuels or subsidies for non-profitable alternative fuels.

iv. To change government purchasing policies towards non-fossil fuel vehicles and infrastructure.

v. To stimulate producers and distributors of fossil fuels to diversify. Their efficient infrastructure could be put to dual use.

vi. To stimulate smart logistics and smart spatial planning in urban and rural areas.

Conclusion and Recommendations

From this brief exploration, it becomes apparent that society should, but also can adapt to the new reality. By gradually reducing the need to use fossil fuels in transport, the economic impact of change can be mitigated. The earlier mentioned 25% rise in fossil fuel consumption and the rise in (CO_2) emissions can than hopefully be prevented.

References

1. US EIA (2016) International Energy Outlook, New York, USA.
2. (2015) International Transport Forum/OECD. The carbon footprint of global trade, tackling emissions form international freight transport, Paris, France.
3. (2022) In the USA, freight transport is responsible for resp. 50% and 20% of the total emissions of NO_x and PM. An, Freight transport matters to supply chain sustainability.
4. Green S (2022) Freight transportation.
5. Ibid [3].
6. Hesse M, Rodrigue JP (2004) The transport geography of logistics and freight distribution. Journal of Transport Geography 12(3): 171-184.
7. (2022) A small cuts in air traffic would level off global heating caused by flying – study.
8. NASA (2022) Earth's Tipping Points: How Close Are We?
9. UNCC (2022) The Paris Agreement.
10. IMO (2018) Initial IMO Strategy on Reduction of GHG Emissions from Ships.
11. World Energy Council (2011) Global Transport Scenarios 2050, London, United Kingdom.
12. America's Energy Future Panel on Energy Efficiency Technologies. Real progress for energy efficiency in the United States, The National Academy Press, USA.
13. Ibid [7].

14. Monaghan J (2020) Reducing carbon emissions – A strategy for the logistics industry.

15. Siemens Mobility, eHighway – Electrification of road freight transport.

16. Petrou EA, Pappis CP (2009) Biofuels: A survey of pros and cons. Energy and Fuels 1009(23): 1055-1066.

17. Abassov F (2022) LNG remains a dead end for decarbonizing maritime transport.

18. (2022) Eurostat, Freight transport statistics.

19. Mazareanu E (2022) U S freight movement mode share in 2018.

20. (2022) An CO_2 emission for shipping goods.