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**Research Report**

## Alternative fuels in road freight transport: Objectives and scope of a literature review

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# Alternative fuels in road freight transport: Objectives and scope of a literature review

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## Abstract

This literature review investigates alternative solutions to fossil fuels in the context of road freight transport, focusing on both ecological and economic perspectives. A rigorous bibliographic methodology was employed to ensure the relevance and quality of the selected studies. The research process was structured through a systematic, multi-step decision-making approach, which included selecting the most appropriate research platform, identifying a relevant keyword combination, and deciding whether to search for keywords in abstracts only or across the entire text. Through this process, 157 scientific publications were identified as relevant for further analysis. The present document focuses on the methodology used to collect, select, and classify the relevant literature.

## Keywords

Literature review, Alternative fuels, Road freight transport

## 1. Introduction

The use of fossil fuels as an energy source for transport has long been predominant due to their performance and energy efficiency characteristics. However, the combustion of these fuels is associated with high levels of pollutant emissions such as nitrogen oxides, carbon oxides, and fine particles (NO<sub>x</sub>, CO, CO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>), which significantly contribute to air pollution, global warming, and public health issues (Pietrzak and Pietrzak, 2020; Zhang et al., 2022). Faced with growing environmental and health concerns, it becomes imperative to seek and adopt alternative solutions that can offer comparable performance while minimizing negative environmental impacts. Among the explored alternatives are electric vehicles, biofuels, hydrogen, and hybrid technologies. Each of these alternatives offers specific advantages and unique challenges in terms of performance, cost, and long-term viability. The main objective of this literature review is to highlight the research that has been conducted in this field.

### 1.1. Purpose of the literature review — research question

This literature review on alternative solutions to fossil fuels focuses on the analysis of drivetrain technologies in road freight transport. The analysis addresses both the economic and ecological aspects of alternative solutions. It is thus essential to evaluate not only the economic viability of these technologies — in terms of total cost of ownership (TCO) and life cycle profitability — but also their environmental impact, notably through life cycle assessments (LCA). These two dimensions enable a comprehensive understanding and comparison of the benefits and challenges associated with each alternative compared to conventional diesel.

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Modes of transport such as pipeline, air, rail, maritime, or river transport are excluded from this study. Indeed, the focus is limited to technologies applicable to road vehicles, which are currently the most impacted by debates and policies on energy transition. It should also be noted that road transport will be limited to the carriage of goods (road haulage).

## **1.2. State of the art**

In the field of alternative solutions to fossil fuels, several literature reviews have already been conducted, each offering valuable but limited perspectives due to certain methodological and thematic aspects.

For instance, the review by Contestabile et al. (2011) focuses primarily on light vehicles in Europe and the United States, using techno-economic models like LBST and ANL GREET to compare technologies such as hybrid electric vehicles, plug-in hybrid vehicles, battery electric vehicles, and fuel cell vehicles. Although this review provides a detailed analysis of existing technologies, it is limited to a few reference studies and does not account for all vehicle types. Indeed, medium-duty vehicles and heavy-duty vehicles are entirely absent. This limitation reduces the scope of conclusions regarding the applicability of these alternative solutions in freight transport.

Sen, Ercan and Tatari (2017) adopt an LCA-approach to evaluate emissions and energy consumption of light, medium, and heavy vehicles in developed areas, mainly in the United States. Their work, which encompasses a set of 31 studies, stands out for its in-depth environmental analysis but fails to address economic aspects and lacks a comprehensive examination of the specific challenges faced by developing regions. Thus, caution must be exercised in generalizing conclusions.

Zhang et al.'s (2022) literature review focuses exclusively on the electrification of heavy-duty trucks in various regions of the world, analyzing costs and emissions. Although this review provides critical insights into technologies used for some heavy-duty vehicles, it neglects other market segments, such as light- and medium-duty freight vehicles, which may prevent a comprehensive overview of fossil fuel alternatives or lead to a biased one.

Faced with these limitations, this literature review stands out by its breadth and depth. Covering 157 scientific publications, it encompasses a wide and diverse range of fuel technologies, transport types, and vehicles in various geographic contexts, including both developed and emerging regions. Moreover, this review includes not only ecological analyses but also economic analyses, relying on various methods such as TCO (Pihlatie et al. 2023), LCA (Haugen et al. 2021, Zhao/Tatari 2015), simulation (Pihlatie et al. 2023, Teichert et al. 2023, Zhao/Tatari 2015), WTW-Analysis (Liu et al. 2020), and mathematical optimization (Castillo/Álvarez 2023, De La Peña et al. 2020, Romejko/Nakano 2017, Sen et al. 2019, Wang et al. 2023). This analysis integrates both retrospective and prospective studies to understand the evolution of technologies and policies related to alternative solutions while identifying emerging trends that could sustainably transform the sector. This literature review also encompasses studies modeling scenarios related to charging conditions, energy prices, and vehicle mileage. This more comprehensive and diversified approach provides more robust guidance for policymakers, researchers, and practitioners in their search for sustainable and efficient solutions to replace fossil fuels in freight transport.

## **2. Procedure for bibliographic research**

The effectiveness of literature research relies on a rigorous and well-defined methodology. This section details the strategies and criteria used in this study to collect and select relevant publications in the field of alternative fuels.

### **2.1. Search criteria**

The search criteria refer to the pre-established principles and conditions that guide data collection during a literature review. Defining these criteria is essential to structure the research systematically and ensure the relevance and reliability of the information gathered. The criteria to be defined for this literature review include the selection of information sources, the choice of keywords, and exclusion criteria.

#### **2.1.1. Selection of information sources**

The selection of information sources involves determining where and how data will be collected. This is a crucial step that directly influences the quality and relevance of the literature review's results.

To ensure comprehensive coverage of available academic work, three research platforms were considered, each offering unique characteristics that could influence the coverage and depth of the research: EBSCO Discovery Service (EDS), EBSCOhost, and Web of Science (WoS). These platforms are widely used in academic circles, libraries, schools, and by professionals to access quality resources in various disciplines.

The next sections provide an overview of the advantages and limitations of each research platform. It should be noted that keyword searches and the application of various filters, such as restricting by date or type of text to refine results, are not discussed here, as these features are available in all three research platforms.

- **EBSCO Discovery Service**

EDS is ideal for preliminary or exhaustive searches because it provides a broad and diversified overview of available resources on a given topic. A single search interface allows access to a wide range of resources, simplifying the search for users who do not need to navigate between different databases. However, the large volume of results generated by EDS can sometimes be overwhelming and may require more meticulous evaluation to isolate the most relevant documents.

- **EBSCOhost**

EBSCOhost's specialized databases are particularly useful for in-depth searches in specific fields. However, unlike EDS, the search in EBSCOhost does not automatically extend to non-EBSCO databases, which may require additional searches in other resources for a comprehensive view. While the platform is designed to be intuitive and easy to use, users must pre-select specific databases to query, requiring some knowledge or familiarity with available resources.

- **Web of Science**

WoS is known for its regularly updated information from verified sources, ensuring high data reliability. It is recognized for its precision and the quality of its content, often serving as a reference for academic evaluations and measuring the impact of research. Key indicators, such as the journal's impact factor and other metrics, help assess the quality and influence of published research. While highly

functional, the interface can be perceived as complex by new users, requiring some time to fully exploit the platform's capabilities.

	Advantages	Limitations
WoS <sup>3</sup>	<ul style="list-style-type: none"> <li>- Data integrity</li> <li>- Authority and precision</li> </ul>	<ul style="list-style-type: none"> <li>- Interface complexity</li> </ul>
EBSCOhost <sup>4</sup>	<ul style="list-style-type: none"> <li>- Specialization</li> </ul>	<ul style="list-style-type: none"> <li>- Limited access to non-EBSCO databases</li> <li>- Pre-selection required</li> </ul>
EDS <sup>5</sup>	<ul style="list-style-type: none"> <li>- Completeness</li> <li>- Simplicity</li> </ul>	<ul style="list-style-type: none"> <li>- Information overload</li> </ul>

Table 1: Advantages and limitations of the research platforms

Table 1 provides a summary of the advantages and limitations of each research platform. Given the specific characteristics of each research platform, it is clear that the results obtained for a study can vary significantly depending on the chosen research platform. This is due to several fundamental factors, such as source coverage, search algorithms, and the frequency of updates. Indeed, each research platform has a unique set of indexed journals, books, conferences, and other resources, determined by licensing agreements and editorial choices. Additionally, databases that are frequently updated can provide more current information.

Thus, the choice of search platform is a decisive first criterion that must be carefully considered to align research tools with the study's needs. This will directly influence the quality, coverage, and efficiency of the bibliographic search.

### 2.1.2. Choice of keywords

Keywords are used to target searches within databases. Identifying keyword combinations is essential for filtering results relevant to the subject under study.

For this literature review, which aims to explore alternative solutions to fossil fuels in transport, a systematic method of combining keyword sets was implemented. This method allows for a focused examination of the ecological and economic impacts of alternative propulsion technologies while covering the two main transport domains: freight and passenger transport. Notably, including keywords related to passenger transport helps ensure that no potentially useful studies are excluded due to overly strict categorization. For example, this approach can capture studies that primarily focus on passenger transport but also include relevant sections or analyses related to freight transport. Similarly, the inclusion of both ecological and economic aspects will be evaluated to ensure they contribute meaningfully to the research objective. Adjustments to keyword combinations may be made depending on the relevance and quality of the results retrieved.

Thus, six different combinations of five keyword sets were prepared to optimize the search. The following shows how the combinations were formulated:

<sup>3</sup> <https://www.webofscience.com/wos/allldb/advanced-search>

<sup>4</sup> <https://research.ebsco.com/c/jpkfed/search/advanced/filters?autocorrect=n>

<sup>5</sup> <https://research.ebsco.com/c/6az4lk/search/advanced/filters?autocorrect=n>

Keyword sets used:

- Set  $E_1$  : "Alternative Drives" — Includes terms related to various alternative propulsion technologies.
- Set  $E_2$  : "Economic aspect" — Focuses the analysis on the economic impacts of propulsion technologies.
- Set  $E_3$  : "Ecological aspect" — Focuses the analysis on the ecological impacts of propulsion technologies.
- Set  $E_4$  : "Freight Transport" — Specifies freight transport as the application domain.
- Set  $E_5$  : "Passenger Transport" — Specifies passenger transport as the application domain.

Each set is defined by a group of keywords, as listed in Table 7 (see Appendix).

Keyword set combinations defined for the search:

- Combination  $C_1$  :  $E_1$  AND  $E_2$  AND  $E_4$  — Focused on the economic analysis of freight transport
- Combination  $C_2$  :  $E_1$  AND  $E_3$  AND  $E_4$  — Focused on the ecological analysis of freight transport
- Combination  $C_3$  :  $E_1$  AND  $E_2$  AND  $E_3$  AND  $E_4$  — Targeting studies that address both economic and ecological aspects of freight transport
- Combination  $C_4$  :  $E_1$  AND  $E_2$  AND ( $E_4$  OR  $E_5$ ) — Focused on the economic analysis of freight and/or passenger transport
- Combination  $C_5$  :  $E_1$  AND  $E_3$  AND ( $E_4$  OR  $E_5$ ) — Focused on the ecological analysis of freight and/or passenger transport
- Combination  $C_6$  :  $E_1$  AND  $E_2$  AND  $E_3$  AND ( $E_4$  OR  $E_5$ ) — Targeting studies that address both economic and ecological aspects of freight and/or passenger transport.

The systematic inclusion of Set  $E_1$  in all combinations reflects the central importance of alternative propulsion technologies in the study, emphasizing the primary goal of understanding and evaluating their viability and impact in the transport sector.

While several combinations are applied to explore the use of alternative propulsion technologies from different angles, only one combination will subsequently be selected to ensure the study's relevance and research results.

### 2.1.3. Exclusion criteria

The exclusion criteria are based on concrete aspects to determine, as the name suggests, which studies or data will be excluded from the research and, by extension, which studies or data will be included. Thus, several limits have been set to refine the search.

- Language: Publications in English were prioritized to ensure a uniform understanding and access to a broad scientific database. However, publications in German were not excluded.
- Year of publication: Only studies published after 2000 were considered to ensure the currency of the technologies and data.
- Peer review: Only peer-reviewed articles were included to ensure the credibility of the information.



Thus, the results utilized in the subsequent sections of this document are restricted by the above criteria. In addition to these three exclusion criteria, one criterion remains to be determined. The decision on whether to include studies based solely on keyword representation in the abstract or in the full text is still to be made.

In summary, three major choices, which will directly influence the quality and scope of the literature review, must be made to effectively structure the bibliographic research. These include selecting the research platform, choosing the keyword set combination, and deciding whether to search for keywords in abstracts only or in the full text.

## 2.2. A multi-step decision-making approach

In this literature review, a methodical, multi-step decision-making approach is adopted to refine the different research criteria. Through a series of four queries, each with different combinations of criteria, the process of selecting sources is gradually optimized.

### 2.2.1. The first query

This first query aims to provide an initial overview of the results from the different databases and can serve to narrow the selection. Initially, all three research platforms (EDS, EBSCOhost, and WoS) are exploited, and all keyword set combinations are tested. In the first instance, full texts are targeted. Then, in the second instance, only abstracts of the documents are analyzed. Table 2 provides the number of search results for each search platform from this query.

	WoS		EBSCOhost		EDS	
Combination	Full text	Abstract	Full text	Abstract	Full text	Abstract
$C_1$	718	263	237	14	8805	20
$C_2$	1933	727	884	41	6771	71
$C_3$	442	132	87	2	787	4
$C_4$	2311	821	4702	245	374140	482
$C_5$	5845	1693	12506	524	5910	1060
$C_6$	1304	363	1054	47	1971	62

Table 2: Number of results retrieved from the first query

For each keyword set combination, the smallest and the highest number of search results among the three research platforms are highlighted in Table 3. The green cells indicate values obtained from WoS, the yellow cells correspond to EBSCOhost, and the blue cells represent EDS. The predominance of EBSCOhost in the smallest results reflects the specialization of its databases, as stated in section 2.1.1.

	Smallest number		Highest number	
Combination	Full text	Abstract	Full text	Abstract
$C_1$	237	14	8805	263
$C_2$	884	41	6771	727
$C_3$	87	2	787	132
$C_4$	2311	245	374140	821
$C_5$	5845	524	12506	1693
$C_6$	1054	47	1971	363

Table 3: Lowest and highest number of search results across the three platforms

Except for combination  $C_5$ , EDS provides the highest number of results when full texts are analyzed. However, this changes when only document abstracts are considered (WoS dominates in this case). Therefore, it is reasonable to question the relevance of results from this research platform. Indeed, a specific search term can sometimes be located in the bibliography or footnotes and still be indexed by the platform's search engine. However, this does not necessarily mean the subject is thoroughly discussed in the text itself. As a result, articles may appear in search results despite not offering substantive discussion on the topic in question. This phenomenon is reflected here by a very low ratio – apart from combination  $C_5$  - between the number of results based on abstracts and those based on full texts (see Table 4). Due to the risk of irrelevant results, EDS was excluded from the platforms used for future searches. From now on, queries will be performed only on the other two research platforms.

Combination	WoS	EBSCOhost	EDS
$C_1$	36,6%	5,9%	0,2%
$C_2$	37,6%	4,6%	1,0%
$C_3$	29,9%	2,3%	0,5%
$C_4$	35,5%	5,2%	0,1%
$C_5$	29,0%	4,2%	17,9%
$C_6$	27,8%	4,5%	3,1%

Table 4: Ratio of results retrieved from abstract searches versus full-text searches

### 2.2.2. The second query

This step aims to define the appropriate research platform for further research. For this second query, only EBSCOhost and WoS were used. Combination  $C_3$  is the subject of the search extended to full texts. This keyword combination was selected because it yielded a relatively low and manageable number of results across platforms, making it suitable for manual evaluation. Additionally, it includes

a balanced representation of ecological and economic terms, aligned with the objectives of this review.

The evaluation conducted here is based solely on document titles, in accordance with the relevance criteria defined earlier (see section 1.1). While this method provides only a preliminary estimate of relevance, it is justified by practical constraints — including the high volume of results, limited access to abstracts or full texts in some cases, and the exploratory nature of this step. This approach facilitates an initial comparison of platform performance and keyword relevance, with the expectation that more in-depth analysis involving abstracts or full texts will follow.

Query results:

- EBSCOhost: 87 documents retrieved, of which 16 were deemed relevant (18.4%)
- WoS: 442 documents retrieved, of which 139 were deemed relevant (31.4%)

WoS stands out not only for its larger number of documents but also for a significantly higher proportion of relevant documents compared to EBSCOhost.

Opting for EBSCOhost over WoS dramatically reduces the number of relevant documents, from 139 to 16. This significant reduction highlights the clear loss of relevant documents. However, among these 16 relevant documents, only six are found in WoS results, raising the question of whether to maintain searches on both research platforms.

A higher number of results does not necessarily imply more relevant documents but inevitably lengthens the analysis time. To quickly assess whether this extra effort is justified, a specific formula was developed:

- A document not found in the results of the other search platform and deemed irrelevant receives a value of -1.
- A document also found in the results of the other search platform receives a value of 0.
- A document not found in the results of the other search platform and deemed relevant receives a value of +1.
- These values are then added to obtain a total score, which is ultimately divided by the total number of examined results.
- Thus, the final score can vary between -1 and 1. A score close to -1 suggests that the extra effort is not worthwhile, while a score close to 1 indicates the opposite, justifying the additional effort.

After applying this formula to EBSCOhost results, the score obtained is -0.70. The extra effort is thus perceived as largely unnecessary. For this reason, WoS was chosen as the sole research platform for the remainder of the study.

### **2.2.3. The third query**

This query aims to determine the keyword set combination that will provide the most appropriate results for this study.

The results from WoS seem at first sight to reveal a predominance of studies focusing on the ecological aspect compared with the economic aspect. Indeed, depending on the part of the text studied and whether passenger transport is included or not, articles resulting from a combination of keywords with an ecological perspective account for between 67.3% and 73.4% of the articles considered in each case, while those based on an economic perspective represent only 26.6% to 32.7% (see Table 5).

	Including passenger transport		Not including passenger transport	
	Ecological perspective	Economic perspective	Ecological perspective	Economic perspective
Full text	71.7%	28.3%	72.9%	27.1%
Abstract	67.3%	32.7%	73.4%	26.6%

Table 5: Breakdown of the number of search results by perspective (whether or not including passenger transport)

Including passenger transport in the search significantly increases the number of results, revealing a stronger scientific focus on passenger transport compared to freight transport alone. Depending on whether the keywords are searched within the full text or just the abstract, the number of results increases by a factor ranging from 2.3 to 3.2 when passenger transport is included (see Table 6).

	Ecological perspective	Economic perspective	Both
Full text	3.0	3.2	3.0
Abstract	2.3	3.1	2.8

Table 6: Increase in the number of search results by including passenger transport

However, including such a large number of articles may hinder the ability to maintain a literature review focused specifically on freight transport. To preserve the overall coherence of the analysis and facilitate the synthesis of results, it is therefore necessary to exclude all keyword combinations that include Set  $E_5$ , which relates to passenger transport. At the same time, neither the economic nor the ecological dimension should be neglected in this study. As a result, a new keyword combination is proposed:

- Combination  $C_7 : E_1 \text{ AND } (E_2 \text{ OR } E_3) \text{ AND } E_4$  — Targeting studies related to the economic and/or ecological analysis of freight transport.

Compared to Combination  $C_3$ , which requires both economic and ecological terms to be present,  $C_7$  adopts a broader logic by allowing for the inclusion of studies focusing on either economic or ecological aspects (or both). This adjustment increases sensitivity by capturing studies that focus exclusively on one dimension (economic or ecological), while still remaining within the thematic scope of freight transport analysis.

This query returned a total of 2,209 documents, illustrating the broader reach of this combination while maintaining relevance to the research focus.

#### **2.2.4. The fourth query**

A final query was conducted using WoS, this time analyzing abstracts only. The same keyword combination as in the second query – namely  $C_3$  – was used to ensure a consistent basis for comparison between full-text and abstract-level searches. Using a different combination, such as  $C_7$ , would have introduced bias, making it difficult to isolate the effect of the section analyzed.

Finally, a last query was conducted using WoS for the same keyword combination as in the second query, that is  $C_3$ , but this time only the abstracts were analyzed. The objective was to determine the part of the text to analyze for this literature review.

Reminder of the second query result ( $C_3$  with full text):

- WoS: 442 documents retrieved, of which 139 were deemed relevant (31.4%)

Result of this fourth query ( $C_3$  with abstracts only):

- WoS: 132 documents retrieved, of which 45 were deemed relevant (34.1%)

Although the relevance rate of documents is slightly higher for this latest query, the results clearly indicate that analyses based solely on abstracts omit important documents. Indeed, 67.6% of the relevant documents identified in the query using full texts were absent from the results obtained with abstracts only. For this reason, although more time-consuming (due to the larger number of documents to analyze), the decision was made to proceed with a full-text review for the literature study.

In summary, this multi-step decision-making approach allowed for the determination of three major choices to structure the bibliographic research effectively. Thus, the WoS search platform was selected, as well as the keyword set combination  $C_7 : E_1 \text{ AND } (E_2 \text{ OR } E_3) \text{ AND } E_4$ . Finally, the decision was made to conduct keyword searches within the full text of the documents.

### **3. Literature assessment**

Following the definition of all research criteria, the next step consists in conducting the literature assessment to build a solid knowledge base and guide future research. This phase begins with an evaluation of the results to identify the most relevant documents according to the research objectives. The selected documents are then classified according to precise criteria, enabling clear organization and effective comparison of the information.

#### **3.1. Evaluation of result**

When conducting a search in a vast research platform like WoS, it is common to end up with a large volume of results. To better manage this abundance of information and reduce "noise" — i.e., the presence of irrelevant documents — the exclusion of categories not essential to the research objectives is crucial. This allows for the extraction of the most relevant documents before moving on to the next step, which is their classification.

It is worth noting that WoS offers a detailed classification system that categorizes scientific publications into specific fields, allowing for further refinement of results through targeted filters. For this study on alternative solutions to fossil fuels, it is essential to retain categories such as “Environmental Sciences & Ecology”, “Energy & Fuels”, “Science & Technology - Other Topics”, “Transportation”, and “Business & Economics”. However, since the study specifically focuses on the ecological and economic aspects of the transition, documents classified under "Engineering" can be excluded, reducing the initial number of 2,209 documents (result for  $C_7$  and full text) to 1,814 documents.

After a careful evaluation based on the titles and abstracts of the articles, 297 documents were considered potentially relevant. A more in-depth reading of key paragraphs from these documents allowed the focus to be narrowed further to road freight transport. As a result, 140 documents were excluded because they focused exclusively on passenger transport, despite the use of a keyword combination targeting only freight transport. An overview of this stepwise filtering process is illustrated in Figure 1. In total, 157 documents were selected for the second phase of the literature assessment, which involves classification. The complete list of these documents is available in Table 8 (see Appendix).

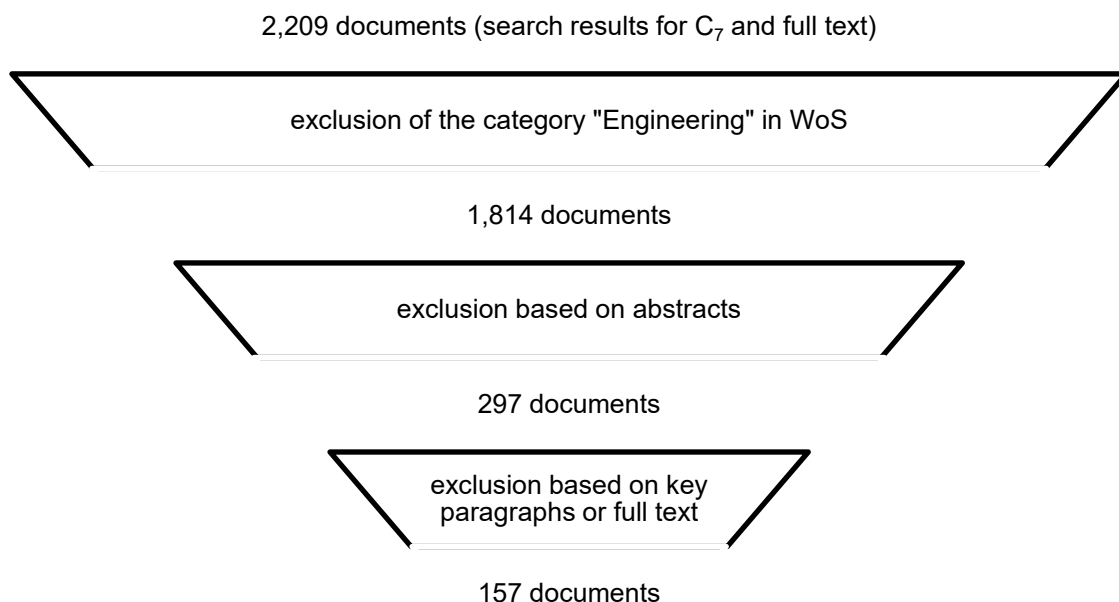


Figure 1: Stepwise filtering of retrieved documents

### 3.2. Classification

Each of the 157 documents was categorized according to the following criteria:

- Title, Authors, Journal or review, Year of publication: These fundamental data provide a quick overview of the source and the time period of the study.
- Geography: Documents are classified by geographic regions, including Africa, Oceania, Asia, America, and the European Union + United Kingdom.

- Perspective: Each study is analyzed to determine whether it addressed ecological, economic, or both issues.
- Scenario focus: Table 9 (see Appendix) groups the various scenarios identified during the analysis of the studies. Note that simply considering different fuels is not retained as a scenario since it is the core subject of the study.
- Transport type: A distinction is made between studies dedicated exclusively to freight transport and those that also cover passenger transport (see section 2.1.2).
- Vehicle type: Table 10 (see Appendix) lists the groups of vehicle types.
- Drivetrain technology and Fuel: Table 11 (see Appendix) summarizes the different vehicle propulsion technologies. In addition, Table 12 (see Appendix) shows the types of fuels studied.
- Study type: A distinction is made between retrospective and prospective studies.

This classification can serve as a foundation for subsequent statistical analysis aimed at identifying current trends and research gaps in alternative fuels for road freight transport. However, such an analysis falls outside the scope of this document.

#### **4. Conclusion**

This paper provides a detailed presentation of the methodology used to conduct a systematic bibliographic search and select relevant studies on alternative solutions to fossil fuels for road freight transport. The selection process was conducted in several stages, including the choice of the WoS research platform, the definition of a keyword combination covering both economic and ecological aspects with an exclusive focus on freight transport, and the decision to perform the search within the full text of the documents. The final corpus consists of 157 scientific publications, carefully selected for their relevance to the research objectives.

Additionally, a detailed classification framework was developed to categorize the selected articles based on geography, perspective (ecological, economic, or both), scenario focus, transport and vehicle type, drivetrain technology, and study type. These classification criteria provide the foundation for future statistical analysis.

#### **Bibliography**

- Bezergianni, S. and Dimitriadis, A. (2013) "Comparison between different types of renewable diesel", *Renewable and Sustainable Energy Reviews*, 21, 110-116.
- Contestabile, M. et al. (2011) "Battery electric vehicles, hydrogen fuel cells and biofuels. Which will be the winner?", *Energy & Environmental Science*, 4(10), 3754. <https://doi.org/10.1039/c1ee01804c>.
- European Union (2023) "Commission Delegated Regulation (EU) 2023/1640 of 5 June 2023 on the methodology to determine the share of biofuel and biogas for transport, produced from biomass being processed with fossil fuels in a common process", *Official Journal of the European Union*, L 205, 18.8.2023, 1-6.
- IEA (2020) "Outlook for biogas and biomethane: Prospects for organic growth", [online] Retrieved June 4, 2025, from <https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth/an-introduction-to-biogas-and-biomethane>.

- Pietrzak, K. and Pietrzak, O. (2020) "Environmental Effects of Electromobility in a Sustainable Urban Public Transport", *Sustainability*, 12(3), 1052. <https://doi.org/10.3390/su12031052>.
- Sen, B., Ercan, T. and Tatari, O. (2017) "Does a battery-electric truck make a difference? – Life cycle emissions, costs, and externality analysis of alternative fuel-powered Class 8 heavy-duty trucks in the United States", *Journal of Cleaner Production*, 141, pp. 110–121. <https://doi.org/10.1016/j.jclepro.2016.09.046>.
- U.S. Energy Information Administration (2024) "Biofuels explained: Biodiesel, renewable diesel and other biofuels", [online] Retrieved June 4, 2025, from <https://www.eia.gov/energyexplained/biofuels/biodiesel-rd-other-basics.php>
- Zhang, X. et al. (2022) "Techno-economic comparison of electrification for heavy-duty trucks in China by 2040", *Transportation Research Part D Transport and Environment*, 102, p. 103152. <https://doi.org/10.1016/j.trd.2021.103152>.

## Appendix

Alternative drives (Set $E_1$ )	"Autogas*" OR "LPG" OR "CNG" OR "natural gas*" OR "fuel cell" OR "diesel" OR "electr*" OR "battery" OR "internal combustion engine*" OR "hydrogen*" OR "alternative drives" OR "alternative propulsion" OR "biofuel" OR "biogas*" OR "Elektr*" OR "Wasserstoff*" OR "Hybrid*" OR "Autogaz" OR "Erdgas*" OR "Bioethanol" OR "Biodiesel" OR "Kraftstoff*" OR "Brennstoffzelle*" OR "Batterie*" OR "alternative Antriebe"
Economic aspect (Set $E_2$ )	"total cost of ownership" OR "TCO" OR "life cycle cost*" OR "operational lifetime costs" OR "LCC" OR "Gesamtbetriebskosten" OR "gesamte Betriebskosten" OR "Gesamtkosten des Betriebs" OR "Lebenszykluskosten*"
Ecological aspect (Set $E_3$ )	"life cycle assessment" OR "life cycle analysis" OR "sustainability assessment" OR "carbon footprint" OR "cradle-to-grave analysis" OR "LCA" OR "Ökobilanz" OR "Umweltbilanz" OR "Lebenszyklusanalyse" OR "CO2-Fußabdruck"
Goods transport (Set $E_4$ )	"ground transport*" OR "land transport*" OR "transport by road" OR "road traffic" OR "heavy goods vehicles" OR "HGV" OR "road freight" OR "road carriage" OR "road haulage" OR "trucking" OR "truck transport" OR "Straßenfracht" OR "Straßengüterverkehr*" OR "Lkw-Transport"
Passenger transport (Set $E_5$ )	"passenger transport*" OR "public transport*" OR "mass transit" OR "passenger car*" OR "Bus*" OR "Personentransport*" OR "öffentlicher Verkehr" OR "Massenverkehrsmittel" OR "ÖPNV"

Table 7: Keyword set



Author(s), Year of publication, Title
<ul style="list-style-type: none"> <li>• Ahluwalia, R.K. et al. (2022) "Performance and total cost of ownership of a fuel cell hybrid mining truck"</li> <li>• Allwright, J. et al. (2022) "Heavy Multi-Articulated Vehicles with Electric and Hybrid Power Trains for Road Freight Activity: An Australian Context"</li> <li>• Alonso-Villar, A. et al. (2022) "Technical, economic, and environmental feasibility of alternative fuel heavy-duty vehicles in Iceland"</li> <li>• Anselma, P.G. and Belingardi, G. (2022) "Fuel cell electrified propulsion systems for long-haul heavy-duty trucks: present and future cost-oriented sizing"</li> <li>• Antonini, C. et al. (2021) "Hydrogen from wood gasification with CCS – a techno-environmental analysis of production and use as transport fuel"</li> <li>• Arteconi, A. et al. (2010) "Life-cycle greenhouse gas analysis of LNG as a heavy vehicle fuel in Europe"</li> <li>• Arvidsson, R. et al. (2011) "Life cycle assessment of hydrotreated vegetable oil from rape, oil palm and Jatropha"</li> <li>• Atkins, P. et al. (2021) "A Local Ecosystem Assessment of the Potential for Net Negative Heavy-Duty Truck Greenhouse Gas Emissions through Biomethane Upcycling"</li> <li>• Bachmann, C. et al. (2015) "Life-Cycle Assessment of Diesel-Electric hybrid and conventional diesel trucks for deliveries"</li> <li>• Balboa-Espinoza, V. et al. (2023) "Comparative life cycle assessment of battery-electric and diesel underground mining trucks"</li> <li>• Baral, N.R. et al. (2021) "Biomass feedstock transport using fuel cell and battery electric trucks improves lifecycle metrics of biofuel sustainability and economy"</li> <li>• Bidart, C. et al. (2022) "Biogas catalytic methanation for biomethane production as fuel in freight transport - A carbon footprint assessment"</li> <li>• Booto, G.K., Espegren, K.A. and Hancke, R. (2021) "Comparative life cycle assessment of heavy-duty drivetrains: A Norwegian study case"</li> <li>• Brand, C., Tran, M. and Anable, J. (2012) "The UK transport carbon model: An integrated life cycle approach to explore low carbon futures"</li> <li>• Brynolf, S. et al. (2022) "Review of electrofuel feasibility—prospects for road, ocean, and air transport"</li> <li>• Burke, A.F. et al. (2023) "Projections of the costs of medium- and heavy-duty battery-electric and fuel cell vehicles (2020-2040) and related economic issues"</li> <li>• Cabrera-Jiménez, R. et al. (2023) "Microalgae Biofuel for a Heavy-Duty Transport Sector within Planetary Boundaries"</li> <li>• Carlsson, F. and Johansson-Stenman, O. (2003) "Costs and benefits of electric Vehicles A 2010 perspective"</li> <li>• Casolari, B.L. et al. (2014) "Model study of a fuel cell range extender for a neighborhood electric vehicle (NEV)"</li> <li>• Castillo, O. and Álvarez, R. (2023) "Electrification of Last-Mile Delivery: A Fleet Management Approach with a Sustainability Perspective"</li> <li>• Charalambous, M.A. et al. (2023) "Absolute environmental sustainability assessment of renewable dimethyl ether fuelled heavy-duty trucks"</li> <li>• Cooper, J., Hawkes, A. and Balcombe, P. (2019) "Life cycle environmental impacts of natural gas drivetrains used in UK road freighting and impacts to UK emission targets"</li> <li>• De La Peña, A.G. et al. (2020) "Projecting adoption of truck powertrain technologies and CO2 emissions in line-haul networks"</li> </ul>

- Drawer, C., Rödl, A. and Kaltschmitt, M. (2024) "Life cycle assessment of construction and driving operation of a hydrogen-powered truck built from a used diesel truck"
- Esteban, B. et al. (2011) "Is it environmentally advantageous to use vegetable oil directly as biofuel instead of converting it to biodiesel?"
- Feng, Y. and Dong, Z. (2023) "Comparative lifecycle costs and emissions of electrified powertrains for light-duty logistics trucks"
- Gerbens-Leenes, W. and Holtz, K. (2020) "Consequences of transport Low-Carbon transitions and the carbon, land and water footprints of different fuel options in the Netherlands"
- Ghandriz, T. et al. (2020) "Optimization data on total cost of ownership for conventional and battery electric heavy vehicles driven by humans and by automated driving systems"
- Gialos, A. et al. (2022) "Calculation and assessment of CO<sub>2</sub>E emissions in road freight transportation: a Greek case study"
- Giordano, A., Fischbeck, P. and Matthews, H.S. (2018) "Environmental and economic comparison of diesel and battery electric delivery vans to inform city logistics fleet replacement strategies"
- González-García, S., García-Rey, D. and Hospido, A. (2012) "Environmental life cycle assessment for rapeseed-derived biodiesel"
- Gray, N. et al. (2022) "Batteries, fuel cells, or engines? A probabilistic economic and environmental assessment of electricity and electrofuels for heavy goods vehicles"
- Gunawan, T.A. and Monaghan, R.F.D. (2022) "Techno-econo-environmental comparisons of zero- and low-emission heavy-duty trucks"
- Guo, Y., Kelly, J.A. and Clinch, J.P. (2021) "Road transport electrification – Is timing everything? Implications of emissions analysis' outcomes for climate and air policy"
- Gustafsson, M. et al. (2021) "Well-to-wheel greenhouse gas emissions of heavy-duty transports: Influence of electricity carbon intensity"
- Haider, M., Davis, M. and Kumar, A. (2024) "Development of a framework to assess the greenhouse gas mitigation potential from the adoption of low-carbon road vehicles in a hydrocarbon-rich region"
- Hanesch, S. et al. (2022) "Life Cycle Assessment of an emerging overhead line hybrid truck in short-haul pilot operation"
- Hannach, M.E. et al. (2019) "Life cycle assessment of hydrogen and diesel dual-fuel class 8 heavy duty trucks"
- Hao, X. et al. (2022) "Evaluating the current perceived cost of ownership for buses and trucks in China"
- Haugen, M.J. et al. (2021) "A fork in the road: Which energy pathway offers the greatest energy efficiency and CO<sub>2</sub> reduction potential for low-carbon vehicles?"
- He, L.-Y. and Chen, Y. (2013) "Thou shalt drive electric and hybrid vehicles: Scenario analysis on energy saving and emission mitigation for road transportation sector in China"
- He, X. et al. (2021) "Life-Cycle Greenhouse gas emission benefits of natural gas vehicles"
- Hoshing, V. et al. (2020) "Comparison of economic viability of series and parallel PHEVs for medium-duty truck and transit bus applications"
- Hovi, I.B. et al. (2019) "Experiences from Battery-Electric Truck Users in Norway"
- Huertas, J.I., Mogro, A.E. and Jiménez, J.P. (2022) "Configuration of Electric Vehicles for Specific Applications from a Holistic Perspective"
- Huo, H. et al. (2012) "Projection of energy use and greenhouse gas emissions by motor vehicles in China: Policy options and impacts"
- Iyer, R.K., Kelly, J.C. and Elgowainy, A. (2023) "Vehicle-cycle and life-cycle analysis of medium-duty and heavy-duty trucks in the United States"

- Jiang, Z. et al. (2022) "Impact assessment of crude oil mix, electricity generation mix, and vehicle technology on road freight emission reduction in China"
- Jones, J., Genovese, A. and Tob-Ogu, A. (2020) "Hydrogen vehicles in urban logistics: A total cost of ownership analysis and some policy implications"
- Keogh, N., Corr, D. and Monaghan, R.F.D. (2024) "An environmental and economic assessment for biomethane injection and natural gas heavy goods vehicles"
- Lajevardi, S.M., Axsen, J. and Crawford, C. (2019) "Comparing alternative heavy-duty drivetrains based on GHG emissions, ownership and abatement costs: Simulations of freight routes in British Columbia"
- Lal, A. et al. (2023) "Electrifying light commercial vehicles for last-mile deliveries: Environmental and economic perspectives"
- Langshaw, L. et al. (2020) "Environmental and economic analysis of liquefied natural gas (LNG) for heavy goods vehicles in the UK: A Well-to-Wheel and total cost of ownership evaluation"
- Lao, J. et al. (2023) "Research on atmospheric pollutant and greenhouse gas emission reductions of trucks by substituting fuel oil with green hydrogen: A case study"
- Lave, L. et al. (2000) "Life-Cycle Analysis of Alternative Automobile Fuel/Propulsion Technologies"
- Lebeau, P. et al. (2015) "Electrifying light commercial vehicles for city logistics? A total cost of ownership analysis"
- Lee, D.-Y. et al. (2018) "Life-cycle implications of hydrogen fuel cell electric vehicle technology for medium- and heavy-duty trucks"
- Lee, D.-Y. and Thomas, V.M. (2017) "Parametric modeling approach for economic and environmental life cycle assessment of medium-duty truck electrification"
- Lee, D.-Y., Thomas, V.M. and Brown, M.A. (2013) "Electric Urban Delivery Trucks: energy use, greenhouse gas emissions, and Cost-Effectiveness"
- Levkovych, O. and Saraceni, A. (2023) "Efficiency in the Last Mile of Autonomous Ground Vehicles with Lockers: From Conventional to Renewable Energy Transport"
- Li, J. et al. (2023) "Assessing the decarbonization potential of China's light-duty truck fleet by electrification"
- Li, Y. and Kimura, S. (2021) "Economic competitiveness and environmental implications of hydrogen energy and fuel cell electric vehicles in ASEAN countries: The current and future scenarios"
- Li, Y. and Taghizadeh-Hesary, F. (2022) "The economic feasibility of green hydrogen and fuel cell electric vehicles for road transport in China"
- Limb, B.J. et al. (2018) "Economic viability and environmental impact of In-Motion wireless power transfer"
- Liu, F. et al. (2018) "The impact of fuel cell vehicle deployment on road transport greenhouse gas emissions: The China case"
- Liu, F. et al. (2021) "Deployment of fuel cell vehicles in China: Greenhouse gas emission reductions from converting the heavy-duty truck fleet from diesel and natural gas to hydrogen"
- Liu, J. et al. (2021) "Synergistic air pollutants and GHG reduction effect of commercial vehicle electrification in Guangdong's public service sector"
- Liu, N. et al. (2019) "Evaluating national hydrogen refueling infrastructure requirement and economic competitiveness of fuel cell electric long-haul trucks"
- Liu, X. et al. (2020) "Well-to-Wheels analysis of Zero-Emission Plug-In battery electric vehicle technology for Medium- and Heavy-Duty trucks"
- Lyu, Z., Pons, D. and Zhang, Y. (2023) "Emissions and total cost of ownership for diesel and battery electric freight pickup and delivery trucks in New Zealand: implications for transition"
- Ma, X. et al. (2024) "Application of fuel cell and alternative fuel for the decarbonization of China's road freight sector towards carbon neutral"

- Ma, Y. et al. (2017) "The analysis of the battery electric vehicle's potentiality of environmental effect: A case study of Beijing from 2016 to 2020"
- Mareev, I., Becker, J. and Sauer, D. (2017) "Battery Dimensioning and life cycle costs analysis for a Heavy-Duty Truck considering the requirements of Long-Haul transportation"
- Mareev, I. and Sauer, D. (2018) "Energy consumption and life cycle costs of overhead catenary Heavy-Duty trucks for Long-Haul transportation"
- Martin, J., Neumann, A. and Ødegård, A. (2023) "Renewable hydrogen and synthetic fuels versus fossil fuels for trucking, shipping and aviation: A holistic cost model"
- Mauler, L. et al. (2022) "Cost-effective technology choice in a decarbonized and diversified long-haul truck transportation sector: A U.S. case study"
- Meinrenken, C.J. and Lackner, K.S. (2015) "Fleet view of electrified transportation reveals smaller potential to reduce GHG emissions"
- Middela, M.S. et al. (2022) "Complete LCA of battery electric and conventional fuel vehicles for freight trips"
- Moll, C. et al. (2020) "Are Battery-Electric trucks for 24-Hour delivery the future of City Logistics?—A German case study"
- Mu, Z. et al. (2024) "Evaluating Fuel Cell vs. Battery Electric Trucks: Economic Perspectives in Alignment with China's Carbon Neutrality Target"
- Navas-Anguila, Z. et al. (2020) "Prospective techno-economic and environmental assessment of a national hydrogen production mix for road transport"
- Noll, B. et al. (2022) "Analyzing the competitiveness of low-carbon drive-technologies in road-freight: A total cost of ownership analysis in Europe"
- Nouni et al. (2021) "Alternative fuels for decarbonisation of road transport sector in India: Options, present status, opportunities, and challenges"
- Oke, D. et al. (2023) "Energy, economic, and environmental impacts assessment of co-optimized on-road heavy-duty engines and bio-blendstocks"
- Osorio-Tejada, J.L., Llera-Sastresa, E. and Scarpellini, S. (2017) "A multi-criteria sustainability assessment for biodiesel and liquefied natural gas as alternative fuels in transport systems"
- Ou, X., Zhang, X. and Chang, S. (2010) "Scenario analysis on alternative fuel/vehicle for China's future road transport: Life-cycle energy demand and GHG emissions"
- Özlü, L. and Çelebi, D. (2024) "Electrifying Freight: Modeling the Decision-Making Process for battery electric truck procurement"
- Pérez, J. et al. (2017) "A methodology for estimating the carbon footprint of waste collection vehicles under different scenarios: Application to Madrid"
- Pihlatie, M. et al. (2023) "Zero-Emission truck powertrains for regional and Long-Haul missions"
- Ping, L. et al. (2022) "Cost–Benefit analysis of synergistic CO<sub>2</sub> and NO<sub>x</sub> Energy-Efficient technologies for the road transport sector in China"
- Qasim, M. and Csiszar, C. (2021) "Major barriers in adoption of electric trucks in logistics system"
- Qiu, Y., Dobbelaere, C. and Song, S. (2023) "Energy Cost Analysis and Operational Range Prediction Based on Medium- and Heavy-Duty Electric Vehicle Real-World Deployments across the United States"
- Rajagopal, D. et al. (2023) "Comparative evaluation of total cost of ownership of Battery-Electric and diesel trucks in India"
- Ramshankar, A.T. et al. (2023) "Sustainability analysis of overhead cable line powered freight trucks: a life cycle impact and techno-economic assessment toward transport electrification"
- Ravigné, E. and Da Costa, P. (2021) "Economic and environmental performances of natural gas for heavy trucks: A case study on the French automotive industry supply chain"
- Reis, J. (2019) "Implementing electric vehicles in public services: a case study research"

- Rial, M. and Pérez, J. (2021) "Environmental performance of four different heavy-duty propulsion technologies using Life Cycle Assessment"
- Richter, S. et al. (2024) "Evaluation of the applicability of synthetic fuels and their life cycle analyses"
- Romejko, K. and Nakano, M. (2017) "Portfolio analysis of alternative fuel vehicles considering technological advancement, energy security and policy"
- Rouhi, K., Motlagh, M.S. and Dalir, F. (2023) "Developing a carbon footprint model and environmental impact analysis of municipal solid waste transportation: A case study of Tehran, Iran"
- Rout, C. et al. (2022) "A comparative total cost of ownership analysis of heavy duty on-road and off-road vehicles powered by hydrogen, electricity, and diesel"
- Sacchi, R., Bauer, C. and Cox, B.L. (2021) "Does size matter? The influence of size, load factor, range autonomy, and application type on the life cycle assessment of current and future Medium- and Heavy-Duty vehicles"
- Samet, M.J. et al. (2024) "Levelized cost of driving for medium and heavy-duty battery electric trucks"
- Samet, M.J., Liimatainen, H. and Van Vliet, O.P.R. (2023) "GHG emission reduction potential of road freight transport by using battery electric trucks in Finland and Switzerland"
- Schmid, F. et al. (2021) "Electrification of waste collection vehicles: Technoeconomic analysis based on an energy demand simulation using Real-Life operational data"
- Schulte, J. and Ny, H. (2018) "Electric Road Systems: Strategic Stepping Stone on the Way towards Sustainable Freight Transport?"
- Scorrano, M., Danielis, R. and Giansoldati, M. (2021) "Electric light commercial vehicles for a cleaner urban goods distribution. Are they cost competitive?"
- Sen, B. et al. (2019) "Robust Pareto optimal approach to sustainable heavy-duty truck fleet composition"
- Sen, B., Ercan, T. and Tatari, O. (2017) "Does a battery-electric truck make a difference? – Life cycle emissions, costs, and externality analysis of alternative fuel-powered Class 8 heavy-duty trucks in the United States"
- Sengupta, S. and Cohan, D.S. (2017) "Fuel cycle emissions and life cycle costs of alternative fuel vehicle policy options for the City of Houston municipal fleet"
- Serrano-Guevara, O.S. et al. (2022) "Energy efficiency of Heavy-Duty vehicles in Mexico"
- Shafiei, E. et al. (2015) "Comparative analysis of hydrogen, biofuels and electricity transitional pathways to sustainable transport in a renewable-based energy system"
- Shahraeeni, M. et al. (2015) "Life cycle emissions and cost of transportation systems: Case study on diesel and natural gas for light duty trucks in municipal fleet operations"
- Shamsi, H. et al. (2021) "Health cost estimation of Traffic-Related air pollution and assessing the pollution reduction potential of Zero-Emission vehicles in Toronto, Canada"
- Shen, X. et al. (2018) "Real-world exhaust emissions and fuel consumption for diesel vehicles fueled by waste cooking oil biodiesel blends"
- Smit, R. et al. (2024) "Greenhouse Gas Emissions Performance of Electric, Hydrogen and Fossil-Fuelled Freight Trucks with Uncertainty Estimates Using a Probabilistic Life-Cycle Assessment (pLCA)"
- Soam, S. and Börjesson, P. (2020) "Considerations on potentials, greenhouse gas, and energy performance of biofuels based on forest residues for Heavy-Duty Road transport in Sweden"
- Soares, L. and Wang, H. (2021) "Economic feasibility analysis of charging infrastructure for electric ground fleet in airports"
- Song, H. et al. (2017) "Energy consumption and greenhouse gas emissions of diesel/LNG heavy-duty vehicle fleets in China based on a bottom-up model analysis"

- Speth, D. and Funke, S.Á. (2021) "Comparing Options to Electrify Heavy-Duty Vehicles: Findings of German pilot projects"
- Sripad, S. and Viswanathan, V. (2018) "Quantifying the economic case for electric Semi-Trucks"
- Sun, D., Zheng, Y. and Duan, R. (2021) "Energy consumption simulation and economic benefit analysis for urban electric commercial-vehicles"
- Sun, S. and Ertz, M. (2020) "Life cycle assessment and Monte Carlo simulation to evaluate the environmental impact of promoting LNG vehicles"
- Syré, A.M. et al. (2024) "Comparative life cycle assessment of battery and fuel cell electric cars, trucks, and buses"
- Taefi, T.T. (2016) "Viability of electric vehicles in combined day and night delivery: a total cost of ownership example in Germany"
- Taefi, T.T., Stütz, S. and Fink, A. (2017) "Assessing the cost-optimal mileage of medium-duty electric vehicles with a numeric simulation approach"
- Takman, J. and Andersson-Sköld, Y. (2021) "A framework for barriers, opportunities, and potential solutions for renewable energy diffusion: Exemplified by liquefied biogas for heavy trucks"
- Tanco, M., Cat, L. and Garat, S. (2019) "A break-even analysis for battery electric trucks in Latin America"
- Teichert, O. et al. (2023) "Techno-economic cell selection for battery-electric long-haul trucks"
- Tong, F., Jaramillo, P. and Azevedo, I.M.L. (2015) "Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Medium and Heavy-Duty Vehicles"
- Trinko, D. et al. (2022) "Economic feasibility of in-motion wireless power transfer in a high-density traffic corridor"
- Üçok, M.D. (2023) "Prospects for hydrogen fuel cell vehicles to decarbonize road transport"
- Van Den Oever, A.E.M., Costa, D. and Messagie, M. (2023) "Prospective life cycle assessment of alternatively fueled heavy-duty trucks"
- Vijayagopal, R. and Rousseau, A. (2021) "Electric Truck Economic Feasibility Analysis"
- Vojtišek-Lom, M. et al. (2018) "On-road and laboratory emissions of NO, NO<sub>2</sub>, NH<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> from late-model EU light utility vehicles: Comparison of diesel and CNG"
- Vora, A.P. et al. (2017) "Design-space exploration of series plug-in hybrid electric vehicles for medium-duty truck applications in a total cost-of-ownership framework"
- Wang, B. et al. (2023) "Technological-economic assessment and optimization of hydrogen-based transportation systems in China: A life cycle perspective"
- Wang, K. et al. (2022) "Life-cycle CO<sub>2</sub> mitigation of China's class-8 heavy-duty trucks requires hybrid strategies"
- Wang, S. et al. (2023) "A data-driven multi-objective optimization framework for determining the suitability of hydrogen fuel cell vehicles in freight transport"
- Wang, Z. et al. (2024) "A total cost of ownership analysis of zero emission powertrain solutions for the heavy goods vehicle sector"
- Wanniarachchi, S. et al. (2022) "Hydrogen fuel supply chains for vehicular emissions mitigation: A feasibility assessment for North American freight transport sector"
- Wolfram, P. and Wiedmann, T. (2017) "Electrifying Australian transport: Hybrid life cycle analysis of a transition to electric light-duty vehicles and renewable electricity"
- Wu, X. et al. (2024) "Assessing climate/air quality synergies and cost-effectiveness for Beijing transportation: Insights into sustainable development"
- Xu, F. et al. (2023) "Environment-economic analysis of diesel, hybrid electric, plug-in hybrid electric trucks in China"
- Yaïci, W. and Ribberink, H. (2020) "Feasibility Study of Medium- and Heavy-Duty Compressed Renewable/Natural gas vehicles in Canada"

- Yan, J., Jing, J. and Li, Y. (2024) "Hydrogen fuel cell commercial vehicles in China: Evaluation of carbon emission reduction and its economic value"
- Yang, L., Hao, C. and Chai, Y. (2018) "Life cycle assessment of commercial delivery trucks: diesel, Plug-In Electric, and Battery-Swap Electric"
- Yeow, L.W., Yan, Y. and Cheah, L. (2022) "Life cycle greenhouse gas emissions of alternative fuels and powertrains for medium-duty trucks: A Singapore case study"
- Yu, R. et al. (2022) "Life cycle CO2 emissions for the new energy vehicles in China drawing on the reshaped survival pattern"
- Yuan, Z. et al. (2019) "Life cycle greenhouse gas emissions of multi-pathways natural gas vehicles in china considering methane leakage"
- Zhang, F. et al. (2021) "Well-to-Wheel analysis of natural gas fuel for hybrid truck applications"
- Zhang, X. et al. (2022) "Techno-economic comparison of electrification for heavy-duty trucks in China by 2040"
- Zhao, Y. et al. (2016) "Carbon and energy footprints of electric delivery trucks: A hybrid multi-regional input-output life cycle assessment"
- Zhao, Y., Noori, M. and Tatari, O. (2016) "Vehicle to Grid regulation services of electric delivery trucks: Economic and environmental benefit analysis"
- Zhao, Y. and Tatari, O. (2015) "A hybrid life cycle assessment of the vehicle-to-grid application in light duty commercial fleet"
- Zhao, Y. and Tatari, O. (2017) "Carbon and energy footprints of refuse collection trucks: A hybrid life cycle evaluation"
- Zhou, T. et al. (2017) "Life cycle GHG emissions and lifetime costs of medium-duty diesel and battery electric trucks in Toronto, Canada"

Table 8: Selected documents for classification

Annual mileage	The total distance covered by a vehicle over a year influences energy demand, operating costs, as well as wear and tear and vehicle depreciation (particularly for electric vehicles, whose range depends on usage).
Battery degradation / vehicle age	Battery performance declines over time due to charging and discharging cycles, affecting maintenance costs, vehicle durability, and energy efficiency.
Driving conditions	Driving conditions affect energy consumption and vehicle wear (load factor, weather, road, and traffic conditions).
Energy price (including carbon price)	Fluctuations in energy prices, including the cost of carbon, which varies according to government policies, directly impact the profitability of fossil fuel alternatives.
Energy production method / energy mix	The source of the energy used to power vehicles (renewable energy, nuclear, fossil fuels) affects the overall life cycle emissions of alternative fuels.
Equipment costs (including subsidies)	The cost of purchasing and installing necessary equipment (vehicles, charging infrastructure, etc.) impacts the financial analysis, as do state subsidies and financial incentives.
Penetration rate / fleet size	The adoption rate of alternative technologies in the vehicle fleet or the size of the fleet of alternative fuel vehicles influences economies of scale for vehicle and infrastructure acquisition and maintenance.
Refueling / recharging method	Different recharging technologies (slow, standard, fast charging, overnight recharging, etc.) influence the operational efficiency of alternative vehicles.
Technological advancements	Future technological advancements can influence the performance, costs, and efficiency of alternative vehicles and infrastructure (e.g., improved batteries).
Vehicle configuration	The specifications of the vehicle (dimensions, weight, type of transmission, tire size, battery type, etc.) affect energy consumption and carbon emissions.
Vehicle lifetime	The operational lifespan of vehicles impacts the TCO and the amortization of investments.
Vehicle range / battery capacity	The maximum range, depending on battery or fuel tank capacity, affects the operational performance of vehicles and the feasibility of transitioning to alternative solutions.

Table 9: Scenarios



Forklift + Pushback tractor	Specialized transport for short distances (in warehouses and airports)
Goods and logistics vehicle + Truck	Generic terms that require more specific details and used when neither the class nor the weight is specified
MDT + MDV	Medium-duty truck and medium-duty vehicle
LDT + MiDT + LDV + LCV + van	Light-duty truck, mini truck, light-duty vehicle, light commercial vehicle and van
HDT + HGV + HDV	Heavy-duty truck, heavy goods vehicle and heavy-duty vehicle

Table 10: Vehicle types

BSV	Battery Swap Vehicle
BEV	Battery Electric Vehicle
CV	Catenary Vehicle
EREV	Extended Range Electric Vehicle
FCEREV	Fuel Cell Extended Range Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
FCHEV	Fuel Cell Hybrid Electric Vehicle
HEV	Hybrid Electric Vehicle
HCV	Hybrid Catenary Vehicle
ICEV	Internal Combustion Engine Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PHFCEV	Plug-in Hybrid Fuel Cell Electric Vehicle
WPT EV	Wireless Power Transfer Electric Vehicle

Table 11: Drivetrain technologies

Biodiesel / oxygenated fuel (ether, ester, alcohol) / FAME	Produced by transesterification of vegetable oils (soybean, rapeseed, sunflower, palm) or animal fats – a reaction between the feedstock and an alcohol (see U.S. Energy Information Administration, 2024)
Biofuel	Generic term for liquid and gaseous transport fuels (such as biodiesel, bioethanol and biogas) made from biomass (see European Union, 2023)
Biogas (gaseous, liquefied)	Mixture of methane, CO <sub>2</sub> and small quantities of other gases produced by anaerobic digestion of organic matter in an oxygen-free environment (see IEA, 2020)
CNG / LNG	Compressed or Liquefied Natural Gas
Diesel	Fossil diesel fuel
Electricity	Generated from fossil fuel, solar energy, biomass, wind, nuclear or hydropower plants (no distinction is made)
Fischer-Tropsch diesel	Synthetic diesel resulting from the FT-synthesis – a reaction between carbon monoxide and hydrogen (see Bezergianni, S. and Dimitriadis, A., 2013)
Fossil fuel	Generic term for non-renewable energy sources, such as coal, natural gas, crude oil and petroleum products
Gasoline	Also called petrol
Hydrogen	Produced from fossil fuels, nuclear or hydropower plant, solar energy, biomass, wind, renewable or grid electricity (no distinction is made)
Hythane	Blend of hydrogen and compressed natural gas
LPG	Liquefied Petroleum Gas
Renewable diesel / HVO	Produced by hydrotreating (Hydrotreated Vegetable Oil), gasification or pyrolysis of biomass feedstock <sup>1</sup>
Renewable NG / biomethane	Near-pure source of methane produced either by “upgrading” biogas (a process that removes any CO <sub>2</sub> and other contaminants present in the biogas) or through the gasification of solid biomass followed by methanation <sup>3</sup>
SVO	Straight Vegetable Oil

Table 12: Fuels

Die PDF-Dateien der folgenden Berichte sind verfügbar unter:

The PDF files of the following reports are available under:

<http://www.htwsaar.de/wiwi>

1 I. Correia, T. Melo, F. Saldanha da Gama

**Comparing classical performance measures for a multi-period, two-echelon supply chain network design problem with sizing decisions**

Keywords: supply chain network design, facility location, capacity acquisition, profit maximization, cost minimization

(43 pages, 2012)

2 T. Melo

**A note on challenges and opportunities for Operations Research in hospital logistics**

Keywords: hospital logistics, Operations Research, application areas

(13 pages, 2012)

3 S. Hütter, A. Steinhaus

**Forschung an Fachhochschulen – Treiber für Innovation im Mittelstand: Ergebnisse der Qbing-Trendumfrage 2013**

Keywords: Innovation, Umfrage, Trendbarometer, Logistik-Konzepte, Logistik-Technologien, Mittelstand, KMU

(5 pages, 2012)

4 A. Steinhaus, S. Hütter

**Leitfaden zur Implementierung von RFID in kleinen und mittelständischen Unternehmen**

Keywords: RFID, KMU, schlanke Prozesse, Prozessoptimierung, Produktion, Forschungsgruppe Qbing

(49 pages, 2013)

5 S.A. Alumur, B.Y. Kara, M.T. Melo

**Location and Logistics**

Keywords: forward logistics network design, reverse logistics network design, models, applications

(26 pages, 2013)

6 S. Hütter, A. Steinhaus

**Forschung an Fachhochschulen – Treiber für Innovation im Mittelstand: Ergebnisse der Qbing-Trendumfrage 2014**

Keywords: Innovation, Umfrage, Trendbarometer, Logistik-Konzepte, Logistik-Technologien, Mittelstand, KMU

(6 pages, 2014)

7 M.J. Cortinhal, M.J. Lopes, M.T. Melo

**Redesigning a three-echelon logistics network over multiple time periods with transportation mode selection and outsourcing opportunities**

Keywords: logistics network design/re-design, multiple periods, transportation mode selection, product outsourcing, mixed-integer linear programming

(49 pages, 2014)

8 T. Bousonville, C. Ebert, J. Rath

**A comparison of reward systems for truck drivers based on telematics data and driving behavior assessments**

Keywords: telematics, driving behavior, incentives, award systems

(9 pages, 2015)

9 I. Correia, T. Melo

**Multi-period capacitated facility location under delayed demand satisfaction**

Keywords: location, multi-period, capacity choice, delivery lateness, MILP models

(35 pages, 2015)

10 C.L. Martins, M.T. Melo, M.V. Pato

**Redesigning a food bank supply chain network, Part I: Background and mathematical formulation**

Keywords: supply chain, sustainability, tri-objective problem, MILP model

(30 pages, 2016)

11 I. Correia, T. Melo

**A computational comparison of formulations for a multi-period facility location problem with modular capacity adjustments and flexible demand fulfillment**

Keywords: facility location, multi-period, capacity expansion and contraction, delivery lateness, mixed-integer linear models

(42 pages, 2016)

12 A. Bernhardt, T. Melo, T. Bousonville, H. Kopfer

**Scheduling of driver activities with multiple soft time windows considering European regulations on rest periods and breaks**

Keywords: road transportation, driver

scheduling, rest periods, breaks, driving hours, Regulation (EC) No 561/2006, mixed integer linear programming models

(137 pages, 2016)

13 C.L. Martins, M.T. Melo, M.V. Pato

### **Redesigning a food bank supply chain network, Part II: Computational study**

Keywords: food rescue and delivery, sustainability, supply chain network design, tri-objective problem, social impact, economic and environmental performance

(57 pages, 2017)

14 A. Bernhardt, T. Melo, T. Bousonville, H. Kopfer

### **Truck driver scheduling with combined planning of rest periods, breaks and vehicle refueling**

Keywords: road transportation, refueling, fuel cost, driver scheduling, rest periods, breaks, driving hours, Regulation (EC) No 561/2006, mixed integer linear programming

(90 pages, 2017)

15 M.J. Cortinhal, M.J. Lopes, M.T. Melo

### **Impact of partial product outsourcing, transportation mode selection, and single-assignment requirements on the design of a multi-stage supply chain network**

Keywords: supply chain network design, facility location, supplier selection, in-house production, product outsourcing, transportation mode selection, single-assignment, mixed-integer linear programming

(51 pages, 2018)

16 C. Sauvey, T. Melo, I. Correia

### **Two-phase heuristics for a multi-period capacitated facility location**

### **problem with service-differentiated customers**

Keywords: facility location, multi-period, delivery lateness, constructive heuristics, local improvements

(41 pages, 2019)

17 I. Correia, T. Melo

### **Dynamic facility location problem with modular capacity adjustments under uncertainty**

Keywords: facility location, dynamic capacity adjustment, delivery lateness, stochastic programming, valid inequalities

(42 pages, 2019)

18 A. Aliano Filho, T. Melo, M. Vaz Pato

### **Tactical planning of sugarcane harvest and transport operations**

Keywords: multi-objective optimization, mixed-integer programming, sugarcane harvest and transport planning

(50 pages, 2020)

19 I. Correia, T. Melo

### **The impact of flexible warehouse lease contracts on the configuration of a two-echelon distribution network**

Keywords: distribution network redesign, short-term storage space rental, mixed-integer linear programming, valid inequalities

(49 pages, 2021)

20 Y. Costa, T. Melo

### **Supplementary material to the book chapter "Facility Location Modeling in Supply Chain Network Design: Current State and Emerging Trends"**

Keywords: Facility location, Sustainable network design, Circular economy,

Data scarcity, Resilience, Omnichannel

(23 pages, 2022)

21 I. Correia, T. Melo

### **Modeling and solving a dynamic logistics network design problem with temporary capacity expansion and reduction**

Keywords: network design, temporary warehouse rental, capacity expansion and reduction, mixed integer programming, matheuristic

(47 pages, 2023)

22 N. Hein, T. Melo

### **Bedarfsanalyse zum Aufbau eines Food Co-Working Space für die Verarbeitung regionaler Lebensmittel(überschüsse) im Saarland**

Keywords: Food Co-Working, regionale Lebensmittel, Lebensmittelüberschüsse, Bedarfsanalyse, Saarland, Nachhaltigkeit

(23 pages, 2024)

23 A. Aliano Filho, I. Correia, T. Melo

### **Designing a resilient and responsive supply chain network under disruption risks: A bi-objective stochastic programming approach**

Keywords: Resilient and flexible supply chains, disruption risks, network design, two-stage stochastic programming, MIP-based heuristic

(55 pages, 2024)

24 M. Meyer, T. Bousonville

### **Alternative fuels in road freight transport: Objectives and scope of a literature review**

Keywords: Literature review, Alternative fuels, Road freight transport

(23 pages, 2025)

## Hochschule für Technik und Wirtschaft des Saarlandes

Die Hochschule für Technik und Wirtschaft des Saarlandes (htw saar) wurde im Jahre 1971 als saarländische Fachhochschule gegründet. Insgesamt studieren rund 6000 Studentinnen und Studenten in 46 verschiedenen Studiengängen an der htw saar, aufgeteilt auf vier Fakultäten.

In den vergangenen zwanzig Jahren hat die Logistik immens an Bedeutung gewonnen. Die htw saar hat dieser Entwicklung frühzeitig Rechnung getragen und einschlägige Studienprogramme sowie signifikante Forschungs- und Technologietransferaktivitäten entwickelt. Die Veröffentlichung der Schriftenreihe Logistik soll die Ergebnisse aus Forschung und Projektpraxis der Öffentlichkeit zugänglich machen.

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## Institut für Supply Chain und Operations Management

Das Institut für Supply Chain und Operations Management (ISCOM) der htw saar ist auf die Anwendung quantitativer Methoden in der Logistik und deren Implementierung in IT-Systemen spezialisiert. Neben öffentlich geförderten Forschungsprojekten zu innovativen Themen arbeitet ISCOM eng mit Projektpartnern aus der Wirtschaft zusammen, wodurch der Wissens- und Technologietransfer in die Praxis gewährleistet wird. Zu den Arbeitsgebieten zählen unter anderem Distributions- und Transportplanung, Supply Chain Design, Bestandsmanagement in Supply Chains, Materialflussanalyse und -gestaltung sowie Revenue Management.

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## Forschungsgruppe Qbing

Qbing ist eine Forschungsgruppe an der Hochschule für Technik und Wirtschaft des Saarlandes, die spezialisiert ist auf interdisziplinäre Projekte in den Bereichen Produktion, Logistik und Technologie. Ein Team aus derzeit acht Ingenieuren und Logistikexperten arbeitet unter der wissenschaftlichen Leitung von Prof. Dr. Steffen Hütter sowohl in öffentlich geförderten Projekten als auch zusammen mit Industriepartnern an aktuellen Fragestellungen zur Optimierung von logistischen Prozessabläufen in Handel und Industrie unter Einbeziehung modernster Sensortechnologie und Telemetrie. Qbing hat auch und gerade auf dem Gebiet der angewandten Forschung Erfahrung in der Zusammenarbeit mit kleinen und mittelständischen Unternehmen.

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