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The impact of zero emission zones on Sweden's Electrification of Heavy-duty trucks: The Göteborg example

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Executive Summary

This study is based on GPS waypoint data from approximately 34 000 Swedish heavy-duty trucks, representing 40% of all Swedish heavy-duty trucks, as well as another 35 000 non-Swedish heavy-duty trucks that were in operation within Sweden in 2022. Three theoretical zones were created in Göteborg and of all trucks included in the study, 11-27% visited one or several of these zones at least once during 2022. Thus, zero-emission zones or any other policy instrument focusing on such a specific geographic area have the potential to impact a significant part of all trucks that operates in Sweden. This study also includes other aspects such as how frequent trucks visit the zone, how many kilometers they drive and if they stop in the zone or just pass by. This data can be used to evaluate the potential impact of different policy instruments focusing on urban areas.

Keywords: Heavy duty electric vehicles and buses; Public policy and promotion

1 Introduction

In the European Union there were approximately 6 million heavy-duty trucks in operation in 2023. Although they represent just 2% of all road vehicles, heavy-duty trucks contribute to 17% of the external costs of the transportation sector [1,2]. Calculated per kilometer, heavy-duty traffic in urban areas has by far the highest impact due to aspects such as local air pollutants and noise emissions, with negative impact on human health. For example, the external costs of heavy-duty traffic in Sweden have been calculated to be twice as high per kilometer in urban areas compared to rural areas [3]. Policy instruments that target heavy-duty traffic in urban areas could thus be efficient measures to reduce negative impact from the traffic sector. The implementation of such policy instruments is first and foremost motivated by factors such as local air quality, noise control and the traffic situation in the city. However, many heavy-duty trucks travel long distances and policy instruments that focus on the urban environment could thus have a wider impact as well.

One example of policy instruments specifically targeting traffic in limited urban areas is zero-emission zones. Such zones are implemented or discussed in an increasing number of cities, for example, Amsterdam, London and Paris [4,5,6]. In fact, the Netherlands has already implemented zero emission zones in 16 cities [7]. These zones normally cover a very limited geographic area in the central part of a city, and, with few exceptions, all non-zero emission vehicles are banned from the zone. In Sweden, a small zero-emission zone will be implemented in the central part of Stockholm [8]. An alternative approach to zero-emission zones is to implement differentiated tariffs to favour zero-emission vehicles and still allow conventional vehicles access to the zone. Such measures are for example the low and ultra-low emission zones in London and the Danish

distance-based and CO_2-differentiated road toll for trucks which include higher cost for roads in some major cities [9, 10].

Analyzing the potential impact of policy instruments targeting a specific geographic area requires in-depth knowledge about how trucks move inside and outside the boundaries of such areas. In this paper, we present how heavy-duty trucks operate in the city of Göteborg, the second largest city in Sweden and host to EVS 38. Parameters included in the study are, for example, how many trucks visit the zone and how often, how much of their total mileage that takes place inside the zone, and finally if they stop in the zone or just pass through.

2 Methodology and data

The analysis presented in this paper is based on GPS waypoint data from 34 000 Swedish and 35 000 non-Swedish heavy-duty trucks in operation in Sweden the year 2022. Anonymized and aggregated data has been provided by Scania and Volvo. These two manufacturers have together a market share of approximately 80% of all heavy-duty trucks in Sweden. For comparison, there are currently 85 000 heavy-duty trucks registered in Sweden [11]. Thus, this study includes approximately 40% of all heavy-duty trucks registered in Sweden.

In addition to the Swedish trucks, there are also a significant amount of non-domestic trucks on Swedish roads. According to the Swedish Transport Analysis Agency, non-Swedish trucks was responsible for 7-8% of all transports by truck and 18-20% of driven kilometers by trucks in Sweden in 2024 [12].

Three theoretic zero-emissions zones have been designed for the city of Göteborg, see Figure 1. The largest zone (Zone C) corresponds to the existing congestion tax zone and covers an area of 15,2 km^2. The medium sized zone (Zone B) is slightly smaller and exclude some of the high-way traffic in the outskirts of the Zone C that is presumed to only pass by the city. The smallest zone (Zone A) is 4,2 km^2 and represents a significant part of the city center.

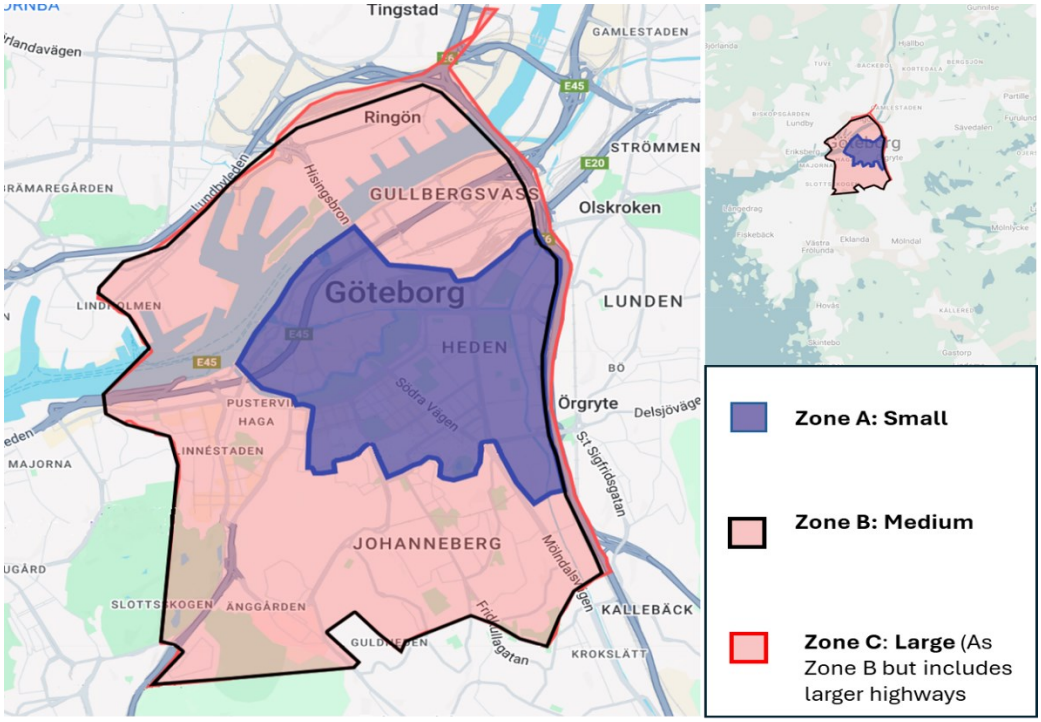

Figure 1: Analysed zones in Göteborg.

3 Results

In 2022, more than 18 000 trucks, corresponding to 27% of all trucks included in this study, visited the larger zone (Zone C) in Gothenburg at least once. As presented in Figure 2, more than 50% of all trucks visiting the zone was non-Swedish. The slightly smaller zone B, which excludes major highways, is visited by almost the same number of Swedish trucks, but the number of non-Swedish visitors drop significantly. Still, more than 20% of all trucks included in this study visit the medium sized zone at least once during 2022. Finaly, as expected, zone A have less visitors but there are still more than 7 000 unique trucks visiting the zone at least once, corresponding to 11% of all trucks in this analysis. To further understand the behavior of these trucks and how they would be affected by different policy instruments we have also calculated the frequency of which they visit the zone, how many kilometers they have driven in the zone and at what time as well as if they stop in the zone or not.

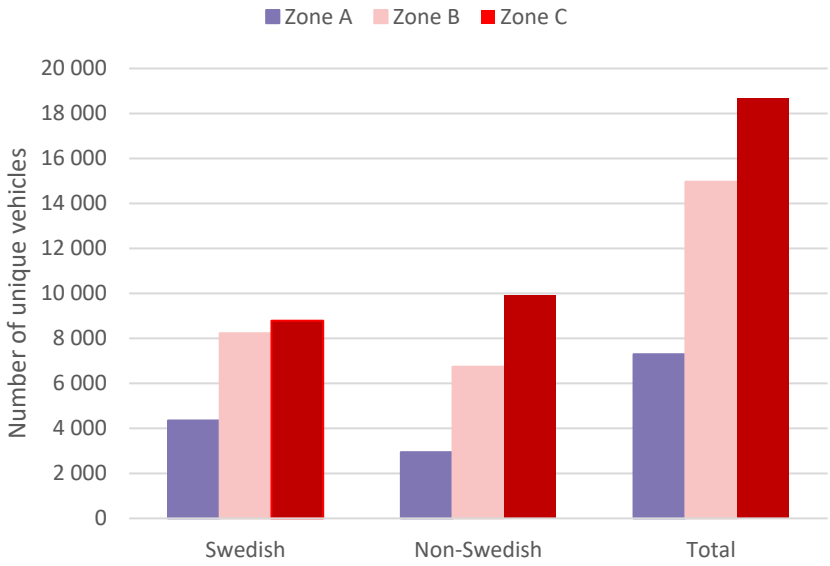

Figure 2: Number of unique vehicles entering the zones in 2022

The frequency of visits is presented in Figure 3. Based on these data, two thirds of the fleet can be characterized as rare visitors (less than 10 visiting days per year) or frequent visitors (more than 100 visiting days per year). The large zone has a higher share of frequent visitors than the smaller zone which instead has mainly rare visitors. Comparing Swedish and Non-Swedish trucks (data not shown here), most frequent visitors, especially in the smaller zone, are Swedish.

However, the negative impact of heavy-duty traffic in the city is not so much connected to the number of trucks but rather the distance they drive in the city. In Zone C, heavy-duty trucks drove more than 3,1 million kilometers in 2022. For comparison, 1,2 million kilometers were driven in zone B and 0,3 million kilometers in zone A. Thus, most of the traffic work takes place on highways on the outskirts of zone C. Although frequent visitors represent a minor part of all trucks visiting the zones, they represent a significant share of the traffic work, see Figure 4.

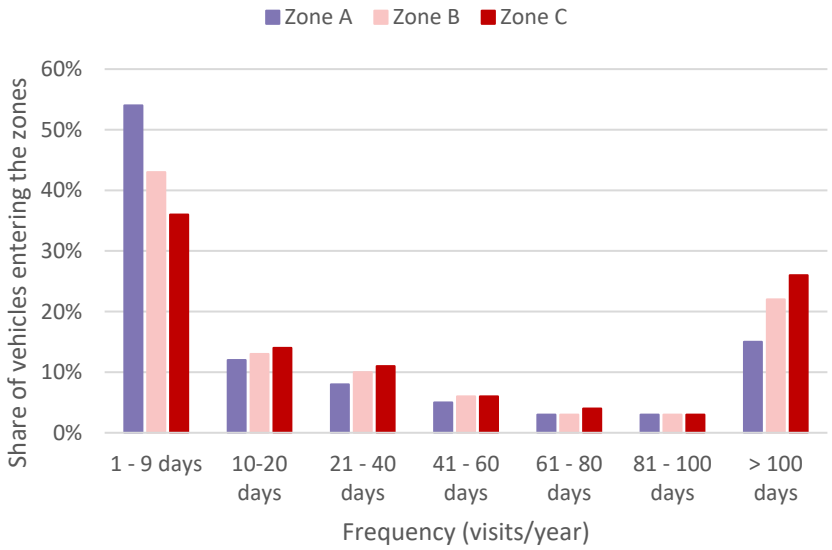

Figure 3: Frequency that vehicles enter the zones

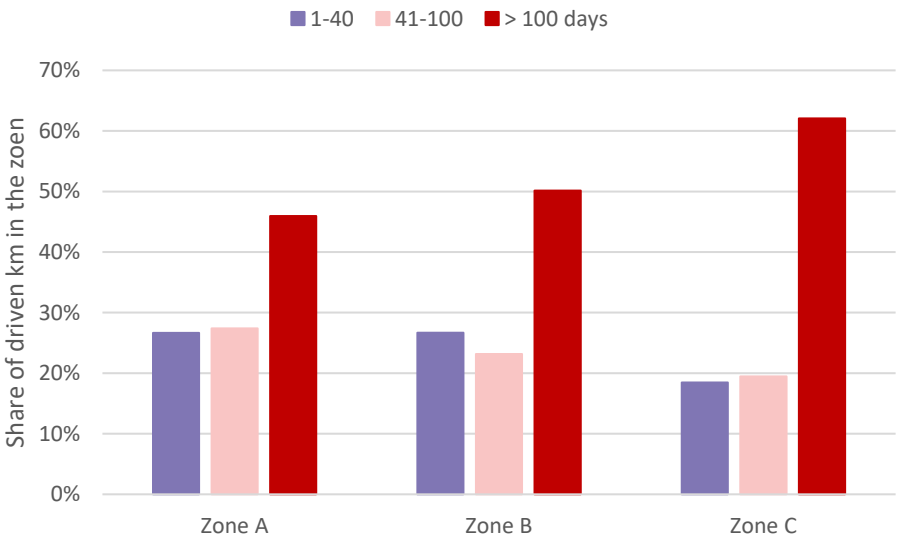

Figure 4: Share of driven kilometers in each zone depending on how many days the trucks visit the zone

In some cases, the negative impact of heavy-duty traffic also differs depending on when the traffic takes place. For example, the risk of congestion is higher during daytime and especially at peak hours since there is also a lot of other traffic at that time. This is also reflected in the current congestion tax in Gothenburg where the tariff varies over the day and there are no tariffs at all during the night. On the other hand, noise disturbances are normally considered as more disruptive during the night, a time when city residents seek sleep. To further analyze how heavy-duty trucks move in the city and to provide data for the evaluation of different policy instruments, we have also calculated how the heavy-duty traffic varies over the day. The result shows that approximately 80% of the distance is driven during daytime. There is also some traffic during the night but very limited traffic during the evening, see Figure 5.

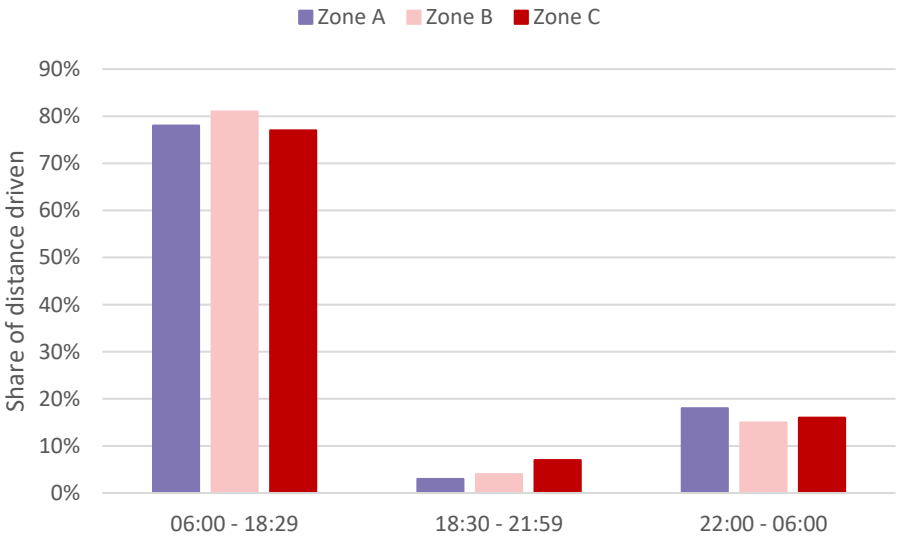

Figure 5: Share of kilometers driven in each zone divided by the time of the day

To understand the potential effect of different policy instruments targeting urban traffic it is also important to understand how many trucks that are just passing through the zone and how many trucks that need to go to the zone to deliver or pick up goods. In this study, we define such a stop as when the truck stands still in the same position for at least 15 minutes. As presented in Figure 6, most rare visitors to the larger zone have also made a stop in the zone (80% of all trucks). For the small zone, only 40% of the trucks made a stop. In general, the share of trucks that make a stop decreases when the frequency of visits increases. For example, only 11 - 15% of the frequent visitors stop in the zone.

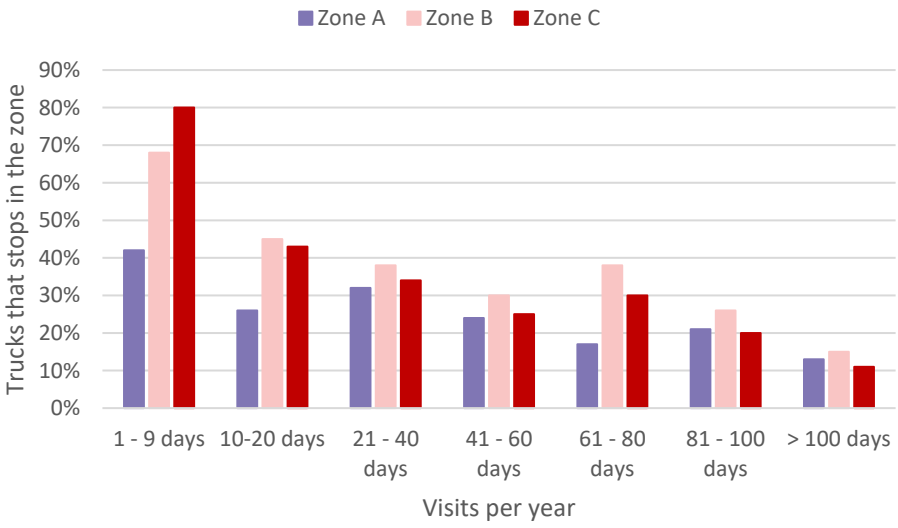

Figure 5: Share of trucks visiting the zone that also stop in the zone

4 Discussion and conclusions

Based on the findings presented in this paper, 11-27% of all heavy-duty trucks that operate on Swedish roads have visited the analyzed zones in Göteborg at least once during 2022. Thus, zero-emission zones or any other policy instruments focusing on such a specific geographic area have the potential to impact a significant part of all trucks that operates in Sweden.

However, the result presented here represents how heavy-duty trucks were operated in 2022 when they were not limited by such policy instruments. Although it has not been studied, it is not unlikely that strict policies such as zero-emission zones would not result in an electrification of all these trucks but rather a change in operation to limit the number of trucks that are operated in the zones. Thus, local benefits with electrified trucks would still be implemented but the impact on the national fleet could be less significant than what is indicated here.

If policy makers would choose other kinds of policy instruments, such as kilometer-based tariffs or differentiated entrance fees to the zones, the impact on the fleet would be different. Depending on the size of these various fees they could still create a strong incentive for frequent visitors to electrify although a relatively low percentage of the frequent visitors stop in the zone. This could mean that they reroute to bypass the zone. However, it could also mean that the current stop definition used in the analysis is too excluding, potentially overlooking many frequent stops shorter than 15 minutes.

Rare visitors could instead choose to pay the fee and still use conventional trucks. The benefits would thus not be as high as with a strict zero emission zone, but it could be a more cost-effective way to reduce negative impact in the city.

Acknowledgments

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Presenter Biography

Mikael Lantz is a senior lecturer at Lund University in Sweden. He has a PhD in Environmental and Energy Systems Studies and he is currently working with several research projects focusing on the electrification of heavy-duty trucks. Mikael is also one of the Theme leaders at the Swedish Electromobility Centre responsible for Theme 5: Vehicle-Grid Interaction.