

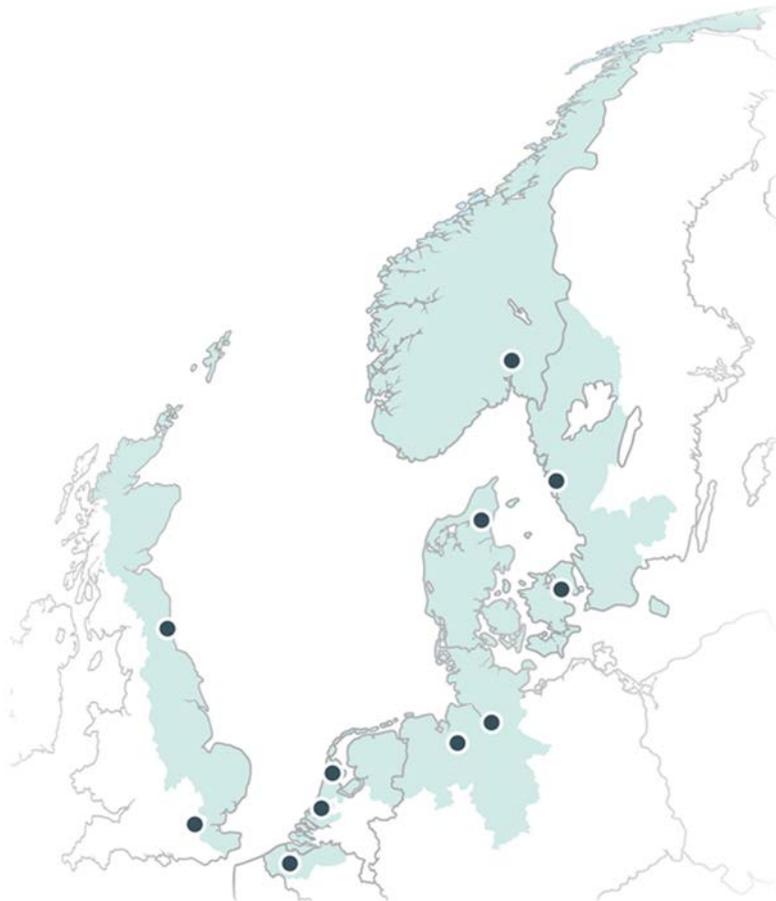


NORTH SEA REGION ELECTRIC MOBILITY NETWORK

e-mobility NSR

Supporting electric vehicles in freight transport in Amsterdam

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Summary

During the last decade the Municipality of Amsterdam has initiated quite elaborate policies to improve the air quality within the city, both for reasons of public health and spatial development. These policies were redefined in 2011 and subsequently evaluated and updated in 2013 (Gemeente Amsterdam, 2011a/b; 2013a). The main focus of these policies is on the reduction of NO₂ and small particulate matter emissions. Supporting electric mobility - for freight as well as passengers - is an explicit part of these policies, rather than a goal in itself.

With regard to the current 'action plan' this implies that two different approaches could be imagined. First, to take current air quality policies as a starting point and zoom in on the role of electric freight vehicles. Or, secondly, to focus explicitly on the latter, thus largely ignoring the prevailing focus applied by the Municipality of Amsterdam for several years now.

We decided to choose the first approach, because it appears more realistic to connect to prevailing insights and policies than to 'reinvent the wheel'. Moreover, we also took into consideration that transnational learning is one of the objectives of Activity 7.4 of the E-Mobility NSR project, and indeed of Interreg as such. This means that whereas the already relatively elaborate - and evaluated - policies in Amsterdam may leave limited opportunities for additional recommendations, they may have a distinct added value for other cities.

Local policy in Amsterdam to support clean freight transport - and clean transport in general - applies a twofold approach:

- an explicit focus on air quality norms, specifically those for NO₂ and PM₁₀ emissions, rather than on electric mobility as a aim in itself. EVs are supported, though, as a means to meet the air quality norms;
- a strong focus on the cost efficiency of policy measures, in order to achieve a maximum improvement in air quality for the given budget. Amsterdam has been the first city to calculate the cost efficiency of measures in detail.

This means in practice that measures focus on a limited number of locations where NO₂ norms are exceeded. Also, measures focus on this categories of vehicles that generate the largest share in emissions, partly because they are large and heavy (trucks), partly because they make the most vehicle kilometres (vans, taxis).

Results so far have been good, but less than expected and hoped for. Several reasons may be indicated for this:

- the reductions in emissions from Euro 4 and 5 vehicles were much less than expected;
- initial expectations concerning the number of EVs and Euro 6 vehicles that could be introduced have been too high;
- the availability of Euro 6 vehicles and electric trucks was less than expected;
- the willingness of private parties to invest was less than expected due to the economic crisis.

In terms of recommendations, some issues can be identified that may strengthen the position of electric freight transport within the prevailing policies:

- it should be considered how to use subsidies in such a way that new initiatives are triggered to improve and demonstrate the reliability and usefulness of electric vehicles, since this remains a main worry for companies that consider electric mobility;
- the municipality should use their influence, not as a policy-maker but as a large customer, to stimulate clean mobility, more so than it does at the moment;
- urban distribution deserves more emphasis, also taking into account the role of electric boats;
- municipal bureaucracy, and divergence of rules between cities and countries remains a problem for firms considering electric mobility;
- the results of policy and of pilot studies so far indicate that at the current stage of development, electric freight transport requires a tailor-made concept and approach such as city logistics.

From the quite elaborated policy in Amsterdam some lessons can be drawn that may also be of use for other cities:

- Amsterdam's policy is characterized to a considerable degree by pragmatic, small, local and efficient interventions, strongly focused in terms of vehicle categories and locations;
- it focuses on measures that generate the most effect per euro invested. This approach is based on elaborate calculations that resulted in the Cost Abatement Curve that guides the selection of policy measures.

1 Introduction

During the last decade the Municipality of Amsterdam has initiated quite elaborate policies to improve the air quality within the city, both for reasons of public health and spatial development. These policies were redefined in 2011 and subsequently evaluated and updated in 2013 (Gemeente Amsterdam, 2011a/b; 2013a). The main focus of these policies is on the reduction of NO₂ and small particulate matter emissions. Supporting electric mobility - for freight as well as passengers - is an explicit part of these policies, rather than a goal in itself.

With regard to the current 'action plan' this implies that two different approaches could be imagined. First, to take current air quality policies as a starting point and zoom in on the role of electric freight vehicles. Or, secondly, to focus explicitly on the latter, thus largely ignoring the prevailing focus applied by the Municipality of Amsterdam for several years now.

We decided to choose the first approach, because it appears more realistic to connect to prevailing insights and policies than to 'reinvent the wheel'. Moreover, we also took into consideration that transnational learning is one of the objectives of Activity 7.4 of the E-Mobility NSR project, and indeed of Interreg as such. This means that whereas the already relatively elaborated - and evaluated - policies in Amsterdam may leave limited opportunities for additional recommendations, they may have a distinct added value for other cities.

Regardless of this somewhat different perspective, the structure of the report resembles that of the action plans for electric freight transport in Hamburg and Copenhagen, which were also developed in the framework of Activity 7.4 of the E-mobility NSR project. Thus, Section 2 presents a brief overview of the urban freight transport situation in Amsterdam. After that, Section 3 discusses the specific aims of Amsterdam's prevailing policies, and Section 4 the more general conditions for the successful support of electric freight transport. This results in a number of recommendations, which are discussed in Section 4 and as said above build mainly on existing policies.

2 Local context

2.1 The city of Amsterdam and its regional context

With around 800,000 inhabitants, Amsterdam is the largest city in the Netherlands (Table 1). Population density is around 4,800 inhabitants per km², almost ten times the national average. Compared to the other main cities within the Netherlands Amsterdam takes a middle position in population density. The income level in Amsterdam is above the national average and above the income level in the other main cities. Amsterdam has a strong economy that is based on financial and legal business services, real estate, tourism and creative and cultural industries.

Table 1: Key figures of Amsterdam compared to other main cities and the national average, 1 January 2012.

	Amsterdam	Rotterdam	The Hague	Utrecht	Netherlands
population, of which:	790,044	616,456	502,802	316,277	16,730,348
- 0-19 (%)	20.4	22.0	23.0	22.2	23.3
- 20-64 (%)	68.2	63.5	63.8	67.8	60.5
- 65 and more (%)	11.4	14.5	13.2	10.0	16.2
population density (inh./km ²)	4,791	2,952	6,251	3,185	496
housing stock	395,875	297,445	240,572	135,267	7,266,295
average income after tax (x €1,000)	15.6	14.0	14.8	15.3	14.9

Source: O+S Amsterdam/Statistics Netherlands.

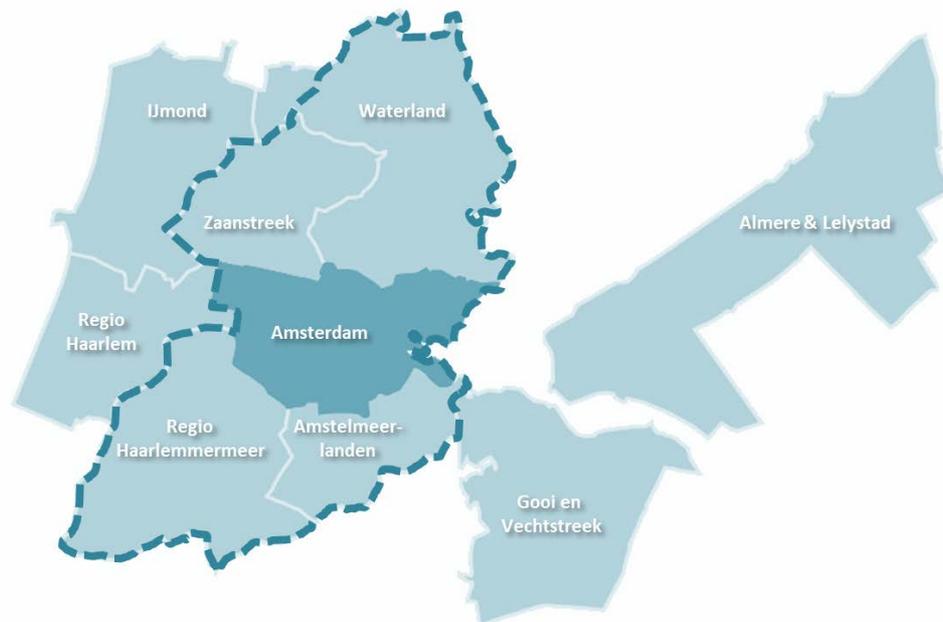
The Municipality of Amsterdam is involved in regional cooperation on several levels, which entails different administrative capacities. The City Region of Amsterdam consists of the city of Amsterdam and fifteen surrounding municipalities (Figure 1). It formally exists since 1985 but can be traced back to the 1970s. The City Region has considerable administrative capacities, for instance in the fields of public transport, urban development and spatial planning.

A more recent development is the Metropolitan Region Amsterdam (MRA), a cooperation of the City Region of Amsterdam, the provinces of North Holland and Flevoland, and 36 municipalities, including Amsterdam, Haarlem, Haarlemmermeer (which includes Schiphol airport) and the 'new town' Almere. In contrast to the City Region the MRA is mainly a platform for regional cooperation and coordination, rather than an administrative body.

The agglomeration of Amsterdam has almost 1.5 million inhabitants, or 2.3 million if measured on the MRA level (Table 2). In the current report we focus primarily on the urban level, i.e. the Municipality of Amsterdam. Most elaborated policies with regard to urban and electric mobility are implemented on this level. Nonetheless, the City Region of Amsterdam and the

MRA also initiated some relevant policies in these fields. When appropriate, these will be discussed as well.

Figure 1: The Municipality of Amsterdam (dark blue), the City Region of Amsterdam (dotted line) and the Metropolitan Region of Amsterdam (light blue).



Source: <http://www.amsterdam.nl/gemeente/organisatie-diensten/economischezaken/economische> (adjusted).

Table 2: Key figures on the Amsterdam region, 1 January 2013.

	Amsterdam	City Region	MRA	Netherlands
population	799,278	1,450,832	2,349,870	16,779,575
surface (km ²)	219.32	1003.53	2580.26	41540.43
population density (inh./km ²)	4,822	1,798	1,464	498

Source: O+S Amsterdam/Statistics Netherlands.

2.2 Transport and mobility

In general the transport-related problems of Amsterdam resemble that of many other European cities: congestions and air quality. Municipal policy recognized that these problems are related, as congestion strongly increases the emissions from a given number of cars. Air quality is particularly a problem at specific locations where NO₂ and PM₁₀ norms are exceeded. Congestion occurs in the city itself, as well as on the A10 beltway. On the beltway a speed limit of 80 km/h has been introduced to reduce emission levels. Other problems, such as sound pollution and the occupation of space, can be found as well, but are not or less prevalent in the city's policies in this field.

Table 3 shows the number of registered vehicles (including motor vehicles and freight trailers) in Amsterdam and its agglomeration. In addition, Table 4 shows a more detailed specification of the number of registered vehicles in Amsterdam, compared to the Netherlands. Within the city the share of passenger cars is higher than on a regional level, while the share of freight vehicles is lower. This difference is for the largest part due to a lower share of trucks, articulated lorries and non-motorized vehicles (trailers). This may partly be explained on the one hand because both Schiphol airport and a large part of the port of Amsterdam are located outside the municipality, and on the other hand because large trucks and trailers are far from suitable for the narrow streets of Amsterdam's historic city centre. As may be expected, the share of mopeds and mini cars in the city (shown only in Table 4) is well above the national average.

Including vehicles not registered in Amsterdam, but visiting the city (e.g. commuters), the daily number of vehicles that drive in the city is even higher (Table 5, p. 11). However, figures indicate that the relative contribution to NO₂ emission varies widely between vehicle types. Absolute vehicle numbers therefore should not be the only (or main) criterion defining the focus of policies.

Table 3: Registered vehicles (not including mopeds etc.) in the Amsterdam region, 1 January 2013.

	Amsterdam		City Region		MRA	
	abs.	%	abs.	%	abs.	%
passenger cars	228,764	81.68	546,139	77.64	1,100,095	78.87
commercial vehicles	33,957	12.12	112,766	16.03	217,124	15.57
motorbikes	17,344	6.9	44,555	6.33	77,668	5.57
total	280,065	100.00	703,460	100.00	1,394,887	100.00

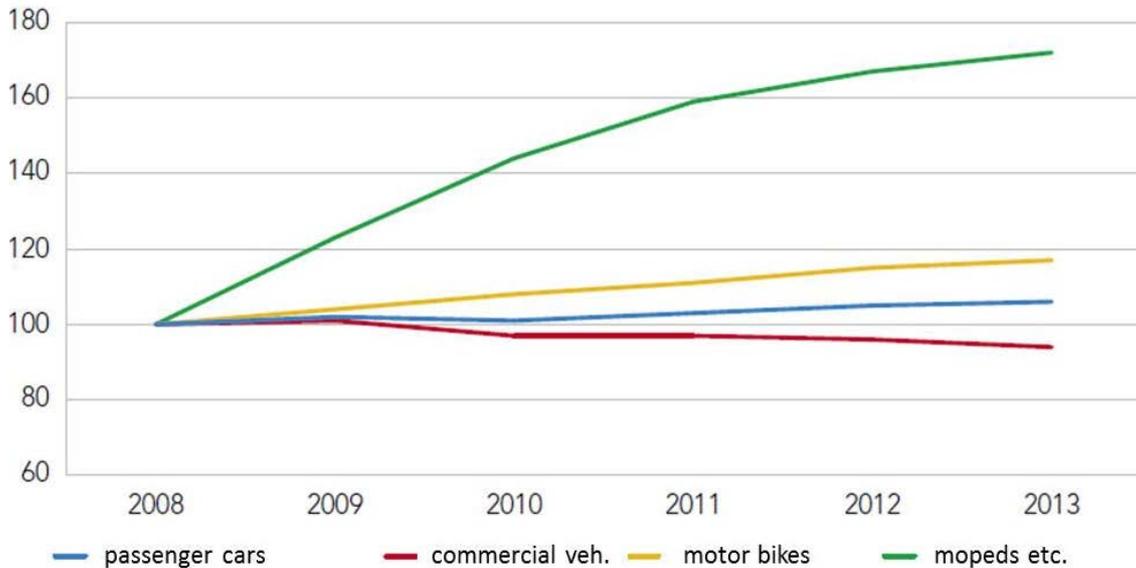
Source: O+S Amsterdam/Statistics Netherlands.

Table 4: Registered vehicles in the city of Amsterdam and the Netherlands, 1 January 2013.

	Amsterdam		Netherlands	
	abs.	%	abs.	%
all vehicles	333,019	100.00	11,789,690	100.00
passenger cars	228,764	68.69	7,915,613	67.14
commercial vehicles, of which	33,957	10.20	2,135,589	18.11
- commercial motor vehicles	23,749	7.13	1,043,415	8.85
- vans	20,402	6.13	832,121	7.06
- trucks	1,063	0.32	67,096	0.57
- articulated lorries	599	0.18	70,422	0.60
- special vehicles	1,416	0.43	63,312	0.54
- busses	269	0.08	10,464	0.09
motorbikes	17,344	5.21	653,245	5.54
mopeds, mini cars etc.	52,954	15.90	1,080,514	9.16

Source: O+S Amsterdam/Statistics Netherlands.

Figure 2: Development of the number of motor vehicles in Amsterdam.



Source: Gemeente Amsterdam (2013b: 230).

Table 5: Number of vehicles present in Amsterdam on average, and their relative contribution to NO₂ emission.

type of vehicle	average number present in Amsterdam	relative contribution to NO ₂ emission compared to reference vehicle
reference vehicle	371,000	1
passenger car in heavy use	5,000	>7
taxi	2,500	35
van (incl. vans in heavy use)	37,000	9 (22 for a van in heavy use)
truck	2,917	199
bus	625	325

Source: Gemeente Amsterdam (2011a: 23).

2.3 Position of electric mobility

Amsterdam is involved in the support of electric mobility both on the city level and the regional level, via the 'Amsterdam Elektrisch' and 'MRA Elektrisch' programmes respectively.¹

MRA Elektrisch (MRA Electric) does not itself invest in electric mobility, but functions as a platform and mediator (MRA, 2012). It focuses on electrical taxis, busses, vans and company-owned passenger cars, a network of public charging points, fast chargers along motorways, and battery swap stations. Regarding the latter a deal was made with Better Place, who

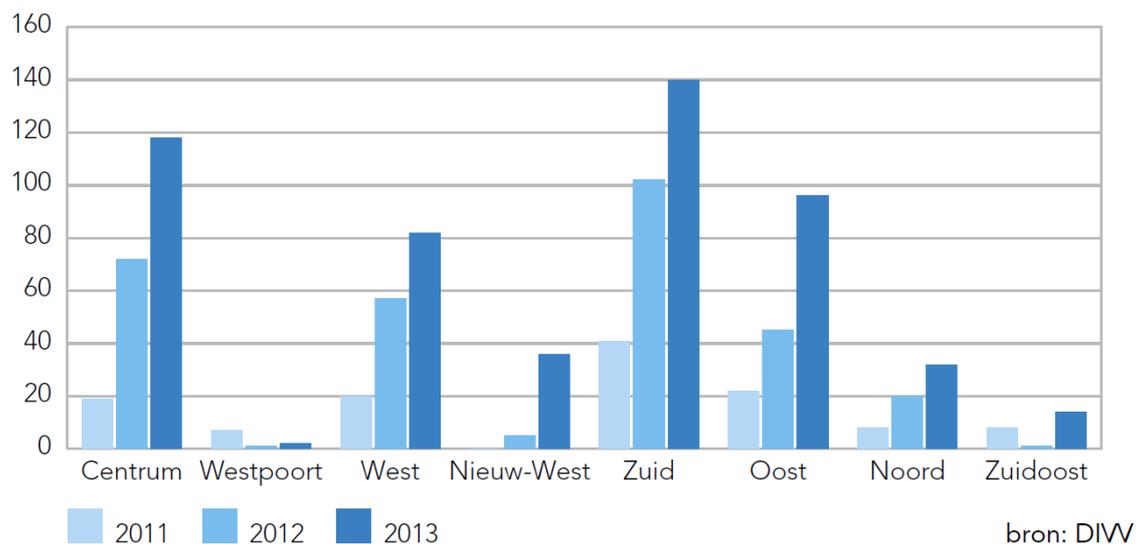
¹ The participation of the Province of North Holland in the E-Mobility NSR project fits in the latter programme.

opened a station at Schiphol Airport, but this was discontinued with the bankruptcy of Better Place.

Local policy initiatives regarding electric mobility are bundled under the Amsterdam Elektrisch (Amsterdam Electric) programme.² These initiatives include shortened application procedures for parking permits, as well as subsidies for the purchase of an electric vehicle and for charging points. Public charging points include dedicated parking places, so only parking of a charging EV is allowed.

The number of charging points shows a strong growth in most districts (Figure 3). By far the most of these are Type II regular chargers. Only very few fast chargers are available. An interactive map (accessible via a QR code) shows where chargers are located, of which type they are and whether they are available (Figure 4). It also shows where electric cars, mopeds and boats can be purchased.

Figure 3: Number of EV charging points per district, 2011-2013.



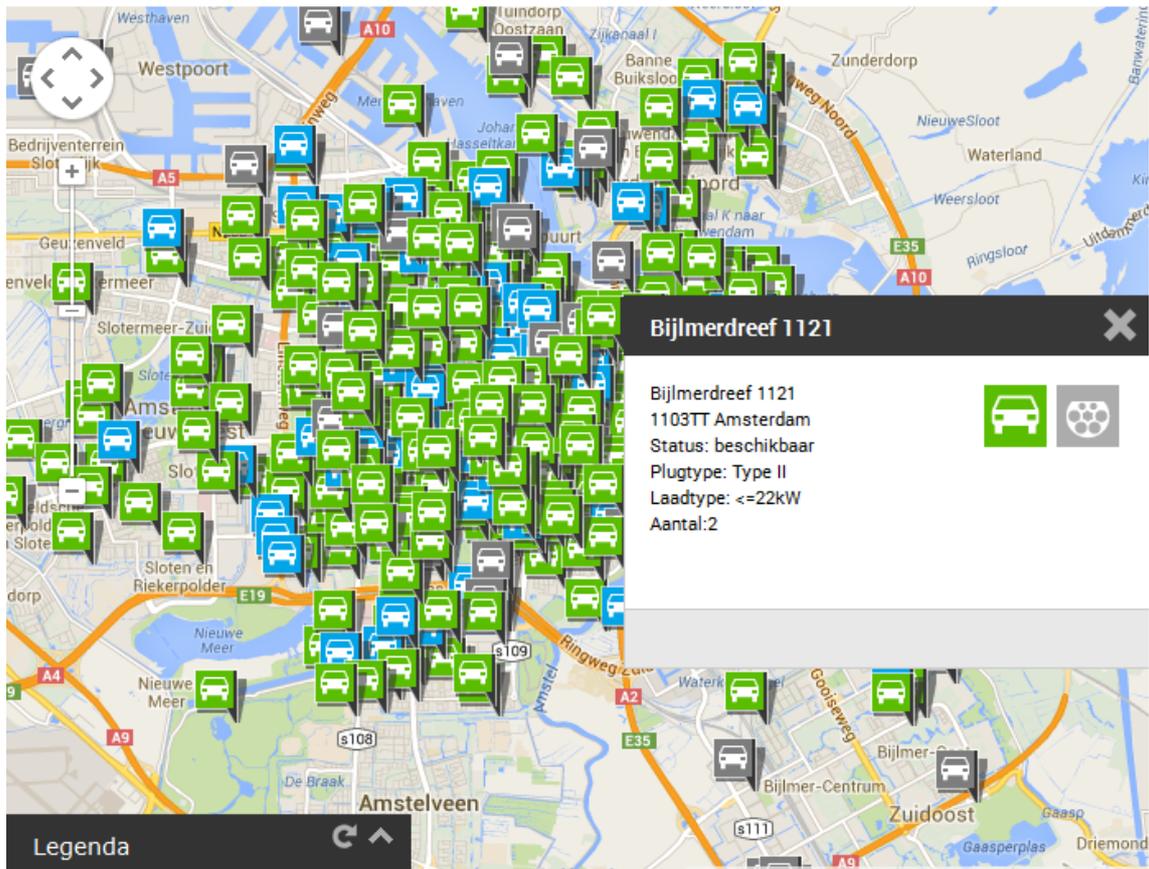
Source: Municipality of Amsterdam, DIVV.

Amsterdam is one of the cities participating in the FREVUE (Freight Electric Vehicles in Urban Europe) project.³ This project analyses a large number of city logistics pilot projects and initiatives of local and national governments and the private sector, from a technical, economic and policy perspective (TNO, 2013).

² See <http://www.amsterdam.nl/parkeren-verkeer/amsterdam-elektrisch/amsterdam-elektrisch/>.

³ See <http://frevue.eu/>.

Figure 4: Interactive map of charging points in Amsterdam.



Source: <http://www.amsterdam.nl/parkeren-verkeer/amsterdam-elektrisch/opladen/>.

3 Prevailing objectives

3.1 Overall policy objectives

During the last decade the Municipality of Amsterdam has initiated quite elaborate policies to improve the air quality within the city. The aim of this is to meet the air quality norms as defined by the European Union. The main reasons for this are twofold:

- to reduce the detrimental effects of air pollution on public health;
- to enable further spatial development in the city.

The latter argument is due to the specific (and much criticized) way European regulation is implemented in Dutch national legislation. Due to the coupling of the EU Air Quality Directive to the Dutch Spatial Planning Act (WRO: Wet Ruimtelijke Ordening) spatial development is not allowed when air quality norms are exceeded. This arrangement is said to put a 'lock' on many urban development projects located near busy roads, motorways etc., although reality proves somewhat more nuanced (Zonneveld *et al.*, 2009: 180-1).

These European norms focus specifically on the levels of nitrogen dioxide (NO₂) and small particulate matter (PM₁₀). Local policy focuses primarily on measures to reduce NO₂, since in practice these lead to a reduction of small particulate matter emissions as well. As a result, the norms for small particulate matter emissions were met in the entire city by 2011. However, this is not the case for NO₂ norms, which have to be met in 2015 (Gemeente Amsterdam, 2011a: 11). After this date - which already means a postponement of the initial deadline - the city runs the risk of being fined by the EU.

3.2 Specific focus of policies

The overall objective mentioned above led to a number of sometimes quite pragmatic choices concerning the focus of policies. Policies focus at seven specific locations in Amsterdam where NO₂ concentrations exceed the European norm. At most of these locations NO₂ emissions norms still will exceed the norm even when the effects of current policies are taken into account (Table 6). As Table 7 shows, over 53% of the NO₂ concentration at these locations can be attributed to road traffic, either at the location itself or elsewhere in the city. About two thirds of this transport-related NO₂ emission is caused by freight transport: 34% is caused by trucks and 30% by vans. These account for respectively 4% and 30% of the vehicle kilometres driven in Amsterdam, an indication of the relatively high level of pollution caused by particularly trucks.⁴

Other traffic is an important source mainly at the Prins Hendrikkade, where most round-trip boat jetties are located. Policies focus therefore primarily on traffic-related emissions. A

⁴ Or, for that matter, busses. Amazingly, a local bus in Amsterdam with average occupation rate emitted more NO₂ per passenger than an average passenger car. From the perspective of air quality, improvement of public transport should therefore focus on cleaner busses and on increasing the occupation rate of existing busses, rather than on expansion of the network or frequency (Gemeente Amsterdam, 2011a: 30).

second reason for this is that other sources of NO₂ emission such as industry or power plants in general can hardly be influenced by local policies. On the whole, therefore, transport-oriented policy measures are considered by far the most effective.

European norms for the emission of NO₂ and small particulate matter emissions do not force cities to focus strictly on electric mobility. Therefore, in Amsterdam supporting electric mobility is considered one of the means to achieve policy objectives, rather than as a policy objective in itself. Measures to improve the circulation of freight traffic and to support the replacement of old diesel vehicles by Euro 6 vehicles are at least as important, as they generate larger results in terms of air quality improvement. In many cases they are also more cost effective than measures aimed at electric mobility per se.⁵

Table 6: Highest concentration of NO₂ in 2015 in problematic locations (2015, including effects of current policies).

Location	NO₂ concentration in 2015 (µg/m³)	above norms (>40.5 µg/m³)
Amstelveenseweg	46.0	5.5
Prins Hendrikkade	42.3	1.8
Tweede Hugo de Grootstraat	43.3	2.8
Jan van Galenstraat	42.3	1.8
Stadhouderskade	40.6	0.1
Amsteldijk	41.0	0.5
Surinamestraat	40.5	0.0

Source: Gemeente Amsterdam (2011a: 18).

Table 7: Sources of NO₂ concentration at problem locations in 2015 (prognosis).

source	%
road traffic at location	31
road traffic elsewhere in Amsterdam (including motorways)	22
other traffic	15
other domestic sources (energy production. construction. industry. processing of waste)	12
other foreign sources	20

Source: Gemeente Amsterdam (2011a: 14).

⁵ This might change when more strict EU norms are implemented, as favoured by the municipality (interview with Mrs. P. Bakker, Municipality of Amsterdam). Obviously this will also depend on the further development of diesel engines.

4 Required conditions

4.1 Electric Vehicle characteristics

The typical characteristics of EVs also, to some degree, apply to electric freight vehicles. These entail:

- a higher purchase price and lower running costs (fuel, tax etc.). In practice the latter depends very much on the specific vehicle, the circumstances in which it is used and charging systems used. Purchased or leased batteries or battery swap systems all have different price tags, as have regular or fast charging techniques. On the whole it is assumed that the total costs of ownership (TCO) of an EV will be less or equal to those of a conventional vehicle. In case of electric freight vehicles the TCO is less favourable compared to conventional freight vehicles, but the cost differential is expected to diminish due to cost reductions of batteries and increased production figures. Findings of CE Delft/DLR (Den Boer et al., 2013) indicate a cost competitiveness of electric trucks between 2020 and 2030;;
- a limited (but growing) choice and availability of vehicles, particularly regarding electric trucks;
- a small range compared to conventional vehicles;
- very silent at low and moderate speeds (at high speed the vehicles tires are the main source of noise);
- higher weight than comparable conventional vehicles due to heavy battery packages and less load capacity. The latter is particularly relevant for freight transport.

4.2 Logistic chain

The characteristics mentioned above suggest electric freight vehicles are as yet less suitable for long-distance transport of large freight volumes, and more appropriate for the transport of smaller freight over shorter distances and in urban areas. This makes electric freight vehicles particularly suitable for an urban distribution system, in which heavy trucks deliver their freight at logistic centres at the city edge, where it is bundled to be distributed to various destinations by smaller vehicles.⁶

Many local governments, including the municipality of Amsterdam, favour urban distribution systems. In cities where traffic is heavily congested, urban freight transport is likely to become increasingly complicated. Urban distribution systems are considered as a way to ban heavy trucks from urban areas, in particular from inner cities (cf. SAFE, undated: 4). Distribution within the city takes place by small trucks or vans. The drawback is that the number of vehicle

⁶ This may be implemented either as a public network that can be used by all transport companies, or as a private network operated by a specific (presumably somewhat larger) transport company that provides urban distribution services to third parties (interview with Mr. H. Tol, Technische Unie). On top of cooperation between companies in bundling freight, companies may also cooperate in use of vehicles. Such an idea for co-operative use of electric vans has been tested in Japan (Taniguchi et al., 2000).

movements may increase. This means clever bundling is required to minimize this effect by combining destinations and increasing the utilization rate of the vehicle.

Although urban distribution systems have clear advantages from an urban quality of life perspective, a problem is that they require additional transshipment, which increases the total transport costs. Electric vehicles might well bring about a breakthrough in this, because if companies could be persuaded or coerced to replace their diesel vehicles by electric ones (for instance by environmental zones), the abovementioned vehicle characteristics make urban distribution a much more sensible option than it was before. Vice versa, the implementation of an urban distribution model may support the use of electric vehicles, since the constraints of a limited range and size become less relevant.

E-commerce is another factor that affects urban logistics and the chances of an urban distribution system. Traditional urban freight transport concerns mainly business-to-business delivery between wholesale, warehouses, shops, offices etc. Due to the increase of e-commerce, an increase in the business-to-consumer deliveries is expected (Agentschap NL, 2013: 4). This implies a larger number of small deliveries, typically made by vans; often trips have to be made twice, if people are not home to receive the delivery. This is the 'last mile' of the logistic chain, which is relatively expensive, inefficient and polluting (Flanders Logistics, 2013: 17). These deliveries may be bundled by means of an urban distribution system, and thus may potentially be replaced by electric transport.

The density and scale of the city may or may not support the implementation of urban distribution and electric freight transport. The emphasis here is on the inner city, as this often is the area which poses the largest problems for freight traffic. Although Amsterdam has some peculiarities such as the large number of canals, in terms of urban pattern and scale of the urban fabric it resembles many old inner cities in the Netherlands (although the overall scale of the historic inner city is considerably larger in Amsterdam than in any other Dutch city). Moreover, aspects such as small blocks, narrow streets and high densities characterize many historic inner cities also outside the Netherlands. This supports the use of small, possibly electric vehicles for urban distribution.

4.3 Charging infrastructure

The availability of charging infrastructure is a condition for the success of electric vehicles. Most attention tends to be focused on charging points for electric private cars and company-owned passenger cars, which are charged either at public charging points or on private premises. Electric freight vehicles are more commonly charged at non-public, company-owned charging points.

The availability of charging infrastructure in Amsterdam has been discussed in Section 2.3 (p. 11).

4.4 Cost-efficiency

The cost-efficiency of environmental policy measures is important as policy-makers tend to strive to achieve as much results as possible within the constraints of a limited budget.

Moreover, it may increase the acceptability and feasibility of measures, both in the short and the long term. Policy measures such as granting subsidies may be successful in the short term, but if they become too costly they cannot be sustained.⁷ As such, cost efficiency of measures may be seen as a condition for effective policy-making in the longer run.

The aspect of cost efficiency is particularly emphasised in Amsterdam, as the municipality recognized that it simply does not have sufficient funds to take any possible measures to improve air quality, while the set of objectives have not yet been met. It therefore decided to focus on those measures that generate the largest improvement in air quality per euro invested. According to the municipality, Amsterdam was the first city to apply such a strong and explicit focus on the cost efficiency of clean air policies, but the calculations on which the approach has been based may be interesting for other municipalities as well (Gemeente Amsterdam, 2011a: 5). These were made by the Dutch Organization for Applied Scientific Research (TNO).⁸

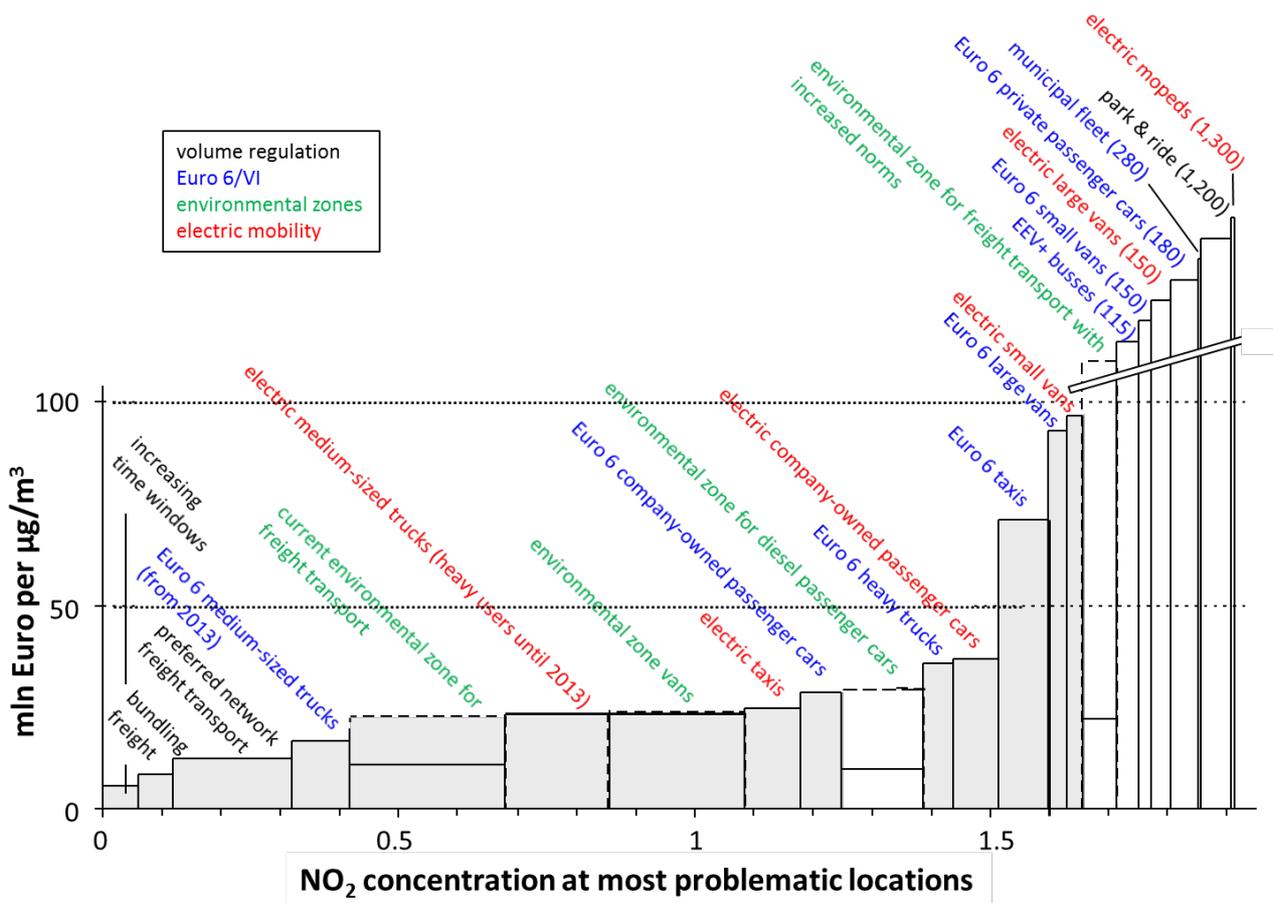
This approach is guided by the Cost Abatement Curve (Figure 5) which for each imaginable policy measure shows the costs in million euros per $\mu\text{g}/\text{m}_2$ reduction in the NO_2 concentration at the abovementioned problematic locations. In Figure 5, measures shown to the left generate a large improvement in air quality at relatively low costs, such as bundling of freight flows, increasing time windows for delivery and replacing light diesel trucks by Euro VI trucks. On the right hand are relatively expensive measures such as the introduction of electric mopeds and the replacement of private diesel cars and the municipality's own fleet by Euro VI vehicles.

To achieve a maximum effect a city can start with measures at the left and continue to the right as far as the budget allows. This is more or less the approach taken by Amsterdam, although measures are taken simultaneously rather than one after another. Measures that cost more than 100 million euros per $\mu\text{g}/\text{m}_2$ NO_2 reduction will not be considered, as they are regarded too expensive relatively as well as, in many cases, in absolute terms.

⁷ This was the case e.g. for the tax exemption granted to clean company cars in the Netherlands.

⁸ See the TNO reports Passier *et al.* (2009) and particularly Verbeek *et al.* (2011).

Figure 5: Cost Abatement Curve: generic policy measures ranked according to cost efficiency of municipal investment.



Source: translated from Gemeente Amsterdam (2011b: 21) , based on Verbeek *et al.* (2011).

5 Summary of policy measures

5.1 Overview

As mentioned before, the focus of policy in Amsterdam is on air quality - more specifically on the reduction of NO₂ and PM₁₀ emissions - rather than on electric mobility per se. This clean air policy is formulated in the programme *Schone lucht voor Amsterdam* (Clean Air for Amsterdam), first introduced in 2011 and evaluated and adjusted in 2013 (Gemeente Amsterdam, 2011a/b, 2013a). The total budget for this programme until 2016 is 76 million euros.

Accordingly to the abovementioned focus, EVs are considered as a mean, not an aim in itself.⁹ Nevertheless they play a role in local policy to replace Euro 3 and Euro 4 diesel vehicles by newer, cleaner vehicles. One of the positive aspects of electric vehicles is the elimination of tailpipe emissions. This is particularly relevant for local policy in Amsterdam, which focuses on the reduction of emissions on specific locations where air quality norms are exceeded.

The availability of electric freight vehicles is improving and the price level is decreasing. However, the availability of electric trucks is much less than that of vans, and the prices of electric trucks are not decreasing as quickly as those of electric vans or passenger cars. In addition, many firms still have doubts about the reliability and use of electric vehicles.

The main target group of local policy in Amsterdam are the 'zakelijke veelrijders', i.e. the rather heterogeneous group of drivers of heavily-used company-owned and company-used vehicles.¹⁰ This includes vans and trucks, but also taxis and company-owned passenger cars. Since these are responsible for the most vehicle-kilometres driven in the city, measures targeted at these groups have potentially the largest effect and are most likely to be cost efficient.

This policy includes four groups of measures, of which only the latter two categories include measures specifically aiming at the support of electric freight mobility (Table 8, p.21):

- measures aimed a reduction of the transport volume;
- measures aimed at reducing tailpipe emissions by means of restrictive environmental zones;
- supportive measures aimed at reduction of tailpipe emissions;
- other supportive measures.

⁹ Nevertheless the attention local policy pays to electric mobility has increased rapidly: the Freight Transport Action Plan from 2008 (Gemeente Amsterdam, 2008) does not mention electric mobility at all, and only briefly discusses the use of hydrogen.

¹⁰ This was based on Passier *et al.* (2009).

Table 8: Cost efficiency of measures (measures related to electric mobility shown in red).

	effect	costs for municipality	costs efficiency
	$\mu\text{g}/\text{m}^3$	€ mln	€ mln per $\mu\text{g}/\text{m}^3$
measures aimed a reduction of the transport volume			
preferred network freight transport	0.20	2.5	13
bundling of freight flows	0.06	0.5	8
increasing time windows	0.06	0.4	6
park & ride	0.05	60.1	1,200
parking tariffs	0.00		
public transport programme	0.00	48.6	-
measures aimed at reducing tailpipe emissions by means of restrictive environmental zones			
current environmental zone for freight transport	0.26	3.3	11
including investments by third parties		5.8	22
environmental zone for freight transport with increased norms	0.06	1.3	22
including investments by third parties		6.4	110
environmental zone for vans	0.23	5.5	24
including investments by third parties		5.5	24
environmental zone for diesel passenger cars	0.14	1.4	10
including investments by third parties		4.0	29
supportive measures aimed at reduction of tailpipe emissions			
Euro 6 private passenger cars	0.04	7.9	180
facilitating policies electric mobility	0.05	4.7	95
electric company-owned passenger cars	0.08	2.8	37
Euro 6 company-owned passenger cars	0.07	2.0	29
electric taxis	0.09	2.3	25
Euro 6 taxis	0.08	6.0	71
electric small vans	0.03	2.7	97
Euro 6 small vans	0.02	3.2	150
electric large vans	0.03	5.0	150
Euro 6 large vans	0.03	2.9	93
Euro 6 heavy trucks	0.05	1.9	36
electric medium-sized trucks (heavy users until 2013)	0.17	1.8	23
Euro 6 medium-sized trucks (from 2013)	0.10	1.7	17
other supportive measures			
EEV+ busses	0.04	4.2	115
EEV+ busses - local effect Prins Hendrikkade	1.20	1.8	1
electric mopeds	0.004	5.0	1,300
municipal fleet	0.01	2.0	280
electric round-trip boats - local effect Prins Hendrikkade	0.40	1.0	3
environmental differentiation of parking tariffs	0.00	0.4	
upgrading to CNG	pm	pm	pm

Source: Gemeente Amsterdam (2011a: 25), based on Verbeek *et al.* (2011).

Since 2013 the targets of several policy measures had to be adjusted downwards, due to the initially too high expectations of Euro 6 and electric vehicles, in combination with the effects of the economic downturn. Simultaneously, the amount of ‘background’ emissions which local policy can hardly influence is increasing more than expected (Gemeente Amsterdam, 2013a: 12).

The next sections subsequently discuss the four categories of measures.

5.2 Measures aimed at reduction of the transport volume

The first category of policy measures to improve air quality are reduction of the transport volume. With regard to freight transport this entails three measures:

- the establishment of a network of preferred routes for freight transport (Gemeente Amsterdam, 2009). The aim of this is to improve traffic safety and the flow of traffic. The latter increases the efficiency of transport, but also results in an improvement of air quality because pollution from congested zones tends to be substantially higher than from uncongested. This entails e.g. attuning traffic lights, avoiding loading and unloading on lanes, and occasionally the construction of new connections or bypasses. In practice the effect of this measure is less than hoped for, partly because of difficulties with regard to the spatial implementation of e.g. new road or tunnels (Gemeente Amsterdam, 2013a: 13-4);
- the bundling of freight flows. The average utilization rate of trucks in Amsterdam is about 80%. Bundling of freight can increase this and reduce the number of truck movements in the city (Gemeente Amsterdam, 2011a: 28). This resulted in a number of successful pilot projects, but so far the improvement in NO₂ reduction falls slightly behind the expectations;
- the enlargement of time windows for deliveries. This enables trucks to call at a larger number of destinations, which may be necessary if freight is bundled. It enables truck drivers to plan their trip more efficiently and drive less distance. On the other hand municipalities consider time windows for deliveries as a way to control and limit the negative effects of truck visits to a limited period during the day. In order to encourage the efficiency of urban freight transport without causing negative effects to visitors of shops etc. there is the possibility to enlarge time windows by allowing very early (before 7:00) or late (after 19:00) deliveries or even deliveries during night.¹¹ According to the new time windows in Amsterdam deliveries may be made between 7:00 and 12:00 (instead of 11:00) and in some cases between 19:00 and 7:00 (Gemeente Amsterdam, 2013a: 14-5).¹² In general these late or night deliveries require silent vehicles, but also silent ways to offload the vehicle. Likewise, drivers should be granted access to shops and warehouses during closure hours.^{13,14}

¹¹ See the E-Mobility Copenhagen Action Plan for more details on night distribution schemes using electric vehicles.

¹² The lack of harmonization of window times between cities is a point of attention as it leads to a more complex logistical organisation and hence additional costs (interview with Mr. C. Vanhoegaerden, UPS) (see e.g. also Quak, 2008; Maes *et al.*, 2012)..

¹³ This is e.g. increasingly the case for some customers of Technische Unie (interview with Mr. H Tol, Technische Unie).

From these measures the regulation of time windows can encourage electric mobility through allowing electric vehicles to deliver outside the regular time windows. Contrary to other Dutch cities (e.g. Utrecht, Nijmegen, Zutphen) this possibility is not taken by the municipality of Amsterdam.

5.3 Measures aimed at reducing tailpipe emissions by means of restrictive environmental zones

A second focus of policy is the reduction of tailpipe emissions by means of restrictive environmental zones, in order to reduce the number of old, relatively polluting vehicles in the city (Gemeente Amsterdam, 2011a: 30-1). Environmental zones in Amsterdam so far only apply to freight transport. An environmental zone for Euro 4 diesel passenger cars has been considered, but is seen as socially unfeasible at this moment.

An environmental zone for trucks has been introduced in 2008. It concerns the area within the A10 belt way but south of the River IJ, i.e. the historical inner city as well as a zone around it (Figure 6). In 2010 the norms have been increased to Euro 3 level, and in 2013 they have been raised to Euro 4 level. The adjustment of norms is carefully planned, taking into account the various adjustments of the Euro norms and the availability of vehicles. The objective of this is to direct the replacement of trucks to the newest possible types. Accordingly, a temporary exemption from the replacement of Euro 3 trucks has been granted to many firms in 2013 while Euro 6 trucks were not sufficiently available. This should prevent firms from replacing Euro 3 trucks by Euro 4 or 5 trucks (Gemeente Amsterdam, 2013a: 12).

A further increase of the norms to Euro 5 level by 2015 is not foreseen, as this would cost more than 100 million euros per $\mu\text{g}/\text{m}^2$ NO_2 reduction. About 11% of the trucks have an exemption, which is more than for other environmental zones in other cities. Given the agreements between the municipality and the transport sector it is hardly possible at the moment to reduce the number of exemptions. On the other hand, control is fully automated by means of cameras, and is more effective than in most other cities. Initially it was the intention to extend the scope of the environmental zone. Thus, it would also apply to vans, with norms at the Euro 4 level or higher. This plan has been abandoned in 2013, however, because of the excessive costs for particularly SMEs.¹⁵

Again, these measures do not specifically aim at supporting electric freight transport. They may induce the replacement of old diesel vehicles by freight EVs, but in the current situation this is unlikely to amount to a significant share of replacements and, therefore, reduction of NO_2 emissions.

Apart from the environmental zone, there is a weight limit of 7,500 kilos for vehicles in the inner city. In view of their higher weight and lower load capacity compared to conventional

¹⁴ A complicating factor is the signature that may be required to confirm the delivery. For this reason UPS is not interested in night deliveries (interview with Mr. C. Vanhoegaerden, UPS).

¹⁵ See RTV Noord-Holland (2013), <http://www.rtvnh.nl/nieuws/117387/Milieuzone+voor+bestelwagens+van+de+baan>.

trucks, electric truck can get an exemption, provided that they are not excessively large or heavy.¹⁶ However, not strict criteria seem to exist for this.

Figure 6: Environmental zone in Amsterdam.



Source: Municipality of Amsterdam.

5.4 Supportive measures aimed at reduction of tailpipe emissions

A third category of measures aims at the reduction of tailpipe emissions by the replacement of vehicles by newer and cleaner vehicles. This is considered supportive to the environmental zone described above, but in fact the two measures are two sides of the same coin. Firms that need to deliver goods at destinations within the environmental zone and do not have an exemption are forced either to replace old vehicles by cleaner ones, or make use of the services of third parties (for instance in the form of an urban distribution model).

Policy measures have been implemented that aim at the replacement of various types of diesel vehicles by either cleaner diesel vehicles or by EVs. Different measures aim at company-

¹⁶ Interview with Mrs. P. Bakker, Municipality of Amsterdam.

owned passenger cars, large vans and medium-sized trucks (Table 9). Introduction of subsidies for the replacement of privately-owned diesel passenger cars are considered insufficiently cost-effective, because they generate relatively little effect. The replacement of company-owned passenger cars and taxis, which tend to drive more kilometres, has a much larger effect. In both cases policy also supports the replacement of diesel cars by EVs. The subsidy for an electric company-owned passenger car has been raised from 3.500 euro in 2011 to 5.000 euro in 2014.

Vans account for about 20% of the vehicle kilometres driven in Amsterdam, but are responsible for 30% of transport-related emissions (Municipality of Amsterdam, 2011a: 35). For small vans (e.g. Renault Kangoo) replacement by EVs is cost-effective. It is foreseen that with a subsidy of 4.000 euro per vehicle in 2015 700 small vans will be EVs, or 7% of the total (the subsidy has been raised to 5.000 euro in 2014). The replacement of Euro 5 diesel vans by Euro 6 vans is not cost-efficient, because the difference between Euro 5 and Euro 6 is too small in practice. With regard to large vans the situation is different. Because electric large vans are much more expensive (and thus require a large subsidy) replacing large Euro 5 vans by EVs is not cost-efficient, while replacement by Euro 6 vans is. Large vans include small buses used for the transport of e.g. school children and elderly. Since this is often commissioned by the municipality, it can be influenced by means of the procurement requirements.

Table 9: Targets and subsidies for the replacement of Euro 5 vehicles by Euro 6 or EV (measures related to electric mobility shown in red).

category	target (2011)	share of total (%)	target (adjusted)	subsidy per vehicle (€)
electric company-owned passenger cars	850	17	425	3,500
Euro 6 company-owned passenger cars	1875	40	1680	1,000
electric taxis	450	20	200	5,000
Euro 6 taxis	940	40	470	6,000
electric small vans	680	7	480	4,000
Euro 6 large vans	1,100	10	715	2,500
Euro 6 heavy trucks	225	10	200	8,000
electric medium-sized trucks	100	3	30	40,000
Euro 6 medium-sized trucks (from 2013)	225	<10	145	7,500

Source: Gemeente Amsterdam (2013a: 20-2)

Trucks account for only 4% of the vehicle kilometres, but are responsible for about 35% of emissions (Gemeente Amsterdam, 2011a: 37). This makes them the largest contributor to transport-related emissions. Of the circa 6.000 trucks in Amsterdam 55% are medium-sized trucks and 45% large ones. The replacement of large trucks is relatively expensive, not making it cost-efficient. Policy regarding large trucks therefore focuses on the replacement by Euro 6 trucks. With regard to medium-sized trucks the situation is more favourable for EVs. This includes the type of trucks used for urban distribution from logistic centres at the edge of the city.

Finally, facilitating policies are implemented to support the introduction of electric mobility. These focus primarily on the development of charging infrastructure and on communication, but are aimed at passenger cars rather than commercial vehicles. Nevertheless, within the context of the FREVUE project, subsidies are available for companies that want to establish a charging point at their own premises. These subsidies vary from a maximum of 1,000 euros for charging points open to the public, to a maximum of 500 euros for charging points for private use only.¹⁷

The target numbers mentioned above have been adjusted in 2013 after the evaluation of the policies introduced in 2011 (Table 9). The effects of Euro 4 and Euro 5 have been disappointing, in the sense that these vehicles were considerably less clean than expected; meanwhile the availability of Euro 6 vehicles was less than hoped for. This made it sensible to 'strategically postpone' some of the measures until sufficient Euro 6 vehicles were available, to prevent firms to invest in Euro 5 vehicles.

The evaluation has not been very positive with regard to electric mobility either. It was concluded that the expectations of the number of EVs that could be introduced have been too high. This was due to a limited availability of electrical freight vehicles, as well as the unfamiliarity of firms with electric vehicles and uncertainty about the risks and possible growing pains.¹⁸ This should not just include reliability, but also the availability of after sales service and the compliance of guarantees.¹⁹ A pilot, subsidized by the national government, in which 50 medium-sized trucks would be replaced by EV, was cancelled. In 2014 subsidies for electric vans and company-owned passenger cars have been raised. These subsidies add to the subsidies granted by the national government.

Regarding EV as well as Euro 6 vehicles, the economic downturn since 2008 also played a role, as firms were less likely to replace their fleet and, if they did, increasingly bought used rather than new vehicles.

5.5 Other supportive measures

Other supportive measures focus on a variety of transport mean other than regular passenger and freight vehicles (Gemeente Amsterdam, 2011a: 38-40). These measures do not focus specifically on electric mobility. Moreover, measures regarding electric mobility have been considered, but are so far not cost efficient.

¹⁷ Interview with Mrs. P. Bakker, Municipality of Amsterdam; see also <http://www.amsterdam.nl/parkeren-verkeer/amsterdam-elektrisch/opladen/subsidie/@462233/pagina/>.

¹⁸ The not yet fully mature status of much of the technology involved also means transport firms themselves may have to apply for legal approval of the vehicle for road use by the Rijksdienst voor het Wegverkeer (the Dutch Driver and Vehicle Licensing Agency), which can be a lengthy procedure, even if a similar vehicle has been approved by for instance the German authorities (interview with Mr. C. Vanhoegaerden, UPS).

¹⁹ Interview with Mr. P. Appel, Peter Appel Transport; interview with Mr. H. Tol, Technische Unie).

Supportive measures include the replacement of old local EEV busses by EEV+ busses.²⁰ The largest effect is generated by the replacement of 70 busses that regularly drive at the Prins Hendrikkade (in front of the Central Station and one of the streets with the highest NO₂ concentration). This measure is therefore considered cost efficient and seems to generate even more effect than initially calculated. After evaluation, however, the target has been adjusted to the replacement of 40 articulated busses by Euro 6 busses. Replacement of the other 160 local busses generates only a minor effect and is not cost efficient.

The Prins Hendrikkade is also the location of the jetties of the round-trip boats which transport tourists through the Amsterdam canals. The concentration of diesel-powered boats adds further to the large NO₂ concentration on this location. It is therefore cost efficient to replace the engines of these boats by newer engines that meet the CCR3 norm.²¹ Nonetheless, subsidies for clean diesel-powered boats have been terminated in April 2014, the now redundant funds being redirected to the subsidy for electric boats.²²

The municipality further considered the replacement of its own fleet of vehicles by EVs or Euro 6 vehicles, but the effect of this is small due to the on average small distances driven by these vehicles. The measure is therefore not cost efficient. Likewise, the replacement of mopeds by electric mopeds is too expensive and generates too little effect to be cost efficient.

5.6 Conclusions

Local policy in Amsterdam to support clean freight transport - and clean transport in general for that matter - applies a twofold approach:

- an explicit focus on air quality norms, specifically those for NO₂ and PM₁₀ emissions, rather than on electric mobility as a aim in itself. EVs are supported, though, as a means to meet the air quality norms;
- a strong focus on the cost efficiency of policy measures, in order to achieve a maximum improvement in air quality for the given budget. Amsterdam has been the first city to calculate the cost efficiency of measures in detail.

This means in practice that measures focus on a limited number of locations, where NO₂ norms are exceeded. Also, measures focus on this categories of vehicles that generate the largest share in emissions, partly because they are large and heavy (trucks), partly because they make the most vehicle kilometres (vans, taxis).

Measures focus on the emission of NO₂. The experience so far is that PM₁₀ emissions also decrease due to measures aimed at NO₂, and do therefore not require additional measures.

²⁰ EEV does not relate to electric mobility but to emission norms comparable to Euro 5/6. In the evaluation of measures in 2013 the municipality used the more common Euro norms.

²¹ An emission norm for inland vessels, defined by the Central Commission for the Navigation of the Rhine.

²² See <http://www.amsterdam.nl/parkeren-verkeer/nieuws-onderdelen/amsterdam-elektrisch/2014/subsidieregeling/>.

Results so far have been good, but less than expected and hoped for. Several reasons may be indicated for this:

- the reductions in emissions from Euro 4 and 5 vehicles were much less than expected;
- initial expectations concerning the number of EVs and Euro 6 vehicles that could be introduced have been too high;
- the availability of Euro 6 vehicles and electric trucks was less than expected;
- the willingness of private parties to invest was less than expected due to the economic crisis.

While the municipality seems to put increasing emphasis on electric mobility (for instance by making some subsidies no longer available for Euro 6 vehicles and the participation in European projects), this shift in attention is not necessarily supported by companies that have experience with the use of electric freight vehicles. They stress that electric mobility may be overemphasised, as Euro 6 technology is also quite clean and much more mature.^{23, 24}

Finally, experiences in Amsterdam have shown that in some cases it is more effective to postpone measures, to stimulate or enable firms to make the step to the cleanest possible, rather than intermediary technology.

²³ Interview with Mr. H. Tol, Technische Unie; interview with Mr. C. Vanhoegaerden, UPS.

²⁴ This is in contrast to the findings of Van Duin *et al.* (2013) who conclude that the current generation of electric freight vehicles may potentially reduce the number of vehicle kilometres in urban distribution in Amsterdam by 19%, and the CO₂ emissions by 90%.

6 Recommendations

6.1 Recommendations

The municipality of Amsterdam already has a quite elaborated policy to support clean freight transport, including both electric and Euro 6 diesel vehicles. It wants to increase its focus on EV, but at the same time the results so far are mixed, and a focus on Euro 6 vehicles is likely to generate much larger results in terms of a quick improvement of air quality. Nevertheless some issues can be identified that may strengthen the position of electric freight transport within the prevailing policies.

Focus on reliability

The quality of the vehicle (reliability and performance, but also after sales and the compliance of guarantees) is crucial. This still is a main worry for many companies that consider electric mobility. The possibility of obtaining a subsidy is in many cases subordinate to this requirement. It should be considered how to use subsidies in such a way that new initiatives are triggered to improve and demonstrate the reliability and usefulness of electric vehicles. It has been done, showcasing successes but also problems, but responses from companies show there is still a lot to win in this field.

The municipality as a customer

Municipality can improve its exemplary role. Whereas it is not cost efficient to replace the municipal fleet, the municipality should still use their influence, not as a policy-maker but as a large organization, to stimulate clean mobility. It does so, to some extent, by means of the procurement requirement for the transport of e.g. school children, but measures such as these could be focused more explicitly at electric mobility, and include freight transport for the municipal organisation.

Urban distribution

Especially in a city such as Amsterdam, transport by electric boats should also be taken into account in urban distribution.

Harmonization of rules

Although subsidies and privileges are available, it is not always easy for companies to apply for them. Overcoming municipal bureaucracy seems to be an uphill struggle, and in some cases prevents companies from applying for subsidies. Moreover, companies complain about every city having different rules (for instance concerning delivery time windows) and procedures, so having experience in one city is only of limited use in another city. Also, since many of the vehicles involved are not yet fully mature, getting an approval for road use may also take a long time, even if the same vehicle is approved in Germany. Better national and international harmonization of rules could improve this.

Tailor-made approach

The results of policy and of pilot studies so far indicate that at this stage of development of electric freight transport a tailor-made approach is required. The municipality, itself lacking sufficient technical expertise, may mediate between firms considering electric freight

transport, and experts that could e.g. analyse the firm's logistic requirements from the perspective of e-mobility.

6.2 Lessons from Amsterdam

An advantage of the quite elaborated policy in Amsterdam is that some lessons may be drawn that may also be of use for other cities.

Focus on costs efficiency and effectiveness

First and foremost this is its distinct focus in several aspects:

- it focuses on the specific locations where the European air quality norms for NO₂ and PM₁₀ are exceeded. Measures focus on the emission of NO₂. The experience so far is that PM₁₀ emissions also decrease due to measures aimed at NO₂, and do not require additional measures;
- it focus on measures that generate the most effect per euro invested. This approach is based on elaborated calculations that resulted in the Cost Abatement Curve (Figure 5, p. 19) that guides the selection of policy measures;
- it focuses on the categories of vehicles that contribute most to NO₂ and PM₁₀ emissions, i.e. vehicles that make the most vehicle kilometres, or that pollute the most per vehicle kilometre.

Particularly the Cost Abatement Curve is a useful tool to maximize the effects of policy (and indeed other cities have shown an interest in this). However, like most of Amsterdam's policy it focuses on air quality, rather than on electric mobility as such.

On the whole, Amsterdam's policy is characterized to a considerable degree by small, local and efficient interventions, focused on maximising effect within a limited budget.

Pragmatism

In some aspects the relevant policy approach in Amsterdam is surprisingly pragmatic. This is for instance the case when measures are strategically postponed until vehicles of the newest (i.e. cleanest) possible type are available. Once companies have invested in a Euro 5 truck rather than a Euro 6 truck, they are unlikely to renew it again anytime soon. Also, control of the environmental zone is likely to become more strict, and the number of exemptions much less, as Euro 6 vehicles are sufficiently available.

Likewise, in certain cases electric trucks, because of their higher weight and lower load capacity, are exempted from the weight restrictions for vehicles driving in the inner cities. The way in which this is done has an air of subjectivity, however, making it vulnerable for criticism by competitor firms.

7 Interviews

interviewee	organisation	involvement
Mr. Peter Appel	Peter Appel Transport	experimenting with the use of electric trucks in food wholesale transport
Mr. Chris Vanhoegaerden	UPS	pilot of 6 electrified Mercedes vehicles
Mr. Henk Tol	Technische Unie	experimenting with electric truck
Mr. Willem Post	Mokum Mariteam	uses electric ships for transport in Amsterdam canals
Mrs. P. Bakker	Municipality of Amsterdam	policy-making

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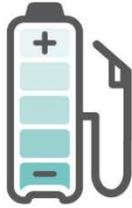
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NORTH SEA REGION ELECTRIC MOBILITY NETWORK

e-mobility NSR

About E-Mobility NSR

The Interreg North Sea Region project North Sea Electric Mobility Network (E-Mobility NSR) will help to create favorable conditions to promote the common development of e-mobility in the North Sea Region. Transnational support structures in the shape of a network and virtual routes are envisaged as part of the project, striving towards improving accessibility and the wider use of e-mobility in the North Sea Region countries.

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