Charging infrastructure for electric vehicles in city logistics

Getting zero emission trucks on the road

Matthijs Otten, CE Delft

CE Delft

Committed to the Environment

CE Delft

- Independent environmental research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- 60 employees, based in Delft, the Netherlands
- Not-for-profit

Clients

Industries
(Small and medium size enterprises, transport, energy and trade associations)

Governments
(European Commission, European Parliament, regional and local governments)

NGOs

Buck Consultants International

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Topsector Logistiek

Connekt

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Introduction: Policy context

Paris agreement -> Dutch Climate Agreement

Dutch Climate agreement

- In 2025: ZERO emission zone in 30-40 cities in the Netherlands (1 Mton CO_2 reduction)
- Regulation in zones:
  - Only ZE/ PHEV Vans can enter ZE zones
  - Only ZE/ PHEV HGVs can enter ZE zones, with exemptions for existing HGVs at January 2025:
    - Articulated Truck-trailer Euro VI, age < 8 years
    - Box lorries Euro VI, age < 5 years
- Larger cities are developing plans that will be presented this year.

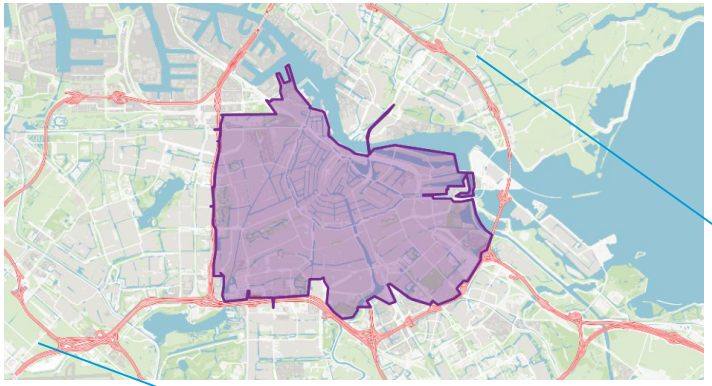
Introduction: Policy context

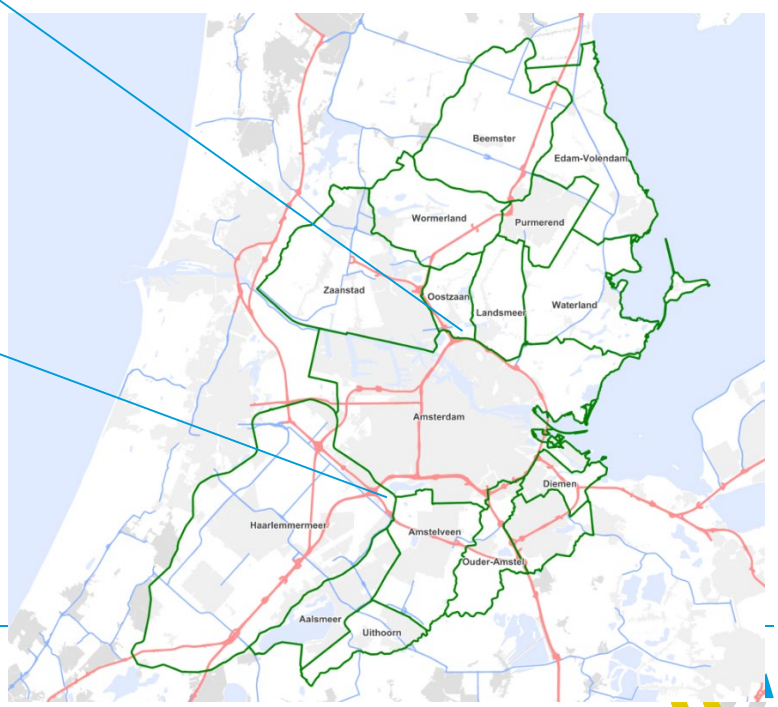
Important questions:

1. At what location are trucks going to charge:
   Depot (Private), Customer site (Private), Third party (Public station)?
   - What is role for fleet owners/ distribution centres?
   - What is role of governments
2. What kind of battery packs and charging power is needed for the trucks?
3. What is the geographical spread in energy/ power demand?
4. What is the impact of the energy demand on the electricity network?

Introduction: Scope of study

- Case study on ZE zone in Amsterdam (current environmental zone)





- Effects on charing for Greater Amsterdam

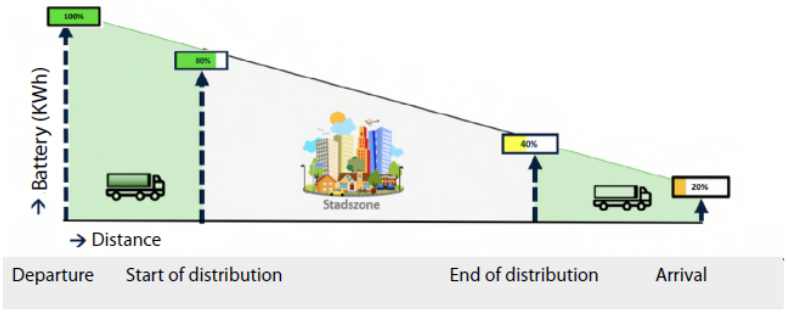
Assumptions

- Logistic profiles remain the same.
- All HGVs will be BEV (no PHEV or H_2)

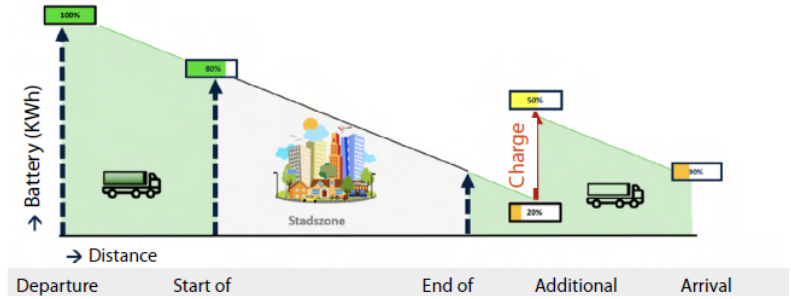
1: Optimal charging behaviour

Cost optimisation model: scenarios

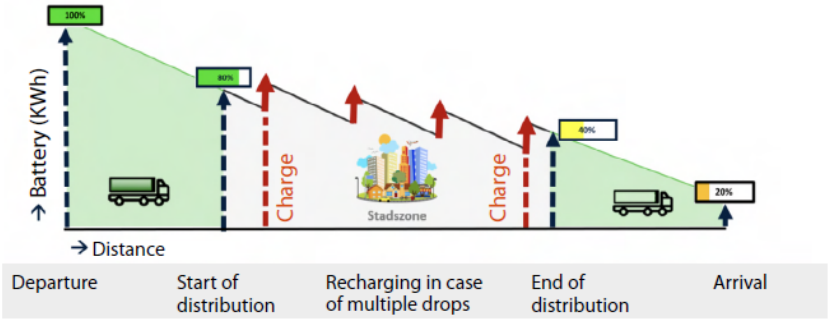
Scenario 1: No recharging



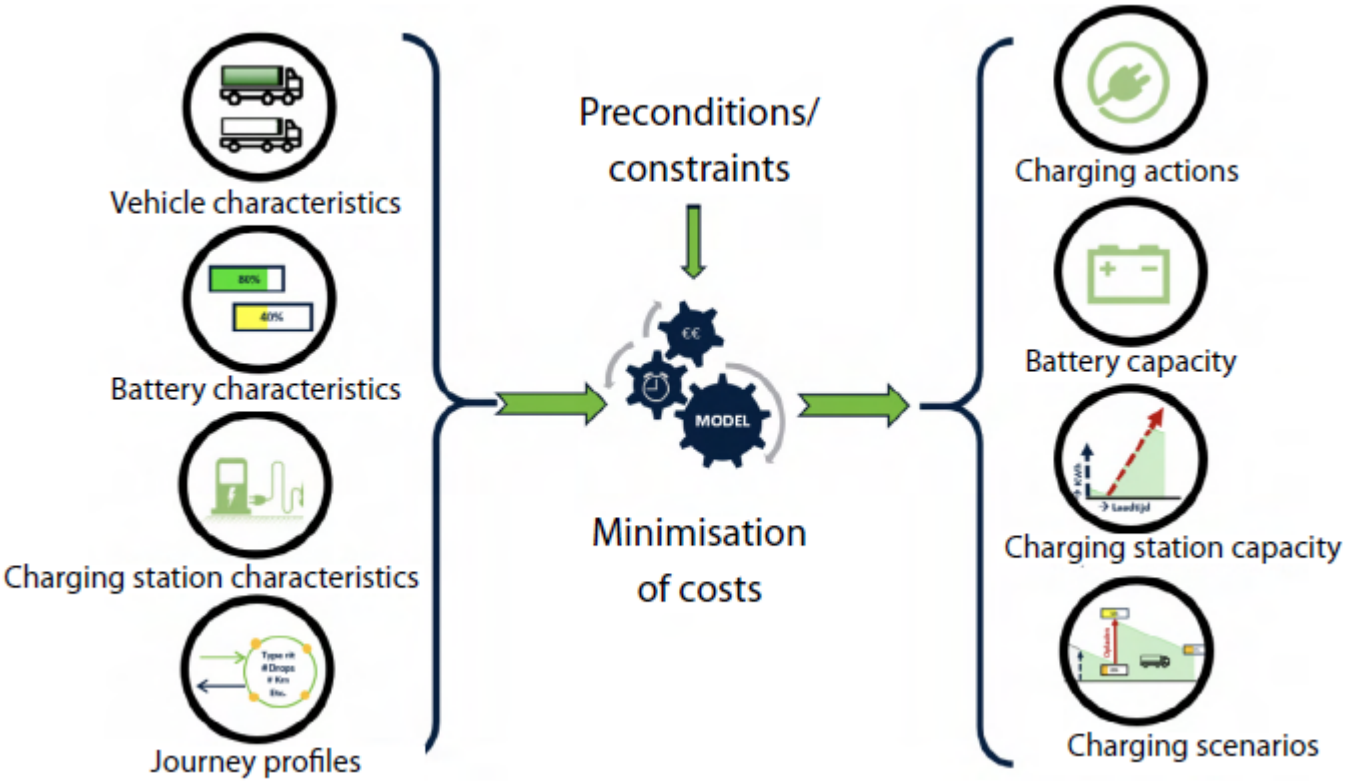
Scenario 2: Additional charging stop.



Scenario 3: Charging at the customer (delivery address/stop address).

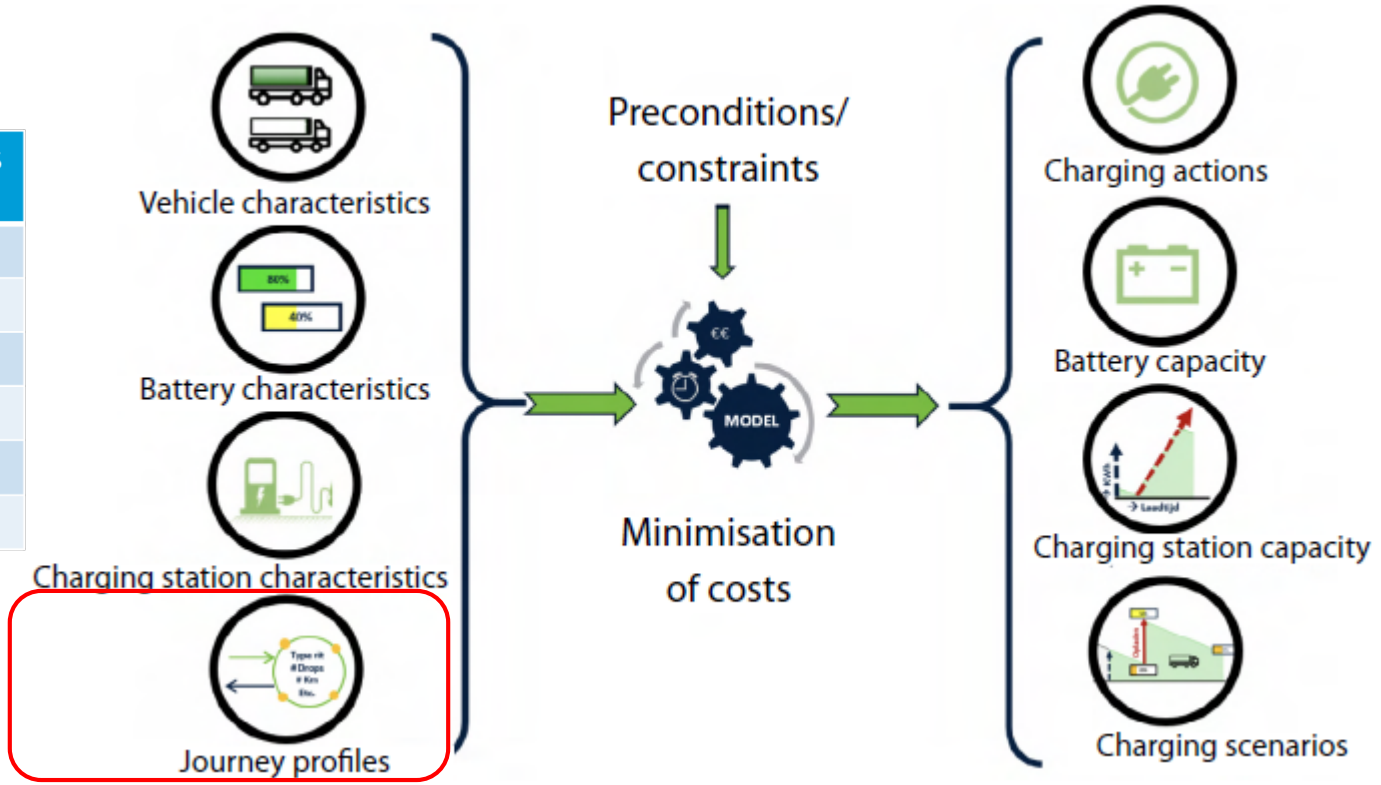


Method: Cost optimisation model



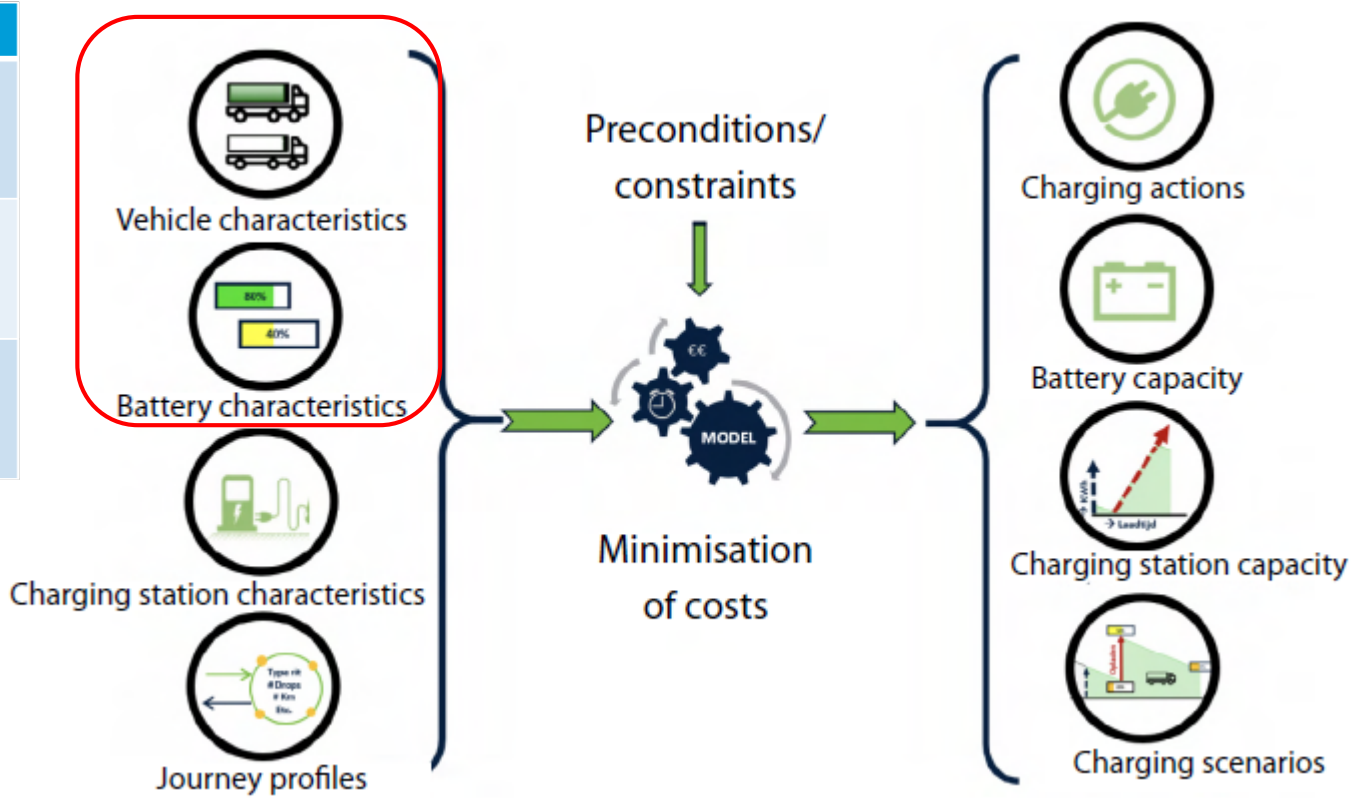
Method: Cost optimisation model

Sectors in city logistics (HGV)
Waste collection
Construction
Facility services
Catering/ hospitality
Retail (Food)
Retail (non-Food)



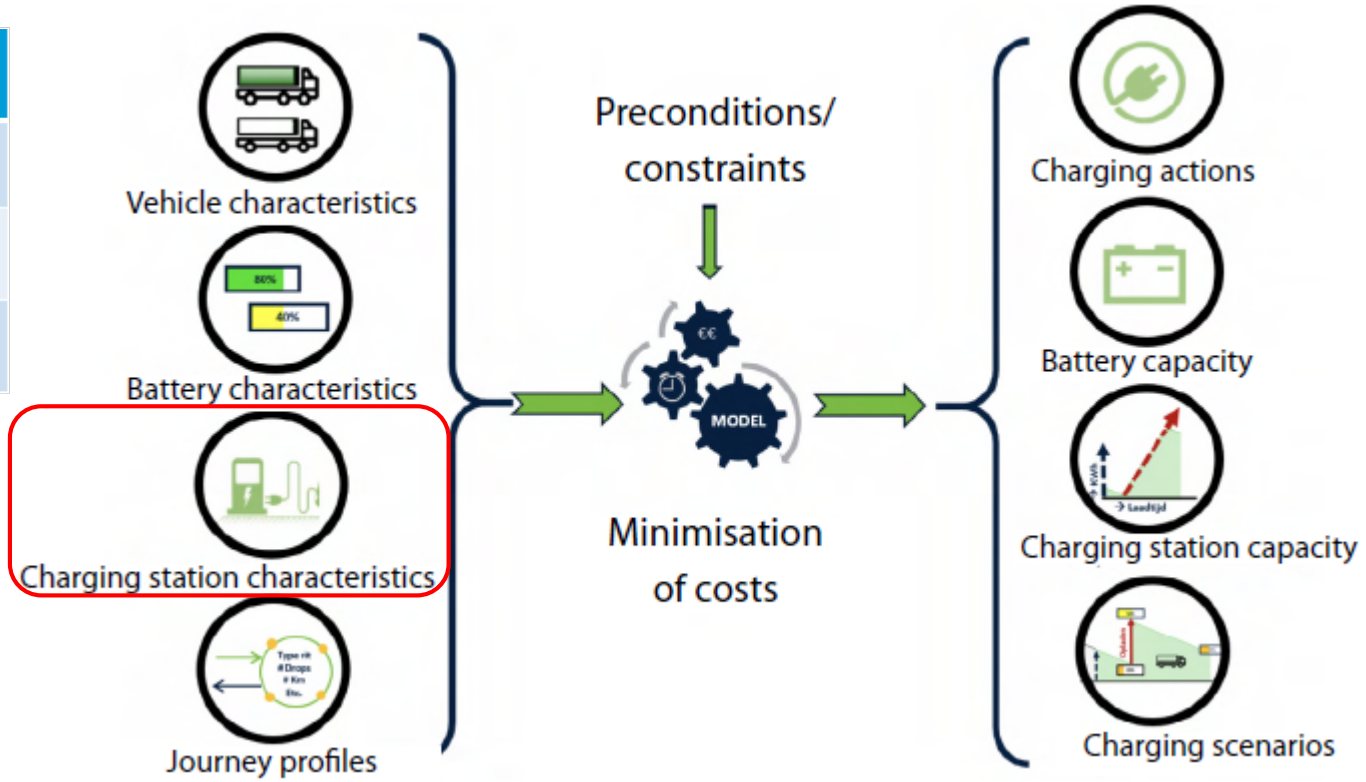
Method: Cost optimisation model

HGVs in analysis
Small box truck (12t) Battery: 80, 120, 160 kWh
Large box truck (19t) Battery 120, 200, 240 kWh
Truck trailer (37t) Battery 170, 240, 320 kWh



Method: Cost optimisation model

Charging solution (Private and public)
FC 50: 50 kW DC Fast charger
HPC150 DC super fast charger
HPC350 DC ultra fast charger



Results: charging behaviour trucks :

% of kWh charges per location type

Sectors in city logistics (HGV)	Fast charging at public station	At depot/ distribution centre	At customer site
Waste collection	15%	85%	0%
Construction	5%	80%	15%
Facility logistics	5%	85%	10%
Catering/ hospitality	5%	85%	10%
Retail (Food)	5%	75%	20%
Retail (non-Food)	10%	60%	30%

Results: charging behaviour trucks

Share (%) of kWh charged per charging station type

Charging station	Fast charging at public station	At depot/ distribution centre	At customer site
FC50 – private 50 kW		5%	2%
HPC 150 –private -150kW		80%	87%
HPC 150 – public -150kW	-	-	-
HPC 350 – private -350 kW		15%	11%
HPC 350 –public -350 kW	100%		

Results: charging behaviour trucks

Optimal battery package (% trip profiles studied)

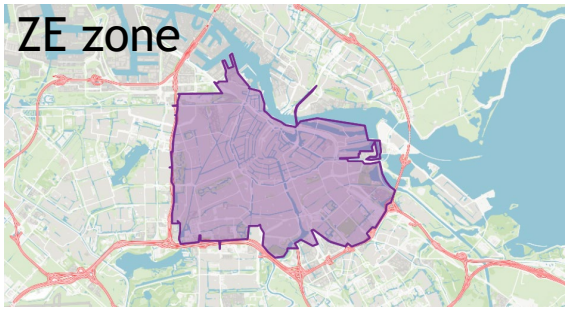
Battery size	Small box truck	Large box truck	Truck trailer
Small	19% (80 kWh)	60% (120 kWh)	6% (170 kWh)
Medium	35% (20 kWh)	21% (200 kWh)	14% (240 kWh)
Large	47% (160 kWh)	19% (240 kWh)	81% (320 kWh)

Part 2: Applying results to case Amsterdam

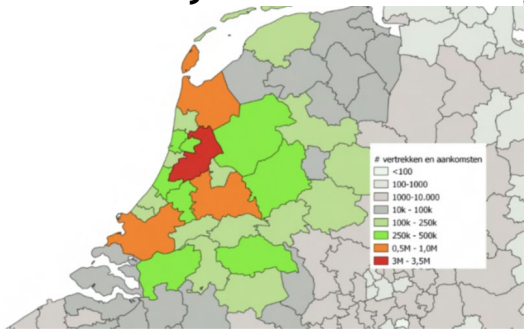
Statistics from annual survey (CBS)

- 4700 trucks visit the environmental zone of Amsterdam regularly
- 325 million kilometres -> 470 GWh energy demand for Electric trucks

	To/ from EZ Amsterdam		All activities	
	# trips / year (x1000)	Distance (mln km)	# trips/ year (x1000)	Distance (mln km)
Truck-trailer	378	26	2,694	204
Box trucks	403	19	1,474	81
Other	150	5	907	40
Total	**931**	**50**	**5,076**	**325**

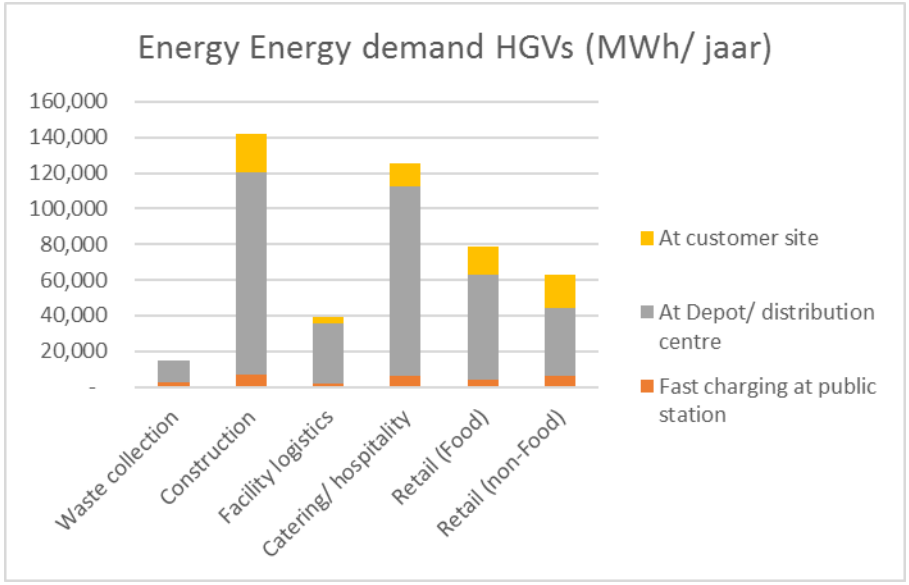


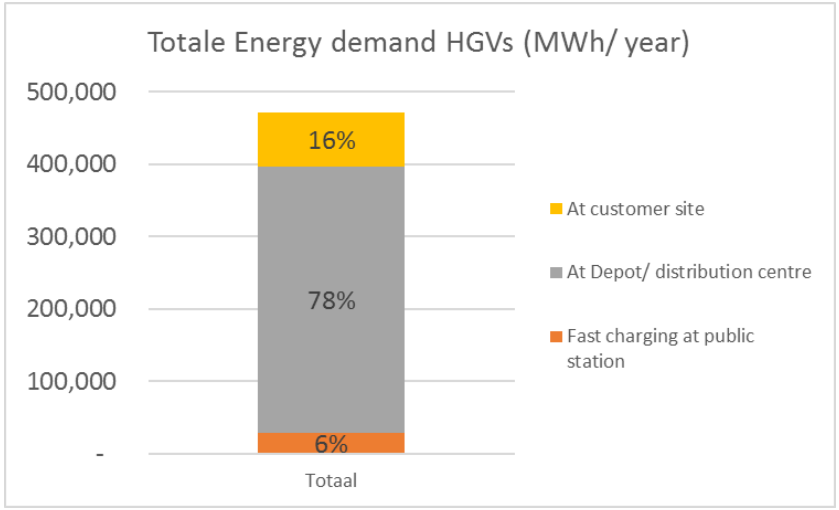
Activity area of trucks



Scaling result for Amsterdam

- Sector in City logistics known for 4700 HGVs (CBS Statics)
  => Energy demand per sector
  => Energy demand per type of location (depot, third party, customer)





Geographical allocation of energy demand

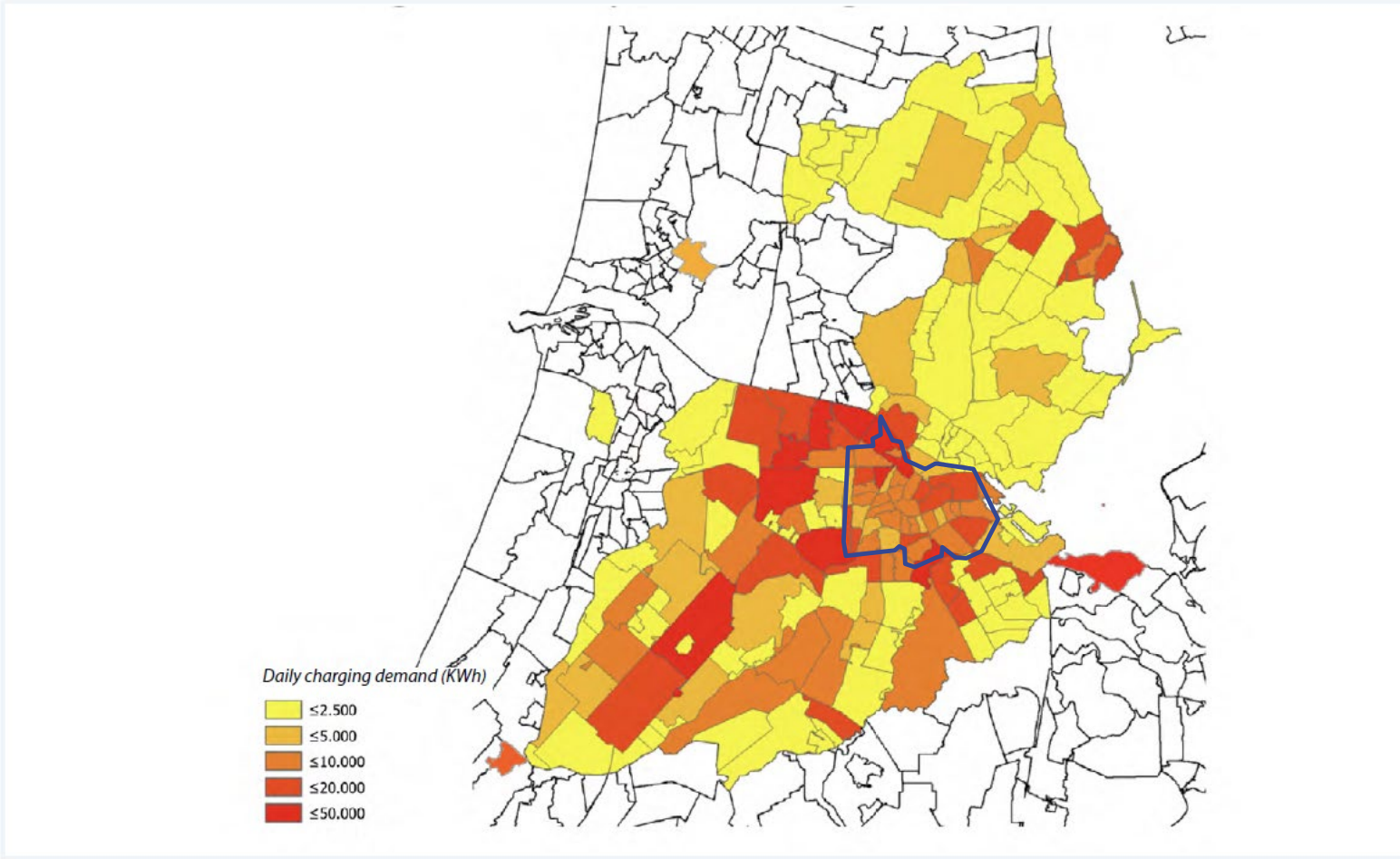
Method

- Depots charging: based on survey information CBS on overnight location trucks (postal code 4 areas)
- Location of customer: Estimated on HGV origin destination relations with Amsterdam (transportation model region Amsterdam)
- Location of fast charging at public station: Traffic intensities on main roads from transportation model.

Result

=> Total Energy demand in Greater Amsterdam from HGVs: **123 GWh** (1-2% of total energy demand)

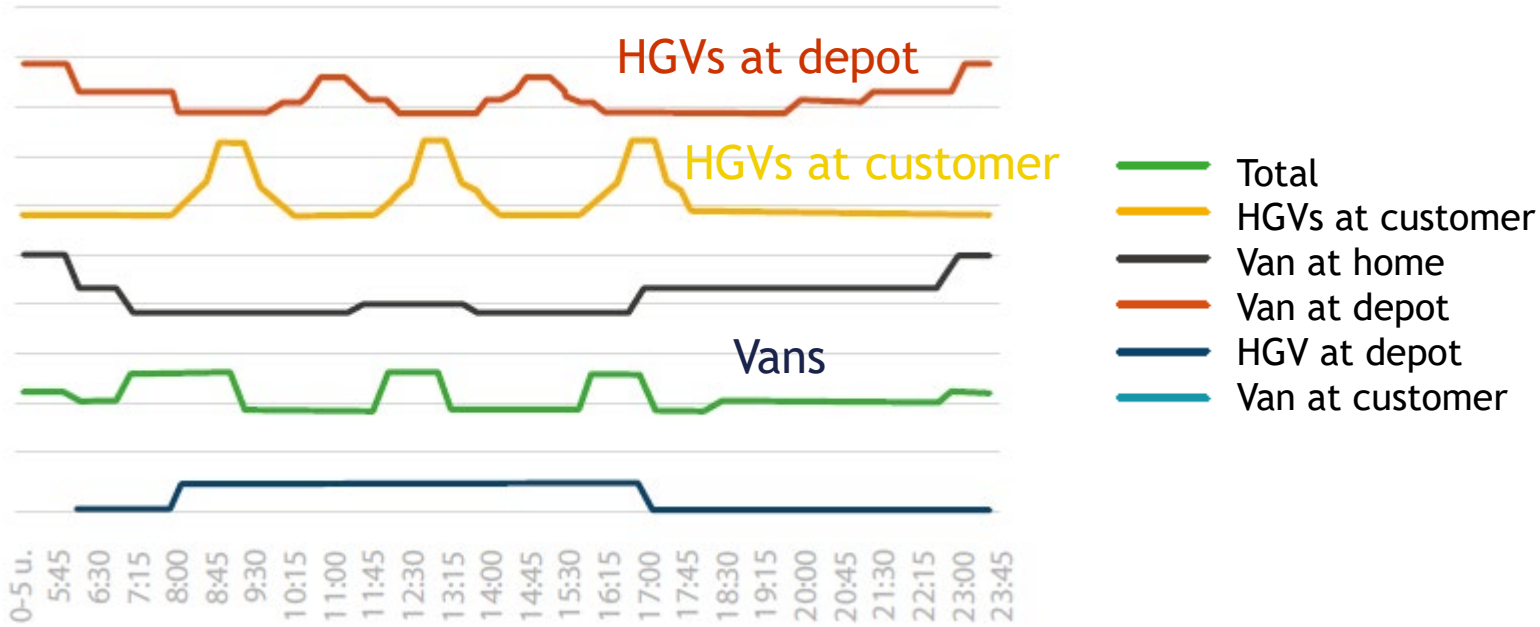
Results: Geographical energy demand (HGVs and vans)



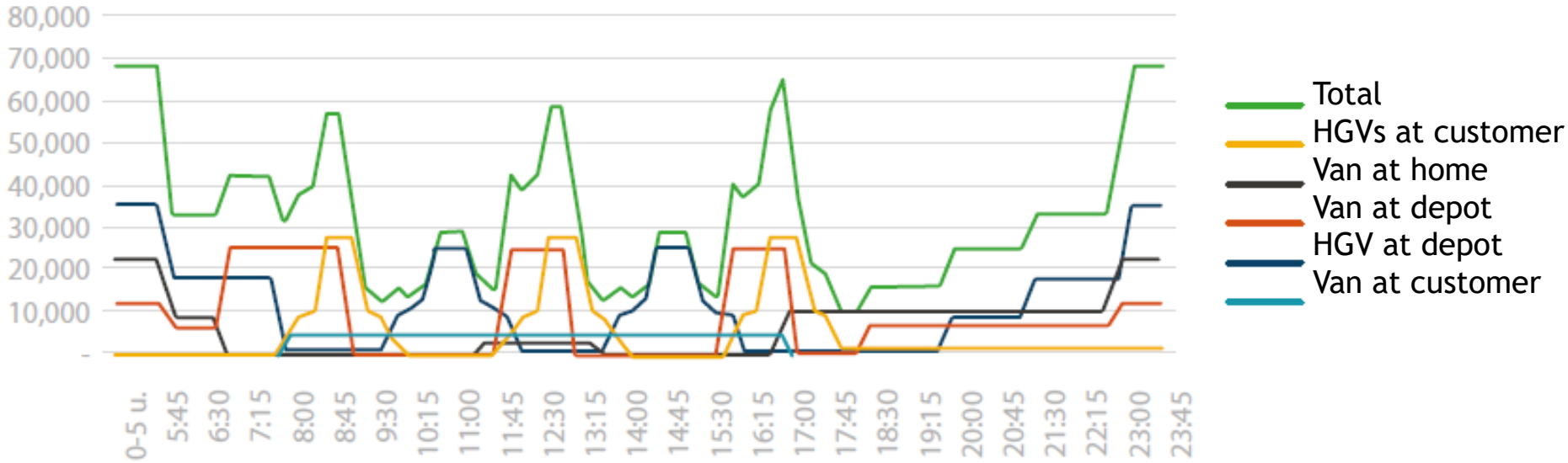
Impact on eletricity net: method

- Conversion of Energy demand in maximum power demand with charging profiles
- Per postal code area, maximum power demand has been calculated.

Charging profiles



Impact on electricity grid:
Result Greater Amsterdam



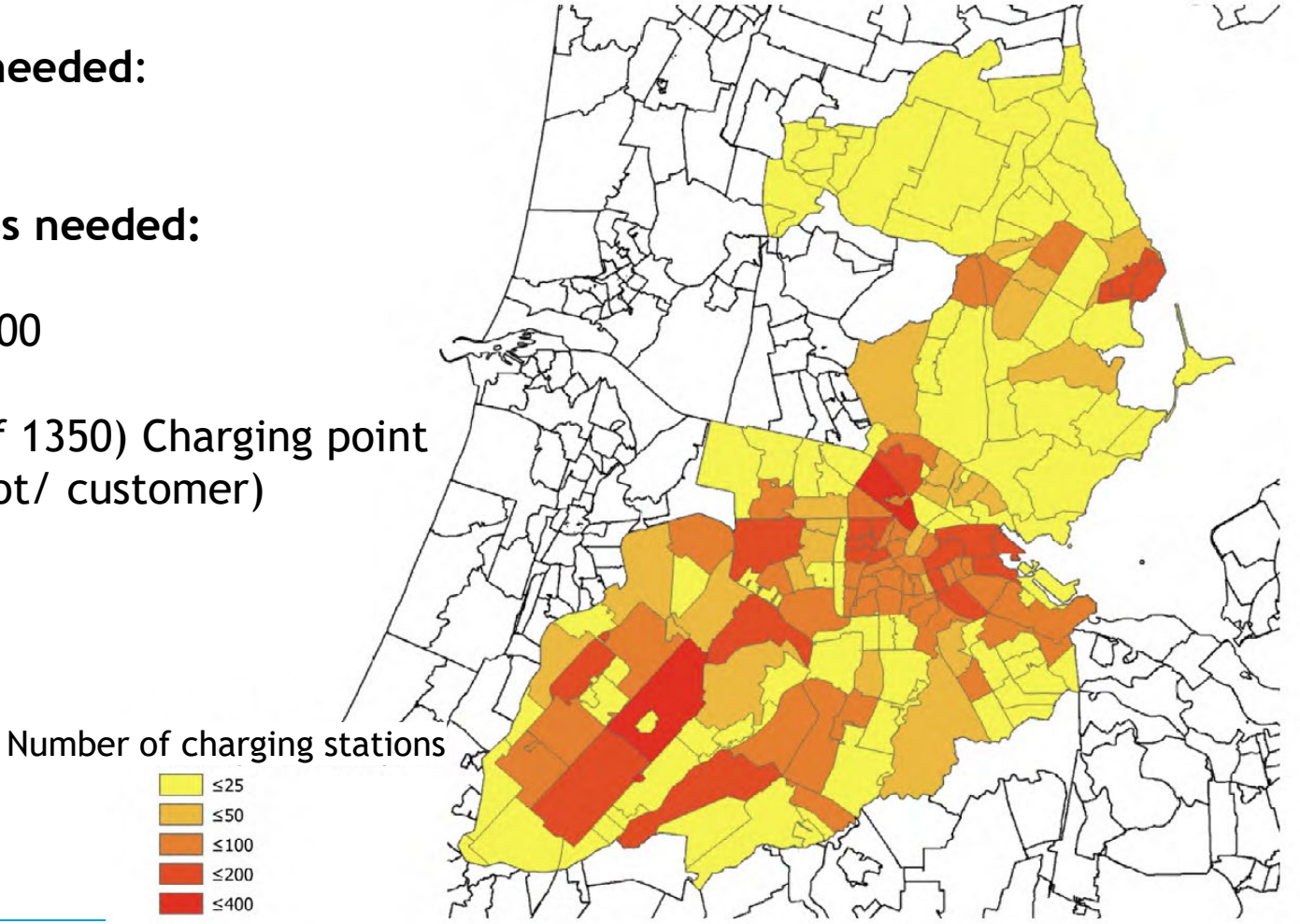
Impact on electricity grid: Result

- Calculation by electricity distribution system operator:
  Only little increase in power demand on power grid substations <0,25% for 25 out of 26 stations, only one station (port area) with a 1.5% increase.
- However: For connections above 2 MW (5 in this case) a direct connection to substation is required.
  - No free field on substation: 1-3 year waiting time
  - Power capacity not sufficient: 3-8 years
- **Fleet owners need to consult electricity distribution system operators in time about their situation and plans.**

Result: Infrastructure need (HGVs and vans)

Charging point needed:
HGV: 1350
Vans 17,130
Charging stations needed:
HGVs: 418-772
Vans: 9.700-10,600

Majority (1340 of 1350) Charging point are private (depot/ customer)



Conclusion

- Electric HGVs in city logistics will charge mainly at depots and distribution centres at night using 150 kW charging stations.

  => No need for local governments to provide charging infrastructure in city centres

- It seems well possible to perform most of current City logistic operations with electric HGVs
- A zero emission zone in Amsterdam will cause a total energy demand in greater Amsterdam of 120 GWh from Electric HGVs (1-2% of total energy demand).

  => 350 GWh energy demands outside greater-Amsterdam.

- The increase in power demand due to the charging of electric vehicles is limited (<0,25%)
- For large electric truck fleets (~50): Consult the energy network company in time.

Ongoing discussions and work

Discussion in response to report.

- Electric HGVs are not commercially available on large scale – still uncertainty on costs, range: little experience.
- Some logistics parties pioneering with E-trucks are experiencing problems with the range of E-trucks in their operation; there is a big variation in logistical profiles

⇒Top Sector Logistics will organize expert/ user discussion groups to share experiences on availability and costs of E-trucks and charging infrastructure.

Ongoing research

- Extension of Amsterdam analysis to other cities and possibly group of cities.
- Check of statistical method with camera observations.