Electric freight vehicles – out of niche into mass market

Results of the IA-HEV Task 27 “Electrification of transport logistic vehicles”
3rd Workshop held in Vienna on October 19th, 2016

suggested citation format:
09:30 Start of Workshop

09:30 - 09:45 Opening and Task 27 introduction
Stephan Schmid, DLR and scientific delegate to the IA-HEV ExCo

09:50 - 10:00 Why Electric Transport Logistic Vehicles? - Major effects relevant to cities
Hans Quak, Senior Scientist at TNO

10:05 - 10:25 Analysis of (Inter)National Electric Vehicle Projects, Key Factors Underlying Success and Failure
Frank Rieck, Lector Future Mobility

Session 1: City and country perspectives

10:30 - 11:00 Best practice experiences of pioneer cities for electric freight vehicles: Case of Amsterdam
Eric Regterschot, Project manager sustainable Mobility of Amsterdam

11:00 - 11:10 Coffee break

11:10 - 11:40 Need for electric freight vehicles implementation: A common understanding of leading european cities
Jos Streng, Projectmanager of FREVUE in Rotterdam

11:45 - 12:15 Introduction of Korea activities in electric truck
Ock-Taek Lim, Professor at Ulsan University

12:15 - 13:30 Electric truck demonstration and lunch break

Session 2: Early adopters of electric freight vehicles

13:30 - 14:00 Case of distributor TNT
Edwin Vermeer, Regional Operations Manager Rotterdam

14:05 - 14:35 Case of transport company Transmission
Bert Roozendaal, Transmission

14:35 - 14:55 Coffee break and networking

Session 3: Infrastructure for charging

14:55 - 15:25 eHighway System - Motivation, Current Status and Outlook
Hasso Grünjes, Siemens AG

15:30 - 16:00 Inductive opportunity charging - Status Quo and Outlook
Daniel Dörflinger, IPT Technology

16:00 - 16:10 Coffee break

Session 4: Panel Discussion

16:10 - 17:00 Plan of action for electric freight vehicle market penetration: Out of niche - into the mass market!
Moderation by Eric Beers

17:00 End of Workshop
Welcome to
IA-HEV Task Force 27
2nd Workshop
Experiences and prospects of electric freight vehicles
from city to distributor to transport company, including infrastructure technology
Enver Doruk Özdemir, Florian Kleiner, Martin Beermann, Bülent Çatay, Eric Beers, Bob Moran, Ock Taeck Lim, Stephan A. Schmid
International Energy Agency
Hybrid & Electric Vehicle Implementing Agreement

IA-HEV Mission

- Supply objective information to support decision making
- Facilitate international collaboration in pre-competitive research and demonstration projects
- Foster international exchange of information and experiences

Target audience

- Governmental bodies at national, regional and city levels
- Automotive industry
- Component suppliers
- Utilities

Network
Disseminate
Collaborate

www.ieahev.org
Need for alternative vehicles

Ever increasing freight demand
- Worldwide road-freight activity and energy use have almost doubled in the last two decades [IEA 2012]

Challenges for Cities
- Worldwide urbanization and online retailing activities are increasing inner city air pollution [UN 2011], [RSS 2012]

Expected changes of the regulation framework:
- Emission free inner city delivery
- CO₂ limits for HDV

Development and market introduction of alternative transport logistic vehicles is essential
Task 27: Electrification of transport logistic vehicles

Objectives & Working Method

**Objectives**

1. Summarize the status of vehicle and infrastructure technologies, implementation and hurdles.
2. Identify early niche markets and commercialization opportunities.
3. Provide policy recommendations for further research and deployment activities.

**Working Method**

Objectives are addressed in three ways:

- **Workshops**: to involve stakeholders and collect information.
- **Desk work**: to establish the scientific foundations, input for workshops and papers.
- **Public outreach**: to raise awareness in the broader community.

- **Project profiles**
- **Vehicle database**
Task 27 – current Outputs

- **1st Workshop held in Germany (2015-03-19):**
  “Electric transport logistic vehicle technology and its application”
  - Expert presentations regarding battery and fuel cell technology and real world data from electric transport logistic vehicles
  - Workshop session – Hurdles of implementation: Discussions about barriers, drivers, strategies and expectations

- **EVS28 (2015) paper:**
  Comparison of country individual Relevant Cost of Ownership per ton-kilometers for light commercial vehicles

- **EEVC (2015) paper:**
  Status and trends for electrified transport logistic vehicles

- **EL-MOTION 2016 conference presentation:**
  International experiences within the IEA HEV Task 27 „Electrification of transport logistic vehicles“

- **Project profiles:**
  Key facts of ongoing or terminated demonstration projects from the partner countries

- **Vehicle database:**
  Key facts of electric commercial vehicles available on the market or presented as prototypes. Approx. 90 vehicles are listed up to now.
Contact details

Operating Agent

Florian Kleiner
German Aerospace Center
Institute of Vehicle Concepts
Pfaffenwaldring 38-40
70569 Stuttgart
Germany
Office: +49 711 6862 8120
E-Mail: Florian.Kleiner@dlr.de

DI. Martin Beermann
JOANNEUM RESEARCH
LIFE – Centre for Climate, Energy & Society
Elisabethstraße 18/II
8010 Graz
Austria
Office: +43 316 876 1313
E-Mail: Martin.Beermann@joanneum.at
WHY ELECTRIC FREIGHT VEHICLES? MAJOR EFFECTS RELEVANT TO CITIES

Hans Quak, TNO
IA-HEV Task Force 27
12 April Amsterdam
Air quality is a problem in cities and CO\textsubscript{2} reduction an ambition

- Ambition European Commission: zero emission urban logistics in 2030
- Ambition in Green Deal Zero Emission City logistics (GDZES) in the Netherlands

The logistics industry is a significant driver of economic growth and essential for sustaining the urbanized way of living, but is also a heavy contributor to unsustainable impacts, such as:

- Polluted emissions, nuisance, decrease in traffic safety and accessibility

The uptake of EFVs in the logistics industry does not go easily

- Chicken and egg problem?
Commercial vehicles in urban traffic

- Commercial vehicles (vans and trucks) account for about 15% of urban traffic.

- Varies slightly between cities (especially ratio trucks – vans).

Source: Vehicle fleet scan Amsterdam (TNO, 2014)
What is a vehicle fleet scan and what data are used?

- Cameras registering license plates for one week of vehicles entering city

- Link to data on:
  - Among others: vehicle mass, fuel type, vehicle type and description, Euro-type, chamber of commerce data (including economic sector vehicle owner)
Urban freight transport

Total CO₂ emissions city traffic in the Netherlands

Estimated total emissions per year per vehicle type for all urban traffic in the Netherlands (TNO, 2015)
Urban freight transport

Total NOx emissions city traffic in the Netherlands

Estimated total emissions per year per vehicle type for all urban traffic in the Netherlands (TNO, 2015)
Urban freight transport

Total PM10 emissions city traffic in the Netherlands

Estimated total emissions per year per vehicle type for all urban traffic in the Netherlands (TNO, 2015)
Commercial vehicles in urban traffic

*Fuel type - example*

> Diesel drivelines dominate in urban freight transport

Based on vehicle fleet scan city of Utrecht (TNO, 2015)
CHALLENGE: TOWARDS ELECTRIC VEHICLES IN CITY LOGISTICS

How to make the transition from diesel dominated urban freight transport to more electrified city logistics?

Challenges:
- Solve chicken and egg problem… current market situation
- Not just replacing vehicles (EFV instead of ICEV), in most cases business case is not feasible:
  - New network and new partners needed for logistics companies
  - High initial costs (vehicle and charging infrastructure), lower operational costs (fuel vs. electricity, policy privileges)
  - Limited range requires other logistics organization
  - (Almost) no extra revenues for more sustainable transport
CURRENT SITUATION (ICE VEHICLES USED FOR CITY LOGISTICS)
ELECTRIC FREIGHT VEHICLES SITUATION (EFVS USED FOR CITY LOGISTICS)
CHALLENGE: TOWARDS ZERO EMISSION CITY LOGISTICS

How to make the transition?
So..

**Electric freight vehicles – why:**

- City logistics activities have unsustainable effects (both for local air quality and contribution of global emissions): electric vehicles can have a huge positive effect to counteract these effects, while maintaining an efficient urban logistics systems.

- Urban deliveries and trips do fit electric vehicle characteristics, but it requires (serious) changes for operators to actually use EFVs.

- Yes: there are challenges, but also good examples how to deal with these (as will be presented later today).
THANKS FOR YOUR ATTENTION

Dr. Hans Quak
Senior Advisor Sustainable Transport & Logistics

Van Mourik Broekmanweg 6
Postbus 49
2600 AA Delft
T +316 31792851
hans.quak@tno.nl

For more information:
• FREVUE Deliverable 1-3 addendum 1 ‘State of the art of the electric freight vehicles implementation in city logistics - Update 2015’ (http://frevue.eu/category/about-us/public-documents/)
“Experiences and prospects of electric freight vehicles”

Analysis of (Inter)National Electric Vehicle Projects, Key Factors Underlying Success and Failure

Frank Rieck, Professor Future Mobility

April 12th, Amsterdam
ANALYSIS OF (INTER)NATIONAL ELECTRIC VEHICLE PROJECTS

KEY FACTORS UNDERLYING SUCCESS AND FAILURE

Assignment: Evaluation Living lab Hybrid and Electric Vehicles
Netherlands Enterprise Agency (August 2014)

Dutch-INCERT, Eindhoven University of Technology and Rotterdam University

AUTHORS: Adrie Spruijt MMC and ir. Frank Neck
Dr. Ewit Roos and Tobias Platenburg BSc

November 16, 2015
National & International Pilots

NL:

• Rotterdam Tests Electric Vehicles
• Full Electric Garbage Truck
• Elektropool Haaglanden
• CityShopper urban delivery service
• Urban distribution with Hytrucks
• Express delivery / Courier service

EU:

• FREVUE (Freight Electric Vehicles in Urban Europe)
• DELIVER
## EV’s on the Dutch roads per type

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger car (FEV)</td>
<td>1.910</td>
<td>4.161</td>
<td>6.825</td>
<td>7.152</td>
<td>8.707</td>
</tr>
<tr>
<td>Passenger car (E-REV, PHEV)</td>
<td>4.348</td>
<td>24.512</td>
<td>36.937</td>
<td>38.978</td>
<td>50.926</td>
</tr>
<tr>
<td>Commercial Vehicle &lt; 3.500</td>
<td>494</td>
<td>669</td>
<td>1.258</td>
<td>1.267</td>
<td>1.392</td>
</tr>
<tr>
<td>Commercial Vehicle &gt; 3.500</td>
<td>23</td>
<td>39</td>
<td>46</td>
<td>46</td>
<td>52</td>
</tr>
<tr>
<td>Busses incl hybrid and trolley busses</td>
<td>67</td>
<td>73</td>
<td>80</td>
<td>80</td>
<td>88</td>
</tr>
<tr>
<td>Quadricycles (like Renault Twizzy)</td>
<td>469</td>
<td>632</td>
<td>769</td>
<td>774</td>
<td>842</td>
</tr>
<tr>
<td>Motor cycle</td>
<td>99</td>
<td>125</td>
<td>196</td>
<td>203</td>
<td>280</td>
</tr>
<tr>
<td><strong>Total on the road</strong></td>
<td><strong>7.410</strong></td>
<td><strong>30.211</strong></td>
<td><strong>46.111</strong></td>
<td><strong>48.500</strong></td>
<td><strong>60.490</strong></td>
</tr>
</tbody>
</table>

- 5,7% share in new sales (0,5% BEV’s)
- 390,000 cars per year
Different categories of Commercial Vehicles

In Europe, the vehicles used for road transport are categorised as follows

<table>
<thead>
<tr>
<th>Vehicle class</th>
<th>Gross vehicle weight</th>
<th>Field of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van (N1)</td>
<td>Below 3.5 t</td>
<td>Service and delivery vehicle</td>
</tr>
<tr>
<td>Light truck (N2)</td>
<td>3.5 – 7.5 t</td>
<td>Short haul</td>
</tr>
<tr>
<td>Medium truck (N2)</td>
<td>7.5 – 12 t</td>
<td>Medium short haul</td>
</tr>
<tr>
<td>Heavy truck (N3)</td>
<td>Above 12 t</td>
<td>Motor tractor in articulated train construction traffic</td>
</tr>
<tr>
<td>Road tractor (N3)</td>
<td>Usually up to 40, resp. 44 t</td>
<td>Long distance haul</td>
</tr>
</tbody>
</table>
City distribution Hytruck
Spijkstaal garbage truck
Clean & silent City Movers
Light Commercial segment
Light van & Cargo Hopper
In-harbour container transport: 40% of road trips shorter than 30 km

Source: M@R
EV’s in Port of Rotterdam

Ref: ECT, APM Terminals, APTS VDL & Terberge
Drivers for Urban e-Mobility

• Today: Air quality / Fine dust
• Today: City & Port Logistics
• Today & Tomorrow: Noise / Quality of live
• Tomorrow: Energy / CO₂
• Always: €€€€€€€€€€
Freight: The ‘big three’ city polluters

In 2015 72% of the NO\textsubscript{x} emissions are caused by 15% of the mileage in Dutch cities – Source TNO
There is no single solution

<table>
<thead>
<tr>
<th>Systeem</th>
<th>Range</th>
<th>Charge</th>
<th>Cost</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery-Electric system</td>
<td>Fair 300 km ↑</td>
<td>Bad 3 uur ↓</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Electric with range extender</td>
<td>Good 900 km</td>
<td>Good 10 min.</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Fuel Cell-Electric system</td>
<td>Good 900 km</td>
<td>Good 10 min.</td>
<td>Bad</td>
<td>Good</td>
</tr>
</tbody>
</table>

‘Horses for Courses’
Research: eMobility-Lab

- Regenerative energy
- Safety
- Cost
- Service

www.emobilitylab.nl
Typical losses in the energy chain

ICE- gemiddelde verliezen
EV- gemiddelde verliezen bij Nederlandse MIX
Regenerative Energy

Typical 1.2 kWh per km

33% Recuperation
= 120kW / 1.5C

No rights can be claimed from this information
Future proof

Raw Energy Needs

- **ICE (2011)**
- **ICE tarsand**
- **EV dutch mix 2011**
- **EV mix 2050**

- **fossil**
- **electric**

Legend:
- usefull
- TTW-loss
- WTT-loss
Total Cost of Operation

SPIJKSTAAL
ECOTRUCK

<table>
<thead>
<tr>
<th>Costs for functional unit at battery pack**</th>
<th>Battery 1</th>
<th>Battery 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life cycle of the affected battery (expected years of functional unit)</td>
<td>4,0</td>
<td>5,0</td>
</tr>
<tr>
<td>Annual year the battery pack is used</td>
<td>4,0</td>
<td>5,0</td>
</tr>
<tr>
<td>Setup costs</td>
<td>€ 99,760.00</td>
<td>€ 99,320.00</td>
</tr>
<tr>
<td>Onderhoudskosten</td>
<td>€ 84,240.00</td>
<td>€ 85,740.00</td>
</tr>
<tr>
<td>Energiekosten incl. amortisation battery cell</td>
<td>€ 45,140.00</td>
<td>€ 26,260.00</td>
</tr>
<tr>
<td>Wagenbeleiding</td>
<td>-</td>
<td>€</td>
</tr>
<tr>
<td>Vervangings</td>
<td>€ 2,491.00</td>
<td>€ 2,695.80</td>
</tr>
<tr>
<td>Financieringskosten</td>
<td>€ 56,572.00</td>
<td>€ 70,051.00</td>
</tr>
<tr>
<td>CO2 tax</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Energiekosten</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lubrication / non-personnel costs</td>
<td>€ 268,528.00</td>
<td>€ 267,320.00</td>
</tr>
<tr>
<td>Personnel costs</td>
<td>€ 415,008.00</td>
<td>€ 443,592.00</td>
</tr>
<tr>
<td>Total costs functional unit at battery pack</td>
<td>€ 673,511.20</td>
<td>€ 706,723.80</td>
</tr>
<tr>
<td>Schade (costs caused by accident)</td>
<td>€ 12,000.00</td>
<td>€ 13,000.00</td>
</tr>
<tr>
<td>Total costs functional unit at battery pack</td>
<td>€ 685,511.20</td>
<td>€ 720,723.80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs of one functional unit in years functional unit</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional unit in years</td>
<td>10</td>
</tr>
<tr>
<td>Affiliates</td>
<td>€ 132,100.00</td>
</tr>
<tr>
<td>Onderhoudskosten</td>
<td>€ 190,000.00</td>
</tr>
<tr>
<td>Brandstofkosten*</td>
<td>€ 76,310.00</td>
</tr>
<tr>
<td>Wagenbeleiding</td>
<td>€ 23,310.00</td>
</tr>
<tr>
<td>Vervangings</td>
<td>€ 2,190.00</td>
</tr>
<tr>
<td>Financieringskosten</td>
<td>€ 95,000.00</td>
</tr>
<tr>
<td>CO2 tax</td>
<td>-</td>
</tr>
<tr>
<td>Brandstof</td>
<td>-</td>
</tr>
<tr>
<td>Lubrication / non-personnel costs</td>
<td>€ 377,655.00</td>
</tr>
<tr>
<td>Personnel costs</td>
<td>€ 210,000.00</td>
</tr>
<tr>
<td>Total costs functional unit</td>
<td>€ 1,887,655.00</td>
</tr>
</tbody>
</table>

Total costs functional unit | € 1,887,655.00

€207,421
Verschil

No rights can be claimed from this information
The economic triangle of e-Mobility
Lack of scale in e-Truck supply

Today: very reliable diesel trucks, the costs for diesel are relatively low and diesel is a one-fit-for-all solution. This is in contrast to electric powered N2 & N3 vehicles that can only be deployed for a specific task.
Little Purchase Price Elasticity

Maximum Price Willing to Pay for Hybrid / EV vehicles that are Very/Somewhat Familiar with Diesel Fueled Trucks (N=55) Frost & Sullivan 2011

- 10-14% higher than a similar conventional truck: 75%
- 15-19% higher than a similar conventional truck: 18%
- 20-25% higher than a similar conventional truck: 7%
Other factors such as a charging infrastructure play a less important role compared to passenger cars. Fast charging can support the feasibility of some concepts like retail distribution (charging during discharging cargo) and service vans. Commercial vehicles are merely leased, so leasing possibilities for BEV are an important condition. In that case, the risk attitude of leasing companies is an issue. A big leap forward can be achieved if electric designed trucks are produced by OEMs, as is already happening with city buses. Besides, it may be a good idea to give extra attention and support to the real pioneers in the whole supply chain. Representative interest groups will generally defend the interests of the average member and will also be inclined to take stragglers into account. More focus on the leaders/initiators could be of interest for accelerating innovation.

8.2.4 Sub question 4

“What is the most economic scale for a project based on electric vehicles?”

As explained earlier, urban areas have biggest potential for exploiting Co-EV but it is important to differentiate by type of transport. The load factor and range for a van (N1) can hardly be compared with a mover N2 or N3 or a garbage truck (N3) with a vehicle for conditioned food transport (N2 or N3). Since the medium (N2) and heavy trucks (N3) are for the time being in a pre-development stage, the technology should first be improved before product launches can take place on a larger scale. As suggested above, the cost for batteries, apart from the range, are the main bottlenecks for adoption, also in the N1 category type vans. The battery technology is improving year on year, but it will take approximately 5 years before the TCO of Co-EV will be on a break-even basis compared with ICE vehicles. In figure 8.2.4.1 below, we indicate where the focus of stimulation per category should lie: on TCO viability for the lighter commercial vehicles and on innovation of the technology for the heavier trucks.

**Figure 8.2.4.1 Focus of stimulation per commercial vehicle category**
Ratio Purchase Price EV versus ICE

• Category N2 & N3: Converted vehicles

• In commercial vehicles > 3,5 ton the purchase price increases exponentially. From 1,5 to 4

• Higher purchase price cannot be recouped by low maintenance cost and lower energy cost per km

• Especially not in urban areas where driving distances are relatively short.
Short Payback Period needed

Hybrid Truck Payback Considerations: Fleet Managers in U.S. Most Comfortable With a Payback Period of 3 Years.

The payback period is another criterion that appears to be important. The majority of fleet managers declare a period of three to four years as the period of amortization in which they expect to recover the purchase price of an EV.
A Viable / positive TCO is the determining factor

- Higher purchase price cannot be recouped by low maintenance cost and lower energy cost per km. Especially not in urban areas where driving distances are relatively short.
- Energy density of batteries compares unfavorably to diesel or gasoline → additional weight → lower payload.
- Specific task design prevents overall deployability
- Higher depreciation
  - Limited deployability
  - Life time batteries

Hybrid and Electric Commercial Vehicle Market Voice of Fleet Managers-U.S.- Vehicle Comparison Based on Cost(U.S.), 2009

Percentage of respondents:
- Purchase price: 18
- TCO: 63
- Cost per mile: 14
- Resale value: 4
- Other: 4
Changing TCO in favour of EV

- Cost reduction for batteries
- Govt’s grants & privileges
- OEMs start with niches and scale up
- Govt’s - Charging in line with pollution, limitations in operational areas

TCO

Time

TCO

NEW TCO

BEV & FCEV

NEW TCO

ICE

2004 USD per kWh
Are Hybrids and HEV’s Old Cows?
Innovam 2014: For heavy commercial vehicles aimed at long-distance transport diesel power remains the main driveline until 2025.

<table>
<thead>
<tr>
<th>GCW / GVW 1* (ton)</th>
<th>Load Capacity (ton)</th>
<th>Typical Application</th>
<th>Pure Electric Attractiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>1.5</td>
<td>Urban distribution</td>
<td>✔ ✔ ✔</td>
</tr>
<tr>
<td>7.5</td>
<td>4</td>
<td>Urban distribution</td>
<td>✔ ✔</td>
</tr>
<tr>
<td>12</td>
<td>7.2</td>
<td>Urban distribution</td>
<td>✔</td>
</tr>
<tr>
<td>18</td>
<td>11</td>
<td>Inter Urban distribution</td>
<td>❌</td>
</tr>
<tr>
<td>26</td>
<td>17</td>
<td>Long distance</td>
<td>❌ ❌</td>
</tr>
<tr>
<td>40</td>
<td>25</td>
<td>Long distance</td>
<td>❌ ❌ ❌</td>
</tr>
</tbody>
</table>
Powertrain map for Future Mobility

Driving distance
(2009 TMC research)
The crucial role of Pilots

Iterative process is needed to scale up electric transport and to bridge the "valley of death"

- But this is not a "classic" innovation
- There is a complex system change needed: Transition

And this innovation is “need to have” and not “nice to have”
Differentiated stimulation needed

• N1 Market growth / scale
  • Fiscal arrangements
  • Grants and privileges depending on deployment
  • Purchase N1 for public services like service cars, vans for transport WMO / disability (e.g. Nissan NV 200).

• N2. Scaling up
  • Guarantees, financial funds
  • Stimulating cooperation and sharing of knowledge
  • Grants and privileges depending on deployment

• N3 Innovation
  • Stimulating innovation by grants
  • Stimulating cooperation and sharing of knowledge

• Apart from this, it is important to differentiate within categories. So movers are easier as segment than heavy trucks that supply supermarkets.
Key findings for stimulation

• Policy makers should
  • Continue to focus on urban areas for short and medium term
  • Differentiate supporting policy to PLC stage
  • Focus on low hanging fruit / sub segments / Niches → Scale
  • Interact more with individual firms to gain industry support rather than industry associations
  • Continue political effectiveness of employing a “carrot and stick” approach that combines technology-forcing with demand-pull policy.
  • Negotiate preferential treatments of certain technologies over others, if possible
  • Uniform policy on grants – vertical and horizontal – Harmonize between cities!
  • Long term concessions for public transport
If we could build an new city
2016: Clean air for Amsterdam

- Expansion of the fast charger network
- Privileges for electric vehicles
- From 1,700 charging points to 4,000 by 2018
- Clean taxi rank near Amsterdam Central Station
- Emission-free passenger carriers by 2025
- Additional charging points in parking structures
- Agreements with business owners about emission-free delivery of supplies
- Agreements with Amsterdam public transport (GVB) on emission-free public transport by 2025
- No new parking permit for most polluting cars
- Subsidy scheme for electric vehicles
- Emission-free municipal vehicle fleet
- Location-specific measures for final bottlenecks to good air quality
- Coaches covenant
- From 3 to 5 cargo hubs for clean urban distribution
- Welcome to Amsterdam

Visit amsterdam.nl/physicalplanning/sustainability
Lessons learned

1. Put a dot on the horizon; give perspective for action!

2. Subsidies for EV trucks

3. LEZ: an infrastructure to secure your ambition

4. Privileges for EV trucks (e.g. parking on sidewalks)

5. Build a platform: Front runners “Sustainable 020”

6. Procurement: practice what you preach!!

7. ..what else?
1. Put a dot on the horizon; give perspective for action!
2. Give subsidies for EV trucks

NOT: the polluter earns BUT: reward frontrunners

And: € for trucks is far more cost efficient than for passenger cars

Uitstoot
Vrachtwagens zijn verantwoordelijk voor 35% van de totale verkeersuitstoot NO2

NO2 uitstoot van 1 vrachtwagen = gelijk aan die van 100 personenauto’s.
3. LEZ: an infrastructure to secure your ambition
4. Privileges for EV Trucks
5. Build a platform: Front runners “Sustainable 020”
6. Procurement: practice what you preach
7. What else..?

Good suggestions, contact and more info:

Erik Regterschot
e.regterschot@amsterdam.nl
0031 6 5201 8693
Promoting electric freight from the urban authority perspective

IA-HEV wg27
Jos Streng, City of Rotterdam
Which cities participate in FREVUE?
What is FREVUE about?

- Demonstrators (=participating organisations) **procure** and deploy a number of fully electric freight vehicles.
- Local authorities support the deployment by **coordinating** it and **some** apply or develop a set of privileges (parking, bus lane use, widening of time windows).
- The vehicles are monitored technically (covering a range of climatic conditions and **goods types**: Oslo to Madrid, **food to construction goods**)
- The companies monitor the impact of EV use on their business
- The research team analyses further **environmental, systemic transport and social impacts** and extrapolates the results to system level
- In the end, it is about which step to take next to speed up zero emission urban delivery **OR**: It is about showing that the current generation of vehicles is suitable for last-mile urban deliveries and what steps are necessary to increase take-up
Reasons for cities to participate

They all want:
• more pleasant and healthy conditions for working and living
• accessibility of city centers
• to contribute to the mitigation of climate change\([\text{CO}_2]\)

Freight traffic (including vans):
• only 10% of all urban traffic
• responsible for a much larger fraction of local emissions (noise and air pollution)

The EU’s rationale for the project:
• a White Paper with a ZE target for urban transport by 2040
Noise reduction potential for Rotterdam when all freight vehicles converted to FEV
What do we implement [what is in our toolkit]

• Local covenants, such as Green Deal Zero Emission Urban Logistics
• Environmental zones and congestion zones
• Privileges [less limited use of zones and time windows for loading-unloading zones, bus lane]
• Procurement policy for our own vehicle fleet [to minimize our direct footprint – only small vans on the market]
• Procurement policy for delivered goods and services [to minimize our indirect footprint]
How to implement

• setting the example
  - investigate the footprint of our own delivery
  - including internal delivery from central storage location

• teaming up with frontrunning companies to speed up the process

• experiment with privileges for FEV [no emission = no regulations]

• look at the whole logistics chain to mobilise the demand for ZE delivery
  - less frequent, more planned ordering makes other logistic concepts possible [ZE last mile and last minute]
  - potential for consolidation of the flow of goods to a group of receivers [Seven Square Endeavour - Schouwburgplein]
The dilemma:

quote from intermediate FREVUE report

- Supportive government policy is still of high importance for the wider uptake of EFVs.
- Initially financial subsidies were largely used.
- Nowadays there is an understanding that non-monetary incentives are also very important, as financial ones are not sustainable in a longer term.
- A better way to support the mass adoption of the alternatively fuelled technology is to give them a long-term competitive advantage.
- However, even frontrunner companies stress that they cannot compete without a means to bridge the financial gap in the business case for FEV.
- Let alone smaller companies with less ambition [OR incentives/reason to act] and/or financial means
Why do EU cities have to team up?

- The more, the merrier
- Creating mass in potential FEV demand [should be sufficiently specific, i.e separate plans for trailers]
- Learning from each other [though you don’t actually need a project for that]
- Counterbalance for competitiveness [city marketing stresses the uniqueness of cities]
- Show that solutions are valid in different climate and policy environments
- Local diversity (within and between countries) in tax regimes and legal regulations
- Difference in economic interest
Discussion points

• In an era where interest rates are very low [and thus in principle large sums of money are unemployed], Europe could put this money to work.

• Quick charging for FEVs is not really addressed in IA-HEV task 20 [completed], limited to passenger cars and free public access. If fast charging is to help business models for FEV, it should be provided at stopover locations, with guaranteed access and very high power. This is quite different from the case described in the task 20 report.

• Batteries are a technical common denominator in buses, FEV and passenger cars, and they dominate vehicle prices.

• How do we keep the playing field level? First hour investors in expensive E-trucks [to be written off in 10 years] fear to be beaten five years from now by competitors who can buy the same vehicle at half the price.
Introduction of Korea activities in electric truck

System Integration Technology Development of Small Commercial EV

Ocktaeck LIM
(Univeristy of Ulsan, South Korea)
## Development situation of Domestic Electric Truck

<table>
<thead>
<tr>
<th>Design</th>
<th><img src="image1.jpg" alt="Image of white truck" /></th>
<th><img src="image2.jpg" alt="Image of pink truck" /></th>
<th><img src="image3.jpg" alt="Image of blue truck" /></th>
<th><img src="image4.jpg" alt="Image of white truck" /></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max. Power</strong></td>
<td>26 kW</td>
<td>40 kW</td>
<td>100 kW</td>
<td>100 kW</td>
</tr>
<tr>
<td><strong>Max. Toque</strong></td>
<td>108 Nm</td>
<td>162 Nm</td>
<td>318 Nm</td>
<td>320 Nm</td>
</tr>
<tr>
<td><strong>Max. Speed</strong></td>
<td>95km/h</td>
<td>100 km/h</td>
<td>130 km/h</td>
<td>130 km/h</td>
</tr>
<tr>
<td><strong>Per-Charge Range</strong></td>
<td>67.5 km</td>
<td>100 km</td>
<td>110 km</td>
<td>120 km</td>
</tr>
<tr>
<td><strong>Battery capacity</strong></td>
<td>17.8 kW (Lithium-Ion)</td>
<td>32 kWh (Lithium-Ion)</td>
<td>35 kWh (Lithium-Ion)</td>
<td>30 kWh (Lithium-Ion)</td>
</tr>
<tr>
<td><strong>Weight on Board</strong></td>
<td>500 kg</td>
<td>1,000 kg</td>
<td>1,000 kg</td>
<td>1,000 kg</td>
</tr>
<tr>
<td><strong>Development form</strong></td>
<td>EV conversion</td>
<td>EV conversion</td>
<td>EV conversion</td>
<td>EV conversion</td>
</tr>
<tr>
<td><strong>Progress of Development</strong></td>
<td>On sale</td>
<td>Prototype</td>
<td>Prototype</td>
<td>Prototype</td>
</tr>
</tbody>
</table>
**Project Title**

Development of small commercial-grade components in RE-EV System Integration Technology

**Final Development Goals**

Development of small commercial logistics vehicles RE-EV

**Key of developments**

- Development, Design and Optimization Lay-out of dedicated commercial vehicle parts RE-EV
  - Drive modules, body modules, battery modules, high-voltage / low-voltage wiring harness, cluster
- Reliability of the RE-EV commercial vehicle control modules and performance of Integration components
- RE-EV commercial vehicle production and performance evaluation

<table>
<thead>
<tr>
<th>Evaluation Items</th>
<th>Unit</th>
<th>Development Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top speed</td>
<td>km/hr</td>
<td>120</td>
</tr>
<tr>
<td>Mileage (EV mode)</td>
<td>Km</td>
<td>100</td>
</tr>
<tr>
<td>Mileage (combined mode)</td>
<td>Km</td>
<td>400</td>
</tr>
<tr>
<td>Charging time 20KW grade (slow)</td>
<td>Hr</td>
<td>7</td>
</tr>
<tr>
<td>Acceleration (0-&gt; 100Km / Hr)</td>
<td>sec</td>
<td>15</td>
</tr>
<tr>
<td>Start of prototype vehicle</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Duration Reducers</td>
<td>km</td>
<td>200.000</td>
</tr>
</tbody>
</table>
Analysis of proposed vehicle spec. & performance

- Driving Fuel consumption analysis
- Power performance #1
- Maximum traction / Climbing ability
- Vehicle spec. analysis
- Transmissions Spec. analysis
- Vehicle Hard Point 3D measurement
- Vehicle & parts instrumentation
- Acceleration performance
- Top speed, climbing ability
- Standard gear ratio selection
- Driving Fuel Consumption analysis

Package Design Review and LAYOUT

- RE-EV vehicles Layout & Parts Design
- FLOOR PANEL
- Motor / inverter, reducer
- Engine & generator
- Battery & BMS
- GCU, ECU, OBC, LDC, PDU
- Fuel system, an exhaust system development
- APS, Drive SW
- Water pumps, vacuum pumps

Vehicle production

- Component modules
  - CALIBRATION
- Mounting Brackets Development
- Vehicle remodeling
- Vehicle Assembly
- Vehicle Test

Parts Design

- Reducer devpmnt. (trucks only)
- VCU devpmt.
- Battery & BMS devpmnt.
- Fuel, exhaust system devpmnt.
- Power Distribution devpmnt.
- APS, Drive Switch Selection
- Cluster devpmt.
- Wire/Harness devpmt.
- Cooling, vacuum Line devpmt.
- LDC, OBC devpmt.
- devpmt ➔ development
Vehicle production core technology development

- Devpmnt. of small cargo vehicle system tech.
  - Utilize the parts developed relying on the passenger vehicles base.
  - Development of system optimization for the best performance by implementing important parts for 1ton truck.

- Devpmnt. of small cargo vehicle wiring harness
  - Complete the harness design part for high/low-voltage
  - Complete the development of wiring harness including unique cluster and power distribution of design vehicle.

- Vehicle driveline control logic development
  - Development of motor tuning and reducer of driving force control for the vehicle driving in simulation utilizing the motor maximum efficiency and good driving pattern.

- RE-EV layout design for small cargo vehicle
  - Utilize the each key part from this project
  - Perform the optimization of chassis module and drivetrain through the distribution of gravity center and package design for 1 ton truck.
  - The second year is scheduled to perform the test vehicle performance by developing brakes,

- Harness Development for small freighters

- Small cargo system technology development

- Small cargo driveline control logic development

- Small cargo cargo layout design

- Small cargo system technology development

- Small cargo driveline control logic development

- Small cargo cargo layout design
RE-EV Development of energy storage systems for commercial vehicles

**Mounting parts Lay-Out Location**
Design: RE-EV See the list

**Exhaust duct / fan**

**Intake duct (Air conditioning equipment connection)**

### Battery System Specification
- **Cell Type**: Li-ion Polymer
- **Number of Cells**: 324 EA 3P-108S
- **Nominal Voltage**: 399.6V 3.0~4.2V /Cell
- **Rate Capacity**: 90A 30Ah*3P
- **Total Energy**: 35.96KWh
- **Operating Temp.**: -20~60℃

### Battery System Test: Quality Certificate

<table>
<thead>
<tr>
<th>Test</th>
<th>Check</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage accuracy</td>
<td>Cell BMS voltage comparison</td>
<td>Lower than ±1%</td>
</tr>
<tr>
<td>Current Accuracy</td>
<td>Cel BMS Compare current</td>
<td>Lower than ±1%</td>
</tr>
<tr>
<td>Temperature accuracy</td>
<td>BMS Temperature and internal temperature comparison</td>
<td>Lower than ±2℃</td>
</tr>
<tr>
<td>Supply Operation</td>
<td>After power +12V, +5V Measure</td>
<td>12V ±0.5V , 5V ±0.5V</td>
</tr>
<tr>
<td>Current consumption</td>
<td>Input power supply operating current consumption measurement</td>
<td>Below 500mA</td>
</tr>
</tbody>
</table>

### BMS Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control voltage input range</td>
<td>9~16V</td>
<td></td>
</tr>
<tr>
<td>Current consumption (Master BMS)</td>
<td>500mA</td>
<td></td>
</tr>
<tr>
<td>Dark Current</td>
<td>1mA</td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>Cell</td>
<td>0~5V</td>
</tr>
<tr>
<td></td>
<td>Pack</td>
<td>250~500V</td>
</tr>
<tr>
<td>Current</td>
<td>Cell</td>
<td>-500~200A</td>
</tr>
<tr>
<td></td>
<td>Pack</td>
<td>-50~100℃</td>
</tr>
<tr>
<td>Temp.</td>
<td>Cell</td>
<td>0~100%</td>
</tr>
</tbody>
</table>
RE-EV Modular Component Development Unit

RE-EV Digital cluster & virtual engine development

- Cluster Configuration System and Software

- Virtual engine sound system and software configuration
RE-EV Test benches for commercial vehicles

- Test bench - front
- Test bench - side
- Test bench - drive modules
- Test bench - High Voltage Harness
- Motor drive check
- Clusters and low-voltage control test

**Testbench Contents**

- CAN communication and motor cluster, check the drive switch
Target vehicle specifications and analytical instrumentation

- Vehicles Hard Point 3D measurement
- Spring stiffness measurements front / rear
- The damper characteristics test front/ rear
Suspension System Modeling

The main components Integration

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Image</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame, water pump, vacuum pump, number of drives tea, vacuum auxiliary tank, cooling valves, flow harness</td>
<td>![Image]</td>
<td>597.5+5.6+1.7+1.55+0.85+2.8+4</td>
</tr>
<tr>
<td>Cabin</td>
<td>![Image]</td>
<td>241.5</td>
</tr>
<tr>
<td>Engine Generator</td>
<td>![Image]</td>
<td>107</td>
</tr>
<tr>
<td>Motor, Reducer, GCU, ECU, LDC</td>
<td>![Image]</td>
<td>65.6+22.8+7.5+8.8</td>
</tr>
<tr>
<td>Battery, OBC</td>
<td>![Image]</td>
<td>302.3+10.45</td>
</tr>
<tr>
<td>Fuel Tank</td>
<td>![Image]</td>
<td>15+0.7∗70 L</td>
</tr>
<tr>
<td>Propeller shaft</td>
<td>![Image]</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1450.45</strong></td>
</tr>
</tbody>
</table>

RE-EV fleet vehicles modeling school
1. External shape 3D scan of commercial vehicle

2. Cabin (TOP), charger, engine parts extraction and 3D Scan

- Air Conditioning System
- Engine / Transmission
- Fuel Tank
- Spare tire
- Exhaust System
- Battery

- Inside the cabin frame and 3D scanner
- Cabin (TOP)
- Engine parts disassembly
- Cabin / loading area disassemble
4. Development of mounting RE-EV module component structure design & mounting assembly component

- LAY-OUT of parts for RE-EV commercial vehicles

  - Water pump mounting
  - Vacuum pump mounting
  - GCU/LDC mounting
  - Alternative engine mounting
  - Motor/Inverter mounting
  - Reducer mounting
  - PDU/OBC mounting
  - Fuel tank mounting
## 5. RE-EV module parts assembly

Details assembled into:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
</tr>
</tbody>
</table>
### Details assembled status

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="PDU" /></td>
<td><img src="image2" alt="Engine generator" /></td>
<td><img src="image3" alt="Vacuum pumps" /></td>
<td><img src="image4" alt="GCU" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="LDC" /></td>
<td><img src="image6" alt="OBC" /></td>
<td><img src="image7" alt="Vibration dampers" /></td>
<td><img src="image8" alt="Vacuum deck" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image9" alt="Water pump" /></td>
<td><img src="image10" alt="Solenoid valve" /></td>
<td><img src="image11" alt="Exhaust system remodeling" /></td>
<td><img src="image12" alt="Radiator" /></td>
</tr>
</tbody>
</table>
6. RE-EV commercial car high/low voltage harness production

- RE-EV commercial car high/low voltage power system and electric circuit, LAY-OUT design

- RE-EV commercial car harness production and connected with actual car
18, Aug, 2015
## Max speed & acceleration performance

<table>
<thead>
<tr>
<th>Classification</th>
<th>RE-EV Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor capacity</td>
<td>110 kW</td>
</tr>
<tr>
<td>Motor max speed</td>
<td>10,000 rpm</td>
</tr>
<tr>
<td>Motor max torque</td>
<td>330 $N \cdot m$</td>
</tr>
<tr>
<td>Battery</td>
<td>90Ah, 399.6V, 36kWh</td>
</tr>
<tr>
<td>Engine generator</td>
<td>Gasoline, 2 cylinder, 1.2L</td>
</tr>
<tr>
<td>Reduction gear ratio</td>
<td>2.185</td>
</tr>
<tr>
<td>Final Drive</td>
<td>3.6</td>
</tr>
<tr>
<td>Rear wheel tire radius</td>
<td>0.27 m</td>
</tr>
<tr>
<td>Setting Weight</td>
<td>1558 kg (empty vehicle weight) +183kg (man, measuring equipment)</td>
</tr>
<tr>
<td>Front axle/Back axle</td>
<td>1048 kg/693 kg</td>
</tr>
<tr>
<td>reducer &amp; Final Drive efficiency</td>
<td>90%, 90%</td>
</tr>
<tr>
<td>air &amp; rolling resistance coefficient</td>
<td>0.4,0.01</td>
</tr>
<tr>
<td>Fuel tank volume</td>
<td>70L</td>
</tr>
</tbody>
</table>

**Max speed**: 129 km/h
**Accel performance**: 12.2 s (0-100km/h)
MILEAGE (EV & composite mode)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Settings</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial SOC</td>
<td>100%</td>
<td>O</td>
</tr>
<tr>
<td>EV Final SOC</td>
<td>10%</td>
<td>O</td>
</tr>
<tr>
<td>EV DoD</td>
<td>90%</td>
<td>O</td>
</tr>
<tr>
<td>HEV Control SOC</td>
<td>20%~22%</td>
<td>O</td>
</tr>
<tr>
<td>HEV DoD</td>
<td>79%</td>
<td>O</td>
</tr>
</tbody>
</table>

< Analysis conditions of RE-EV Vehicle Mileage >

< AVL Cruise modeling >

MILEAGE at EV mode = 106 km
MILEAGE at Composite mode = 799 km
(106km+9.9km/L*70L)
Performance Analysis of RE-EV integrated Vehicle

Vehicle longitudinal acceleration correlation

Data collection device
Brake pedal sensor
Inverter
Vehicle CAN Gathering information

<Correlation test vehicle settings>

<Acceleration Test>

<table>
<thead>
<tr>
<th>Test mode</th>
<th>Target variable</th>
<th>Correlation vehicle(%)</th>
<th>The coefficient of determination $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration Test</td>
<td>Vehicle Speed (TPS 50%)</td>
<td>98.6</td>
<td></td>
</tr>
<tr>
<td>Deceleration Test</td>
<td>Vehicle Speed (-0.5g)</td>
<td>88.4</td>
<td></td>
</tr>
</tbody>
</table>

$$R^2 = \frac{\sum (\hat{y}_i - \bar{y})^2}{\sum (y_i - \bar{y})^2} = 1 - \frac{\sum e_i^2}{\sum (y_i - \bar{y})^2} = 1 - \frac{SSE}{SST}$$
1. Korea has developed EV logistic trucks successfully

- Development, Design and Optimization Lay-out of dedicated commercial vehicle parts RE-EV
  - Drive modules, body modules, battery modules, high-voltage / low-voltage wiring harness, cluster
- Reliability of the RE-EV commercial vehicle control modules and performance of Integration components was developed
- RE-EV commercial vehicle production and performance evaluation was finished
Thank you very much

Ocktaeck LIM

otlim@ulsan.ac.kr
Freight electric vehicles

TNT – Edwin Vermeer

12th of April 2016
Content

➢ The motivation of TNT to participate in the Frevue project
➢ Our experience so far
➢ The benefits for TNT
➢ What are or were the barriers we faced in using EV's
➢ What stopped us to make the next step
➢ What is needed in order to take the next step and ultimately, deliver energy neutral.
➢ Which support or privileges are needed from authorities or partners to make this interesting for TNT
FREVUE linked to our Corporate Responsibility and Strategy

Our Corporate Responsibility commitments

- Constant focus in improving our performance on Health & Safety and Environment (HSE).
- Invest in healthy and safe working conditions for our people
- Reduce our consumption of energy and natural resources, and decrease our emissions.

Outlook strategy

1. Move More by Road
2. Drive sales from four priority industries
3. Serve more SMEs even better
4. Increase profitability Domestics
5. Realise the Perfect Transaction
6. Increase efficiency and productivity
7. Establish superior revenue management
8. Prioritise Health & Safety practices
9. Create focused and accountable units
10. Strengthen leadership culture
Environmental initiatives focus on reducing our CO2 emissions

**OUR OPERATIONS**

*Improve CO₂ footprint of our operational activities*

**OUR CUSTOMERS**

*Provide insight and support on CO₂ emissions to our customers*

**OUR PEOPLE**

*Engage, train employees and subcontractors on Environment*

Performance Management

CO₂ emissions are managed and reported transparently

- Replacement by more efficient aircraft
- Eco driving training
- Replacement by more fuel efficient vehicles
- Energy efficiency improvement in warehouses

* Including subcontracted activities,
Electric vehicles track record

UK: 2006 introduced a 7.5 tonne electric vehicle into our delivery fleet at our Barking depot.

2008 introduced a further 50 vehicles (3.5 and 7.5t)

2012 commenced delivery of 20 replacement 7.5 tonne “new generation” electric trucks

Other EV trials in Europe and in ROW led to further roll out phase but still at limited scale and with various providers / OEMs
Electric assisted tricycles Roll out
FR-EVUE Amsterdam & Rotterdam

Tests cases description
  • All Electric Parcel distribution centres

Objectives
  • Prove that urban freight deliveries can use 100% electric mode
  • Deploy a total of 24 large EVs (from 3,5 t vans to 18 t trucks) in Amsterdam and Rotterdam exploring exemptions for time-windows, parking and weight regulations and more flexible permission for night-deliveries
  • ICT solutions and intelligent charging systems.
  • Establish reliability and technical feasibility of large electric trucks in beverage distribution
  • Get a comprehensive cost overview (including usage of charging stations - on depot and in the city)

TNT involvement
  • 9 vehicles / 2 NL depots (Schiphol Rijk, Dordrecht)
  • Operational set up: Replacement of PUD vans and truck by Electric vehicles on inner city routes
Benefits for TNT to invest in EV’s?

- Improve our operational efficiency and get privileges through collaboration with city authorities (e.g., Rotterdam / Amsterdam)
- Save fuel therefore costs
- Reduce CO2 and tailpipe emissions, noise and congestion in cities
- Gain experience and skills with motivated drivers
- Public exposure
- Customer acquisition / competitive edge

“Less gear changes, less tired at end of day”

“Takes the stress out of driving”

“Vehicle is excellent for city centre driving”

“Our customers think a zero emission vehicle is excellent”

“People stop and watch me – they are amazed how quiet the vehicle is”
Main challenges

- Technology reliability
- Daily range – less flexible
- Duty Cycle / Charging
- Driver acceptability / Driver training
- Fitting of telematics to monitor vehicle performance remotely
- Suitable charging infrastructure in place
- Positive business case to invest for Electric Vehicles
Deliver via Electric vehicles!
Starting of the transplantation....
Work in progress
Second “life”
The new hart
Project at risk

- Technical issues put the EV project at risk
- Negative impact on motivation drivers
- Productivity and quality impact by late arrivals
Next steps to move forward

- More production of EV’s makes it attractive to invest in this type of vehicles
- No clarity of rest value makes it less interesting for lease companies to step in
- Infrastructure structure for power supplies is insufficient
- Facilities for charging stations on TNT locations are limited
- Cost price for charging stations are to high
- Local privileges by using bus / tram lane or private parking area to be more efficient
- Adjust driverlicense B, to max weight of 4,5 T (due to net weight of the EV)
Thank you!
Electrical city distribution: a ‘quick and easy’ solution?
Bert Roozendaal 12 April 2016
Town councils struggle with their air quality

- Emission of fine dust and NO\textsubscript{x} are often too high
- Traffic jams and road safety
- Quality of life

- Pressure groups are ‘flexing their muscles’
- Increasing volumes of small e-commerce deliveries
- How can a distributor take its responsibility?
Our solution: The Cargohopper concept

- Cargohopper is a zero-emission last mile system since 2008
- Our aim: more volume with less trucks in the inner city
- Hub at the border of the environmental zone
- Are we a game changer after eight years of try and error?
That’s iffy, If no one moves, nothing happens...

- Municipalities are aiming at more electrical transport in inner cities
- Their problem is: how?
  - Councils do not transport
  - The market has little financial room to manoeuvre
  - And...Who benefits from it?
50 kilometres, daily 5 days a week

- Cargohopper operates in Amsterdam and Enschede
- 5 self developed vehicles do up to 70 drops a day covering 50km,
- 1.100.000 kg annually
- Beloved in the city: Cargohopper is Amsterdam!
- We have a perfect solution to distribute copier paper, but..
- We haul construction materials
We are an advanced living lab

• We are growing but...
• Business case could be better
• Initial cost stays high, not enough advantages of privileges to close the financial gap
• We get some support from the cities
• But no major breakthrough so far
It is all about regulations and batteries

- Everyone wants you to transport electrically, until you really try... roadlegalisation stays hoplessly behind
- We struggled with our batteries
- Forget about solar
- But our 3th generation Cargohopper is a really reliable and practical product
Cargohopper has the highest payload per Euro

- 2.8 ton payload on 6.3 ton TTM is better than a 7.5 ton diesel truck
- We have the most cost efficient solution but...
- Industry does not develop distribution EV’s

Cost electric versus diesel x 1.000
It is not the operational costs

- Only small maintenance twice a year
- Most problems are small mishap
- ‘fuel costs’ eu. 0,05 vs eu. 0,17/km with diesel
- Lower speed and good training prevents accidents
- No charging problems, just some wear and tear on cables and connectors
- But that is not enough to neutralize the initial costs.
What will the future bring us?

- Cargohopper will continue but cannot expend with the rules momentarily in place.
- In the end it is the community that benefits. So if fast progress is wanted, that depends on how fast cities create adequate conditions.
- Strong appeal to develop an integral European vision on electrical distribution.
Transport will increasingly be the biggest challenge for decarbonization

Source: European Commission reference scenario for 2050 (2013)
Freight emissions will replace passenger traffic as main source of CO₂ already by 2030

Long haul is by far the biggest segment of HDV in terms of fuel consumption and GHG-emissions

Measures to reduce road freight CO$_2$ emissions

Source: German Ministry of Environment (BMU), March 2013
© Siemens AG 2016
Alternative concepts

Investigated concepts comprise external power supply and on-board storage systems.

- **On-board storage**
  - Alternative fuel
  - Electricity
    - Battery
    - Capacitors
    - Fuel cell

- **External power supply**
  - Contactless
    - Inductive power supply
    - Linear s. motor concepts
  - Conductive
    - Ground based contact line
    - Overhead contact line
Zero-emission trucks are possible with renewable energy, but efficiency varies greatly

### Battery
- **Range**: 48 km
- **Efficiency WTW**: 62%
- **Example vehicle**: eTruck

### Hydrogen
- **Range**: 24 km
- **Efficiency WTW**: 29%

### Power-to-Gas
- **Range**: 17 km
- **Efficiency WTW**: 20%

**Source**: German Ministry of Environment
Investigated concepts comprise external power supply and on-board storage systems.

- **On-board storage**
  - Alternative fuel
  - Electricity
    - Battery
    - Capacitors
    - Fuel cell

- **External power supply**
  - Contactless
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    - Overhead contact line
Zero-emission trucks are possible with renewable energy, but efficiency varies greatly.
What an Electric Road System could look like
How it could work

Film clip
The overhead contact line hybrid can be configured to suit very different applications.

<table>
<thead>
<tr>
<th>Truck types</th>
<th>Drive system</th>
<th>On-board source of electricity</th>
<th>Combustion engine</th>
<th>Non-electrical source of energy</th>
</tr>
</thead>
<tbody>
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</table>
But is it realistic?

Public road demonstration in Sweden

Source: Vägverket Konsult
Public road demonstration in the U.S.
Electrification is especially attractive on highly frequented routes

**eHighway application fields**

**near term**
- Shuttle transport
- Mine transport

**long term**
- Long-haul traffic

The development path of road electrification is likely to echo that of rail electrification a century ago.
Infrastructure built on the heavily trafficked roads can address significant part of heavy duty emissions

60% of the HDV emissions occur on 2% of the road network (BAB = 12,394 km)

The most intensely used 3,966 km handle 60% of all ton-km on the BAB
Thank you for your attention

Hasso Georg Grünjes  
Head of eHighway Business Development

Siemens AG  
Mobility  
Technology & Innovation  
eHighway  
Erlangen  
Mobile: +49 (173) 277 8387  
E-mail: hasso.gruenjes@siemens.com  

www.siemens.com/mobility/ehighway
Presentation TASK 27, Amsterdam 12th April 2016
History

... never heard ...

iPI Technology

???
Innovative Power Transfer for a World of Movement

We design, build and deliver comprehensive power transfer solutions for the needs of our markets.
We are a professional partner for our customers.
Typical applications served

Continuous Power Transfer

i.e. Production Line Electrification in the Car Industry, Plane Manufacturing, ...

Discontinuous Power Transfer

i.e. Buses in Public Transport, Microbuses to Double Deckers

Baggage and Parcel Transport and Sorting in Airports, Distribution Centers, ...
Experiences

More than a Decade of Experience – on the Road and off the Road

IPT® Charge – Turin and beyond!

Rotorua, Genoa, Luzern, Japan, Utrecht, Chattanooga UTC, s'Hertogenbosch, Milton Keynes, London, Bristol ...
Core Competences

- Design
- Implementation
- Services
- Production
- System Engineering
- Monitoring
- Research
- Customizing
Electrification Mega-Trend … and Need

Oil Resources

More Sustainability
- Conscious Use of Energy
- Efficient Use of Energy
- Low Emission Use of Energy
- No Noise

clean, quiet, efficient Transportation

Urbanization

- +122% (Land)
- -17% (Stadt)


Commercial Vehicles in Cities

- Vehicles of Municipality
- Garbage Trucks
- Street Cleaning
- Rescue Services
- Police
- Social Services
- Taxis
- Rental Cars
- Car-Sharing
- Driving Schools
- Shuttle Services
- Food Services, „Pizza Delivery“
- Construction Works
- Mail Services
- Couriers
- Parcel Services
- Shipping Companies
- Service Vehicles
- Contractors
- Distribution (Supermarkets, etc.)
- Intercompany Traffic
- …..

Inhomogeneity in Use of Vehicles!

Clustering homogeneous Groups!

Fast Implementation Strategy!
Plug-in vs Wireless

Wireless

Plug-in (overnight Charging)

- Supervision & Handling
- Cost Battery
- Cost Maintenance
- Cost Installation
- Hardware Cost
Plug-in vs. Wireless
Clustering
Fast Implementation Track

<table>
<thead>
<tr>
<th>No local Emissions</th>
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</thead>
<tbody>
<tr>
<td>Operations primarily in Urban Areas!</td>
</tr>
<tr>
<td>Intense Use of Charging Infrastructure!</td>
</tr>
<tr>
<td>Limited Operation Range allows a Minimum of Batteries!</td>
</tr>
<tr>
<td>Time Saving Component!</td>
</tr>
<tr>
<td>“Proprietary” Systems allow quick Implementation!</td>
</tr>
</tbody>
</table>
Fast Implementation Track

Vehicles using a “home base” frequently throughout a day!

Vehicles following rather fix routes day by day!

Drivers wins time to do other jobs!

No waiting for the Implementation of a public charging infrastructure!

Delivery to Supermarkets, Malls, …

Last Mile Delivery into City Centers, …

Mail Services and Parcel Services in Urban Areas

Social Services, Food Delivery, …

Taxis primarily operating in City Centers, …

Contractors, services primarily operating in Cities, …

…
Fast Implementation Track
Opportunity Charging with IPT®

Potential Restrictions of Electrification

Image Electric Buses:

- More efficient

but …

- Not enough range
- To expensive
- Not practicable

Discharge @ affordable battery capacity

Longer operating times for electric Buses with Opportunity Charging

Operation time / Range
Opportunity Charging with IPT®

Need for Opportunity Charging

Longer operating times for electric Busses with Opportunity Charging

Realistic Operation Scenarios
Opportunity Charging with IPT®
Trend E-Mobility

Clean
Quite
Safe operation
Protection of resources

Electric Drive Systems
Ecologic & Economic Win-Win with IPT® Charge

No plugs, less batteries
No emission fees
No worries, efficient
Cost competitive
Opportunity Charging with IPT®

System Overview

Vehicle Side (Battery, BMS, VCU, PLC)

- Rectifier
- Pickup

- Charge Pad
- IPT® Charge (Track Supply)

Control Inputs (i.e. overtemperature, overvoltage)

Power flow:
- Power from Grid
- Power to Battery

Monitoring Unit

Radio Modem

RBCI

Heat Exchanger

CAN I/O

Vehicle Components

Stationary Components
Opportunity Charging with IPT®

Optimized Infrastructure
For Dense City Traffic & Commuter Routes
Projectimpressions „London“
Opportunity Charging with IPT®

Modular Setup IPT® Charge

1 module active

2 modules active

3 modules active

= Possible module activation
Opportunity Charging with IPT®

Installation

1. Installation site (i.e. Bus Stop)
2. Excavation with connection to grid
3. In-Ground Module installed
4. Charge Module connected
5. Finished Charge Station operational
Opportunity Charging with IPT®

More than a Decade of Experience – on the Road and off the Road

IPT® Charge - not just Turin!
Rotorua, Genoa, Luzern, Japan, Utrecht, Chattanooga UTC, s’Hertogenbosch, Milton Keynes, London, Bristol ...
Outlook

3 kW (6 kW)
22 kW
"50 kW"
100 kW
200 kW
300 kW
Innovative Power Transfer for a World of Movement

www.ipt-technology.com