



## Electrification of Heavy Transport - market and technology perspectives

“TOWARDS TRANSNATIONAL E-MOBILITY – EUROPEAN INSIGHTS ON CHARGING TECHNOLOGIES AND THE ELECTRIFICATION OF HEAVY TRANSPORTATION”

Sten Bergman  
StonePower AB

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- Market Outlook
- Heavy Trucks
- Tractors etc.
- Buses (BEV and FCV)
- Electric Roads
- Climate Impact
- Technology Outlook
- Demo Platforms
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- Perspectives



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- 2010 the HDV sales 3,2 million
- 2020 sales is predicted 4,8 million
  - 3,2 million commercial HDV
  - 1,1 million medium sized HDV
  - 0,4 million buses
- 9% of the sales (100 000) will be in West Europe
- Frost & Sullivan predict 7% of the market (77 000) of medium heavy vehicles will be hybrids or battery electric in 2020.
- Sales from US (48%), EMEA (15%), Asia (37%)



## Global Market Outlook

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In 2018 the market for Battery, Hybrid Electric, and Fuel cell buses is expected to be more than **20 000** by Pike Research which is 4 times what is sold this year (5000 in 2012)



15 000 of those would be sold in Asia Pacific Region  
In Europe the number is about 2000 electric buses (HEV, PHEV, FCV).

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In 2005 455 000 Heavy Duty Vehicles run almost 10 billion km. That imply an average annual distance of 2,262 km.  
Timber HVD travelled 135 390 km  
General purpose HVD travelled about 18 000 km  
15 600 buses travelled 910 million km and buses for 61-70 pasengers travelled annualy 75 950 km.



- If those HVD had ben pure lectrical they would have saved about 2,2 billion litre diesel, which is 45% of the total transport sector consumption. They would have required 7,3 TWh electrical energy and saved 15% of the national fossil GHG emissions (6,9 million ton)

## Heavy Transport Sweden 5

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In EU27 about 2,8 million vehicles (36%) are city distribution and general transport vehicles. Many Cities will be "Green & Quiet Cities" simply by shifting to Electric drive mode in urban centers.



## Electric City Transport 6

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## Tractors etc.

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Since 2011 PostNord operate two Volvo FE 300 4x2 diesel-electric hybrids in City-distribution of Gothenburg.

Fuel consumption has been reduced by approx. 20 %.



## Hybrid Heavy Duty Vehicles 8

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US is one big market for Hybrid Buses. In 2010 there were more than 6 000 on the streets. Quebec ordered 509 Hybrids in 2012.

In Japan 100/150 Hybrid Buses are sold per year

London has 295 Buses but plan for 455 already next year.

UK has in total more than 650 Hybrid Buses

*According to Pike Research a Hybrid Electric Bus is approx. 200 000 USD more expensive than a conv. Diesel Bus.*



## Hybrid Electric Bus 9

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Volvo and partners have sold over 700 Battery Electric Buses.

Over 10 manufacturer in China only. (Subsidy of 500000 RMB)

Over 1000 Electric Buses on the Chinese roads.

In Europe sales are about 1000 Buses (HEV, PHEV,FCV) which is expected to grow to 2000 in 2018.

Li-ion batteries for E-buses are predicted to grow from 0,16 million kWh 2012 to 1,3 million kWh in 2018\*

\* Pike Research



## Battery Electric Bus

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In mid-2011, there were 25 fuel cell transit buses in operation in the US:

- 18 Van Hool buses with UTC Power fuel cells,
- 1 New Flyer bus with a Ballard fuel cell,
- 2 Proterra plug-in hybrids with Hydrogenics fuel cells,
- 3 Ebus plug-in hybrids with Ballard fuel cells,

and

1 Daimler/BAE diesel hybrid with Hydrogenics fuel cell (APU) *Cost of FC Bus 1,3-1,8 MEuro compared to 170 000 for ICE version*

*Fuel Cell Buses are in pre commercial phase.*

*In 2011 there were 12 mfg and 110 buses in operation*

## Fuel Cell Bus

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Resonant Inductive Charged Electric Transfer is rapidly gaining interest also for heavy vehicles, buses etc. Demonstrations are now taking place in Korea, US and Europe (Holland).

## Inductive Charged e-Bus

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Type	million	km	CO2 Mton/yr
Service (3,5-7 ton)	1,9	35000	35
City Distribution	0,45	40000	12
General City Transport	0,40	25000	15
Regional Distribution	1,2	60000	40
Long HaulTransport	2,0	130000	100
Building/Construction transport	1,0	50000	30
City Bus	0,45	50000	25
Coach	0,4	52000	18
<b>Total</b>	<b>7,8</b>		<b>275</b>



Contribution to CO2 emissions from HDV's  
 Long Haul Transport 36 %  
 City Bus + Coach 16 %

Reduction and testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles: Strategy Final Report to the European Commission – DCG Climate Action– AEA 2011

**Climate impact** 14

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Heavy Duty Vehicles		Buses	
Improvement	%	Improvement	%
Pneumatic Booster	2,8	Pneumatic Booster	1,5
Heat recovery	3,9	Heat recovery	1,8
Full Hybrid	10	Start-stop	3,7
Tires (wide)	4,95	Full Hybrid	24
Aerodynamics	8,95	Wide tires	4,6
Weight reduction	2,33	Weight reduction	4,86
Automatic gear	2,2	Automatic gear	3,95
Estimated natural improv	4,6	Estimated natural improv	4,0
<b>Total</b>	<b>39,7</b>	<b>Total</b>	<b>45,0</b>



\* Reduction and testing of Greenhouse Gas (GHG) Emissions from Heavy Duty Vehicles: Strategy Final Report to the European Commission – DCG Climate Action– AEA 2011

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**Vehicle Demo Platforms** 17

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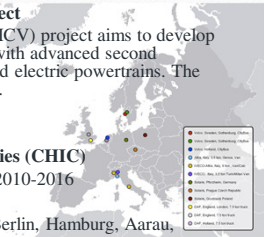
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**Hybrid Commercial Vehicle Project**  
 The Hybrid Commercial Vehicle (HCV) project aims to develop urban buses and delivery vehicles with advanced second generation of energy efficient hybrid electric powertrains. The project is coordinated by Volvo AB.

**Clean Hydrogen in European Cities (CHIC)**  
 Budget 81,8 million Euro. Project 2010-2016  
 60 FCV Buses  
 Demonstration in Whistler, Köln, Berlin, Hamburg, Aarau, Bolzano, London, Milano, Oslo  
 Demonstration of FCV Buses started already in 2003. From 2009/2010 the Buses have Hybrid drive trains.



**Vehicle Demo Platforms** 18

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**Visions of the future** 19

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- **Market expansion**
  - HDV market is expanding about 2,5% per year. Shift of markets to Asia Pacific. City transport, Long haul vehicles and Buses are key in the short term to solve expanding transport needs of people and goods.
- **Technology progress**
  - Research and Technology Development is accelerating. Batteries will be better/Cheaper. Inductive technologies show good progress. Battery swap and FC Range extenders may alter the map significantly. Energy saving potential is between 25-50%
- **Challenges**
  - To see the **vehicle and road as a system (VRS)** not as individual parts.
  - Integration of **VRS with IT Logistics**. Many aspects are present with electricity as a "fuel".

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