

Opbrid Roger Bedell CEO

Göteborg HyperBus Busbaar Charging Station Experiences after 1.5 Years of Service



Furrer+Frey[®]
Overhead contact lines



Furrer+Frey[®]
baut Fahrleitungen

Opbrid

“Enabling the Fast Charging Revolution”



- Electrification of vehicles without sacrificing reliability or carrying capacity
- The Opbrid Bûsbaar: High Power Transfer Conductive Charging Station
- Ultra-fast charge at route ends

Volvo Hyperbus Project

- Added larger battery (28kWh) and Opbrid Busbaar to existing 7900 Hybrid
- From 100% diesel to 80/20 electric/diesel with 5 minutes charging at ends of route
- Two 120kW chargers at the ends of the #60 route





Göteborg Energi BUSBAAR

SKÄLARE, TYSTARE OCH RENARE MED
VOLVO L40H HYBRID

HYBRID

HYBRID

usettefil

Elida



Summary

- 120kW Furrer+Frey/Opbrid Busbaar charging stations at Redbergsplatsen and Masthugget operating with the Volvo Plugin Hybrid since May 2013
- No major problems
- Completed on time and within budget
- A successful pilot project
- Volvo launches 7900 Electric Hybrid series product based on this pilot in September 2014

Hyperbus Project Timeline

Project go-ahead July 2012

Design complete September 2012

Hardware delivered December 2012

First charge January 2013

Second station delivered March 2013

Both stations operational April 2013

Ribbon cutting May 13, 2013

Operation continuing today

January 2013 Delivery



First Charge Cycle



Installation

- Sufficient available 400V 3 phase power – consult with electric company
- Concrete pads for charger and Busbaar post
- Took about a week to commission





Performance

Typical 4 minute charge at Redbergsplatsen,
6 minutes at Masthugget @90kW

Difference due to elevation of Masthugget
being higher than Redbergsplatsen.

All electric 85% of the time

81% less fuel than diesel bus

About 11 liters/100km

Cold Weather

Charger worked well during the winter.



Unexpected Issues

At Masthugget, electricity had to be run 800 meters, more costly

AC Electrical Fusing was 30% larger than expected

Efficiency was 5% lower than expected (cooling, unnecessary circuitry)

One of the 6 power units at Redbergsplatsen failed, the other 5 continued normally, no loss in service due to parallel redundancy.

Graffiti during summer months



Lessons learned

- Drivers are more precise than originally thought if given visual cues
 - Curb for lateral cue, drivers are very good at parking close to the curb.
 - Post or colored curbstone for longitudinal cue.
- Station should have height and distance from curb adjustments to handle small corrections to site preparation.
- It rains a lot in Gothenburg! (Water in antennas and pantographs)



Feedback from Neighbors

Curiosity – “What is this?”

Concern - “Is it dangerous? Does it emit harmful radiation?”

Pleasure – “The bus is so quiet and smooth.”

Almost no negative feedback. A poster was added to explain the system.

Thoughtful design is important, while charging the bus blocked the handicap ramp.

Next Step: Opbrid Busbaar V3



Fixed Bar on Vehicle

- Minimal rooftop space requirement, fits most buses and trucks
- Low weight, cost and maintenance on vehicle
- Insulating cover for additional electrical safety and weather protection.
- Designed in electrical safety
- Future proof standards candidate

Fixed Bar Current Collector



Fits easily on trucks or other vehicles
with limited roof area



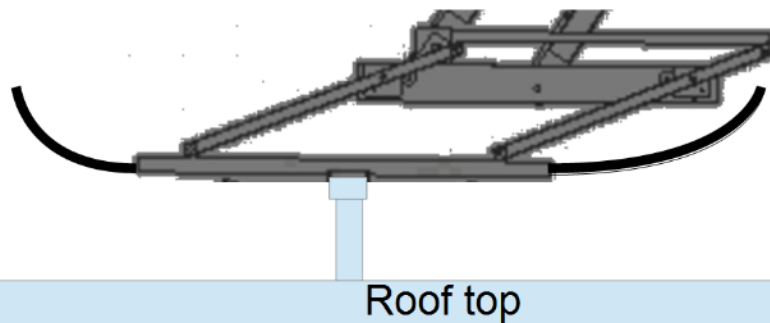
Versatile Design



Drop down –
Lowers from 4.5
meters



Depot – Lowers from 3.6 meters, Low Cost



Dynamic Charging – Bus can accelerate away
from station using grid power (BRT)

Drive Into/Through – For instant connections

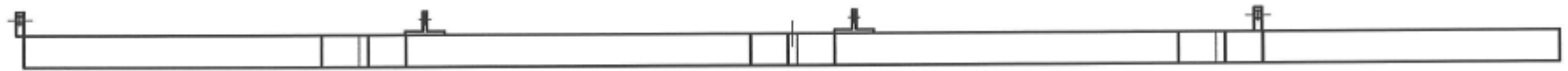
Depot Charger with Simplified Overhead Pantograph



Designed in Electrical Safety



Normal parking position center



Limit of normal parking position, still good contact



Outside parking position, charging cannot occur

Future Proof and Standards

Standards candidate designed to adapt to future very high power requirements without penalizing the vehicles of today

Vehicle collector sized to requirements of the vehicle.

Overhead gantry sized to the power output of the station.

Any vehicle can charge at any station.

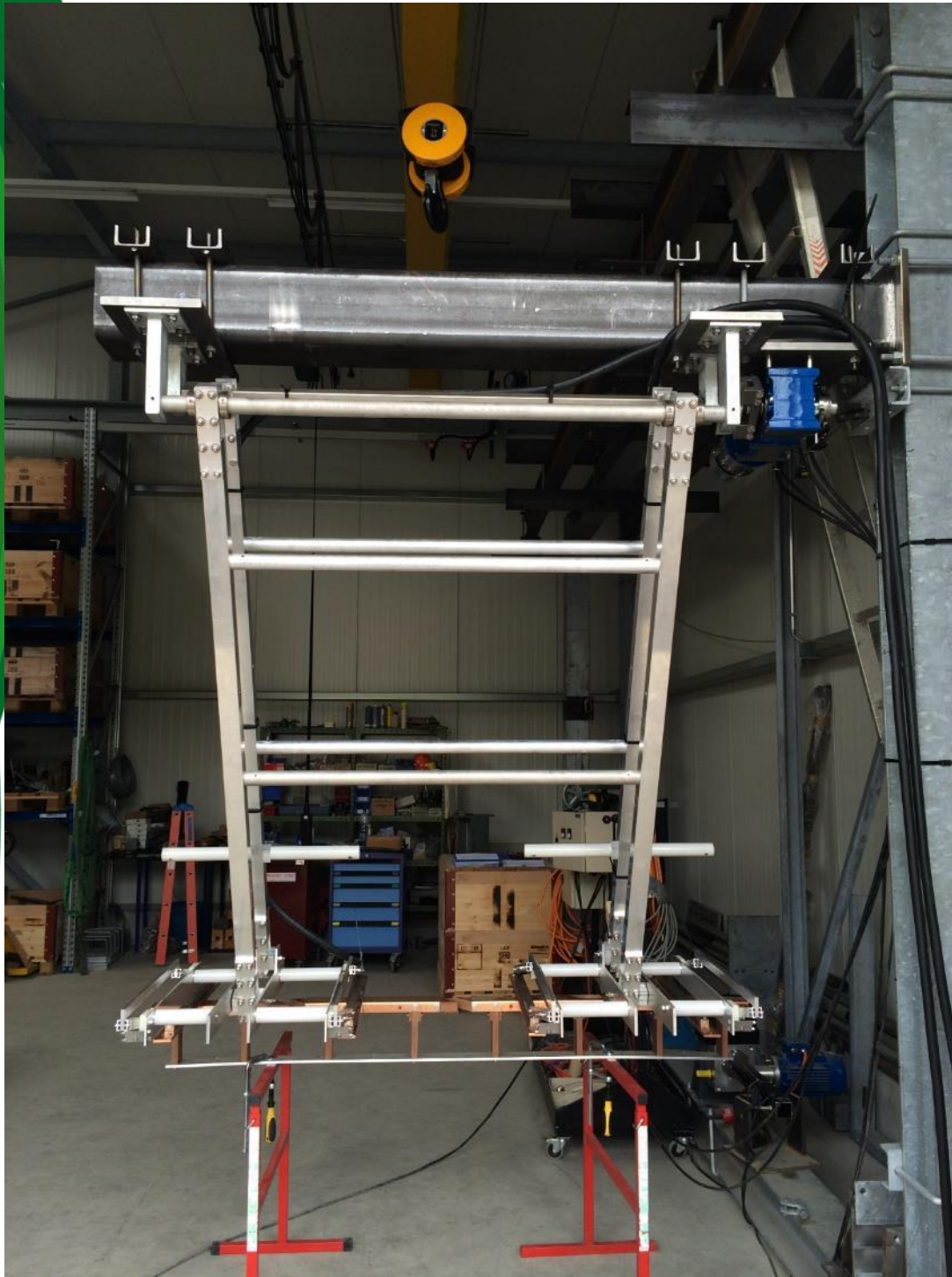
Wireless 15118 communication

36cm Lateral Docking Tolerance



75 cm Longitudinal Docking Tolerance





Busbaar V3:

Public Release IAA
Sept. 2014

Deliveries starting
November 2014



Furrer + Frey®
baut Fahrleitungen

Why Opbrid/Furrer+Frey?

- F+F: 90 years experience in high power transfer to vehicles (trains, trams, trolleybuses), worldwide presence
- Opbrid: Focused solely on fast charge stations for buses since 2007
- Proven safe transfer of very high power > 625A @700V DC
- 4 contact CCS based
- 2 years experience working with Volvo