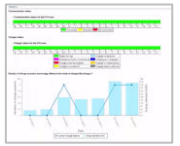
MAY 2019

Electrifying Transit: The Bus Depot of the Future, 20/20 and Beyond

Daniel Simounet, VP of Transportation Sector, Americas

ABB EV Charging Infrastructure

Connectivity Remote diagnostics, service, connection to payment, API's

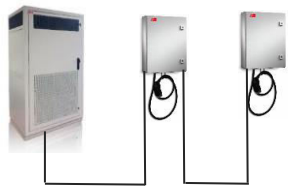


Car Charging → **Heavy Vehicle charging**

25kW DC Wallbox

50kW All-in-one

50kW-150kW with sequential charging



150kW-350kW with liquid cooled cable

150kW-600kW with Automated Connection

Grid Integration Compact substations, transformers, switchgear

Service & maintenance Local service, spare parts, maintenance & 3rd party training

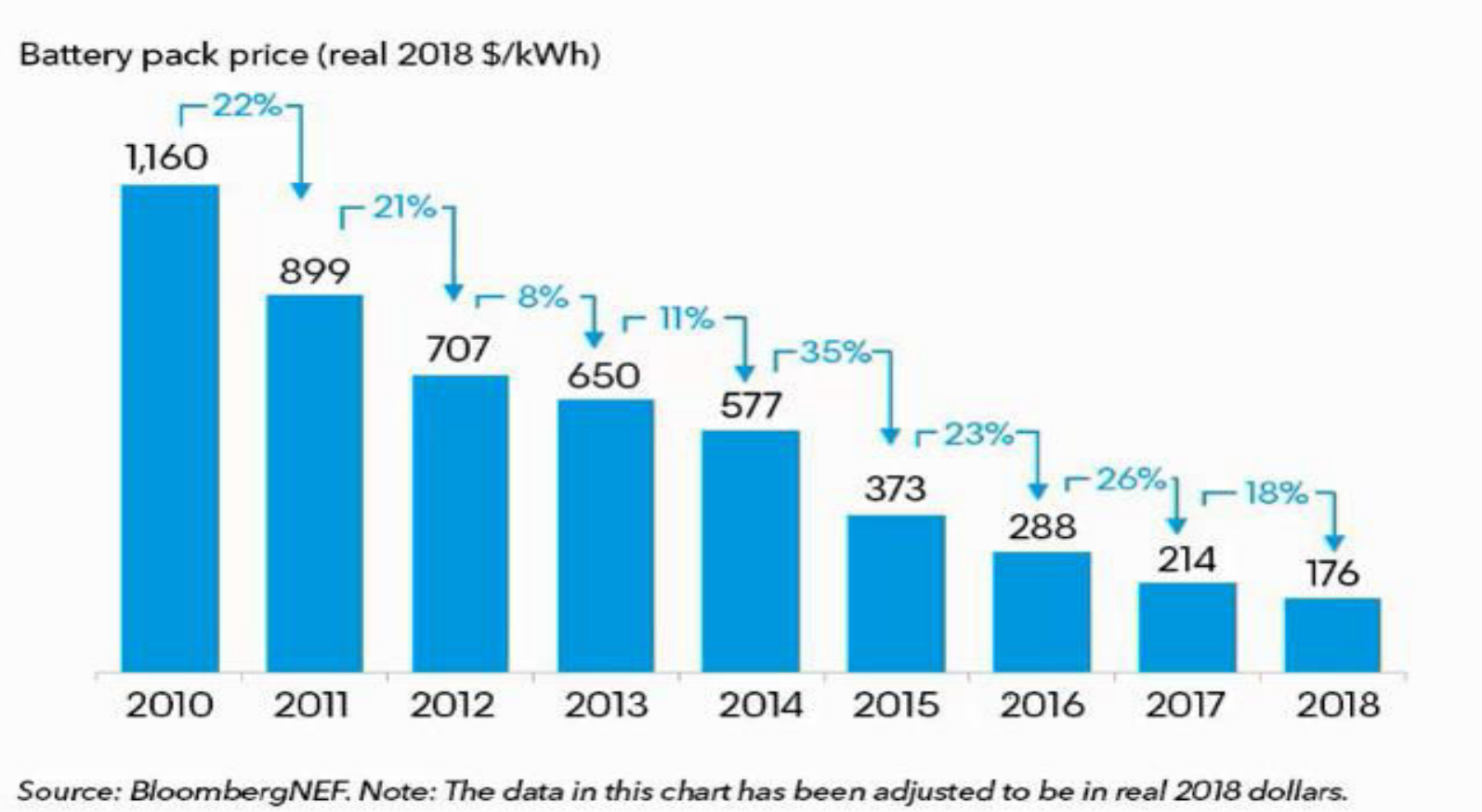
Electric Bus Global Overview

The electric bus revolution

- Global estimates of Bus fleet size are over 3 million units in operation around the world in 2017
- Currently, the #1 propulsion is Diesel, followed by CNG
- Electric Bus Technology has made huge advancements in the past decade
- Electric Bus Pilots are underway in every corner of the world
  - 18% electrified bus fleet in China
  - 385k electric buses globally

The Future of Transport

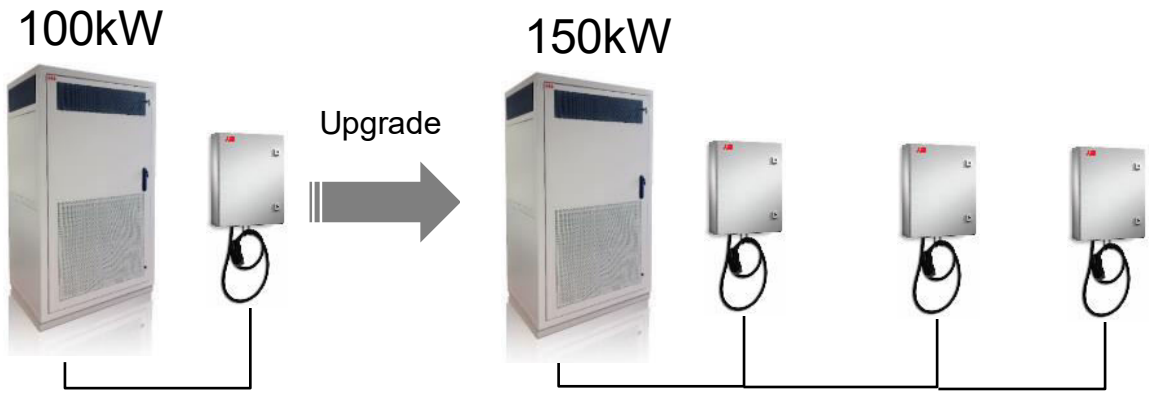
Improvements in battery technology leading to larger capacities and lower prices

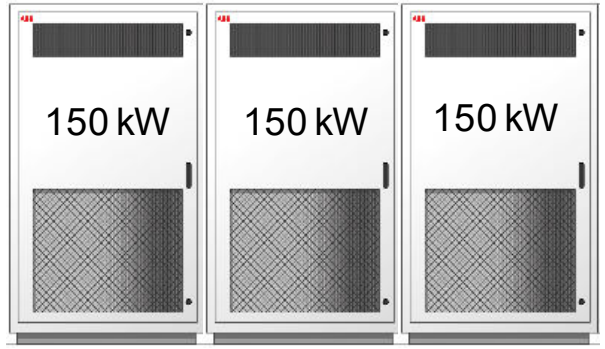


*Source Bloomberg New Energy Finance

Factors in Selecting Battery Charging

Modular, Future-proof charging equipment





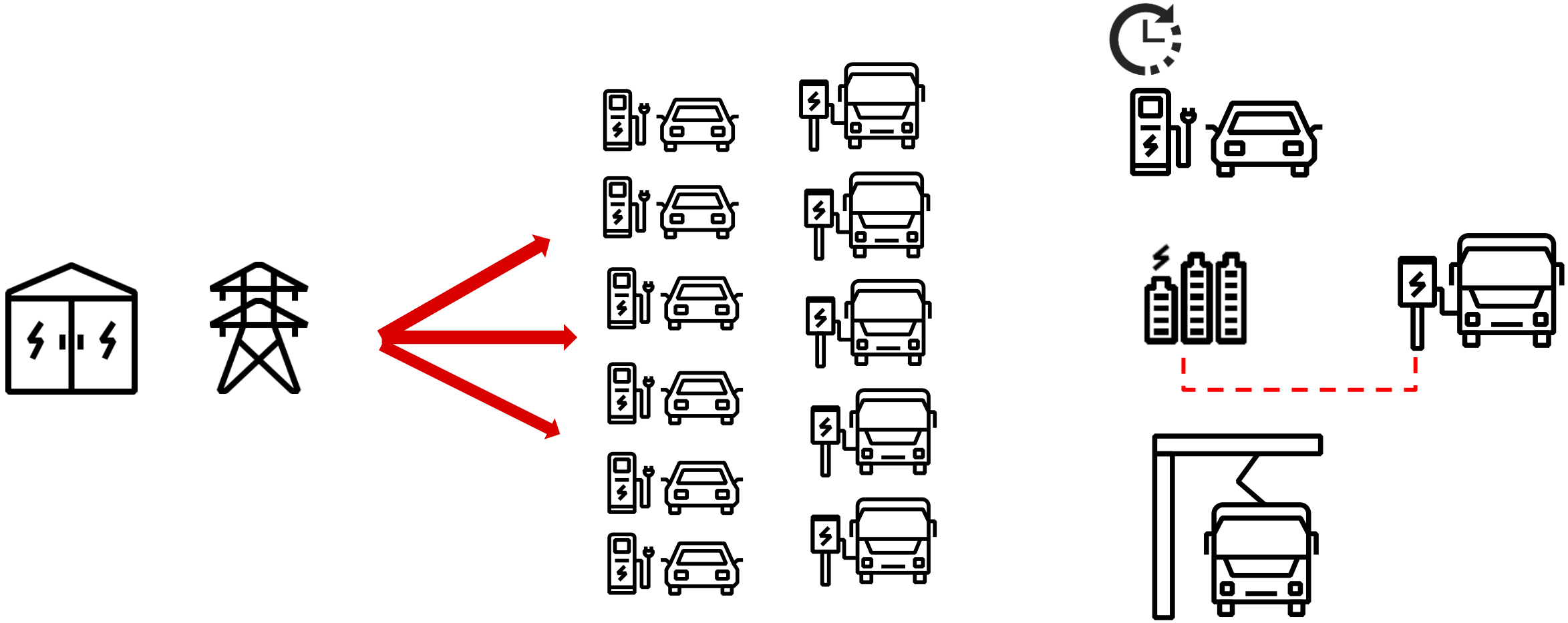
Upgrade can be done in the field by adding an extra module.
No groundworks, digging and disturbance to the site required

More busses with large battery capacity in the fleet

2017	2018	2019	2020	2021	2022
> 100 kWh	> 200 kWh	> 300 kWh	> 400 kWh	> 500 kWh	> 600 kWh

Electrification of Transportation Grid Impact

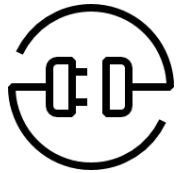
Solutions to grid impacts



Bus Charging – Importance of Standards

CCS standard changes required for power >150 kW

Standard	Specification (today)	Max charging power for EV car
CHAdeMO	50-500V, 125A	~50 kW
CCS	200-500V, 200A	~95 kW



CCS today	New high power CCS proposal
CCS connector	Special CCS connector, backward compatible with today's vehicles
200 – 500 V_{DC}	Up to 920 V_{DC}
200 A_{DC}	350 / 500 A_{DC}
Up to ~80-90 kW charging power	160 kW – 350 kW charging power
	Power electronics cabinet parameters under review: • Current • Voltage - Safety concept - Isolation concept - Electro Magnetic Compatibility (EMC) • Power quality • Accuracy
	Update of IEC standards takes until 2018/2019

CE / UL charger certification based on today's standard

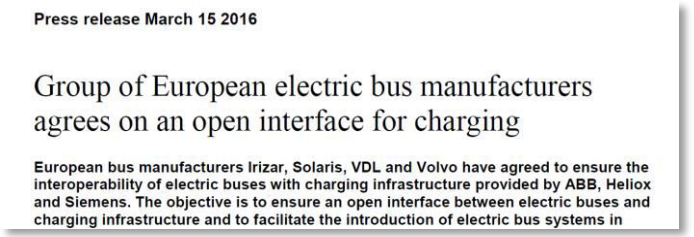
CE UL LISTED

Bus Charging – Importance of Standards

Standardization effort on overhead terminal charging in NAM

Accelerate the deployment of electric buses in the cities

- Manufacturers to create **a common standard** for the overhead opportunity charging
- In USA, ABB is supporting the "EPRI Bus and Truck Charging Working Group" to develop the **SAE J3105**
- In Canada, ABB is collaborating with **CUTRIC**, (including: Novabus, New Flyer, Siemens, city of Brampton, Alectra, etc.) for demonstration project to **demonstrate interoperability** of the common standard based on Oppcharge **(https://www.oppcharge.org/)**


Press release March 15 2016

Group of European electric bus manufacturers agrees on an open interface for charging

European bus manufacturers Irizar, Solaris, VDL and Volvo have agreed to ensure the interoperability of electric buses with charging infrastructure provided by ABB, Heliox and Siemens. The objective is to ensure an open interface between electric buses and charging infrastructure and to facilitate the introduction of electric bus systems in

OPPcharge

CUTRIC CRITUC

Pan-Ontario Electric Bus Technology Demonstration & Integration Trial (2017-2020): Standardization of the Emergent J3105 Overhead Charging

SAE INTERNATIONAL