BERLIN, 23.10.2017

Grid compatible flash charging technology

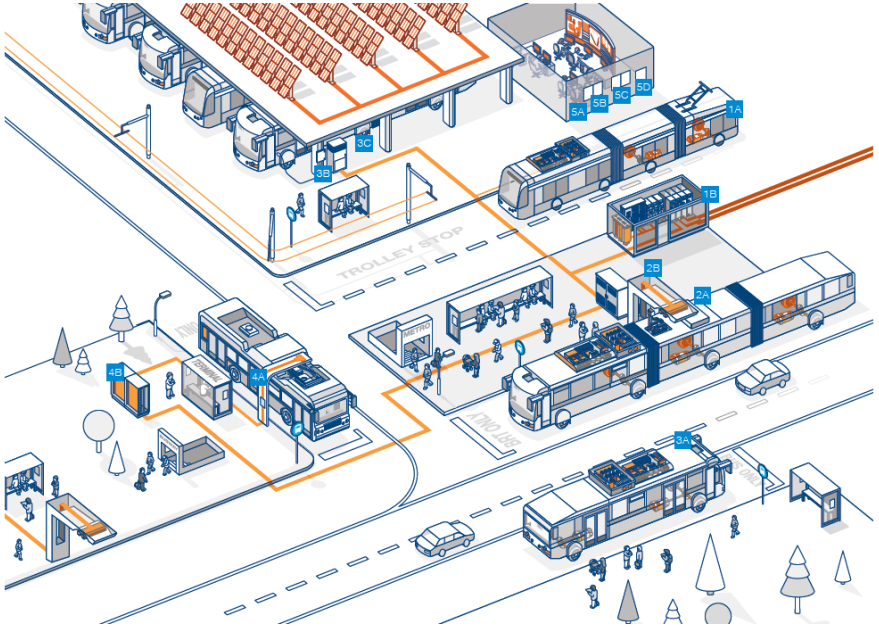
E-Mobility Integration Symposium

Shaping urban mobility

e-bus solutions, infrastructure and tools

ABB's portfolio

- **Depot-Charging** DC fast-charging at the bus depot
- **OppCharge** automated DC fast-charging solutions with charging powers from 150 to 600 kW and remote connectivity features
- **TOSA** catenary-free high-capacity fully electric articulated bus system with 15-seconds flash-charging at selected bus stops
- **Drivetrain solutions**, including traction converters, energy packs, motors and other on-board components
- **Associated control and monitoring tools** to operate and maintain customers valuable assets under the ABB Ability™ platform
- **Prefabricated e-bus substations / MV and HV substations** providing full integration into the AC power grid



Flash Charging Technology

Technical functionality

Project Approach

Energy simulation based on key parameters

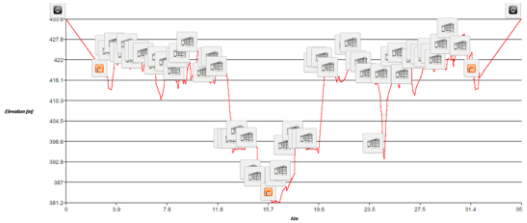
Line identification

Selecting the bus line (s)

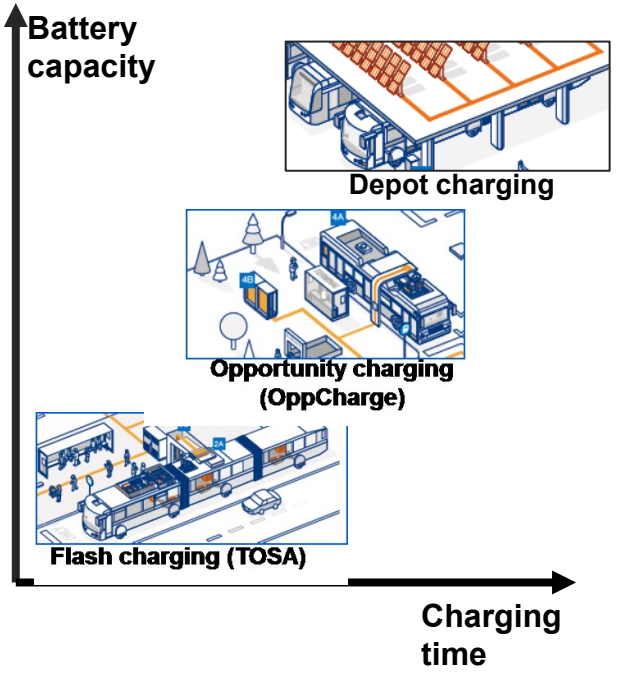
Calculation of energy demand

Identification of key parameters

- Route length
- Commercial speed
- Timetable
- Passenger capacity
- Auxiliaries (heating, air condition)
- Specify battery capacity



Choosing the right solution

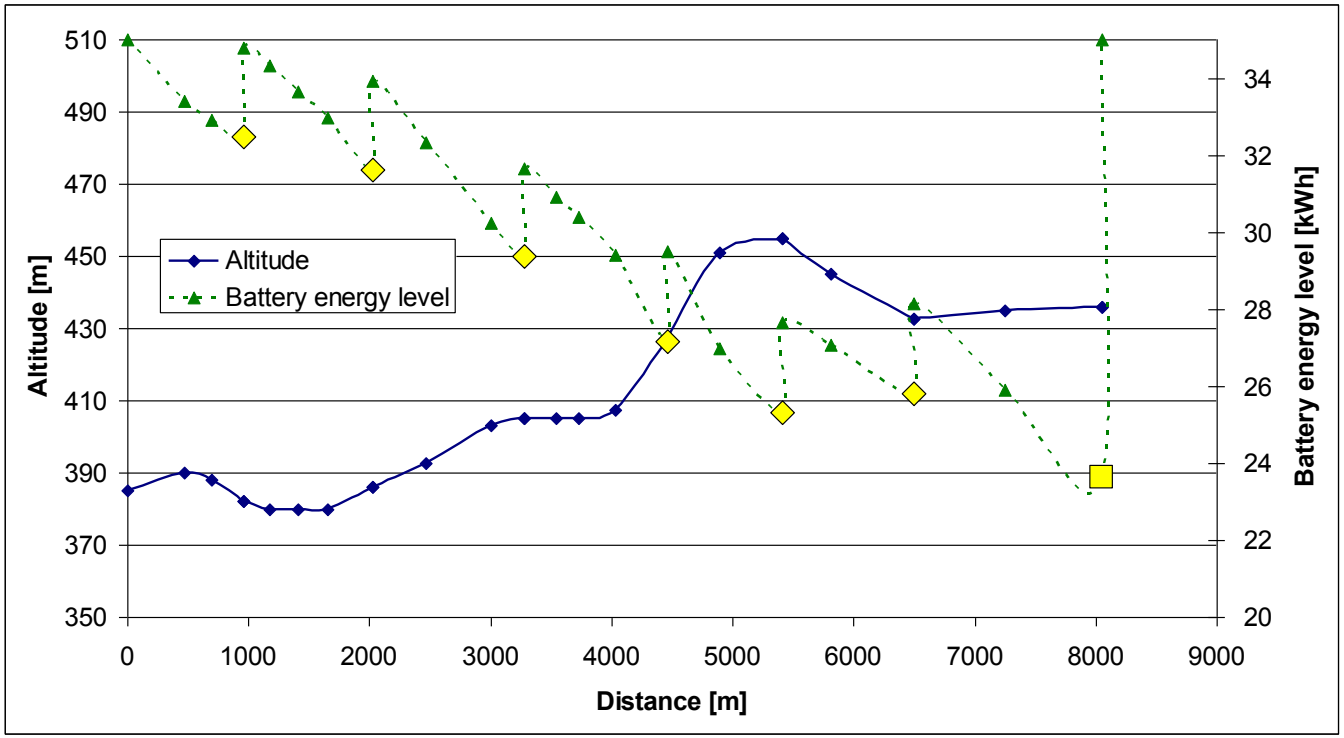


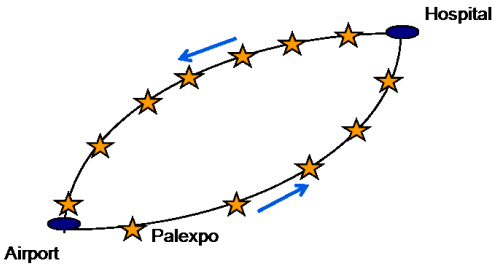
TOSA e-bus system

Intelligent energy management

Goal: Reduce the energy storage on board

High energy efficiency and cost efficiency





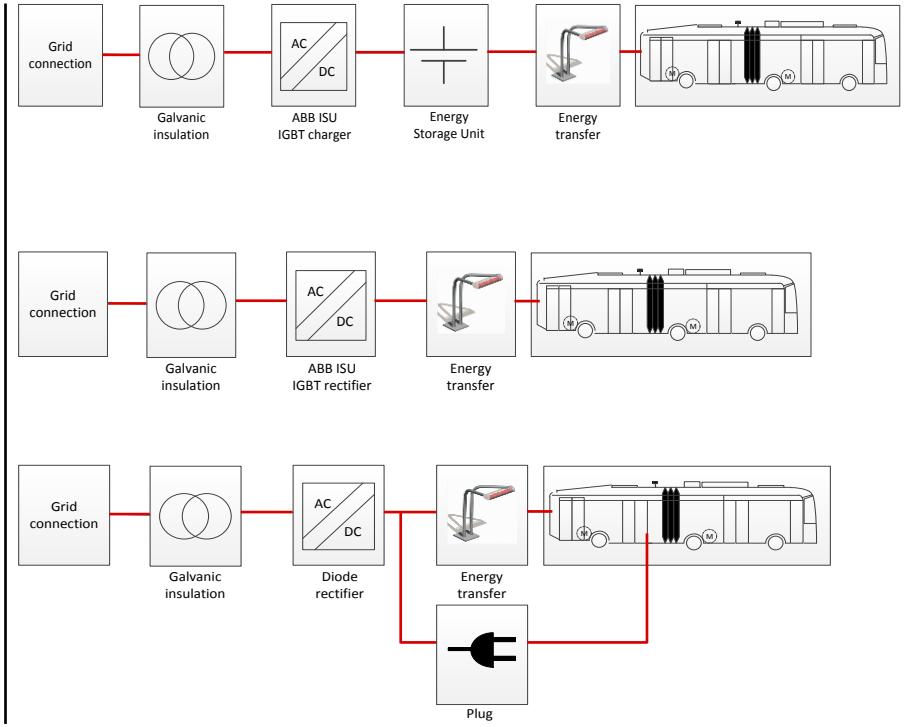
TOSA e-bus system

Flash / Terminus / Depot feeding stations

Energy storage for peak shaving designed according to local grid requirements and line's operation.

Three types of chargers:

- Flash-charging stations at selected bus stops (15 sec)
- Terminal feeding stations (2-5 min)
- Depot stations (30 min)



Quantity of flash-charging stations depends on route profile and service requirements

Operating TOSA

Total cost of ownership - requirements

Timetable

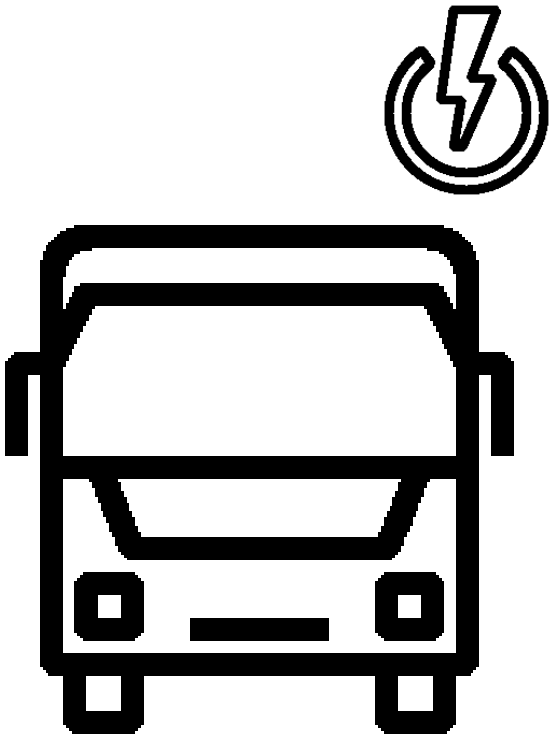
High-power in-route charging at selected bus stops and short layover time at terminal → same driving hours and commercial speed as a diesel fleet

High-passenger capacity

All technology mounted on the roof (all floor for passengers) for articulated and double-articulated buses

Long-life battery

Thanks to in-route charging principle, the high-power/low-energy battery pack is used in its optimal operating range



Operating TOSA

Total cost of ownership - requirements

Grid	1	Connection fee and energy cost minimized through embedded peak shaving functionality
Frequency and BRT	2	In-route charging (15") at selected bus stops (*) while passengers are disembarking and embarking and layover time compatible with high-frequency lines (up to 4,000 passengers/hour)
Light infrastructure at depot	3	Either free parking after fast (4-5 min) high-power charging upon arrival or low-power (45 kW) mutualized charging for four buses
Homogenous fleet	4	TOSA bus configuration (e.g. battery size) is line-independent. The line profile determines the required infrastructure

Reduction of energy costs (30% below those of a diesel bus) and CO_2 emissions (1,000 tons per year for 600,000 km)

TOSA technology

First articulated e-bus under real-life operating conditions from May 2013 to end of 2014

TOSA in Geneva

Line 23, connecting Geneva's airport with suburban Geneva

Line 23

18.75 m
bus length

133
passengers per bus

Technology

13 out of 50
stops flash-charging stations

600 kW 20 sec
flash charging

Vital statistics

More than
10,000
passengers a day travel on the route

>600,000 km
per year

Benefits

1,000 t
reduction of emissions per year for
600,000 km

10 decibels
noise level reduction
Half the noise pollution generated by conventional diesel buses.

TOSA enables emission-free public transport in Geneva