



Optimized solution for Electric Transit Buses

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Bus and Paratransit Conference
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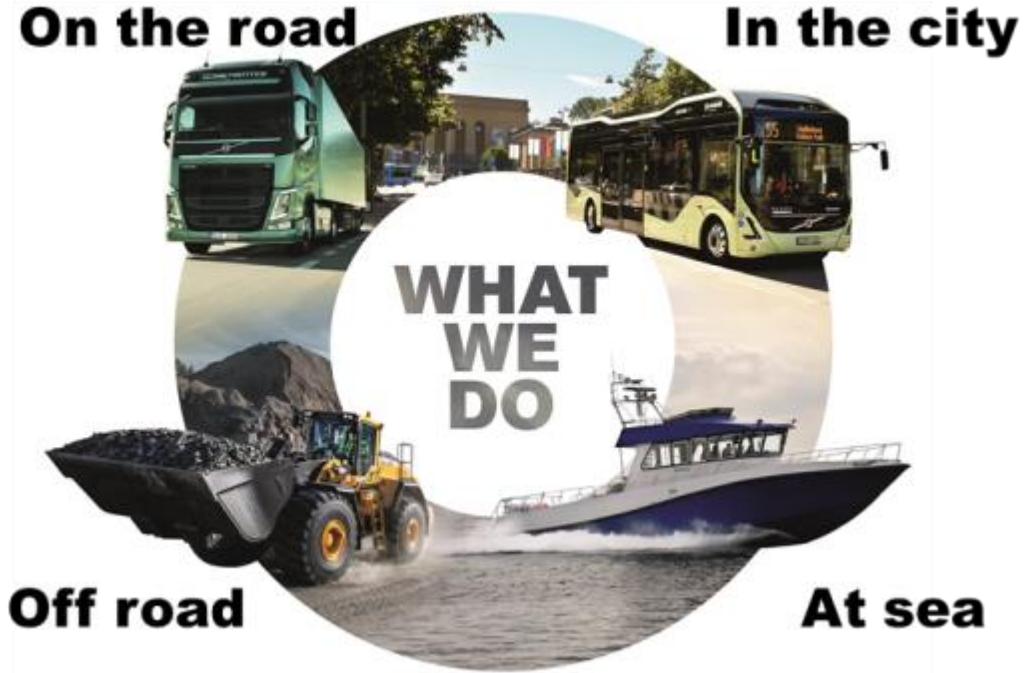
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Content

- Introduction on Electromobility
- Opportunity Charging Solution
- Benefits for the Transit Authority
- Application in Montreal
- Key learnings for stakeholders



Volvo Group : 100.000 people, business in 190 countries



12 brands, represented by **Nova Bus** and **Prevost** brands in North America



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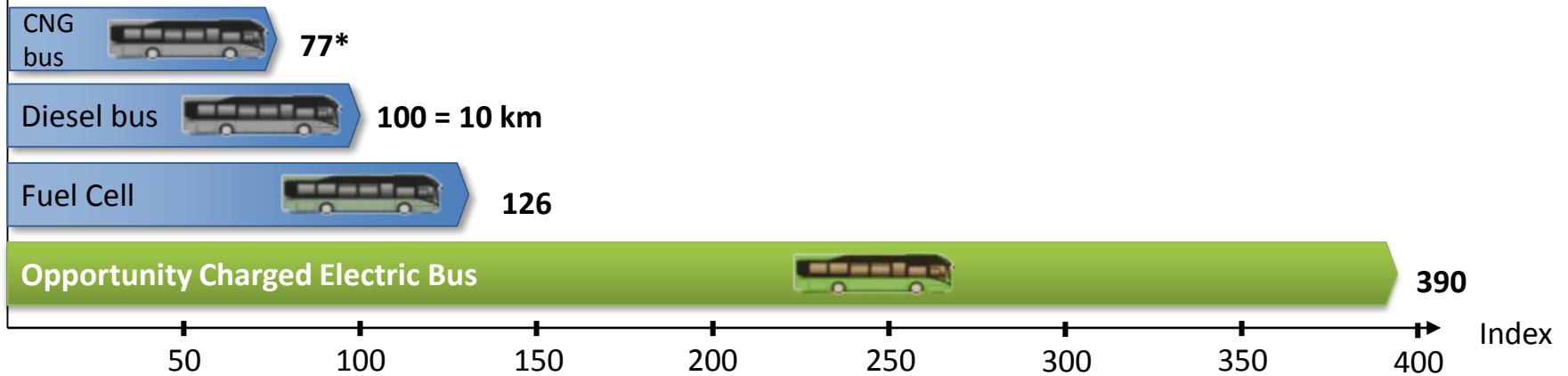
Global drivers impacting our society

- Population growth and **urbanization**
- Changes of demography in Western world
- **Pollution, climate change and alternative fuels**
- **Shortage of natural resources and raw material**
- Traffic and road safety
- Digital revolution



Electric buses have superior energy efficiency

- How far does 180 MJ of energy take you in a City bus?*



SOURCE: FCH JU , International Energy Agency 2011

* Well to wheel comparison:

- 5l diesel
- 5 Nm³ CNG
- 50 kWh of electricity

New opportunities for urban planning

- Bring the bus closer to user
- Silent and Zero Emission mode of public transportation improving quality of life
- Enabling indoor bus to improve passenger comfort and safety
- Significantly reduces emissions and particles improving air quality
- Energy efficient public transport



Opportunity charging

COMMON STANDARD FOR COST-EFFICIENT CHARGING

- Continuous operations
- High power charging infrastructure
- Optimized system performance
- Electricity consumption distributed over day and night
- Power outtake distributed geographically

- Pantograph
- High ground clearance
- Common standard by

SIEMENS ABB



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2017

VOLVO GROUP ELECTRO MOBILITY PROJECTS

150 PHEV/EV and 28 ch. stations
in revenue service and coming

NOVA BI

Montreal, QC, Canada 

- 3 Full electric buses
- Spring 2017



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OPRcharge

OPPORTUNITY CHARGING OF ELECTRICAL VEHICLES

ABB SIEMENS heliox Opbrid



**IVECO
BUS**



www.oppcharge.org

Open to other urban users
(garbage trucks, delivery trucks)



AMERICAN
PUBLIC
TRANSPORTATION
ASSOCIATION

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OPRcharge System Components

Infrastructure

- Height: 4–5 m (OK for open roads)
- Grid voltage : 600 V (CAN) / 480V (US)
- Pantograph voltage : >600V DC
- Charging power: 300 / 450 kW
- Moving parts on the stationary side of the charge system.
- Towards SAE J3105 compliance

 **QUICK START**

 **HIGH POWER**



Charging station

Mast

Pantograph

Contact rails

e-Bus



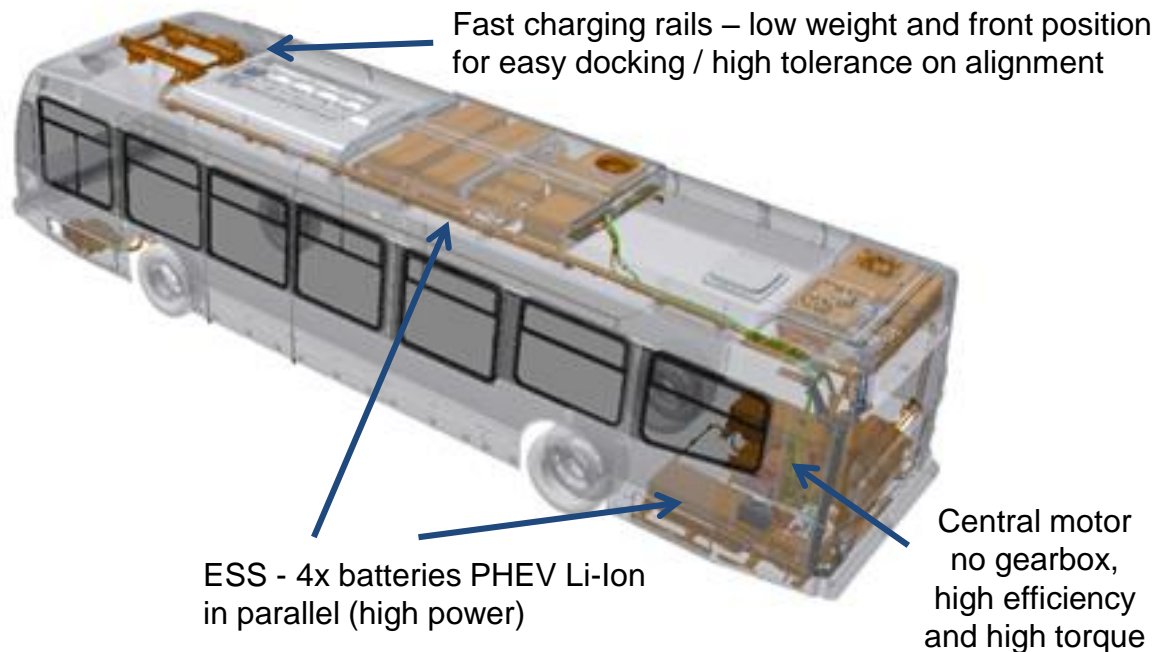
Batteries





Technical Specifications

- Motor: **230 kW and 2700 Nm**
- Batteries: **4x lithium-ion (76 kWh total)**
- Fast charging system:
300kW and 450 kW overhead system
- Depot charging system (for maintenance):
Off-board EVSE supplying energy to on-board low power charger (11kW)
- Typical distance between fast chargers :
Up to 20km route.
- Charging time (fast charging):
5 minutes (@ 450kW) per hour of use



Maintenance / in-depot charging

Low Power Charging functions :

- HV battery balancing
- HV battery calibration and equalization
- HV battery overnight depot charging

Electrical Grid

480Vac 60Hz
3Phase

EVSE
(charging station)
480Vac 3Phase



Slow Charger Interface
(with vehicle Inlet Lock)
480 Vac



IEC 62196 Type 2
Coupler System



On-Board Charger
(in vehicle)



Fundamentals : Durability and Safety

Based on the proven LFS platform

10,000+ buses on the road

Stainless heavy duty structure

High Quality Service network



ACTIVE SAFETY

HVIL (Hazardous Voltage Interlock Loop)
Internal battery contactors for each pole
Voltage leak detector
Contactor state and health measurement

PASSIVE SAFETY

No easy accessibility on electric hazard
Charging rails electrically isolated while not in use
Touch Proof connectors
Work and safety instructions
Training and certification



PASSED VOLVO SAFETY AUDIT, a core value of **VOLVO** Group



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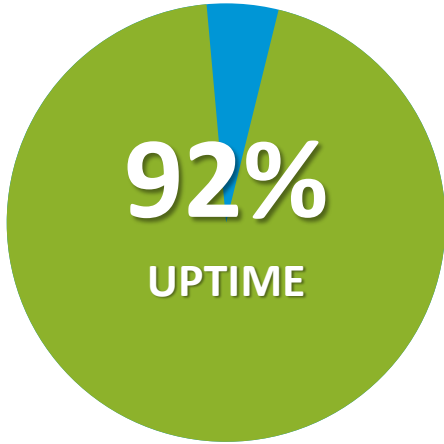
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LFS is winterproof !

Tested last 2 winters :

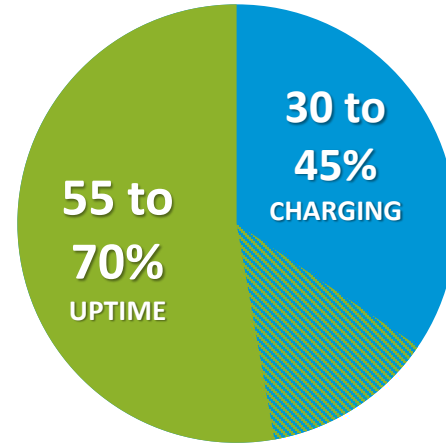
- Safe driving performance (Traction control, stability)
 - Battery heated to get the right performance (and the durability)
 - Rails and pantograph heated (no ice)
 - Fuel-fired heating for severe winter conditions.
- ⇒ **No interruption of service in heavy snow conditions**





5 MINUTES CHARGING PER HOUR OF OPERATION
WHICH FITS BUS LAYOVERS

LONG RANGE
DEPOT CHARGING SOLUTION



20 MINUTES CHARGING
PER HOUR OF OPERATION

OUR FAST CHARGE TECHNOLOGY OFFERS 24H OPERATION WITH

Low charging time | Maximum uptime | Optimized number of buses in your fleet



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35
SEATED

71
TOTAL

- Optimized energy storage for a maximum payload
- Optimized battery positioning on rooftop :
 - No sacrifice of interior space.
 - No in floor batteries, floor kept at low level.
 - Vehicle is fully accessible.

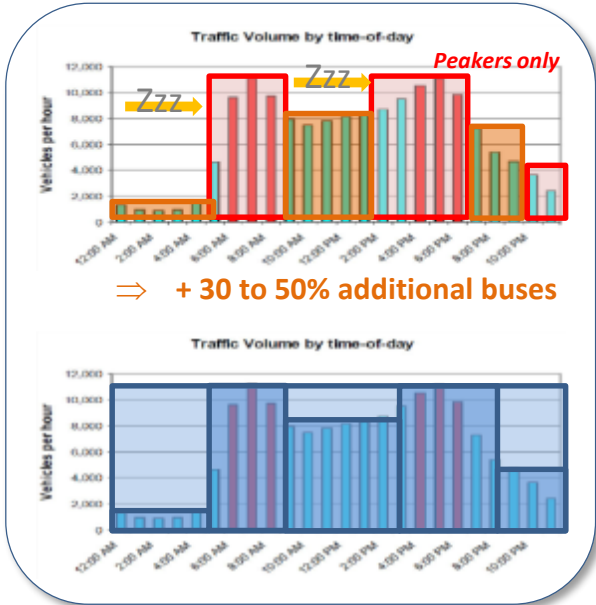
Optimized weight to transport passengers



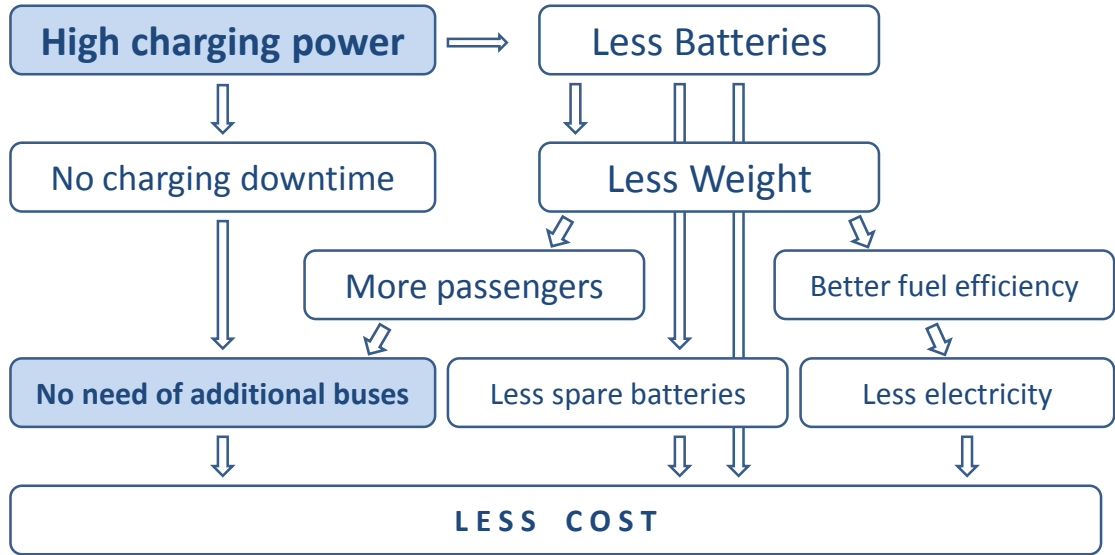
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Cost-Oriented solution

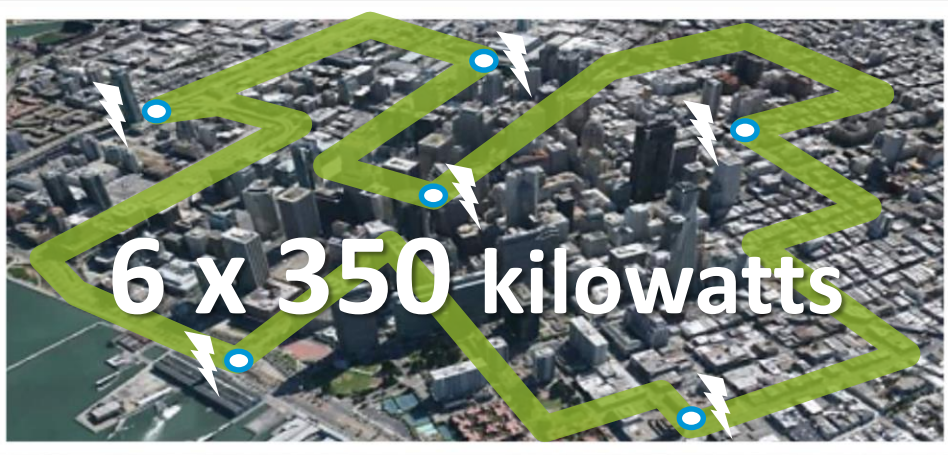


OPRcharge



Grid-friendly solution

6 X CHARGING SUB-STATIONS



Power is distributed along the day and all over the city offering a **BETTER BALANCE IN THE GRID.**

OPPORTUNITY CHARGING

can be much more easily integrated into the grid than overnight charging in the depot.



1 HIGH-ENERGY CHARGING STATION

February 2017 : Project delivery in Montreal



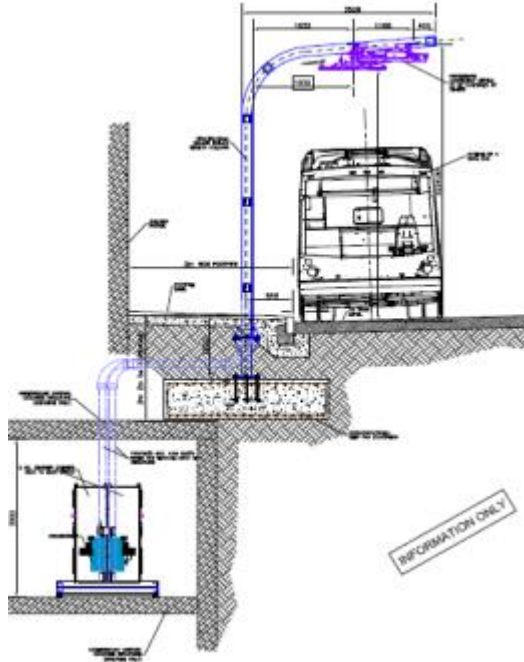
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February 2017 : Project delivery in Montreal



Charging Station at Square Victoria (Montreal)



Charging Station at Angrignon Terminus (Montreal)

- 1 Mast and Pantograph
- 2 Charging station shelter
- 3 HQ and STM equipment's shelter
- 4 Angrignon subway entrance

*Installation in progress
(november 2016)*





Conclusion : an optimized and beneficial solution for all stakeholders

- Fleet Managers :** **Compatibility, interoperability** of **OPPcharge** non-proprietary solution
- Operations :** **Continuous operations.** low charging time
High level of Safety : People can board while charging.
- Maintenance :** **Cost-efficient concept.** No transmission, no oil change, no aftertreatment
- Drivers :** **Easy and comfortable :** Low vibration. Smooth, powerful, progressive acceleration.
- Passengers :** **Peaceful,** less noise, less vibration, no exhaust smell.
- Utility :** **Grid friendly :** Distributed power. Low voltage connexion
- City :** **Real solution to mitigate local pollution**
Infrastructure integration can be customized

Nova Bus offers a turn-key electromobility solution
which is Reliable and Optimized

Thank You !



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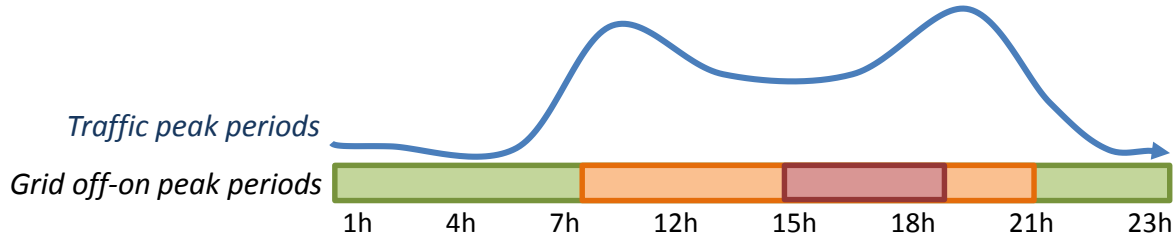
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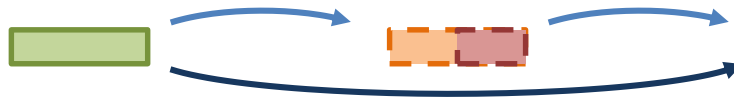
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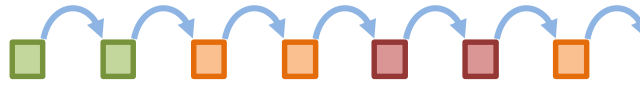
Time-Of-Use



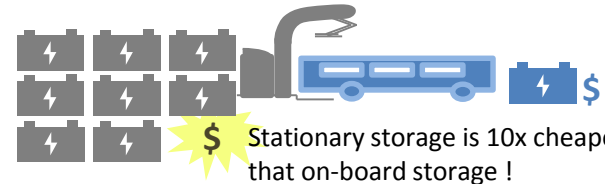
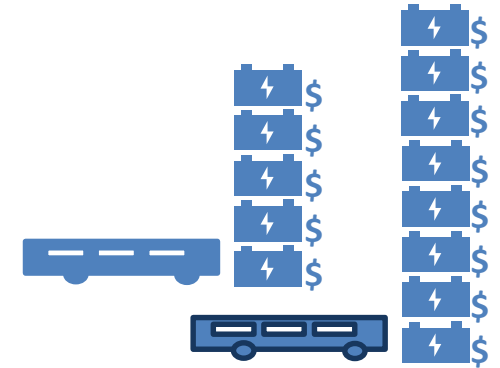
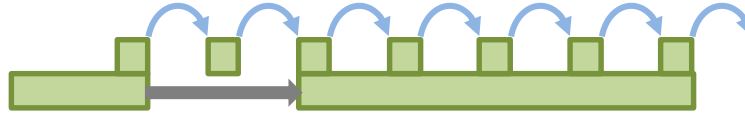
Depot-Charging



Opportunity-charging



Opportunity-charging with stationary storage at the charging station



Stationary Storage and Smart Charging

Application of electric buses at a city scale will open the possibility for **Energy Services** :

- Stationary storage to support local energy services : Load leveling, **peak power shaving**, frequency regulation, **renewable power integration**.
- Smart-charging : **Battery State of Charge Management** in order to balance mobility needs (taking into account traffic, weather forecast...) with energy costs.

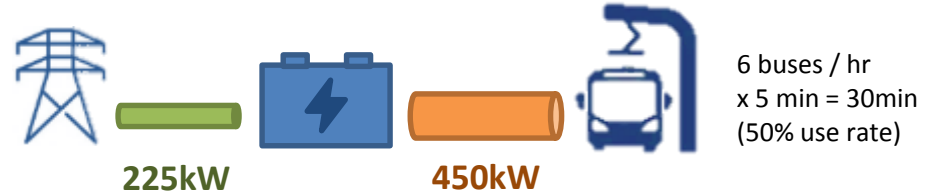
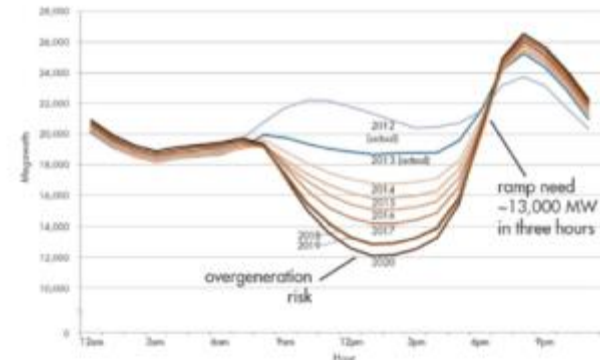


Figure 18: The California ISO “duck curve” (March 31)



Source : CALSTART