# Planning for the Direction of Battery Electric Buses

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Michigan Tech Talk

# CALSTART's 265 + Member Companies and Organizations

(PARTIAL LISTING)

## Making Clean Transportation Happen

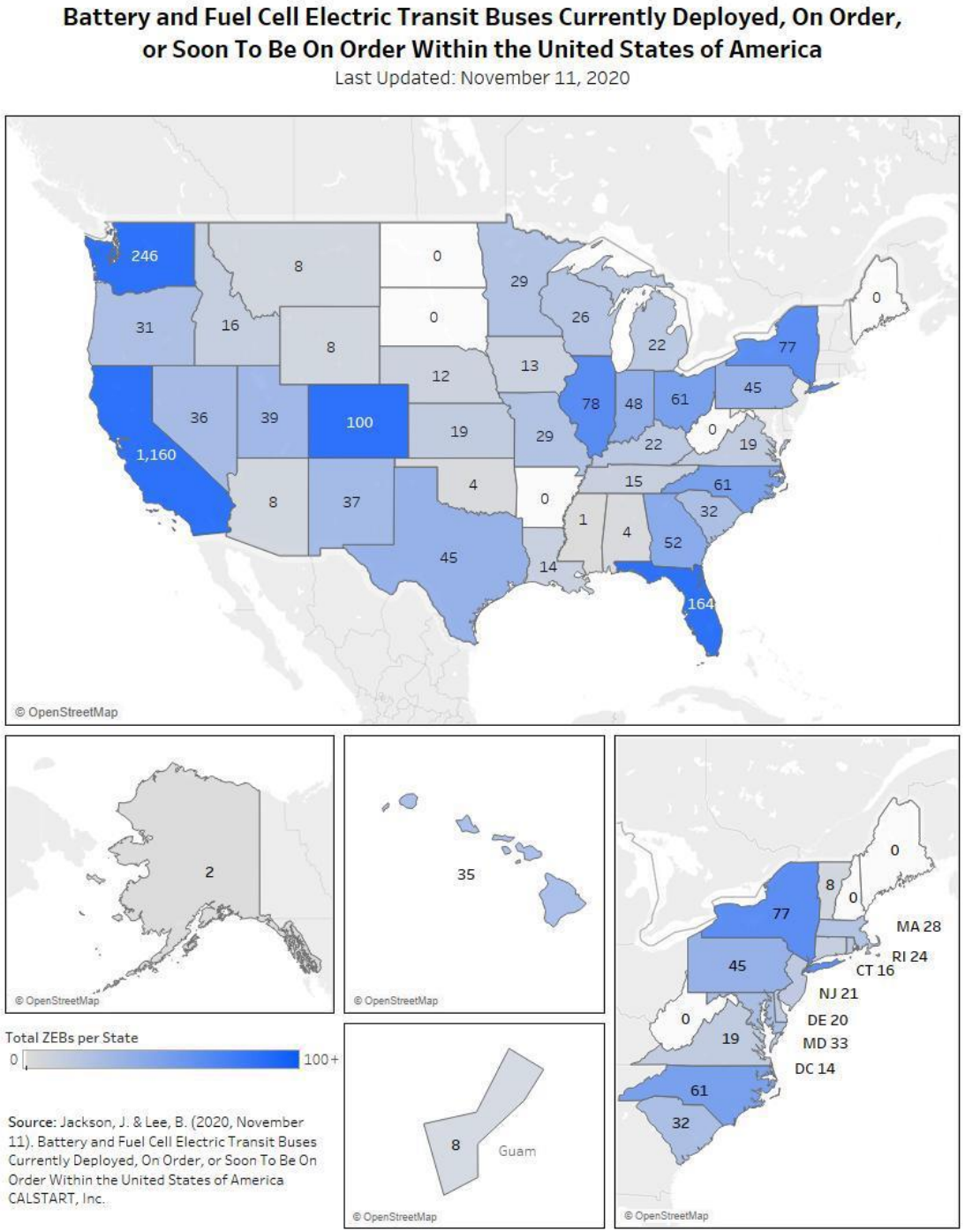
# CALSTART – A National Organization 9 Offices
# Seven Regional Offices + Two Field Offices

# Zeroing in on ZEBS and Inventory Across the Nation

As of December, 2020 there are:

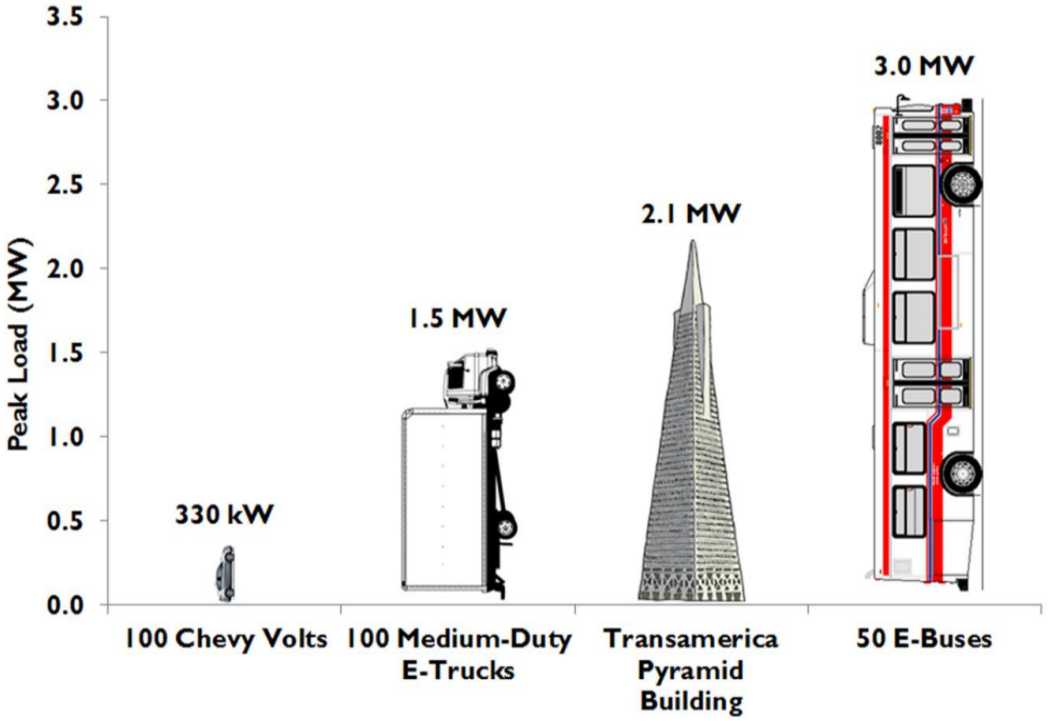
- Total Zero-emission Buses (ZEBs): 2,790
  - Battery Electric Buses (BEBs): 2,703
  - Cutaway Buses (BEB): 617
  - Hydrogen Fuel Cell Buses (FCBs): 87
- An increase of 24% over the last calendar year.
- 229 transit agencies
  - Median number of ZEBs per property is six
  - 57 properties are in California.

https://www.cleantransitnetwork.org/site/wp-content/uploads/2021/01/Zeroing_In_on_ZEBs_Official_Final_Document-Dec-2020.pdf



# What Makes a ZEB Different Than A Conventional Buses?

- The infrastructure is all new for a ZEB
- A small rollout of ZEBs may be easier with a battery bus
  - However when growing the fleet size the cost effectiveness of Hydrogen refueling can in some cases be lower or at parity with a battery electric bus
  - Just the access to electric power can be steep and expensive



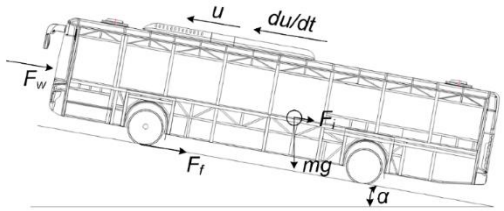

***Assumptions: the Chevy Volt charging rate is 3.3 kW, the medium-duty E-Truck charging rate is 15 kW and the E-Bus charging rate is 60 kW.***

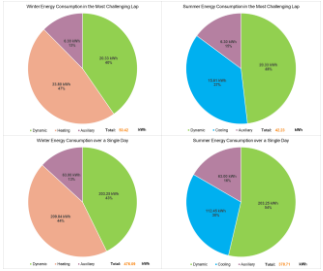
# Planning

- Align short and long-range transit plans
  - Key for future funding and planning
- Energy Consumption Analysis
  - Determination of power needs and operational feasibility
- Utility Engagement
  - Power availability (ask for a site walk)
  - Possible funding for infrastructure
- Identify Funding Opportunities

# CALSTART Electric Bus Corridor Model Tool Key Outputs

- **Planning Tool** to assess the efficiency of a battery-electric bus on a pre-determined route.
- Utilizing route speed, topography, seasonal temperatures, etc.



Energy Consumption Breakdown for the Design Days in Winter and Summer

| Key Design Output | |
|---|---|
| Average Energy Consumption per mile in the design day in Summer (kWh/mi) | 4.23 |
| Average Energy Consumption per mile in the design day in Winter (kWh/mi) | 5.32 |
| Minimum battery size if using Depot Charger Exclusively (kWh) | 732 |
| Minimum required charging power for depot charger if using Depot Charger Exclusively (kW) | 66 |
| Minm um battery size if using On Route Charger Exclusively (kWh) | 78 |
| Minimum required charging power for on-route charger if using On-route charger exclusively (kW) | 224 |
| Minimum battery size if using both Depot and On-route Charger (kWh) | 78 |
| Minimum required charging power of depot charger if using both Depot and On-route | 7 |

Energy Consumption Breakdown for the Design Days in Spring and Fall

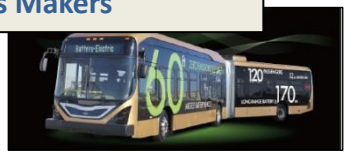
| Additional Key Output for Typical Days in Spring and Fall | |
|---|---|
| Average Energy Consumption per mile in a typical day in Spring (kWh/mi) | 3.54 |
| Average Energy Consumption per mile in a typical day in Fall (kWh/mi) | 3.64 |
| Average Energy Consumption per lap in a typical day in Spring (kWh) | 31.63 |
| Average Energy Consumption per lap in a typical day in Fall (kWh) | 32.52 |

# Additional Technology Considerations

- Data Logging
  - Viricti
  - Hams (IO Controls)
  - Proprietary Software (Connect, APEX, etc.)
  - Used in TCO Calculations and Validation
- Smart Charging Software
  - Installed on chargers or the bus
    - Helps to lessen peak demand price issues
- Distributed Energy Resources (DER)
  - Microgrids
  - On-Route Charging capabilities




**More Than 30 Transit Style and Cutaway Bus ZEB Products Across Twelve Bus Makers**









CALSTART

# The new phrase in BEBs

# Nova Bus


LFS e+

Powered by BAE Systems

- Nova + BAE
- Up to 594 kWH of on-board storage
- Overhead or Depot charging available
- 3.25 hours to full charge on either system


# New Flyer Xcelsior Charge NG

- Next Generation
- Up to 525 kWH of on-board storage
- Overhead or Depot charging available
- 179-251 Mile range
- 3.25 hours to full charge on either system


# Proterra ZX5

- 450 - 675 kWh battery pack
- 240 - 329 Mile Range
- 2.9-8 hour recharge time
- Additional front port charging
- Both overhead and in-depot charging available on same bus
- 600v System for faster recharge capabilities

# Cutaway / Trans Van BEBs

- Smaller battery sizes: 105kw-130kw
- Often Familiar Bus Builders: Forest River
  - Utilization of “Integrators”
- Smaller Charger Sizes = Less Infrastructure and Power Supply Needs
- Shorter testing life: 5 years
- Approximately 3x the purchase price
- Rapidly expanding market
- Option for auxiliary heater
- Charge Time: 1.5-8 hours depending upon battery and charger size

# GreenPower

- Ford Transit-*STYLE* vehicle
- Based in Porterville, California
- Buy America compliant
- Altoona tested
- Up to 150 miles

# Phoenix Motorcar

- Starcraft Body – E450 Chassis
- Based in Ontario, California
- Buy America compliant
- Altoona testing to begin Q2, 2021
- 80-150 mile range depending on battery size

# Lightning eMotors

- E450 Chassis
- Based in Loveland, Colorado
- Buy America compliant
- Altoona testing to begin Q2, 2021
- Electric Range: 80-120 miles based upon battery size
  - 3 new pack sizes will be available with up to 180 miles of range
  - Ford Transit to be tested as well

# Motiv

- E450 Chassis – Forest River
- Based in Forest City, California
- Buy America compliant
- Altoona testing to begin Q2, 2021
- Electric Range: 80-120 miles based upon battery size

# Optimal

- E450 Chassis – Optimal
- Based in Plymouth, Michigan
- Projected Availability: Q3, 2021
- Proterra Batteries
- Low-Floor
- Electric Range ???

# Current Hurdles for Cutaway Market

- Component waste
  - Engine, transmission, etc.
- Ford eQVM has been cancelled
- Little data available
- 1 OEM has completed Altoona
- 5-year Altoona Test
- Current price makes for a poor TCO


# Forest River + Green Power

- Exclusive chassis agreement announced February 11, 2021
- 150 chassis purchased for initial order
- Buy America Compliant, Altoona Testing 2022
  - 7-10 year test
- New bus “brand” and pricing will be released in Summer 2021
  - Expect a price well below anything on the market

# Thank you

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