ELECTRIC SCHOOL BUS NETWORK

ROUTE MODELING

South/Gulf Coast Electric School Bus Working Group

May 17, 2023 | 1:00 p.m. ET

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WORKING GROUP AGENDA

MAY 17, 2023

01. Intro to the Electric School Bus Network
02. Guest Speaker Introduction: InCharge
03. Route Modeling Demo
04. Q+A
04. Summary + Closing

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MEET THE TEAM

Rachel Chard
National Program Manager

Michelle Hanson
Program Manager

Ian Fried
Lead Project Manager

Juan Espinoza
Lead Project Manager

Chrystal Ales
Project Manager

Katelyn Tomaszewski
Project Manager

Liza Walsh
Associate Project Manager

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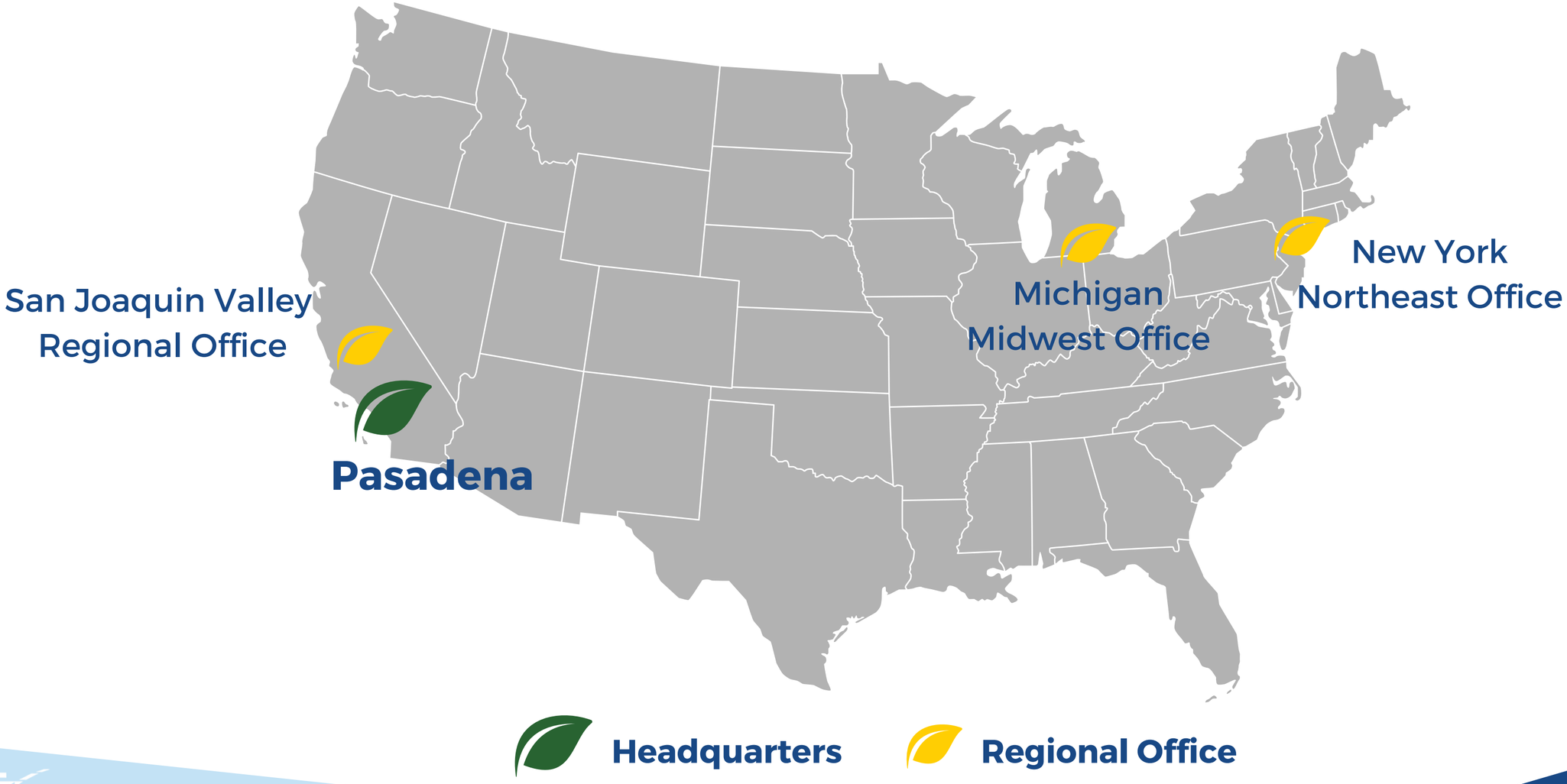
GLOBAL ORGANIZATION TRANSFORMING TRANSPORTATION FOR GOOD



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ELECTRIC SCHOOL BUS NETWORK

The Electric School Bus Network accelerates nationwide school bus fleet electrification through **peer-to-peer networking** and **dialogue-driven working group meetings** for school districts, advocacy and government organizations, and industry representatives. The ESB Network provides access to educational tools, resources, and subject matter experts to **help support the electric school bus fleet transition.**

In Partnership with:

WORLD RESOURCES INSTITUTE

CALIFORNIA HVIP

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ELECTRIC SCHOOL BUS WORKING GROUPS

- **Working Groups are not webinars!**
- **They are ongoing**, not static
- Panels with industry subject matter experts
- Goal: **Ease the transition of the U.S. school bus fleet to electric**
  - Facilitate conversations
  - Provide up-to-date information
  - Independent/Third Party Partner

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QUESTIONS?

Please raise your hand or type your questions for our panelists in the chat!

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WORKING GROUP TOPIC:

Route Modeling

Van Wilkins
SVP of Operations
InCharge

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InCharge™

We Bring the Power

CalStart ESB Network Working Group

May 17, 2023

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Charging analysis process

Route Analysis
- Miles driven
- Dwell time
- Operational flow

Vehicle Review
- Vehicle charging rates
- Electric rates/demand
- Thermal load management

In-person Site Visit
- Site conditions
  - Available power
  - Panel location
  - Site logistics
  - Charging port location
  - Future proofing

Proposals
- Charger recommendation
- Financing/Grant eligibility

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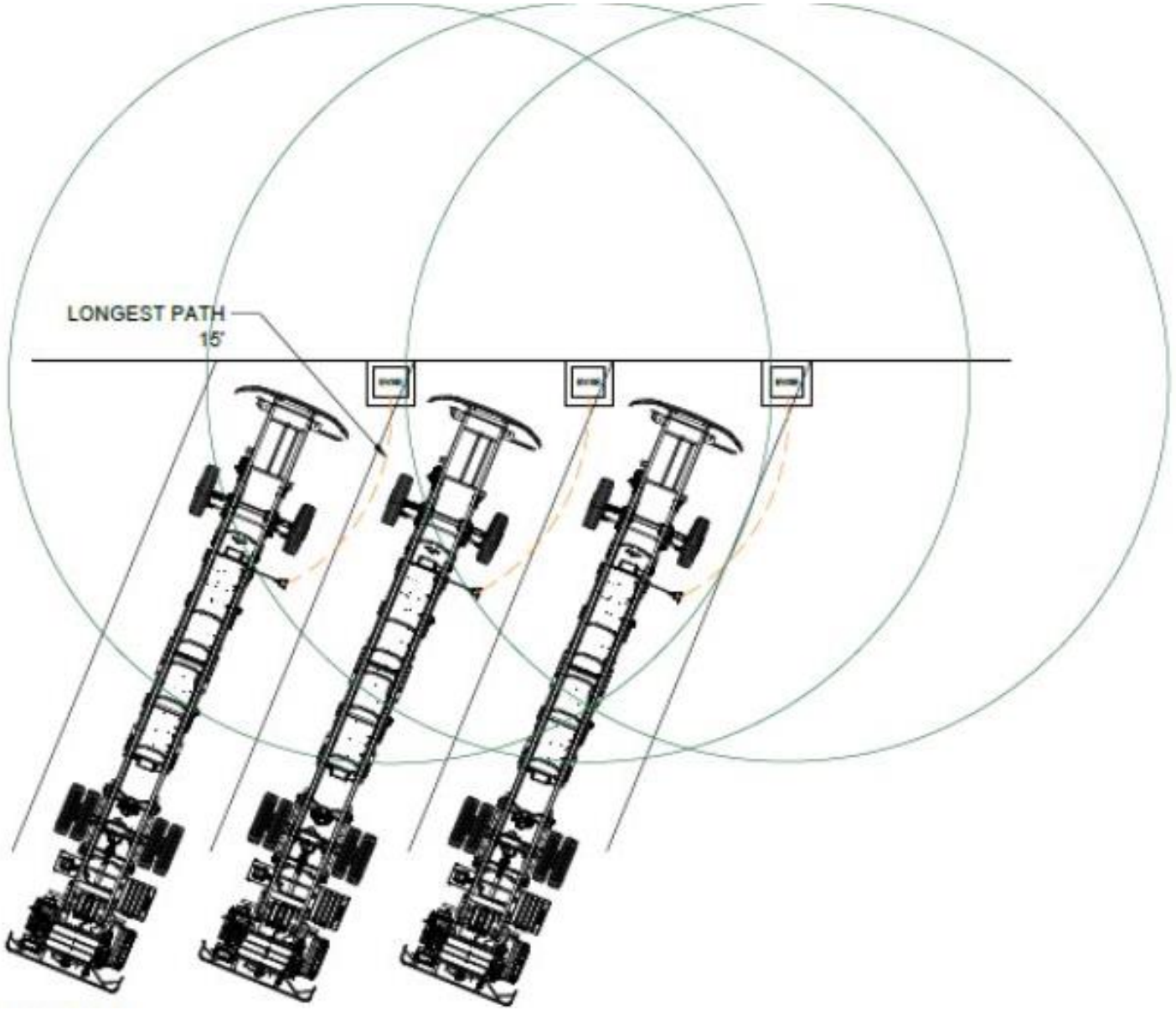

Location, Location, Location

- Charger size based on all-day routing needs
- Physical location of charger impacts cable reach, user interaction
- Bus port location for the fleet (front / rear / left / right)
- Snow removal equipment needs impact bollards or wheel stops

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Charging 101: The Basics

80A AC (Level 2)

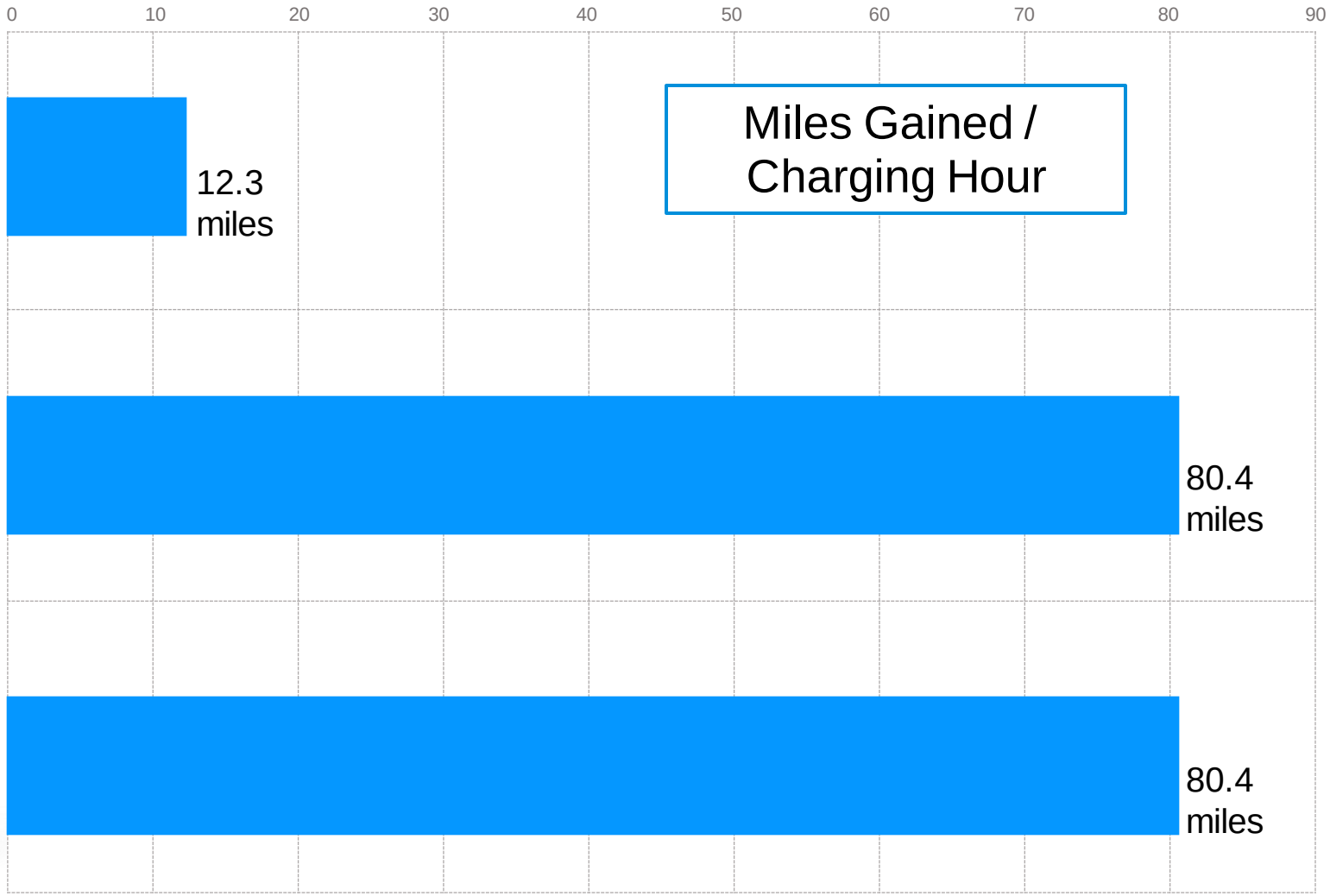
- 208-240V
- AC Charger
- Residential & commercial
- 16.6-19.2JW

DC 30kW

- 480V
- DC Charger
- Dual Port Sequential
- Commercial

DC 60kW

- 480V
- DC Charger
- Dual Port Simultaneous
- Commercial



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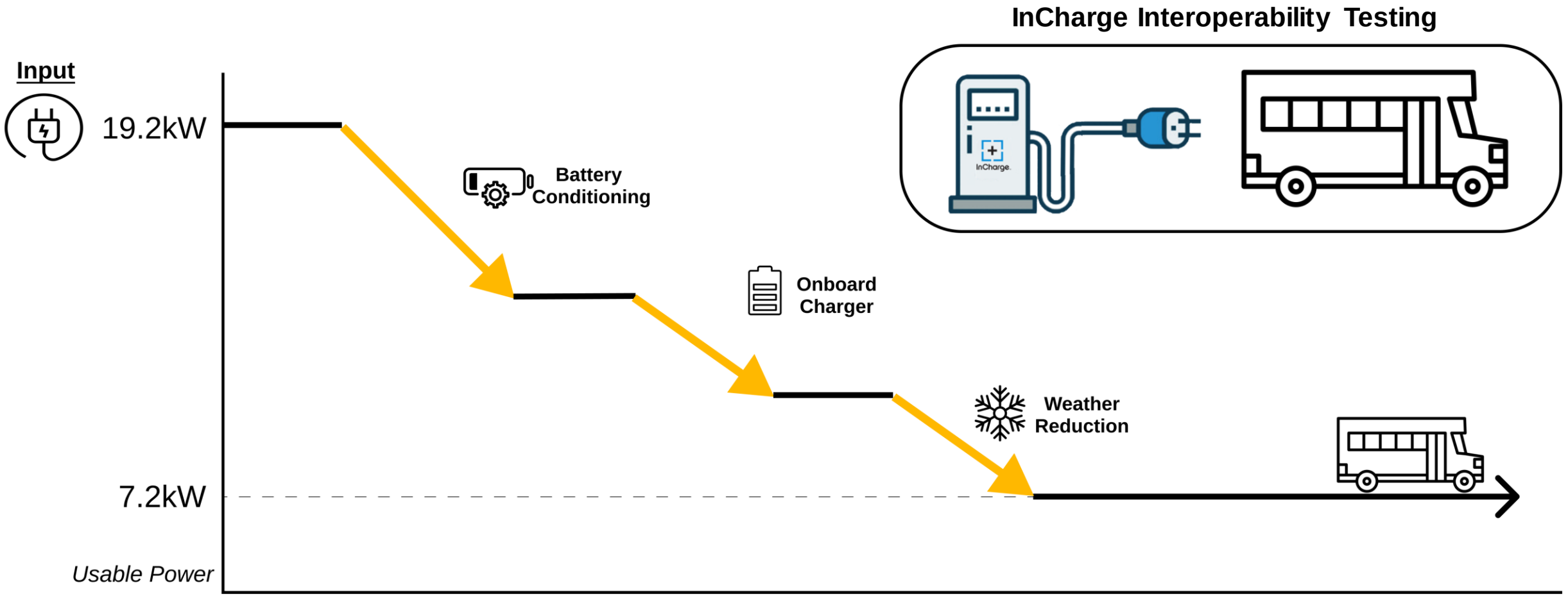
The Charging Reality



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ESB Fleet Deployment

Scenarios & Discussion

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Successful ESB Fleet Deployment

Boston Public Schools

Vehicle battery size: 120 kWh

Route distance: 35 miles

Route elevation: 300’

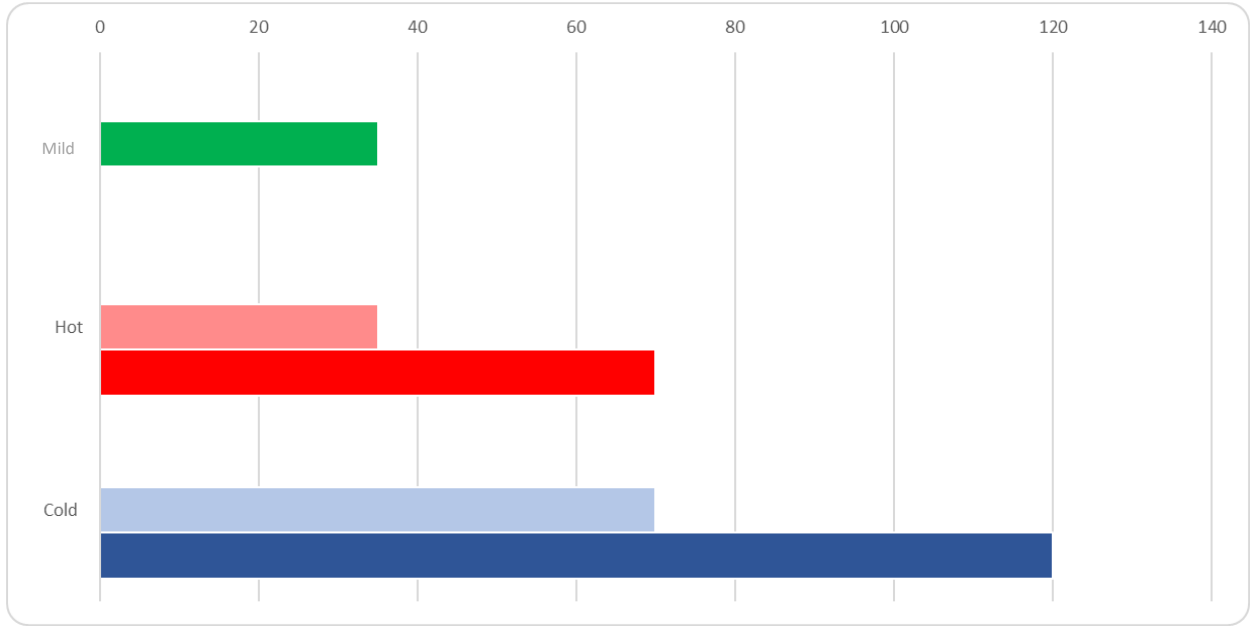
Cold weather temperature range: 22° – 37°F

Hot weather temperature range: 59° – 77°F

Mild day: Bus will use 35kWh during route

Hot day: Bus will use 35-70kWh during route

Cold day: Bus will use 75-120kWh during route



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ESB Scenario 1

Amarillo, TX area

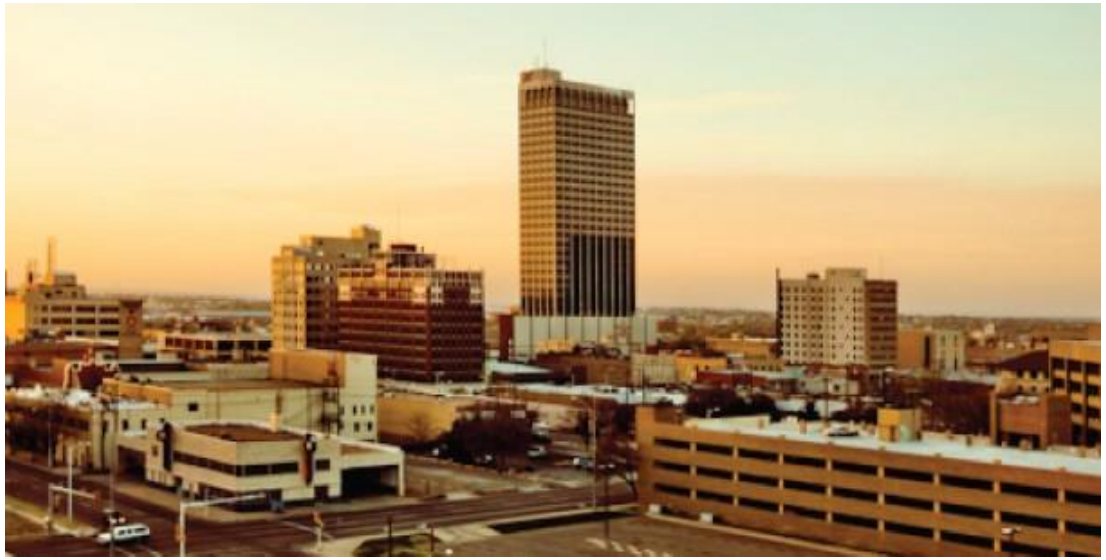
Vehicle battery size: 120 kWh

Route distance: 35 miles

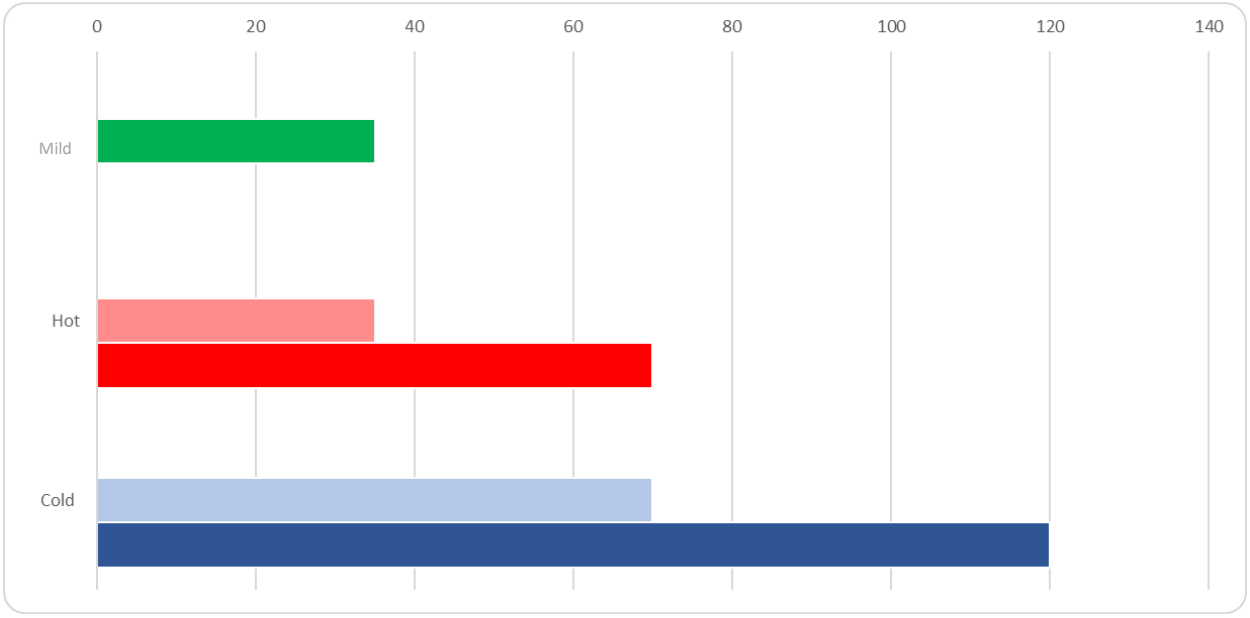
Route elevation: 100’

Cold weather temperature range: 23° – 50°F

Hot weather temperature range: 64° – 90°F



AMARILLO SCENARIO



Mild day: Bus will use 35kWh during route

Hot day: Bus will use 40-100kWh during route

Cold day: Bus will use 70-110kWh during route

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ESB Scenario 2

Fayetteville, AR area

Vehicle battery size: 120 kWh

Route distance: 35 miles

Route elevation: 300’

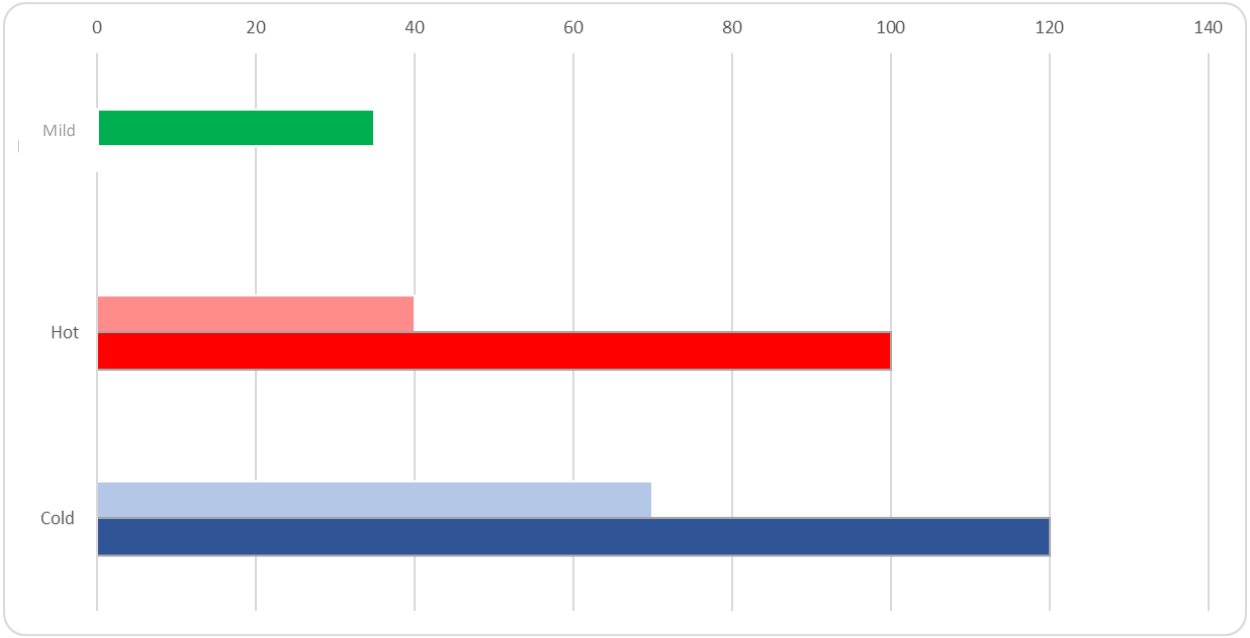
Cold weather temperature range: 25° – 45°F

Hot weather temperature range: 67° – 89°F

Mild day: Bus will use 35kWh during route

Hot day: Bus will use 40-100kWh during route

Cold day: Bus will use 70-120kWh during route



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Successful Deployments of ESB Fleets

Moreno Valley Unified School District

- 38 electric school buses powered by 38 ICE-30 (30 kW) DC fast chargers
- Innovative and cost-effective installation with a k-rail solution
- Future-proofed the site to install another 8 DC fast chargers in the future
- Secured ~$1.7M in grant funding
- Successful deployment August 2022

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Thank You

Van Wilkins
SVP Operations

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Appendix

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120kW Charger Typical session just under 2-hours 8% - 91% SOC

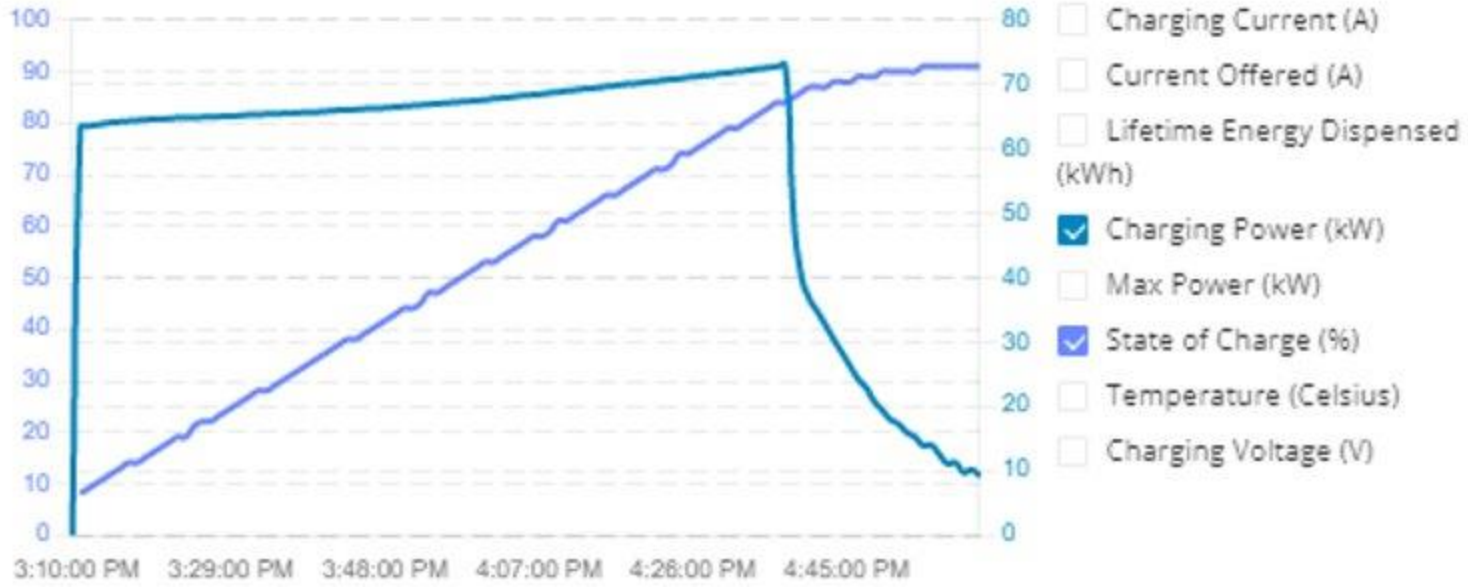
63.5kW start
8% SOC

Session details

Export chart ···

Start time : 04/12/2023 03:09:17 PM
End time : 04/12/2023 05:01:51 PM
Connector : 1 : CCS
Authorization : FREE
Auth ID : 100000
Status : Done

Duration : 1h 52min 34s
Energy : 107.54 kWh
Fuel displacement : 17.92 gal
GHG : 141.58 kg
Max power : 72.384 kW
EVCCID : -



72.384kW peak at
85% SOC

40kW-10kW 85%
to 91%

InCharge

120kW Charger Typical session just under 2-hours

104.9Amps
604VDC
8% SOC

104.9Amps
696 Volts DC
at 85% SOC

Max battery Voltage is <700 so as approaches that level bus will stop charging.

InCharge

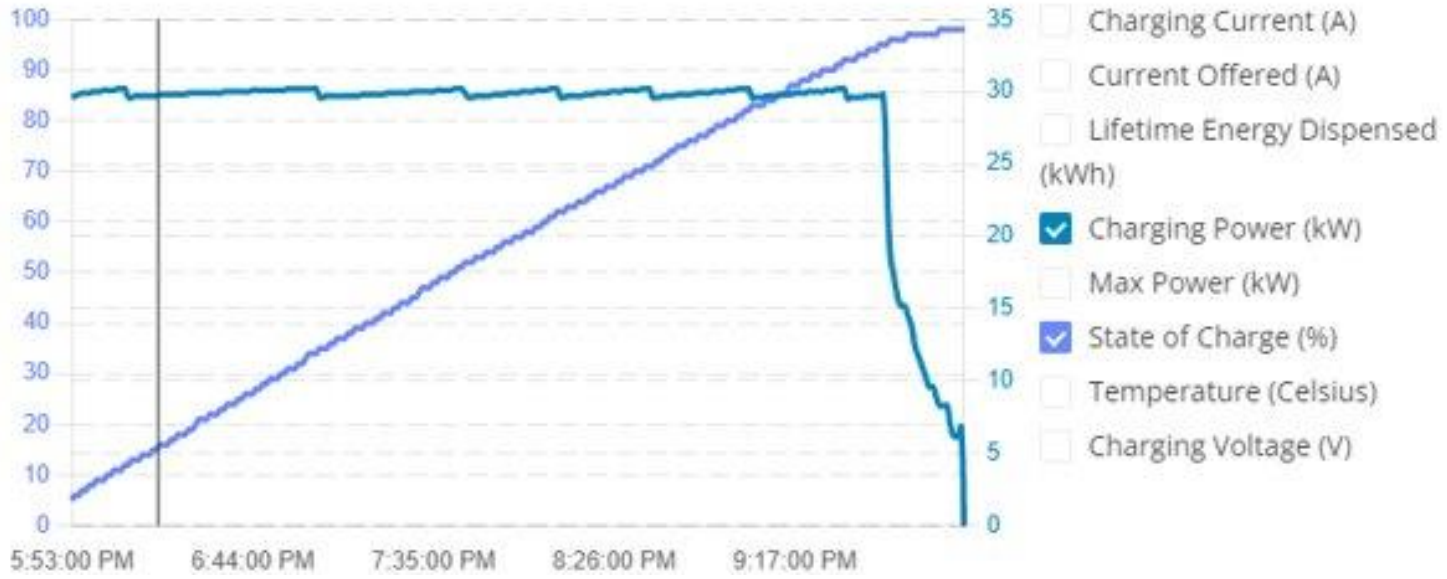
30kW Charger Typical session 4-hours 5%-98% SOC

Session details

Export chart ···

Start time : 03/14/2023 05:51:54 PM
End time : 03/14/2023 10:04:45 PM
Connector : 1 : CCS
Authorization : VEHICLE
Auth ID : VID:00168113522C
Status : Done

Duration : 4h 12min 51s
Energy : 119.02 kWh
Fuel displacement : 19.84 gal
GHG : 156.69 kg
Max power : 29.712 kW
EVCCID : 00168113522C



29.6kW start
5% SOC

30.2kW peak at
92% SOC

29.72kW average
5% to 95%

Then drops to 6kW

InCharge

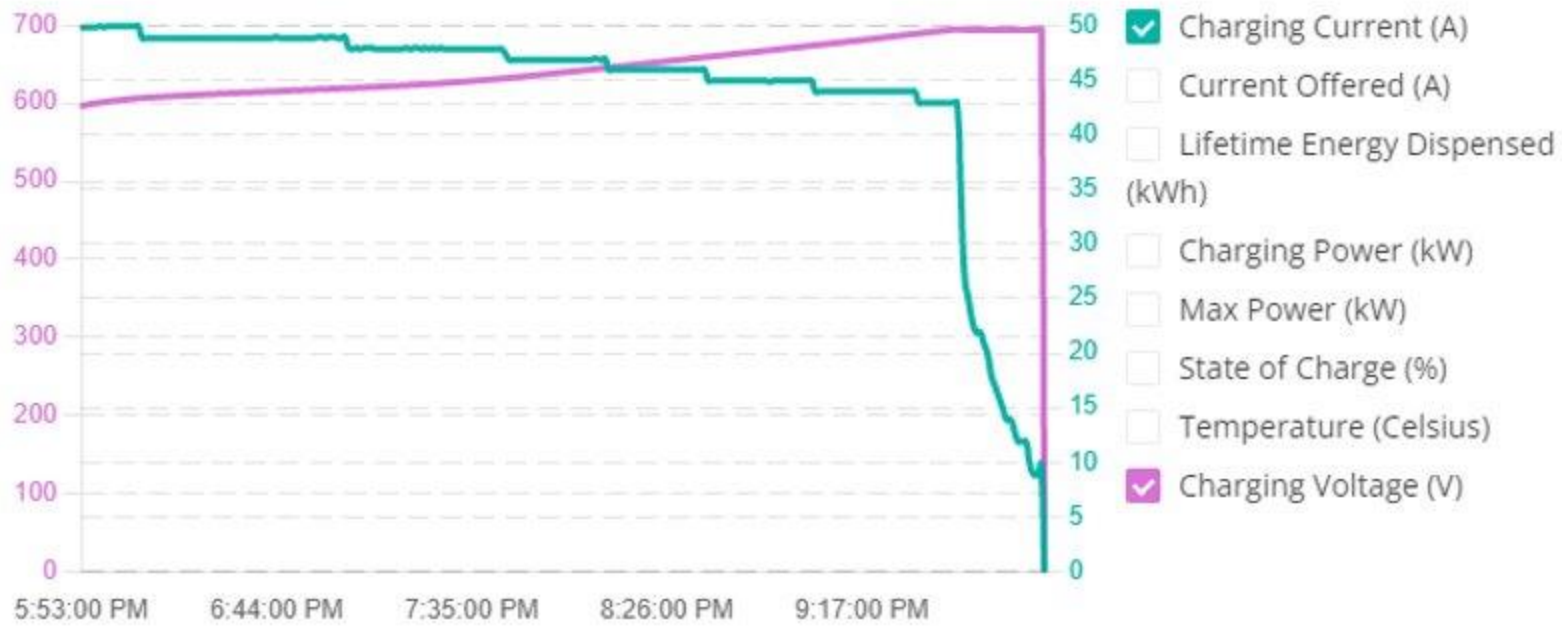
30kW Charger Typical session 4-hours 5%-98% SOC

Session details

Export chart ···

Start time : 03/14/2023 05:51:54 PM
End time : 03/14/2023 10:04:45 PM
Connector : 1 : CCS
Authorization : VEHICLE
Auth ID : VID:00168113522C
Status : Done

Duration : 4h 12min 51s
Energy : 119.02 kWh
Fuel displacement : 19.84 gal
GHG : 156.69 kg
Max power : 29.712 kW
EVCCID : 00168113522C



49.7Amps
597VDC
5% SOC

42.9 Amps
694 Volts DC
at 95% SOC

Max battery Voltage is <700 so as approaches that level bus will stop charging.

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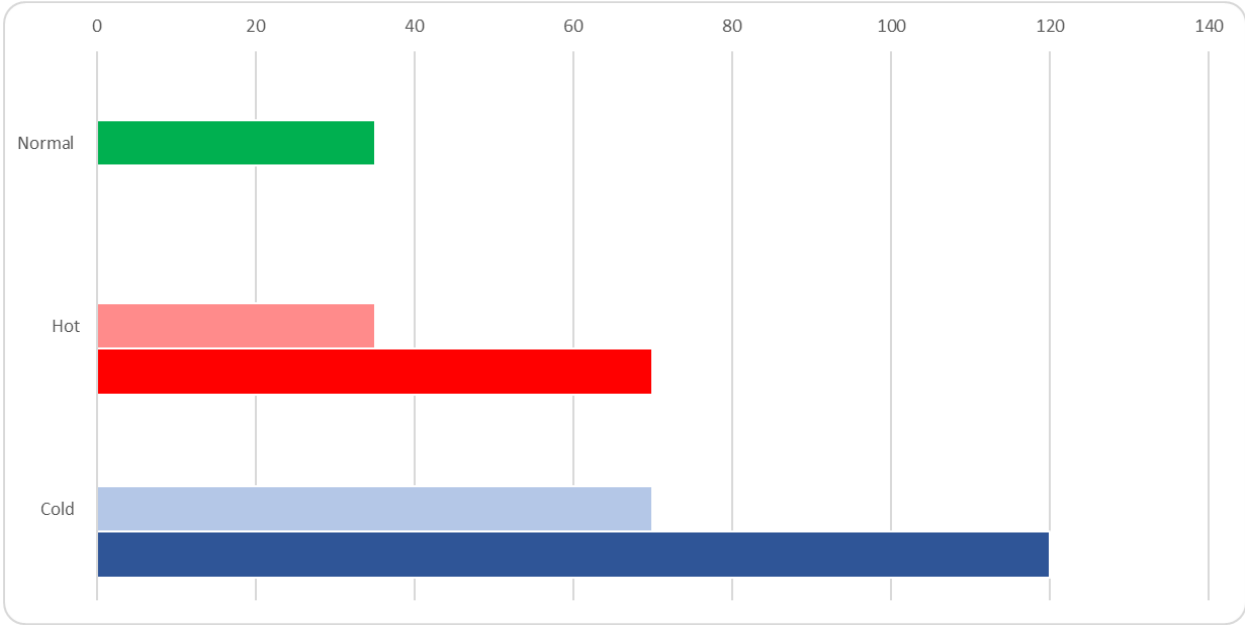
Successful Deployments of ESB Fleets

Boston Public Schools

Vehicle Details:
Vehicle battery size: 120 kWh
Route distance: 35 miles
Route elevation: 300’
Cold weather temperature range: 22° – 37°F
Hot weather temperature range: 59° – 77°F

- On a mild day, a bus will use 35kWh during its morning route
- On a hot day, a bus will use 35-70kWh during its morning route
- On a cold day, a bus will use 75-120kWh during its morning route



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Route Planning and Fleet Modeling

Cold Climate Assumptions:

- **2.10 kWh/mile**
- Battery thermal management system load applicable: 10 kW
- Eight hr. dwell time
- Max Charge rate 60 kW
- 155 kWh battery (124 kWh usable battery)
- Range: 120 miles

Time [H:MM] Required to Recharge Battery After X Miles Driven			
	Miles Driven		
	40	55	70
Charger Power Rating (kW)	Energy Used (kWh)		
	84	115.5	147
19.2	9:07	12:33	15:58
30	4:12	5:46	7:21
60	1:40	2:18	2:56
120	1:40	2:18	2:56

Temperate Climate Assumptions:

- **1.70 kWh/mile**
- Battery thermal management system load applicable: 10 kW
- Eight hr. dwell time
- Max Charge rate 60 kW
- 155 kWh battery (124 kWh usable battery)
- Range: 120 miles

Time [H:MM] Required to Recharge Battery After X Miles Driven			
	Miles Driven		
	40	55	70
Charger Power Rating (kW)	Energy Used (kWh)		
	68	93.5	119
19.2	7:23	10:09	12:56
30	3:24	4:40	5:57
60	1:21	1:52	2:22
120	1:21	1:52	2:22

Gray indicates non-conducive charging solution based on scenario

Able to charge within desired dwell time

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2023 EPA CLEAN SCHOOL BUS GRANT PROGRAM

- EPA anticipates awarding approximately $400 million in Clean School Bus funding
- Application opened on April 24, 2023, and will close on August 22, 2023, at 11:59 p.m. Eastern Time
- Eligible applicants include state and local governmental entities that provide a bus service, public school districts, eligible contractors, nonprofit school transportation associations, Indian tribes, tribal organizations, or tribally controlled schools
- https://www.epa.gov/cleanschoolbus/clean-school-bus-program-grants

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CLOSING

FOLLOW UP

Follow-Up Email on 5/19
Recording of meeting
Copy of slides
Links to resources shared

UPCOMING MEETING

Third-Party Operators | May 22, 2023
Northeast/Mid-Atlantic meeting
at 1:00 PM ET

QUESTIONS

Email SchoolBusTeam@calstart.org

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