



# School Bus Electrification and Vehicle-Grid Integration

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# PGE's Transportation Electrification Strategy



## PLAN

- Improve EV load forecasts for bulk system, distribution system, and individual customers
- Identify future grid constraints
- Early engagement & tracking of planned EV load



## SERVE

- Build infrastructure to enable EV adoption in a grid-friendly way
- Focus on underserved communities
- Grow network of distributed EV charger resources to increase flex load potential



## MANAGE

- Manage charging to connect EV load without T&D upgrades
- Enable EV load control via Virtual Power Plant
- Use TE flex load to integrate more renewables while maintaining reliability

TE Programs

SINCE LAUNCH  
IN 2020

**\$20M**  
Funded

**87**

Electric School  
Buses

**16**

School Districts

# PGE Electric School Bus Fund

- Funded by the Oregon Clean Fuels Program
- Annual grant program for school districts and their transportation contractors
- Pays for the incremental cost of electric school buses (up to 3 per school district)
- Also provides optional funding for charging infrastructure
- Benefits underserved communities and supports STEM education programs





# Fleet Partner

- Pairs fleet advisory services with turnkey design and construction of make-ready infrastructure
- PGE owns the infrastructure; customer owns the chargers
- Make-ready incentives are based on 10-year energy usage commitment by customer, capped at \$400,000
- Supports Level 2 or DC charging for all vehicle classes
- Allows chargers to be installed as needed over time

**\$10M**

Funded

**85**

Customers  
Served

**31**

Sites Constructed

**386**

Ports Installed

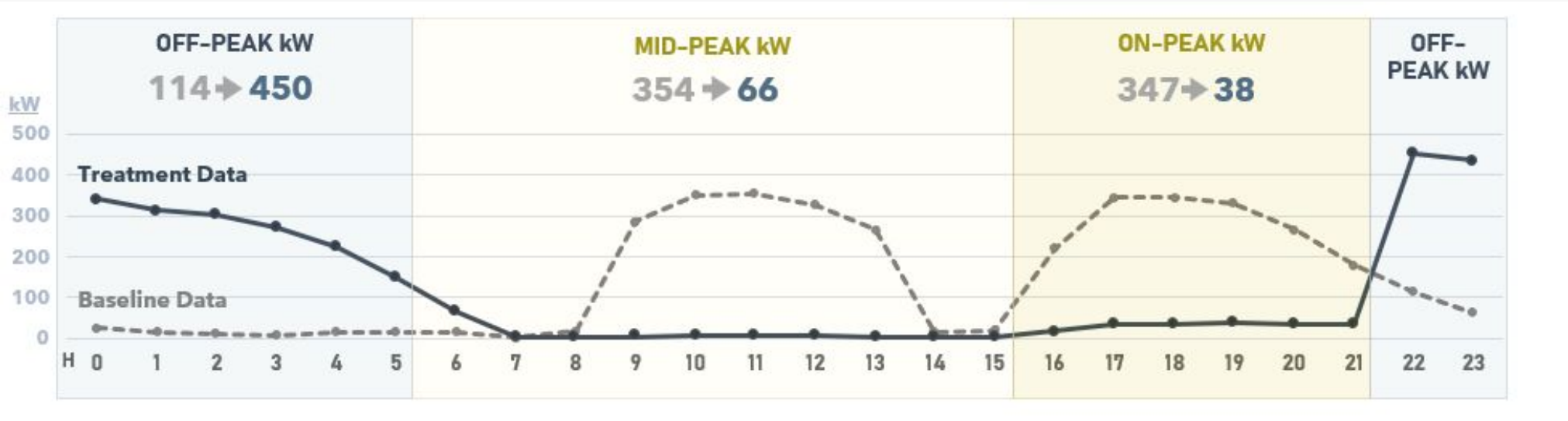
# Managed Charging: Time-of-Use Rate Optimization

Helped fleets schedule charging for off-peak hours

Used features built into existing charge management software

Reduced average peak load by 74%

Saved Beaverton School District over \$1,500 per month



*BSD Depot 3 Average Hourly Charging Load: Before & After*

# School Bus Vehicle-to-Grid (V2G) Objectives



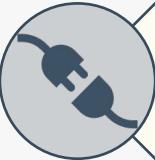
Test the technology's ability to reliably discharge to the grid during peak events



Measure impacts to understand potential grid value



Understand customer willingness, impacts, and overall experience



Evaluate how bidirectional charging fits within utility interconnection process



Inform product roadmap and program design





2020

2021

2022

2023

2024

2025

2026

Phase 1

Phase 2

Phase 3

Phase 1

*Location: Sherwood, OR*  
 1x Blue Bird Bus (Gen1)  
 60 kW BorgWarner V2G Charger  
 Nuvve software

- PGE funded V2G-capable bus, charger, and infrastructure
- Installed V2G charger
- Completed interconnection process
- Performed functional test to confirm discharging capability
- Explored potential IEEE 2030.5 integration

Phase 2

*Location: Sherwood, OR*  
 1x Blue Bird Bus (Gen2)  
 60 kW BorgWarner V2G Charger  
 Nuvve software

- Replaced with Gen2 bus
- Called demand response events during the summer
- Used email and manual processes
- Tested functional reliability
- Collected data on grid benefits
- No V2G compensation

Phase 3 (in progress)

<i>Beaverton</i>	<i>Gresham</i>
<i>2x BYD/RIDE Buses</i>	<i>3x Blue Bird (Gen3)</i>
<i>2x 60 kW BorgWarner</i>	<i>3x 44 kW Heliox</i>
<i>OpConnect</i>	<i>Ampecontrol</i>

- New locations, bus OEM, charger hardware and software
- Called events during school year
- Automated process using dashboard
- One site is using ISO15118-20
- Testing functional reliability
- Collecting data on grid benefits
- No V2G compensation

## SUCCESSSES

- Strong interest from some early-adopter school bus fleets
- School buses have good availability during utility peak times
  - Not used in the summer
  - Back by 5 or 6 pm on school days
  - Winter mornings on non-school days
- No opt-outs from customers
- Large load reduction potential per participant
- Flexibility on discharge rate vs duration
- Interconnection process uses existing energy storage process
- Success depends on buy-in from all stakeholders:
  - Utility
  - Customer
  - Software Provider
  - Charger Manufacturer
  - Bus OEM

## CHALLENGES

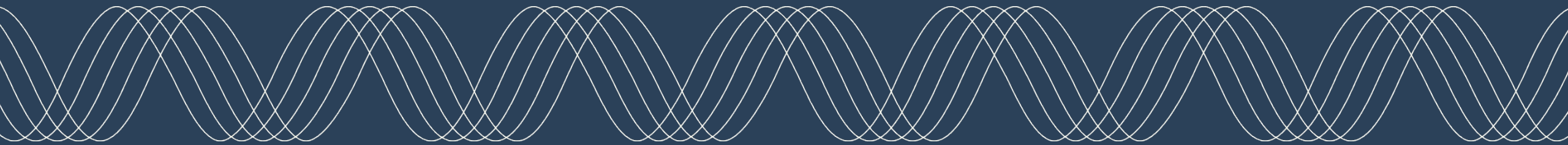
### Market Challenges

- Very few V2G-capable chargers available in an unstable market
  - BorgWarner announced exit from EV charging business in 2025
- Very limited number of CMS providers with actual V2G experience
- Some school bus OEMs don't have V2G capability even though they advertise that they do
- High upfront cost of V2G chargers/infrastructure (10x Level 2 cost)
- Early V2G capabilities built on proprietary integrations

### Technical Challenges

- Not "plug-and-play"; requires many hours of troubleshooting and testing solutions
- Issues following managed charging schedule after discharging ends
- Issues starting discharging when bus is fully charged

# Looking Ahead



# Electric School Bus Charging Incentives

*Incentives that lower the up-front charger and infrastructure costs while preparing for a flexible and reliable grid*

## INCENTIVE DETAILS

- V2G Make-Ready Infrastructure Incentive
  - Up to \$10,000 per make-ready port
  - Up to \$300,000 per site
  - Or up to 100% of actual costs, whichever is lowest
- V2G EV Charger Incentive
  - 90% of actual V2G charger cost
  - Up to \$50,000 per charger
  - Up to \$500,000 per site
- Both can be combined with PGE's [Electric School Bus Fund](#) and [Fleet Partner](#) programs to help reduce upfront costs.

## V2G CHARGER REQUIREMENTS

- Minimum power rating of 30 kW per port
- UL 1741-SB, ISO15118-20, OCPP 2.1
- Meets all other minimum requirements for PGE qualified chargers, as vetted by EPRI
- Must be paired with PGE-qualified software provider



# Questions

