



## Product Specifications



# Definitions

## Technology Glossary

<b>HEVO Power Station ("HPS")</b>	IoT enabled and smart-grid ready wireless charging technology consisting of an inverter and transmitter with vehicle alignment technology and accompanying installation materials
<b>HEVO Vehicle Receiver ("HVR")</b>	Vehicle-based system consisting of a rectifier and receiver with vehicle alignment technology and accompanying installation materials that is mounted on the vehicle chassis
<b>HEVO Power Network ("HPN")</b>	Complete network to include inverter, transmitter, rectifier, receiver, mobile app and dashboard
<b>Inverter</b>	Grid-connected system consisting of inverter, PFC, gateway (IoT) assemblies and accompanying mounting hardware
<b>Transmitter</b>	Inverter-connected, wireless power transmission device equipped with vehicle alignment technology that is either surface mounted or embedded into the ground
<b>Receiver</b>	Vehicle-mounted, wireless power receiving device equipped with vehicle shielding and vehicle alignment technology
<b>Rectifier</b>	Receiver-connected, DC power conversion device equipped with gateway (IoT), CAN communication and accompanying mounting hardware
<b>Foreign Object Detection (FOD)</b>	Thermal detecting system integrated with LOD to provide detection, deterrence and safety
<b>Living Object Detection (LOD)</b>	Motion detecting system integrated with FOD to provide detection, deterrence and safety
<b>Mobile App</b>	User app interface for station location, reservation, route guidance, parking alignment, remote start/stop charging, wireless bill pay, user statistics and account management
<b>Dashboard</b>	Interface for management of charging stations, queue management, electric vehicles and statistical analyses

## Naming Convention

<b>X</b>	Wireless charging technology
<b>R</b>	Equipped for non-public applications
<b>C</b>	Equipped for public applications

## Numerical Convention

<b>8</b>	8 kilowatt
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Model Specification		HPS X-8R		HPS X-8C		
HEVO Power Station – Wireless, 8 kW, Non-Public				HEVO Power Station – Wireless, 8 kW, Public		
Dimensions	Inverter	Transmitter (Tx)	Tx Install Frame	Inverter	Transmitter (Tx)	Tx Install Frame
Length	23.5 in (597 mm)	26.8 in (680 mm)	30 in (762 mm)	70 in (1,778 mm)	26.8 in (680 mm)	30 in (762 mm)
Width	14.6 in (371 mm)	30.0 in (762 mm)	43.5 in (1104 mm)	20 in (508 mm)	30.0 in (762 mm)	43.5 in (1104 mm)
Depth	6.4 in (163 mm)	1.4 in (35.8 mm)	1.8 in (45 mm)	8 in (203 mm)	1.4 in (35.8 mm)	1.8 in (45 mm)
Weight	44.5 lbs (20 Kgs)	66.7 lbs (30 Kgs)	15.6 in (7 Kgs)	67 lbs (30 Kgs)	66.7 lbs (30 Kgs)	15.6 in (7 Kgs)
AC Conduit Length	10 ft (3.05 m)					
HFAC Conduit Length	10 ft (3.05 m)					
General	Current		Voltage		Power Range	
Input Electrical (Wireless)	40 A		208 ~ 240 VAC; 320~370 VDC		2.3 kW - 8 kW	
Output Electrical (Wireless)	30 A		800 VAC		2 kW - 7.2 kW	
Output Return	30 A		208 ~ 240 VAC, 50-60 Hz		2.3 kW - 8 kW	
Total harmonic distortion at rated power	Grid Synchronized, Full Sine Wave (<3% THD)					
Grid Service Type	Single-Phase					
Voltage tolerance	±15%					
Input frequency	50 / 60 Hz					
Frequency tolerance (normal operation)	-30% / +40%					
Frequency tolerance (grid export)	±5%					
Power Factor	0.99					
Service Panel GFCI	External GFCI Required					
Wiring – Standard	3 Wire – L1, L2 plus Earth (no neutral)					
Station Power	50 W typical (standby), 100 W maximum (operation)					
Frequency	85 kHz (81kHz min ~ 89.5kHz max)					
Power Measurement Accuracy	±2% from 2% to full scale (32 A)					
Power Report / Store Interval	15 minute, aligned to hour					
Battery Charging Method	Constant Power , Constant Current , Constant Voltage					
Inverter	Series					
Receiver	Series					
Capacitors	Embedded in the coils					
Inverter Type	2 channel half bridge interleaved, soft switching with patented interconnect structure					
Inverter Output	Transformer coupled; galvanically isolated					
Control Scheme	Full digitally power controlled. Phase based power controller with close tracking of resonant frequency for optimal efficiency (Patented)					
Rectifier	Series topology with boost conversion providing adaptive impedance control					
Power transfer coupling magnetics	Single rectangular coil with series capacitance					
Electronic components	Inverter, Transmitter, Receiver, Rectifier					
Inverter raw materials	Aluminum Alloy, Polycarbonate (5VA -F1)					
Transmitter raw materials	Aluminum , Polycarbonate (5VA-F1), EPOXY, Brass Fasteners					
Receiver raw materials	Aluminum , Polycarbonate (5VA-F1), EPOXY, Brass Fasteners					
Thermal managment	IP55 rated Forced Air cooling					
Efficiency						
Peak Efficiency	91% grid-to-load (at peak alignment)					
X-Axis & Y-Axis Range	0 ~ 10 cm (>81% min efficiency) per SAE J2954					
Z-Axis Range	11 ~ 20 cm (>81% min efficiency) per SAE J2954					
Export to Grid Efficiency	90% (Peak)					
Compliance and Classifications						
Charger Type	SAE J2954					
Charger Class	WPT 1 & WPT-2 (2 ~ 7.7 kW)					
Charger Z-Gap Class	Z2-Class (11 ~ 20 cm)					

<b>Standards Compliance</b>	UL and C-UL listed (pending) product per UL 2750, UL2231-1, UL2231-2. NEC Article 625 compliant UL and C-UL listed per UL916 Energy Management Equipment
<b>EMC Compliance</b>	FCC Part 15 Class B and Part 18
<b>Inverter Enclosure Rating</b>	NEMA Type 4, IP55
<b>Transmitter Enclosure Rating</b>	NEMA Type 4, IP67
<b>Fire Rating</b>	5VA
<b>Environmental Rating</b>	F1
<b>Communication</b>	HEVO Power Networking (HPN v1.1)
<b>Safety</b>	
<b>Foreign Object Detection / Living Object Protection</b>	Infrared Thermal Imaging, LWIR 80x60 Sensor, +/- 0.5 Degree Accuracy, 120 Degrees Field of View, 15 ft Depth of View, Up to 27 Frames per Second, Inverter Mounted or Vehicle Mounted, Motorized X-axis & Y-axis Adjustment
<b>Surge Protection</b>	6 kV @ 3000 A. In geographic areas subject to frequent thunder storms, supplemental surge protection at the service panel is recommended.
<b>System Protection</b>	Input Over-current, Input Over-voltage, Output Over-current, Output Over-voltage, Over-temperature
<b>Operational Conditions</b>	
<b>Storage Temperature</b>	-40°C to +60°C (-40°F to 140°F)
<b>Operating Temperature</b>	-30°C to +50°C (-22°F to 122°F)
<b>Operating Humidity</b>	Up to 85% @ +50°C (122°F) non-condensing
<b>Non-Operating Humidity</b>	Up to 95% @ +50°C (122°F) non-condensing
<b>Operating Altitude</b>	Up to 3050m above sea level
<b>Maximum Charging Stations per 802.11 Radio Group</b>	1 maximum. Each charging station is equipped with a HEVO Gateway.
<b>User and Network Interfaces</b>	
<b>LED Display</b>	Located on Inverter front cover for charger identification, parking alignment and charging progress
<b>Mobile App</b>	Interface for account management, charger selection, route guidance, parking alignment, remote start/stop, station reservations, user statistics, wireless bill pay, alerts and messages
<b>Dashboard Management</b>	Interface for account managers to supervise charger management, fleet management and statistical analyses
<b>Charger-to-Cloud</b>	Ethernet 100Mbps, LTE 4G US ( EU Bands on request )
<b>Charger-to-Vehicle Physical Interface</b>	2.4 GHz Wi-Fi (802.11 b/g), DSRC IEEE 802.11p ready
<b>Charger-to-Vehicle Network Interface</b>	TCP/IP
<b>Parking Alignment</b>	Camera for parking spot detection; Low-power excitement based parking alignment; Optional 4-sensor based XY parking alignment system
<b>Backend Architecture</b>	
<b>Backend</b>	Build on-top of the Mutable Microservices platform, with build in redundancy and multiple system / CPU scalability; AWS hosted
<b>Database</b>	Redis, PostgreSQL
<b>Network Protocol</b>	API for full charger control and configuration (JSON)
<b>Security</b>	SSL
<b>User Interfaces</b>	Full WEB based ERP for Network and Station Management, supporting billing and customer management and provisioning
<b>Reporting</b>	Energy consumption by region or station, Total energy consumption, Financial reporting, Maintenance reporting
<b>Operating System</b>	iOS 10.0.0 or newer, Android 4.2 or newer
<b>Load Balancing</b>	Active demand response based power management for multi-station operation
<b>API</b>	HEVO Power Networking (HPN v1.1)
<b>Network Security</b>	
<b>Charger-to-Vehicle Network Security</b>	WPA 2
<b>Charger-to-Cloud</b>	SSL with Tokenized Authentication (HPN v1.1)
<b>Diagnostics and System Management</b>	
<b>Communication</b>	HEVO Power Networking (HPN v1.1)
<b>Firmware Update</b>	Full remote updating capability via HPN v1.1
<b>Diagnostic Elements</b>	85 different end-points reported via HPN v1.1



Model Specification

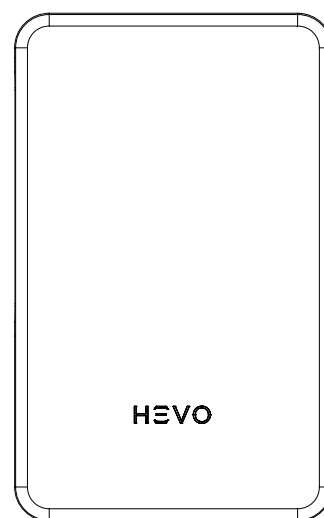
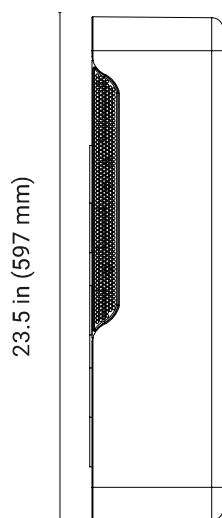
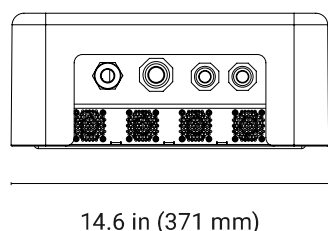
HVR X-8

HEVO Vehicle Receiver – Wireless, 8 kW

Dimensions	Rectifier	Receiver (Rx)	Rx Shield
Length	10.3 in (262 mm)	16.7 in (422 mm)	28.5 in (724 mm)
Width	7.2 in (182 mm)	15.8 in (400 mm)	17.25 (438 mm)
Depth	2.2 in (55 mm)	0.8 in (19 mm)	0.2 in(5 mm)
Weight	6 lbs (2.7 Kg)	12 lbs (5.45 Kg)	10 lbs (4.54 Kg)
DC Conduit Length	10 ft (3.05 m)		
HFAC Conduit Length	10 ft (3.05 m)		
CAN Communication Length	10 ft (3.05 m)		
General	Max Current	Max Voltage	Power Range
Input Electrical (Wireless)	40A	1000VAC	2.3 kW - 8 kW
Rectifier Output	40A	450VDC	2.3 kW - 8 kW
Frequency	85 kHz (81kHz min ~ 89.5kHz max)		
Topology	Series with Coil Integrated Capacitors		
Compensation	Dynamic Impedance Control		
Power Consumption ( Active )	200mA		
Power Consumption (Deep Sleep )	1mA		
Operating Voltage	12VDC		
Z-Axis Range	11 ~ 20 cm (>81% min efficiency) per SAE J2954		
Power Up / Down feature	Soft capacitor bank charge and discharge		
Thermal Management	Heatsink with forced air colling required		
Compliance and Classifications			
Charger Z-Gap Class	Z2-Class (11 ~ 20 cm)		
Standards Compliance	SAE j2954		
EMC Compliance	FCC Part 15 Class B and Part 18		
Inverter Enclosure Rating	NEMA Type 4, IP55		
Transmitter Enclosure Rating	NEMA Type 4, IP67		
Fire Rating	5VA		
Environmental Rating	F1		
Communication	WiFi		
Safety			
System Protection	Input Over-voltage, Output Over-current, Output Over-voltage, Over-temperature, Constant current High Voltage Capacitor Discharge		
Operational Conditions			
Storage Temperature	-40°C to +60°C (-40°F to 140°F)		
Operating Temperature	-30°C to +50°C (-22°F to 122°F)		
Operating Humidity	Up to 85% @ +50°C (122°F) non-condensing		
Non-Operating Humidity	Up to 95% @ +50°C (122°F) non-condensing		
Operating Altitude	Up to 3050m above sea level		
Interfaces			
Communications Protocol	CAN Bus		
Charging Protocol	CHAdEMO		
Charger-to-Inverter Physical Layer	WiFi 802.11b		
Charger-to-inverter Network Layer	TCP/IP		
Network Security			
Charger-to-Vehicle Network Security	WPA 2		

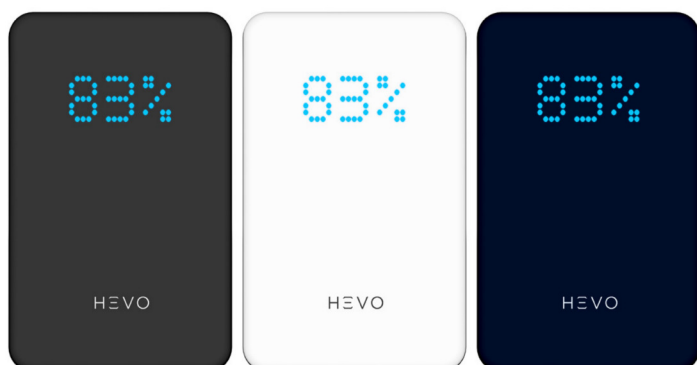
# HPS X-8R Inverter

(Non-Public Model)



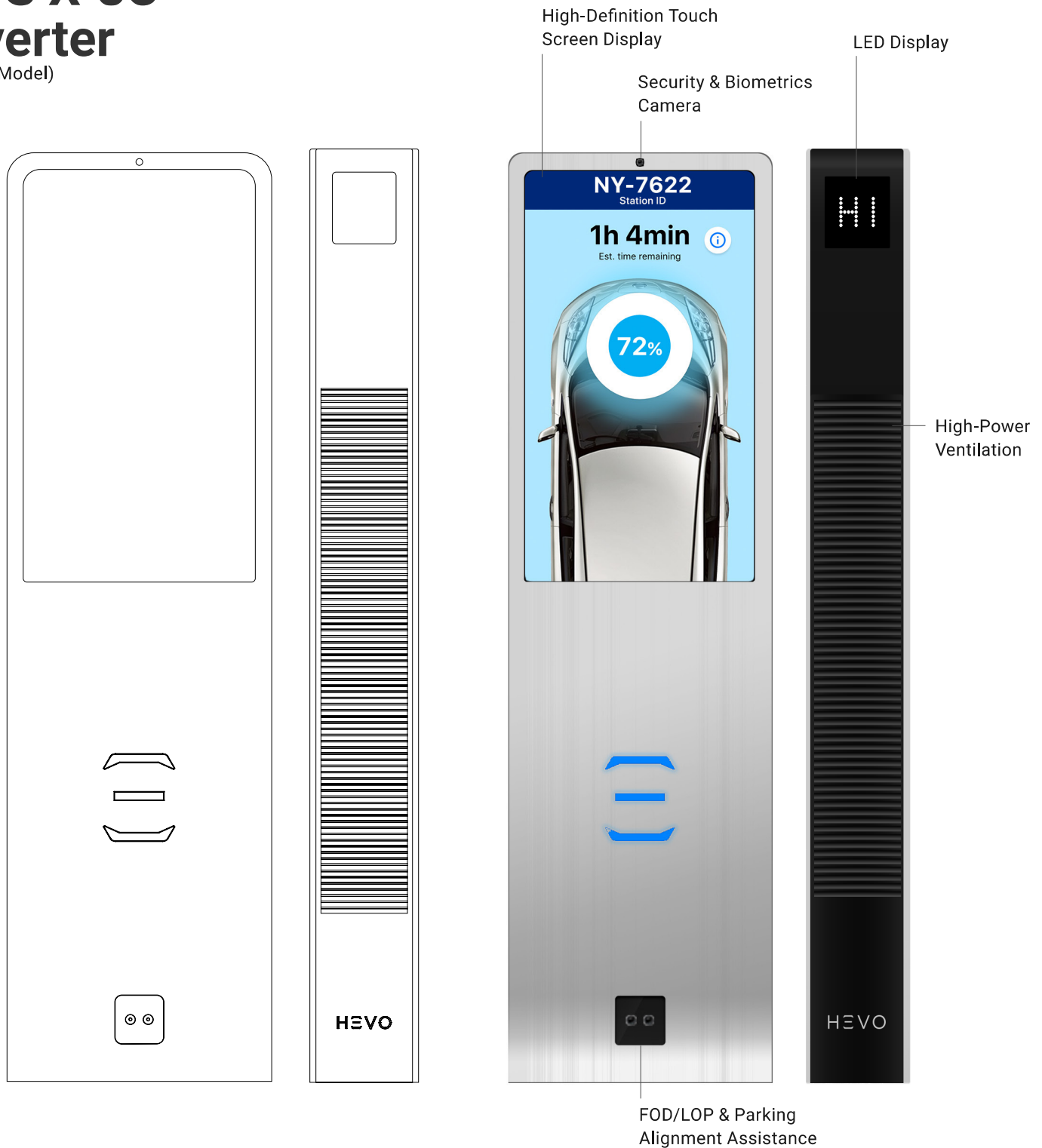
## About

This model is equipped to serve applications at home, garages and secured areas. The inverter is directly connected to the electric grid or a DC source such as solar panels. At the input, the inverter converts AC or DC power into 400 VDC that delivers a power factor of no less than 98 percent. The inverter then converts the 400 VDC power into 800 VAC and delivers it to the transmitter via a patent-pending topology (No. PCT/US15/16383), which ultimately controls the power delivered to the vehicle. This topology ensures peak charging efficiencies from the outlet to the vehicle battery up to 92 percent. Equipped with an LED display.



# HPS X-8C Inverter

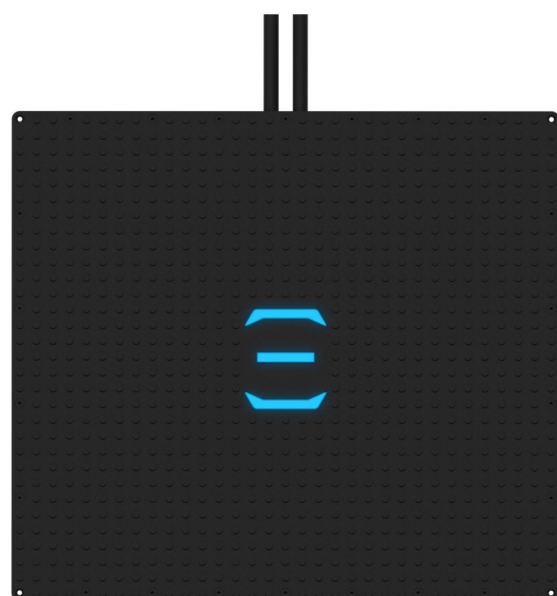
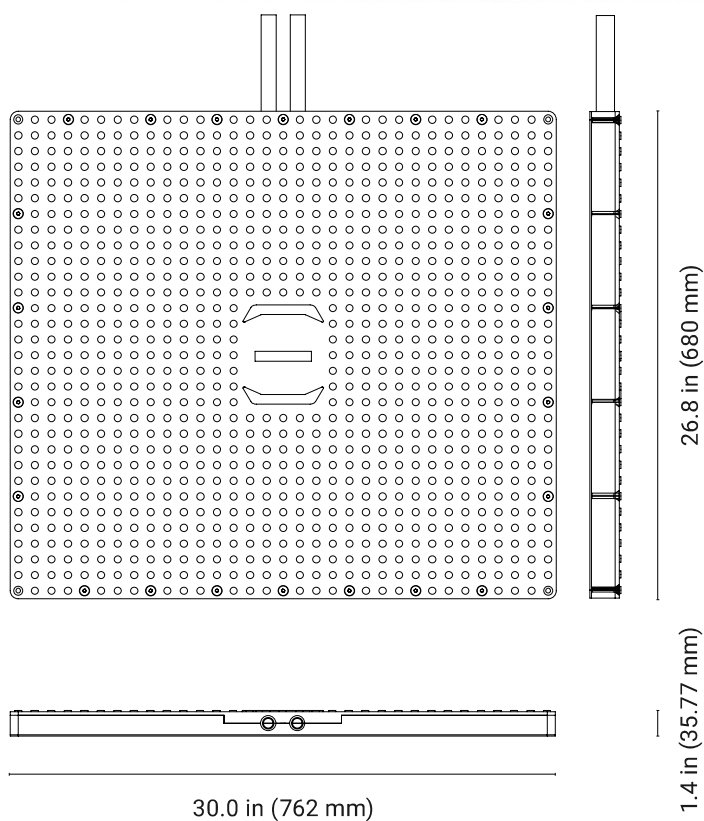
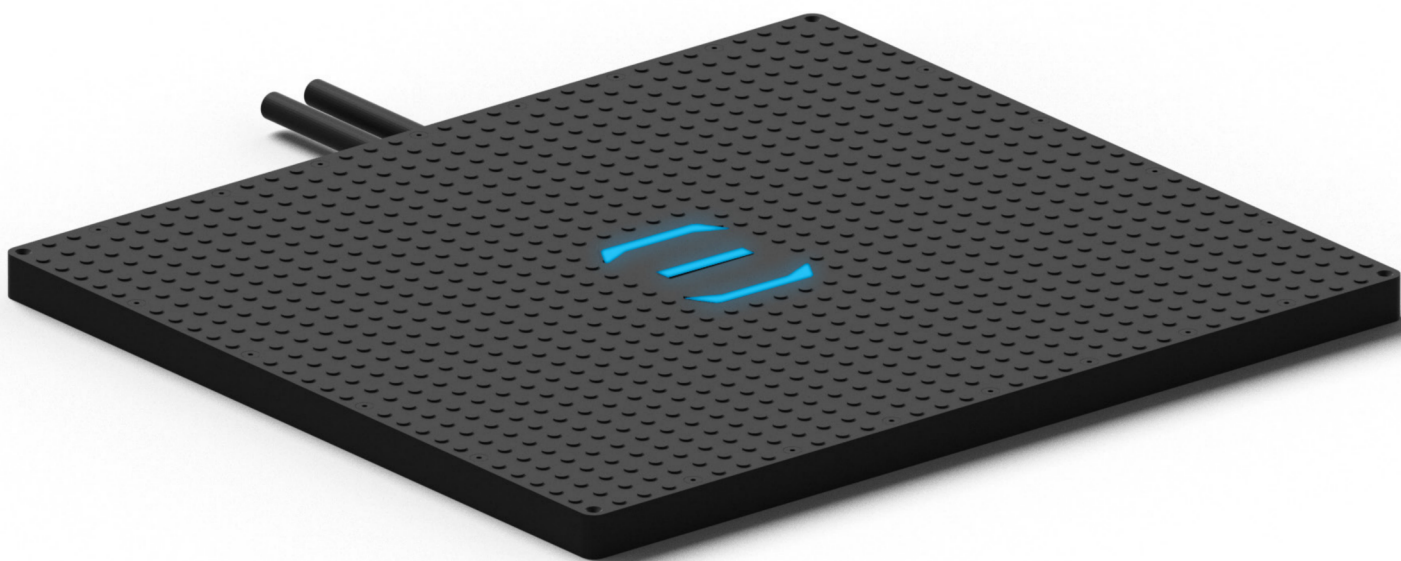
(Public Model)



## About

This model is equipped to serve applications in garages and public areas of any type. The inverter is directly connected to the electric grid or a DC source such as solar panels. At the input, the inverter converts AC or DC power into 400 VDC that delivers a power factor of no less than 98 percent. The inverter then converts the 400 VDC power into 800 VAC and delivers it to the transmitter via a patent-pending topology (No. PCT/US15/16383), which ultimately controls the power delivered to the vehicle. This topology ensures peak charging efficiencies from the outlet to the vehicle battery up to 92 percent. This model includes built-in FOD/LOP, parking alignment assistance with a security & biometrics camera, high-definition touch-screen display and side panel LED indication.

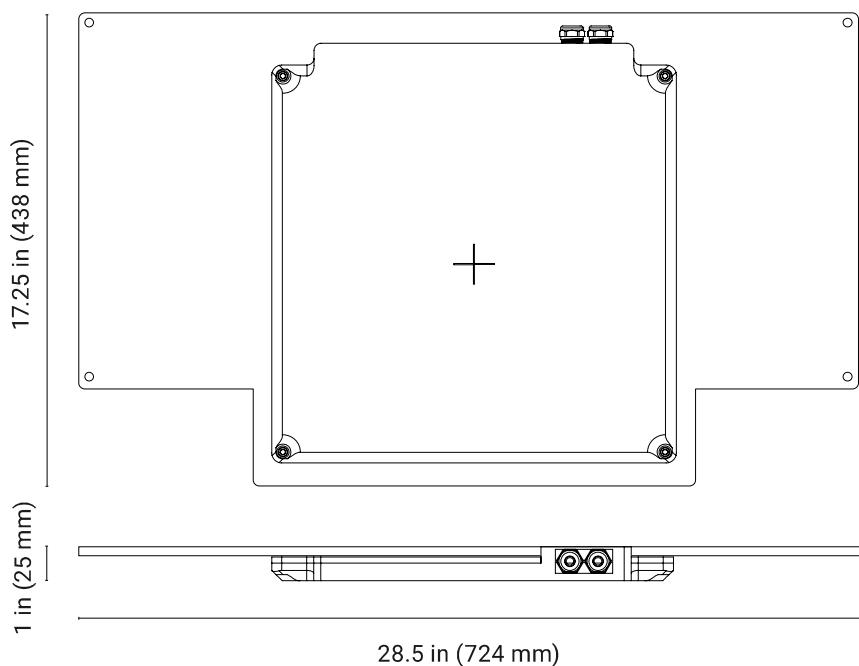
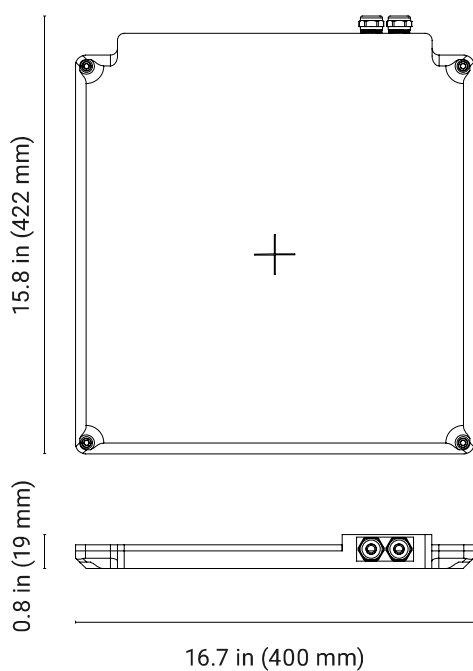
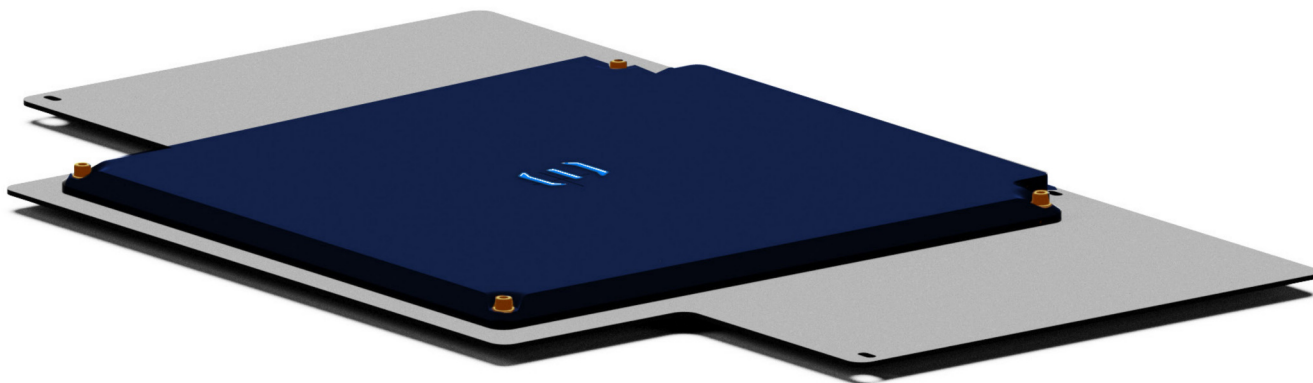
# HVR X-8 Transmitter



## About

The transmitter is a resonant tank that converts 800 VAC into an oscillating, directed magnetic field. The inductance and capacitance of the transmitter are designed to resonate at a 85 kHz frequency, as required by the Society of Automotive Engineers (SAE) guidelines. The transmitter is also equipped with sensors necessary for parking alignment and can be either flush-mounted or surface-mounted in the ground.

# HVR X-8 Receiver



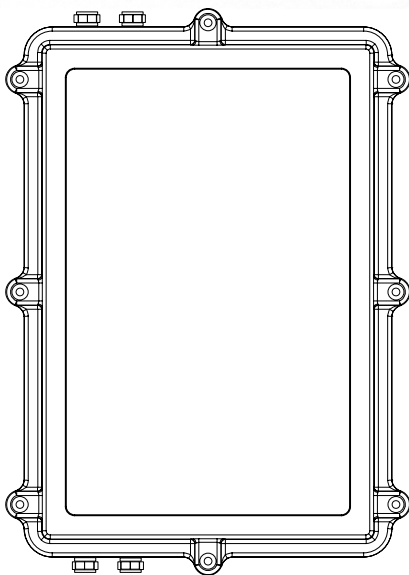
## About

The receiver is a resonant tank that captures the oscillating, directed magnetic field from the transmitter. The receiver is commonly centered and mounted between the two front tires along the vehicle chassis. When parking the vehicle, the driver visually aligns the receiver over the transmitter via the parking alignment feature of the mobile app. During the parking alignment process, the receiver operates as a sensor that facilitates accurate positioning of the vehicle for maximum charging efficiency. Once aligned, the rectifier and inverter form a “handshake” that initiates the transfer of wireless power.

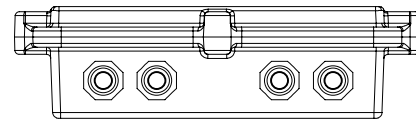
# HVR X-8 Rectifier



10.3 in (422 mm)



2.2 in (19 mm)



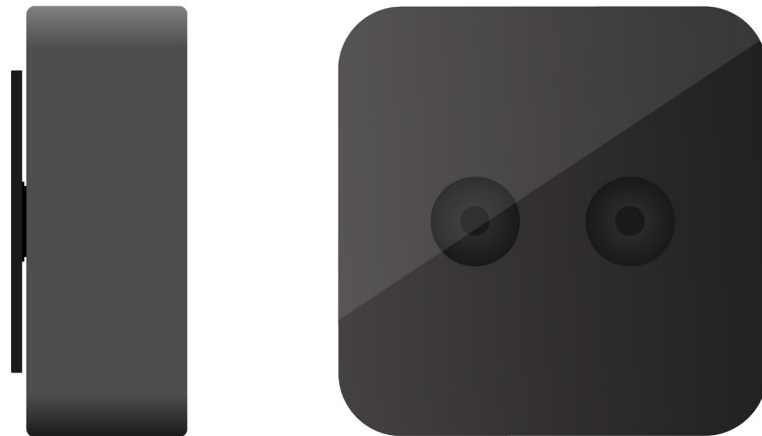
7.2 in (400 mm)



## Rectifier

The rectifier converts the receiver's high frequency AC voltage into DC (350-450 VDC) and supplies it to the vehicle battery. It also interfaces with the battery management system (BMS), which communicates voltage and current requirements to the rectifier. The rectifier then relays the vehicle battery voltage and current requirements to the inverter through a local, secure, proprietary wireless interface. Through the wireless interface, output power is seamlessly adjusted to match the BMS requirements. However, if no BMS is present, the rectifier can store the battery's charging profile and operate safely on its own. The total grid-to-battery system efficiency is above 80% in all operating conditions and is typically in the range of 85-92% efficiency.

# Detection & Alignment System



## About

### Foreign Object Detection (FOD)

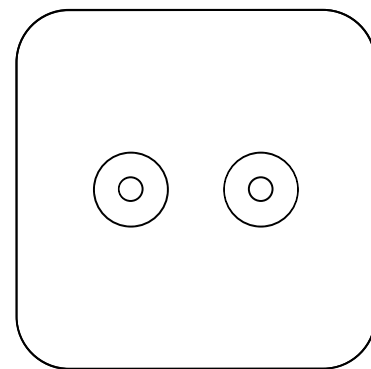
This specialized infrared detection technology detects metallic objects emplaced on top of the transmitter during the wireless transfer of power. If a metallic object is detected during the charging process, the system will safely turn off the inverter and alert the user via the mobile app to remove the object before resuming normal operation. The FOD can accurately detect metallic objects as small as paper clips from 10 ft (3m) away.

### Living Object Protection (LOP)

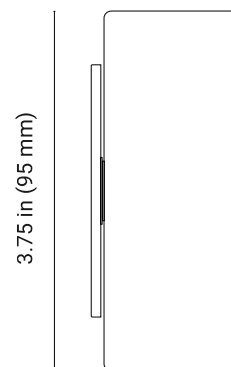
This specialized infrared detection technology uses motion and temperature to detect living objects in real-time situated on top of the transmitter before or during the wireless transfer of power. If a living organism is detected during the charging process, the system will safely turn off the inverter and alert the user via the mobile app to remove the living organism before resuming normal operation. The LOP can accurately detect living objects as small as human hands from over 10 ft (3 m) away.

### Parking Assistance

Visual alignment is achieved using augmentation in cooperation with the built-in parking alignment sensors located inside the transmitter and the receiver. This technology can achieve accuracies of  $\pm 10$  cm with human operators and  $\pm 2$  cm with autonomous parking assistance.



3.75 in (95 mm)



3.75 in (95 mm)

1.5 in (38 mm)



# Vehicle Installation





# Non-Public Installation

Example A: Flush-Mounted Installation

HEVO Inverter with Concealed Cable Installation

FOD/LOP with Concealed Cable Installation

Flush-Mounted Transmitter with Concealed Cable Installation



Example B: Surface-Mounted Installation

HEVO Inverter with Exposed Cable Installation

FOD/LOP with Exposed Cable Installation

Flush-Mounted Transmitter with Exposed Cable Installation



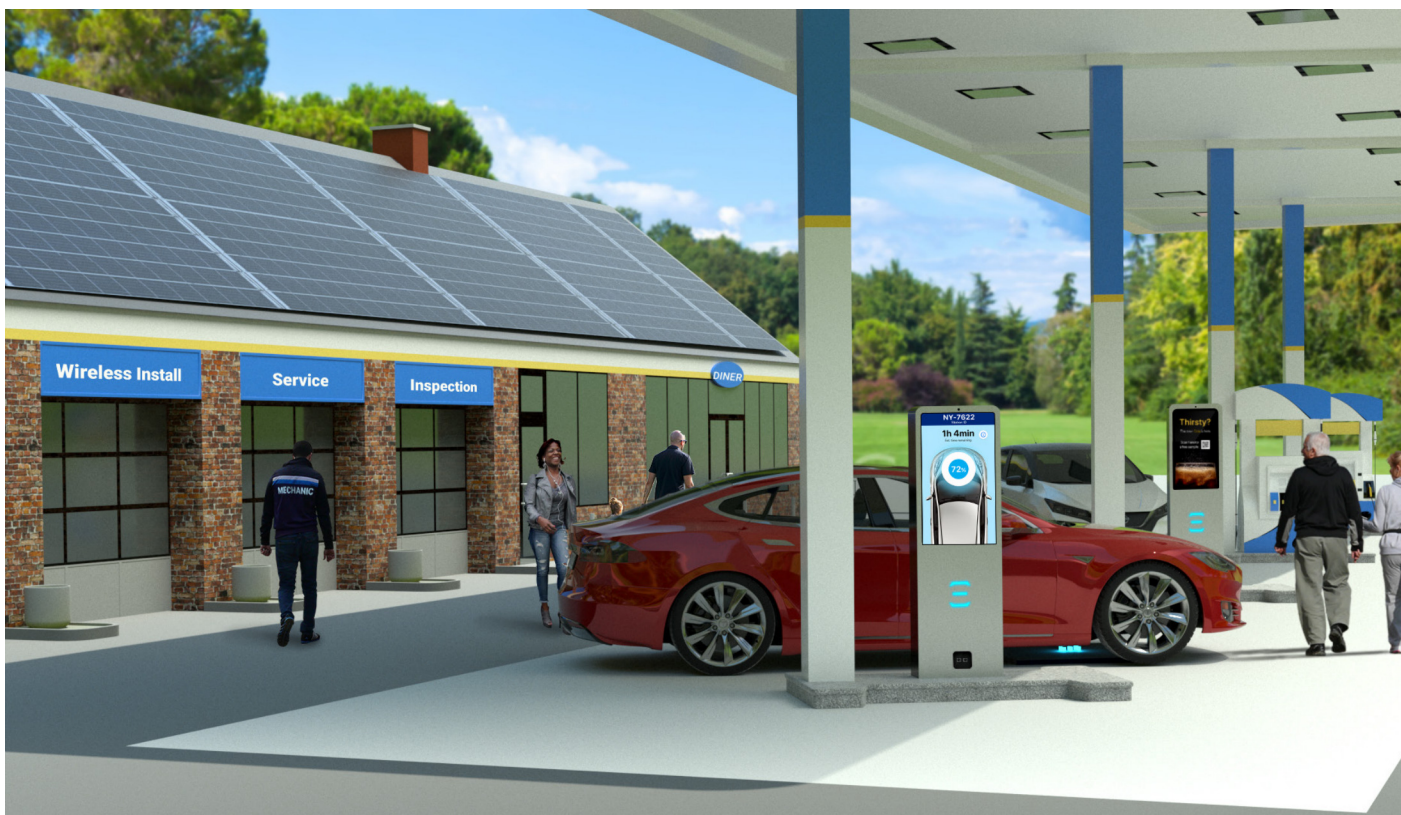


# Public Installation Category

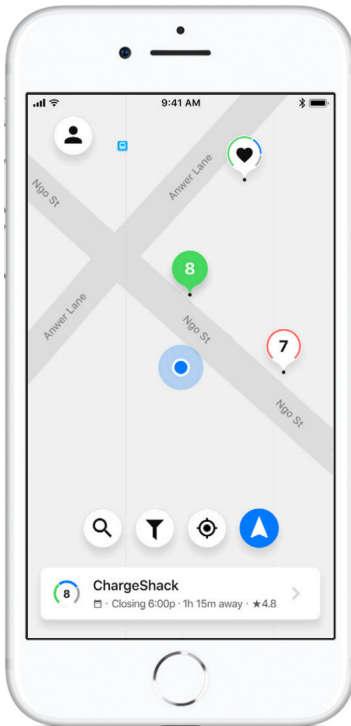
Example A: Curbside Installation



Example B: Range Station Installation

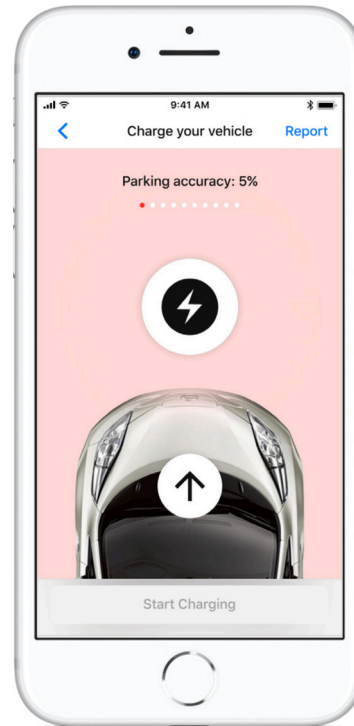


# Mobile Application



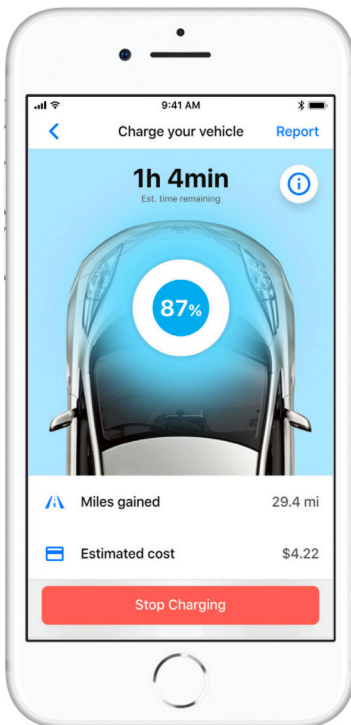
## Navigate

Select a vacant charging station and choose the best route to your destination



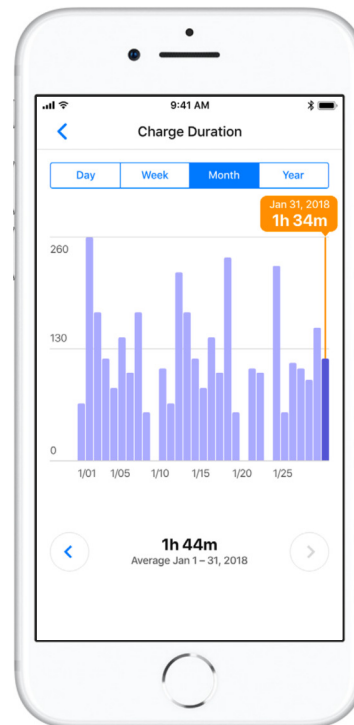
## Align

Utilize visual and audible parking assistance to ensure maximum charging efficiency



## Charge

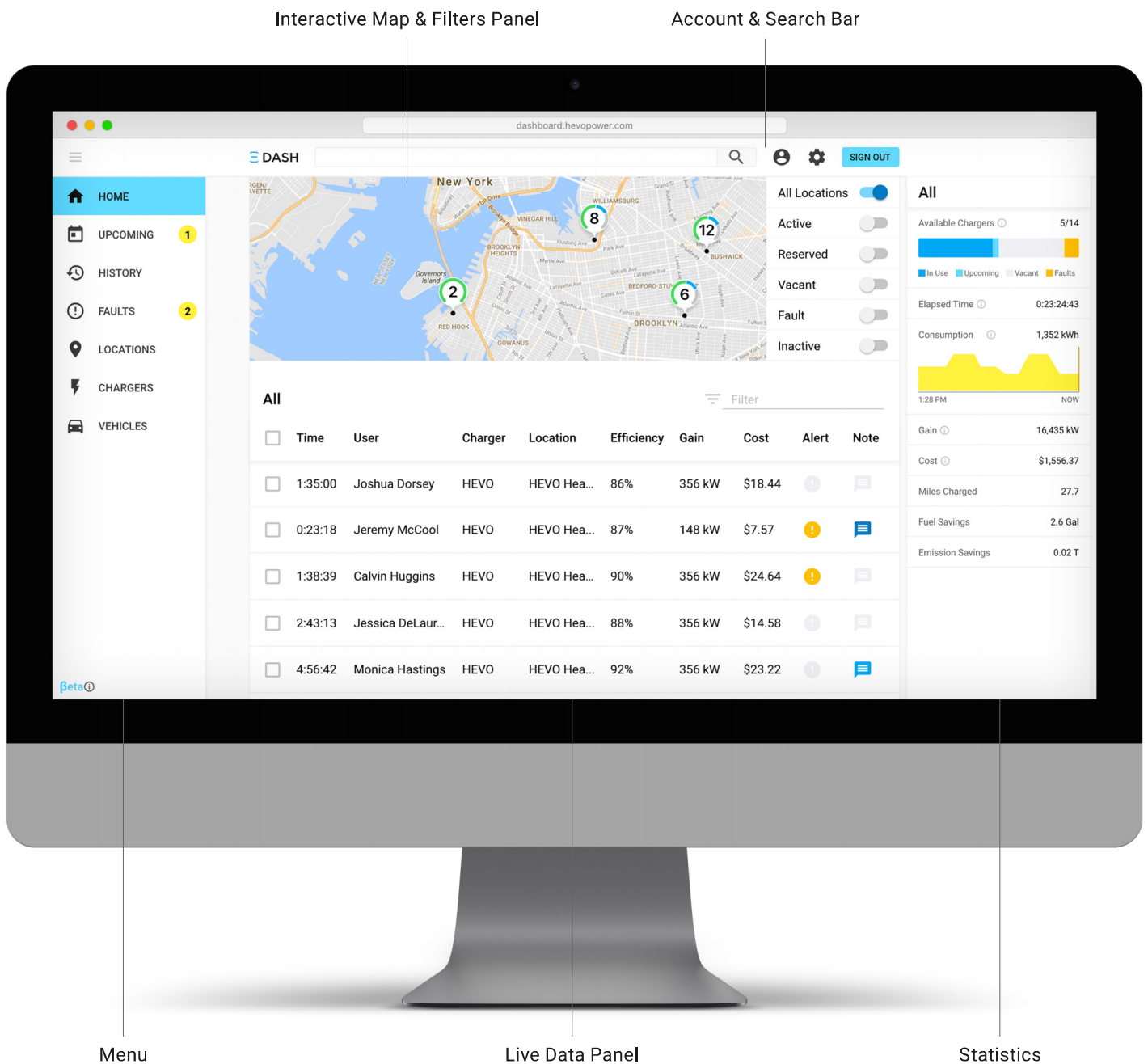
Remotely start and stop the charging process while accessing real-time charging data on the fly



## Management

Wirelessly pay your bill, monitor your receipts and evaluate your charging statistics

# Dashboard

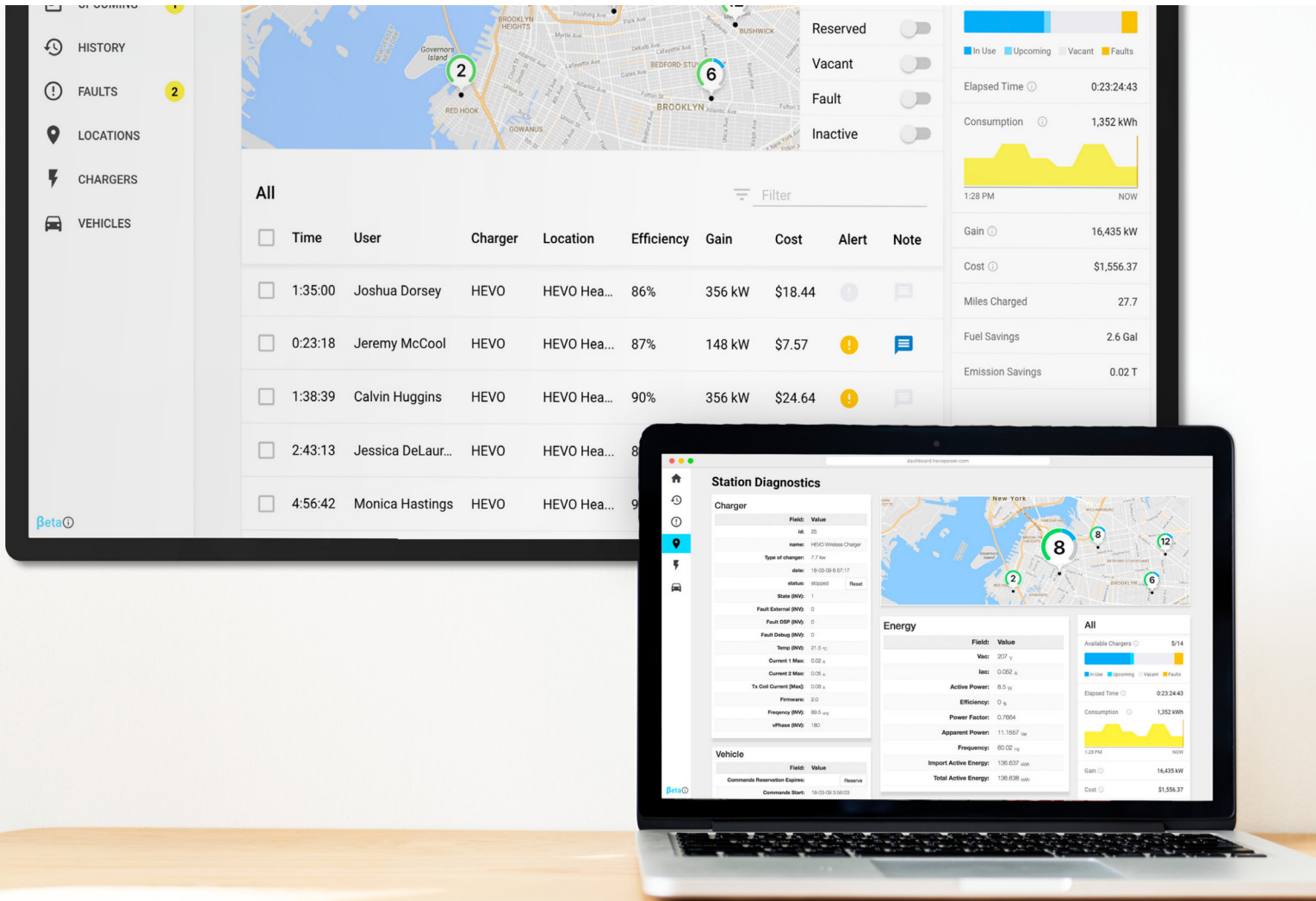


## Management Platform

The HEVO Dashboard serves as the primary interface for managing accounts, charging stations, electric vehicles and statistical analyses. The user interface is easily customizable and scalable to meet the dynamic requirements of fleets and EV charging operations.



# Diagnostics



## Predictive Telematics

The HEVO API seamlessly collects and delivers information from 85 different data points at a rate of five times per second from the charging station, electric vehicle, energy meter and embedded sensors. Predictive analytics saves valuable maintenance and repair time to keep operations up and moving.



EV Wireless Charging and Telematics

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