FREEWiRE

EV Charging on Corridors
Issues and Opportunities

IBTTA – Emerging Tech & EV Infrastructure WG
May 19, 2022

Agenda

1. Introduction to FreeWire Technologies
2. Overview of EV charging technology
3. Challenges to installation and operation of EV fast charging
4. The FreeWire approach to fast charging
5. Federal and state EV charging programs

Introductions

Jordan Baroody

Sales Director
State and Local Government

Peter Olmsted

Director of Regulatory Affairs

FreeWire Technologies

FreeWire is a leading manufacturer of battery-integrated EV charging equipment

Founded in 2014 in the San Leandro, California

FreeWire offers flexible, turnkey EV charging and power solutions leveraging energy storage for rapid and sustainable electrification

We help utility, automotive, workplace, city, retail and fleet operators deploy EV charging and scalable power solutions

World-class investors include:

bp, ABB, RIVER STONE, Energy Innovation Capital, MACQUARIE, STRAWBERRY CREEK VENTURES, trirec, BLUE BEAR CAPITAL, STANLEY Ventures

High-profile, Fortune 100 customers include:

TA, AMERICAN ELECTRIC POWER, LA DWP Los Angeles Department of Water & Power, otg, Ryder, Google, UCDAVIS UNIVERSITY OF CALIFORNIA, NETFLIX, American Red Cross

FreeWire is deeply committed to manufacturing and deploying advanced charging and grid management infrastructure

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EV-Charging Startup FreeWire Raises $125 Million From Investors Including BlackRock

Developer of electric-vehicle chargers expects to pursue traditional IPO in next 18 months, CEO says

FAST COMPANY

WE MADE THE LIST!

WORLD CHANGING IDEAS 2022

INSIDEEVs

USA / GLOBAL

CHARGING

By Mark Kane

FreeWire Introduces Its Most Powerful and Flexible EV Charger: Boost Charger 200

Thanks to an integrated battery, it can supply up to 200 kW (DC), with input power of just up to 27 kW (AC).

15h ago 3

ElectricCarsReport charge the future

HOME ABOUT US PRIVACY POLICY ADVERTISE CHARGING MAP

FreeWire Expands Premium EV Charging to Japan

Demand for Fast and Ultrafast Charging is Surging

	Charger Type	Time to Full Charge
	AC Charging	10 hours
	DC Fast Charging	1 hour
	DC Ultrafast Charging	20 minutes

Major DC Fast Charger Applications

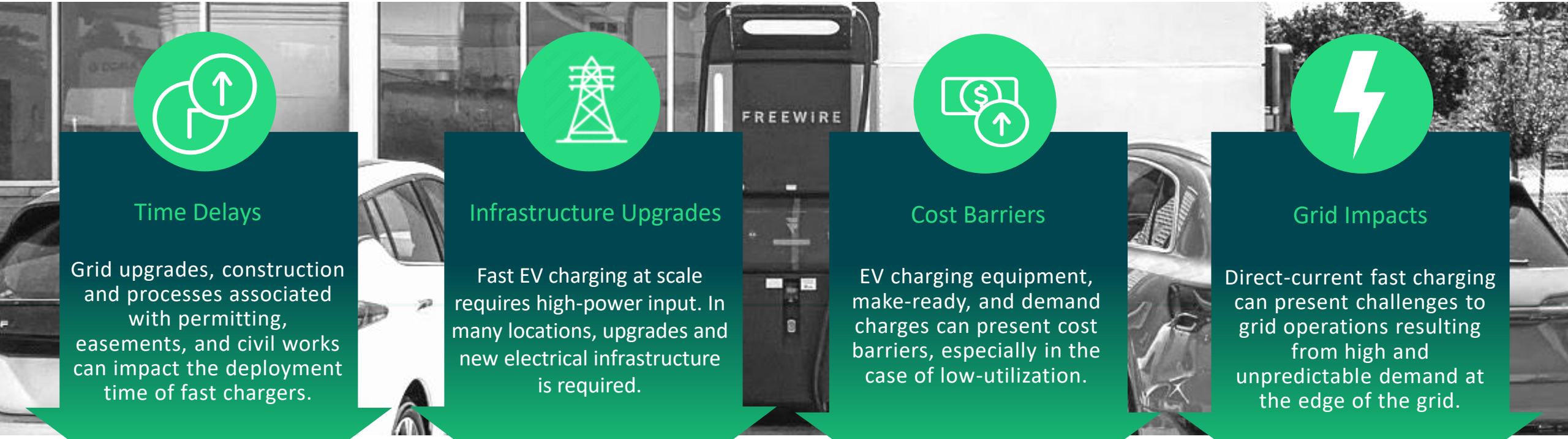
Fleet

- Transporting goods
- Last mile delivery
- Municipal (ambulance, police, etc.)

Public

- Retail
- Urban dwellers (no off-street parking)
- Tourist destinations
- Post office, train station, etc.

Challenges with Direct-Current Fast Charging Deployment



Time Delays

Grid upgrades, construction and processes associated with permitting, easements, and civil works can impact the deployment time of fast chargers.

Infrastructure Upgrades

Fast EV charging at scale requires high-power input. In many locations, upgrades and new electrical infrastructure is required.

Cost Barriers

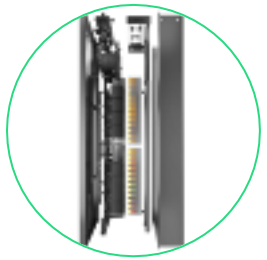
EV charging equipment, make-ready, and demand charges can present cost barriers, especially in the case of low-utilization.

Grid Impacts

Direct-current fast charging can present challenges to grid operations resulting from high and unpredictable demand at the edge of the grid.

McKinsey estimates that it will cost $125 billion through 2030 to upgrade the grid for EVs

FreeWire's Approach to Ultrafast Charging



NEXT-GEN POWER CONVERTER
Proprietary power conversion technology with silicon carbide architecture & 99% efficiency.

ADAPTIVE BATTERY PACK
Proprietary battery pack with flexible architecture that switches between 400V & 800V.

ADVANCED CONTROL SYSTEM
Optimized to enable distributed energy services.

200 kW fast charging

200 kW to charge 1 EV
100 kW to charge 2 EVs simultaneously

160 kWh battery-storage

Lithium-ion energy storage boosts power from the grid

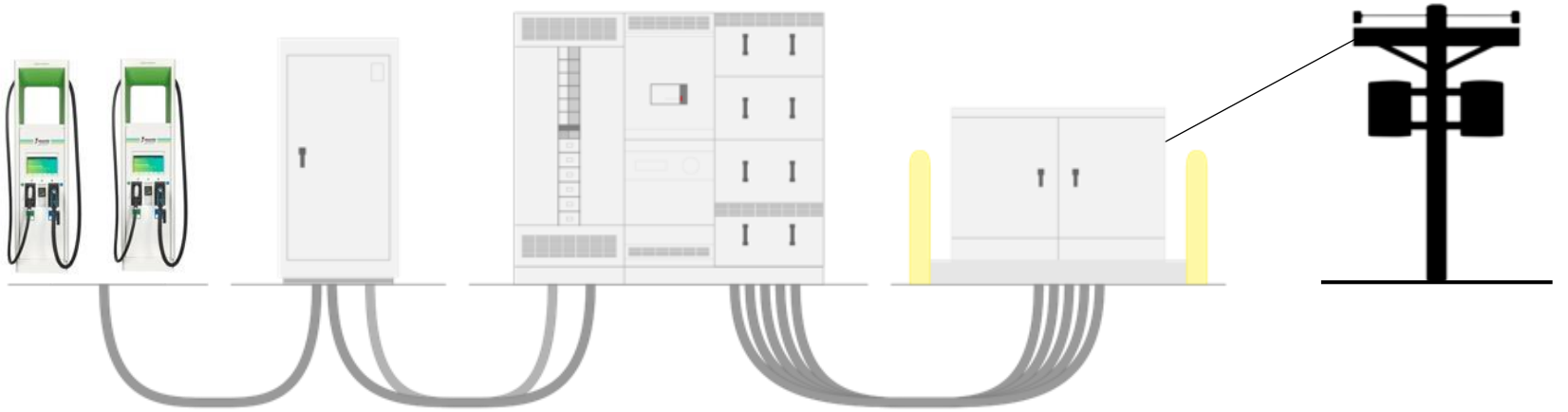
Low-voltage grid

Connects at widely-available 208V or 240V, same as Level 2
Avoids utility and customer-side electrical infrastructure

Illustrative Schematic of Make-Ready Requirements

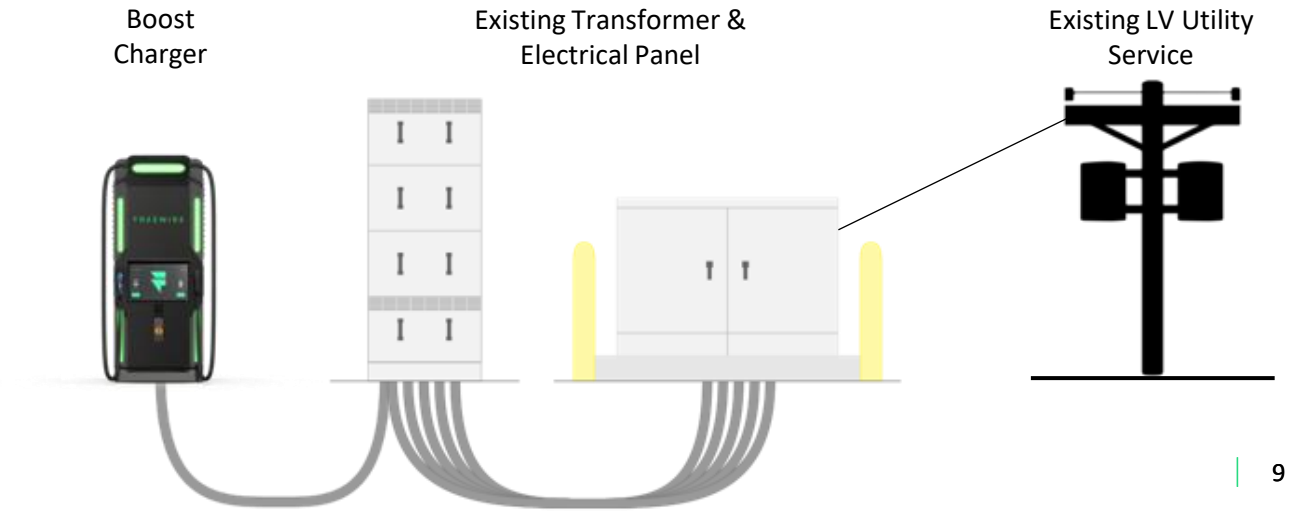
Conventional Fast Charger

- Requires grid and customer-sited upgrades (make-ready)
- Requires 480V power



FreeWire Boost Charger

- Connects at 208V or 240V resulting in minimal upgrades
- Same as L2 charging, widely available



Fully-Integrated Solution Eases Complexity and Cost

Fully-Integrated

BOOST CHARGER

VS

Charging Infrastructure

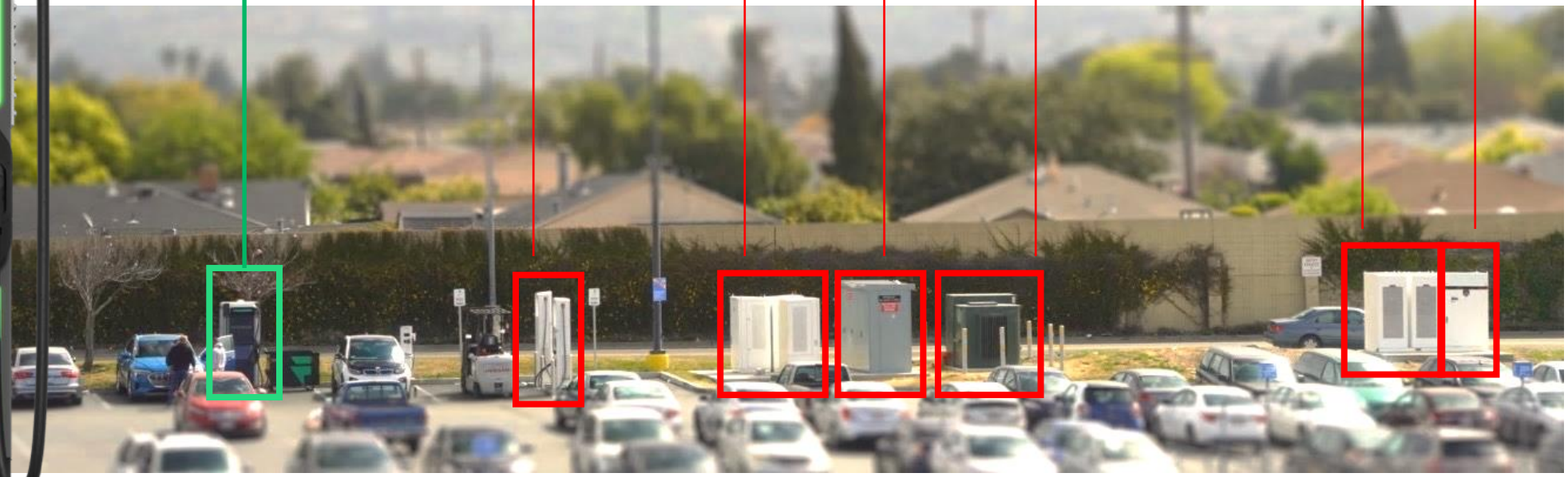
DISPENSER + POWER CABINET

Grid Infrastructure

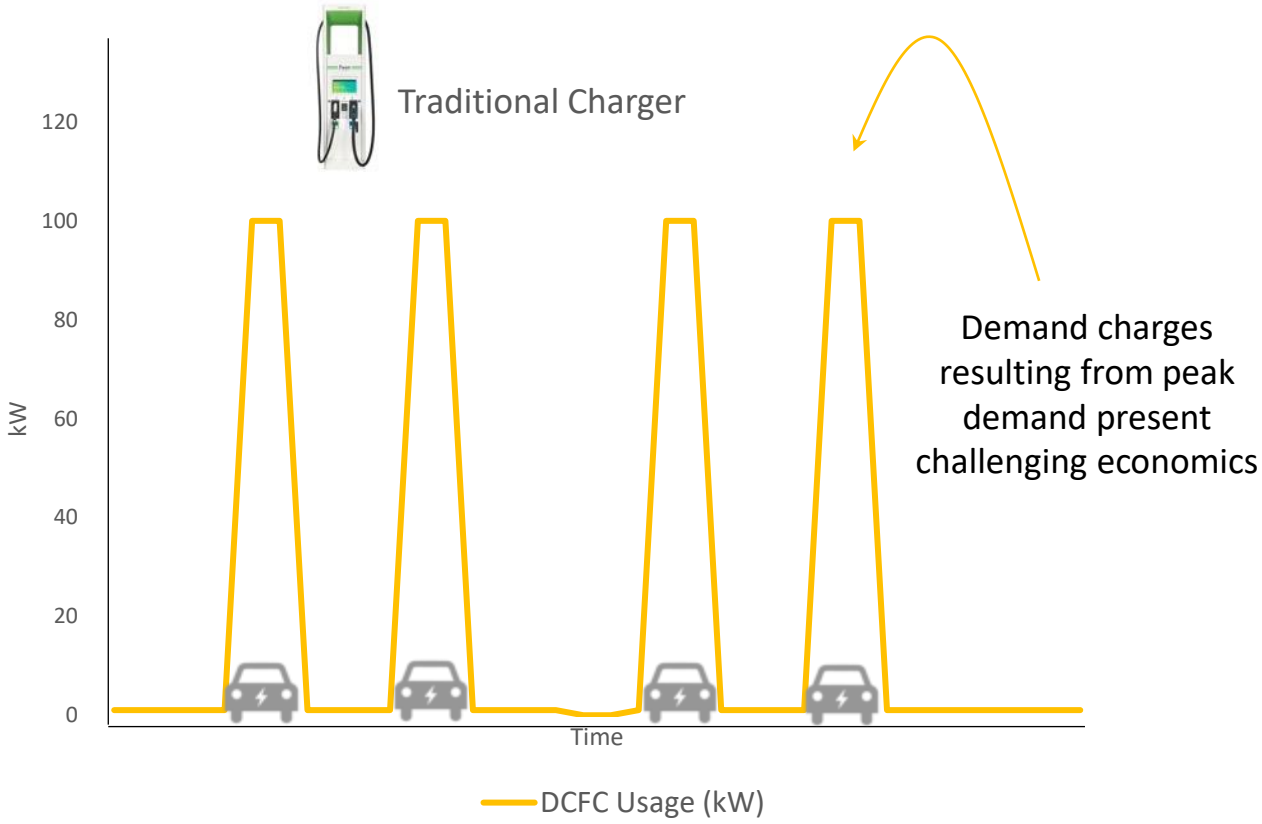
SWITCHGEAR + TRANSFORMER

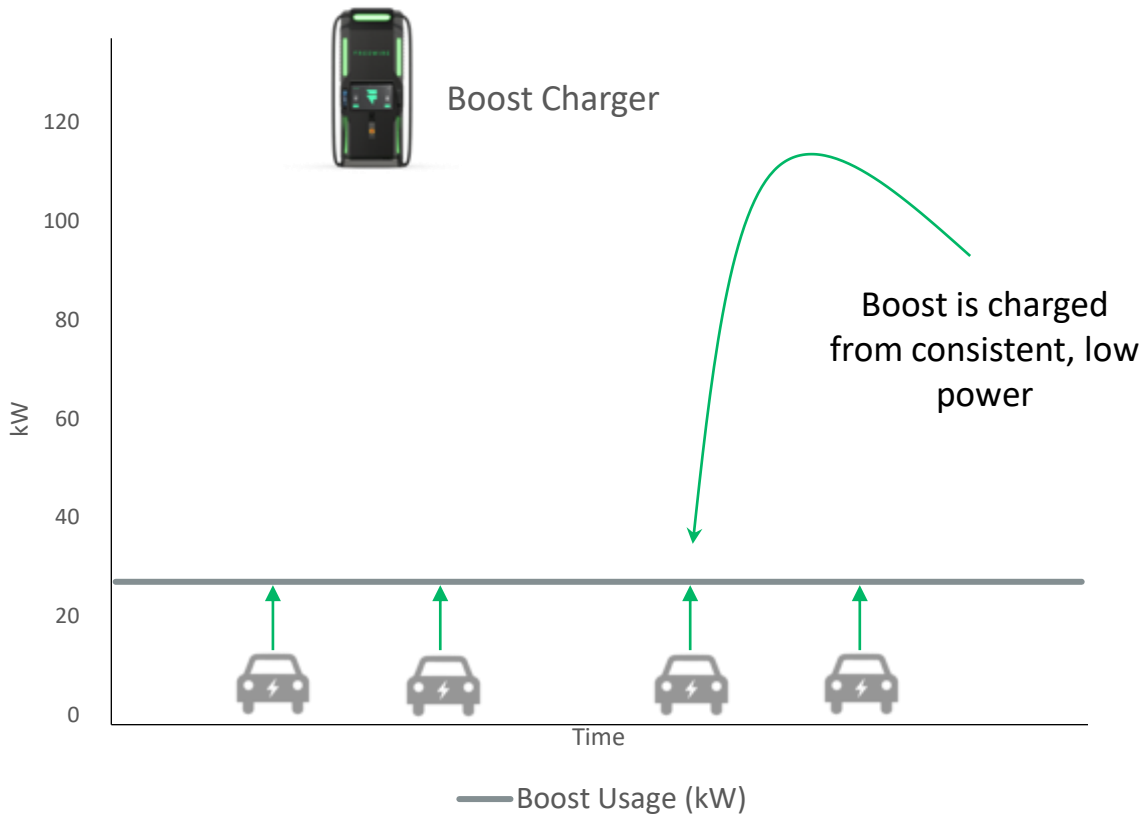
Energy Storage

BATTERY + INVERTER



Technology Solution to Mitigating Demand Charges

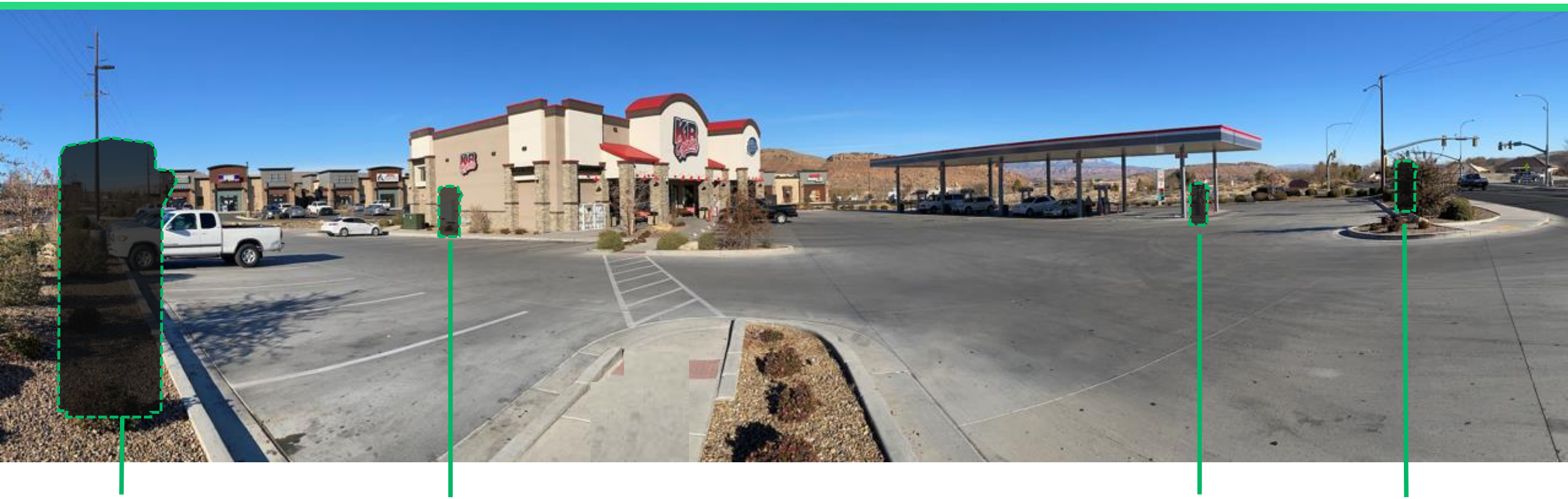




- In the case of the Boost Charger, the station never peaks higher than 27 kW
  - 20 kW is utilized to recharge the Boost's integrated battery and 3-7 kW utilized for heating/cooling/operations
- As a result, battery-integrated EVSE can reduce demand charges and respond to energy pricing

Plug and Play Solution

Small footprint and low electrical requirements enables placement anywhere



Parking lot

Side of Store

Under Canopy

Edge

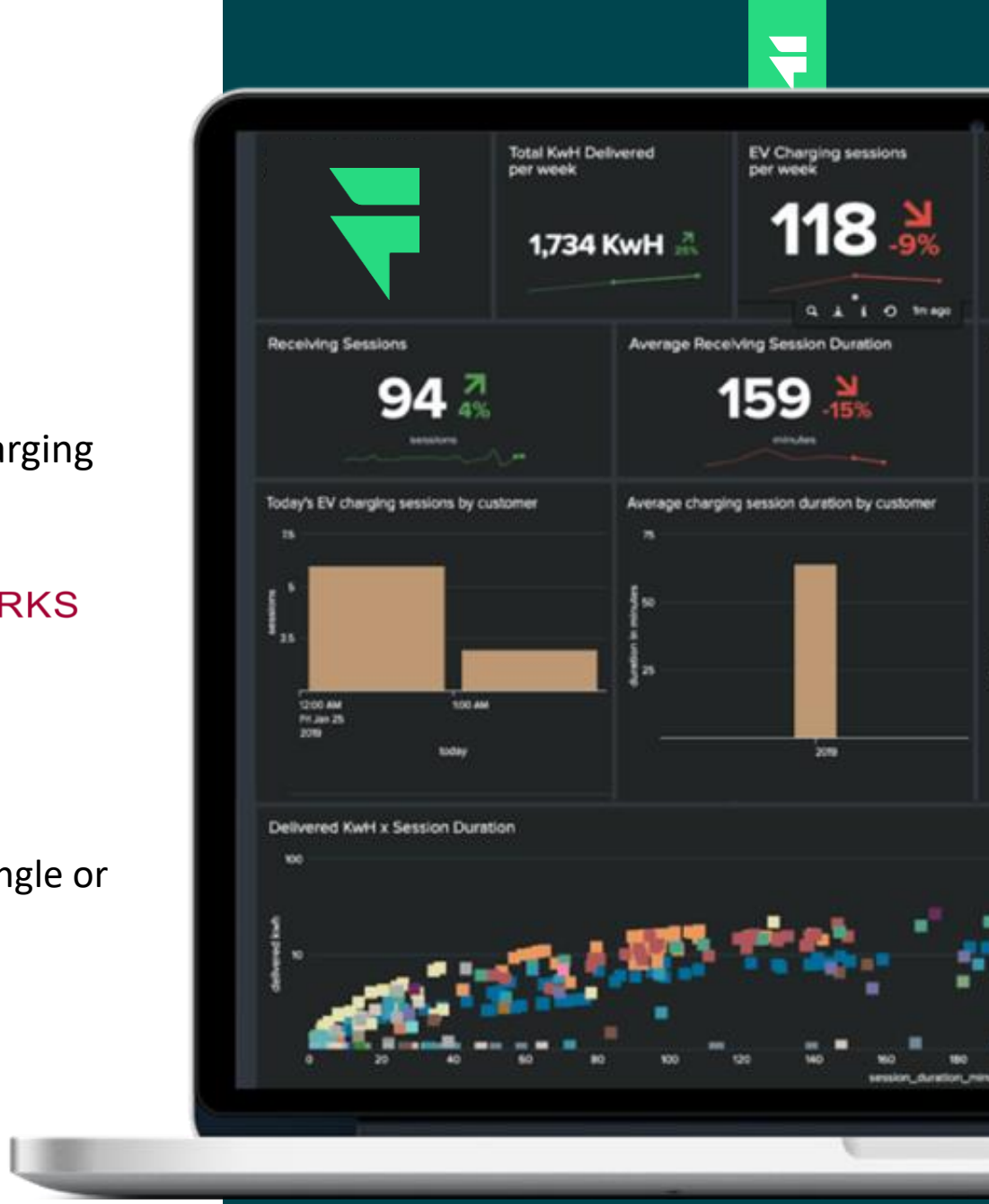
Software & Network Capability

NETWORKED

Open Charge Point Protocol (OCPP) 1.6 Compatible

Enables secure communication between EV charging stations and charging networks

evconnect greenlots A Member of the Shell Group chargepoint AssetWORKS



NATIVE SOFTWARE

Asset Management Platform (AMP)

AMP provides you with the data and tools necessary to easily manage single or multiple ultrafast Boost Charger deployments.

- Remotely track utilization and performance
- Organize chargers by groups
- Optimize energy services
- Easily produce summary reports

EV Charging Programs – FreeWire Recommendations

- Prioritize EV charging technologies and strategies to achieve the following:
  - Minimizing of grid impacts
  - Quick deployment
  - Reduction of overall construction or operational costs
  - Minimizing of demand charges or other fixed utility fees
- Prioritize projects that can demonstrate readiness and viability, completion within 6 months
- Provide flexibility around power output requirements and let the market discover need & demand
  - Federal $$ (NEVI) – Four 150 kW chargers per location
- Include all cost components in the evaluation and selection of projects
- Encourage and incentivize EV charging paired with battery-storage to reduce costs & overcome barriers

Thank You!

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GM EV Presentation to IBTTA | November 17, 2022

GM IS HERE TO HELP WITH YOUR EV TRANSITION

Ali Jahed

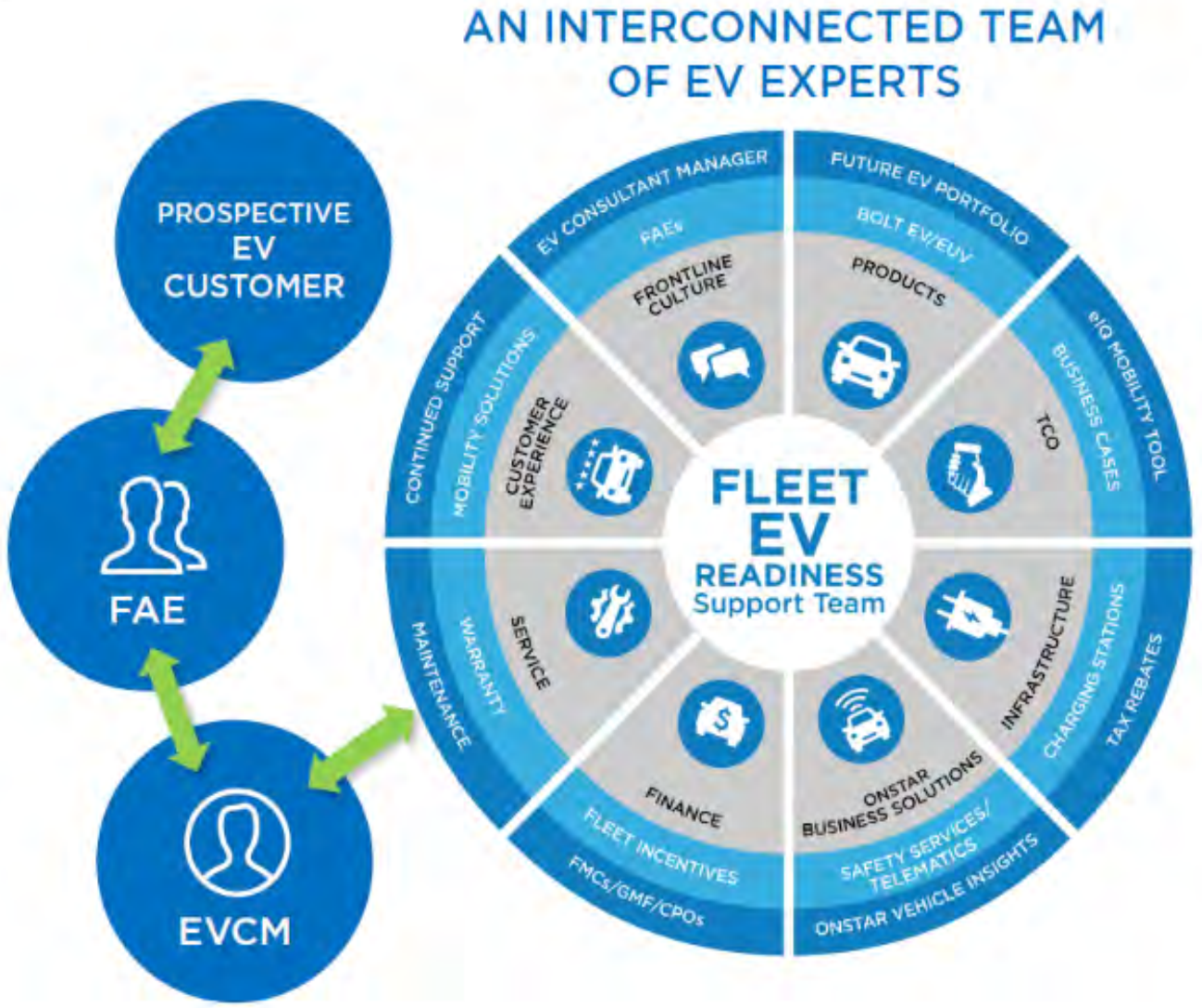
EV Consultant Manager

GM FLEET

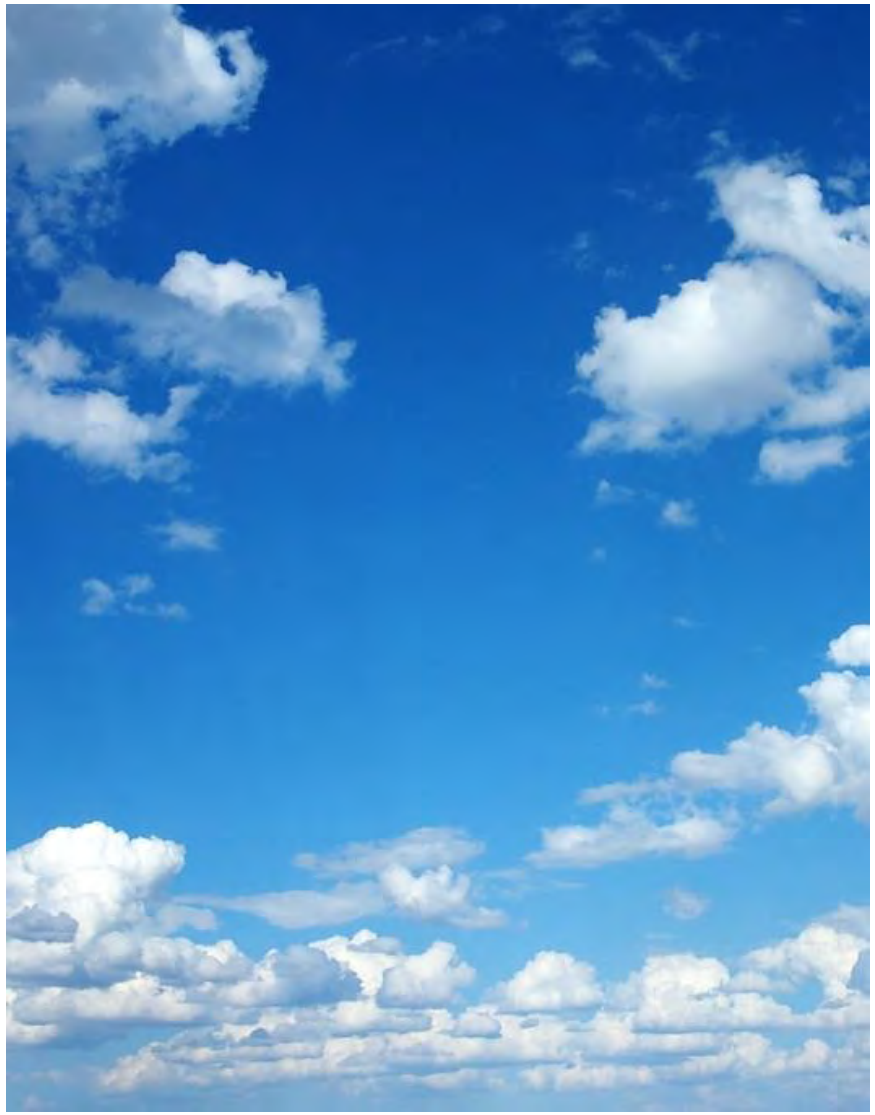
Stephen Marlin

EV Consultant Manager

GM FLEET



PRESENTATION AGENDA



GM ZERO VISION

GM INVESTMENTS

EV TRANSITION

EV PORTFOLIO

CHARGING

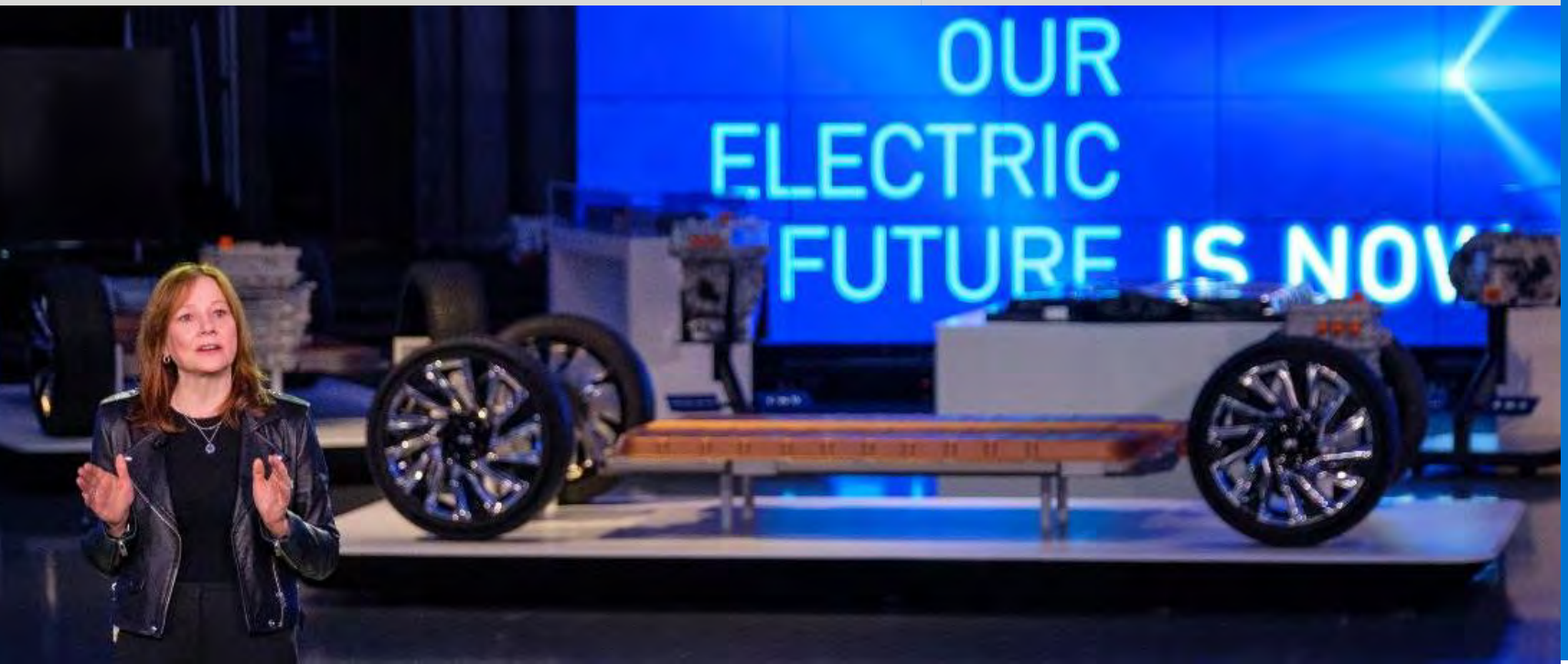
TELEMATICS (OnStar)


Zero
Crashes
Zero
Emissions
Zero
Congestion

"We are investing aggressively in a comprehensive and highly-integrated plan to make sure that GM leads in all aspects of the transformation to a more sustainable future."

–Mary Barra
Chair and CEO, General Motors

$35 BILLION
to be invested in EVs and AVs through 2025

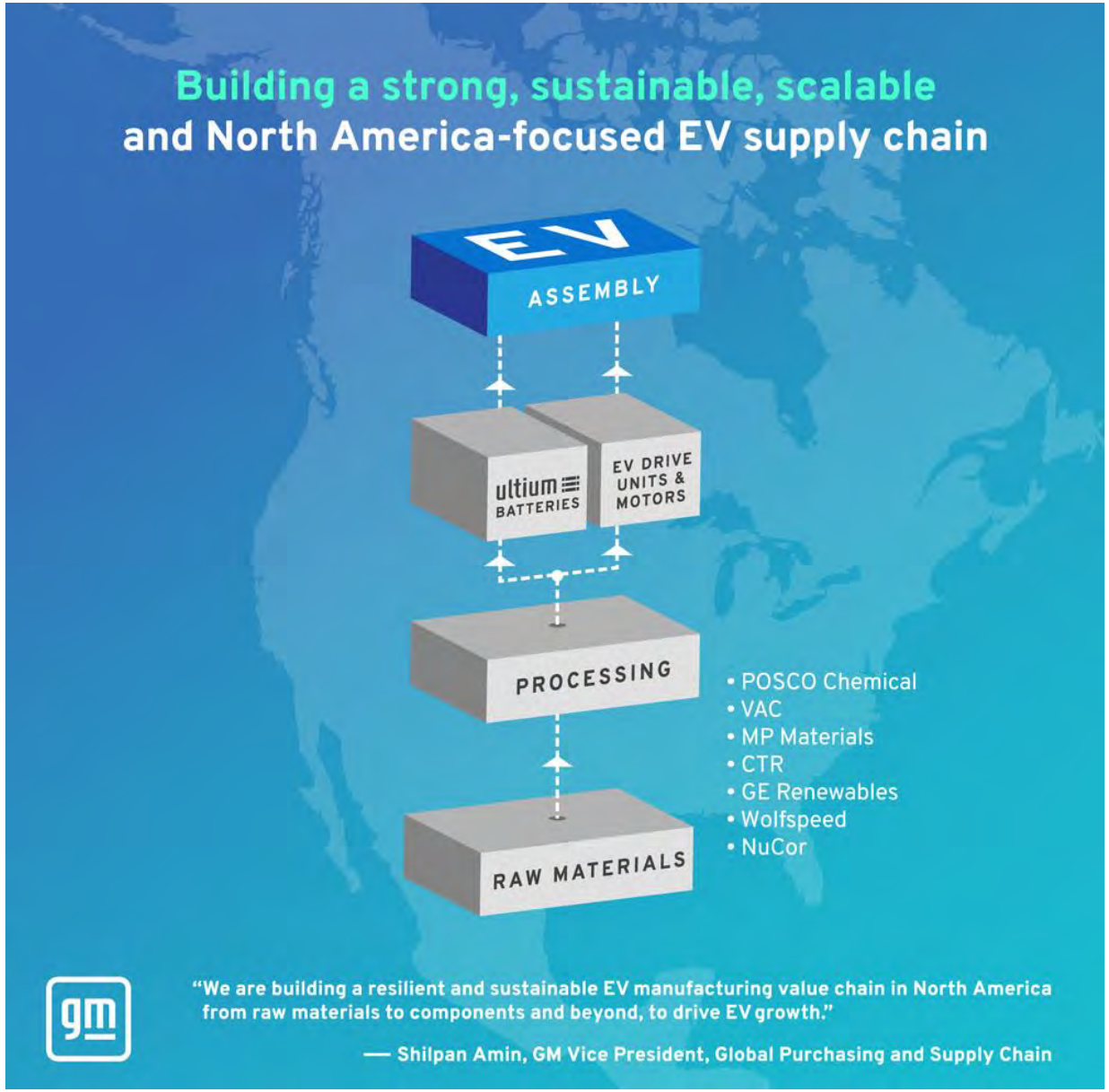


ACCELERATING ULTIUM BATTERY CELL PRODUCTION IN THE UNITED STATES

EXPANDING AND ACCELERATING THE ROLLOUT OF EVS

SAFELY DEPLOYING SELF-DRIVING TECHNOLOGY AT SCALE

SUSTAINABLE EV SUPPLY CHAIN



Forbes

BREAKING • TRANSPORTATION

GM Invests In Controlled Thermal Resources For U.S. Lithium Production

Sam Abuelsamid Senior Contributor ⓘ
A lifetime in the car business, first engineering, now communicating

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Jul 2, 2021, 08:00am EDT

WSJ

BUSINESS | AUTOS & TRANSPORTATION | AUTOS INDUSTRY

GM Strikes Deal to Secure Cobalt for Electric-Car Batteries

Multiyear agreement with Glencore is latest in auto industry's race to secure key battery materials

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GM IS INVESTING TOWARD AN ALL-ELECTRIC FUTURE!

TOTAL EV & AV INVESTMENT TO **$35B** THROUGH 2025

$2.2B investment in Factory Zero EV assembly plant in Detroit, Michigan

$2.3B investment in the new Ultium battery plant in Lordstown, Ohio. **2022**

$2.3B invested for a second Ultium battery plant in Spring Hill, TN. **2023**

$7B investment in 4 MI sites, including a third battery plant in Lansing, Michigan. **2024**

FACTORY ZERO

ULTIUM CELLS
A COLLABORATION BETWEEN GM + LG CHEM LTD

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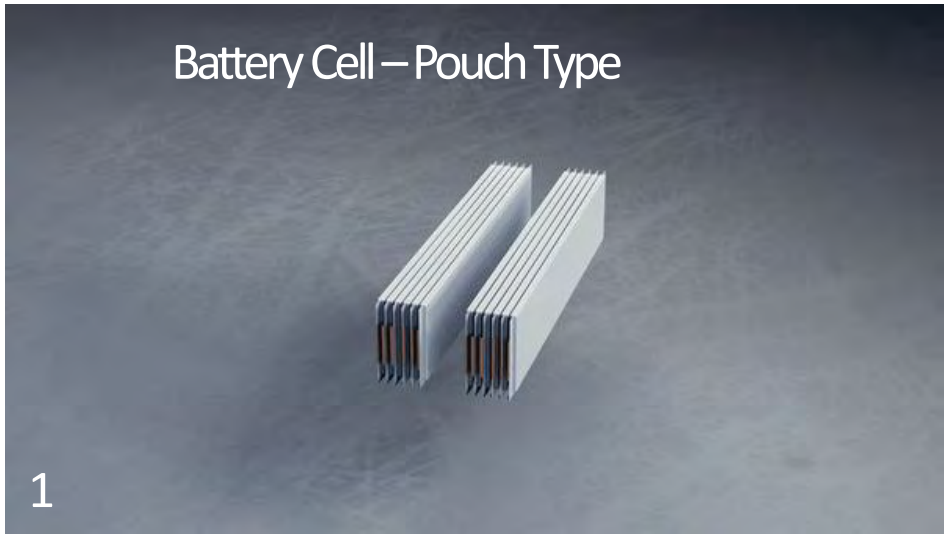
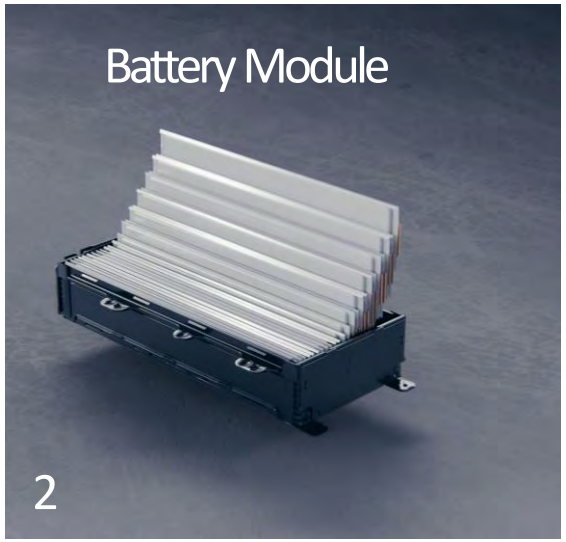
MODULAR PLATFORM AND BATTERY SYSTEM

Modular Platform and Battery System





- 70% less Cobalt content (NCMA)
- 8 Year/100,000 Mile Battery Warranty
- Parts Commonality, Parts in Stock, Fast Service
- Aftersales Support: 4,000 GM Dealerships
    - *Tesla has 140 service centers in the U.S.*
- 87% of U.S. population is within 10 miles of a GM Dealership

GM EVs ALREADY LAUNCHED OR ANNOUNCED

BOLT EV

Availability - Now

BOLT EUV

Availability - Now

LYRIQ

Availability – Q3 2023

HUMMER EV PICKUP & SUV

Availability – Q4 2023

SILVERADO EV

Availability – Q3 2023

BLAZER EV

Availability – LT Q1 2024

EQUINOX EV

Availability – LT Q1 2024

BRIGHTDROP

Zevo 600

Zevo 400

gm FLEET

SILVERADO EV

Production Start 3/23

CHEVROLET SILVERADO EV

- All-new, all-electric full-size pickup
  - Pure EV platform, unlike F-150 shared platform
  - All-new exterior and interior
- Launching “Fleet First” – First time in GM history!
- Reliable/Durable/Dependable/Capable - What you’d expect from a Silverado!
- Crew Cab configuration, 5’11 bed size (current Silverado 5’10)
- Truck and Battery manufactured in the U.S.

SILVERADO EV Work Truck (Fleet Version)

MECHANICAL

- 2-motor e4WD
  - 1 front & 1 rear electric drive unit
  - Up to 500 hp and 740 lb.-ft. of torque
  - Approximately 6.7 seconds 0-60 mph
- Lithium-ion battery
- 19-kW onboard AC charging module
- 800V - DC fast charging capability - up to 350 kW
- Dual Level Charge Cord (1.4/7.7 kW)
- One Pedal Driving
- Regenerative braking
- Driver Mode Control – Normal, Tow/Haul
- Electronic parking brake
- Keyless Open and Start
- Independent front and rear coil suspension
- 4-wheel antilock disc brakes with blended regenerative capability
- StabiliTrak Electronic Stability Control System with traction control
- Class 3 trailer hitch provisions
- Advanced Trailering System
  - Integrated brake controller
  - Hitch Guidance

RANGE (GM ESTIMATED) ON A FULL CHARGE

- 24 Module – Up to 400 miles (SOP 3/23)
- 20 Module – In Validation (SOP 8/23)

MAX TOWING AND PAYLOAD CAPABILITIES

- 24 Module – 8,000 / 1,200 lbs.
- 20 Module – 8,000 / 1,600 lbs.

WARRANTY

- 3-Year / 36K Bumper-to-Bumper
- 8-Year / 100K Electrification
- 5-Year Corrosion

FINAL ASSEMBLY PLANT

- Detroit, MI – Factory ZERO
- Orion Township, MI

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EXTERIOR

- **GM estimated lowest drag coefficients of any production full-size pickup – enabling impressive range**
- Crew cab, fixed bed, fleetside body style
- 18-inch aluminum wheels with All-Season LT265/70R tires
- LED exterior lighting (headlamps, taillamps, DRLs)
- Center high-mounted stop-lamp with integrated bed light
- Roof mounted shark fin antenna
- **Rear charge port with illuminated charge status**
- Front intermittent wipers
- Tinted rear side glass
- Assist steps
- High strength steel body construction
- Body colored painted door handles with front door PEPS buttons
- Available colors: Summit White (LSOP) and Black (Nov. 23 LSOP)
- Painted manual folding side view mirrors
- Durable molded front facia, bumpers and wheel well trim

gm FLEET

INTERIOR

- Best-in-segment storage space in the first row
- Best-in-segment couple distance (between first and second rows)
- High wear vinyl seats and flooring
- 4-way manual front seats
- Power tilt/telescoping steering column
- Power adjustable/heated outside rearview mirrors
- Electric rear window defroster
- Spacious dual storage floor console with 4 cupholders
  – 2 front and 2 rear
- Flip-up rear seats with under-seat storage
- 8-inch instrument panel cluster
- 11.3-inch integrated center stack touch-screen
- Fleet management software/apps
- Google built-in
- Available built-in WiFi® Hotspot
- Overhead microphone for voice recognition
- 12-volt DC power outlet in console
- 120-volt power outlet, shares 7.2 kW power -rear of console
- 4 USB ports (2 front power/data, 2 rear power)
- OnStar
- Next gen infotainment system with apps
- SiriusXM Satellite Radio – trial subscription N/A
- Theft deterrent system

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EXPORTABLE POWER/BATTERY AS CHARGE SOURCE

1. **Vehicle 2 Load**

   Discharge rate: 3kW (120V * 25Amp) Max.
   Or Discharge rate: 6kW (240V * 25Amp, single phase) Max

2. **Vehicle 2 Vehicle**

   Discharge rate: 6kW (240V * 25Amp) Max

3. **120V Inverter**

   Cab: 120V, ~ 3 Amp

   PU Box: 120V, ~ 3 Amp

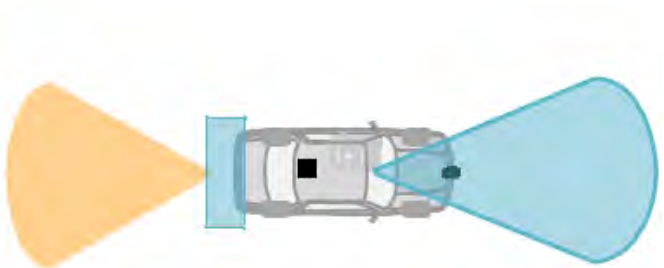
4. **USB/Auxiliary Power Outlet**

   USB: Shared 60-Watt, 45 Watt max each port
   APO (cab and eTRUNK™): 12 VDC, 15 Amp Max

10 Hour Day on the Job	Power Consumption
Starting EV State of Charge	80% ~320 miles of range
➢ Work light on for 8 hours	10 kWh
➢ Table saw running for 2 hours	15 kWh
➢ Hand drill running for 2 hours	5 kWh
➢ Air compressor on for 8 hours	35 kWh
➢ Vehicle accessories on for 4 hours	15 kWh
End of Day State of Charge	45% ~ 180 miles of range

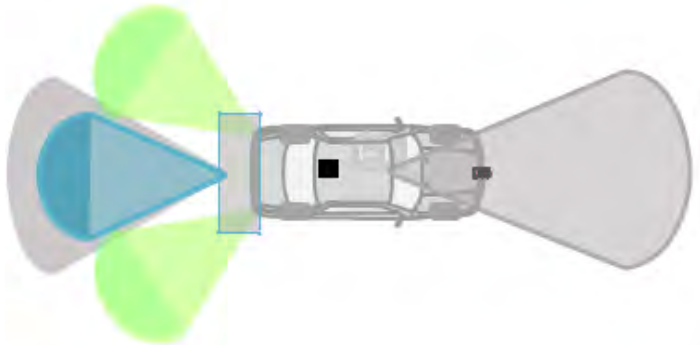
Based on 24 Mod battery pack with ~400 miles of range and 10.2 kW V2L capability .

SAFETY FEATURES MY24



Base (Standard)

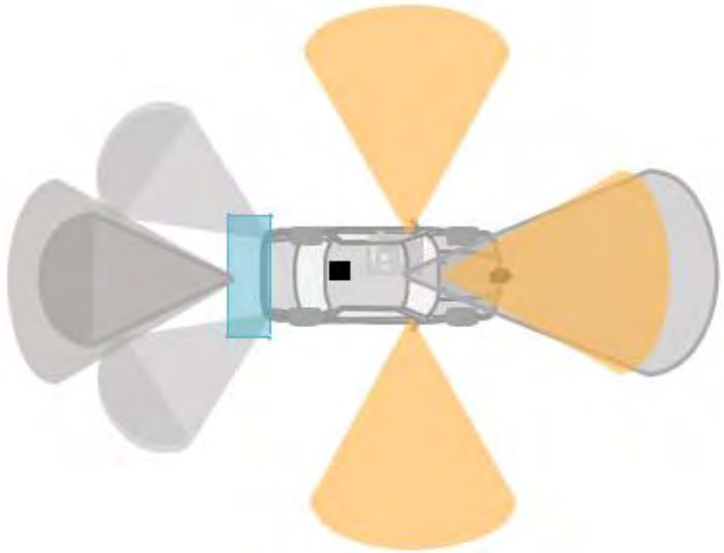
- Automatic Emergency Braking
- Forward Collision Alert
- Following Distance Indicator
- Front Pedestrian Braking incl Bicycle Collision Mitigation
- Lane Keep assist w/Lane departure warning
- Auto High Beam Assist
- Rear Vision Camera
- Rear Park Assist



Package 1 (AS1)

ADDS

- Reverse Auto Braking
- Safety Alert Seat
- Lane Change Alert w/Side Blind Zone Alert
- Rear Cross Traffic Alert with Braking
- Lateral Impact Avoidance/Side Collision Assist



Package 2 (AS2)

ADDS

- Surround Vision w/TVR
- Rear Pedestrian Detection
- Enhanced AEB and Adaptive Cruise Control
- Intelligent Speed Assist/Limiter w/Traffic Sign Recognition
- Forgotten Cyclist detection (Door/hooking)
- Intersection Collision Mitigation
- Enhanced Lane Keep Assist

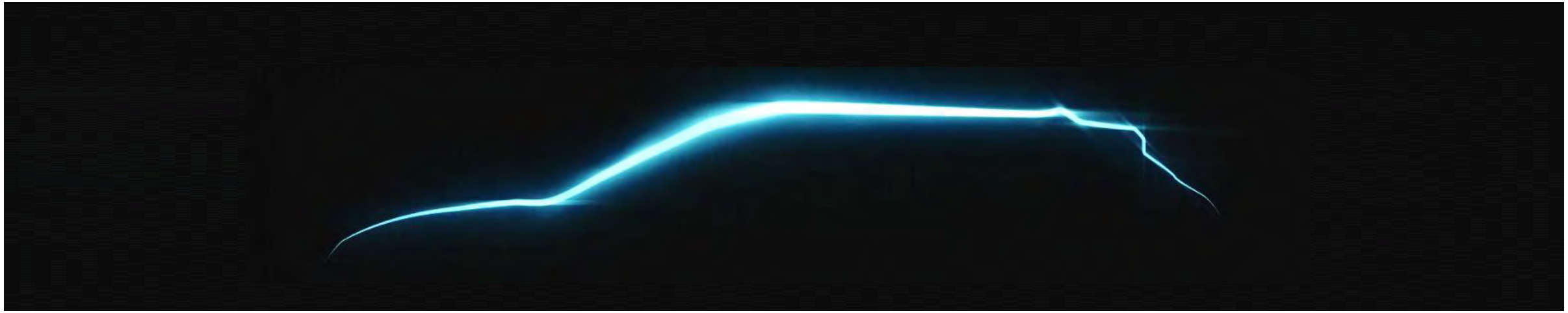
EQUINOX EV

Production Starts 6/23

Battery Manufactured in the U.S.

FUTURE CHEVROLET EV COMPACT SUV

- All-new, all-electric SUV, similar in dimensional size to an Equinox
  - Ground-up, new design, as a purpose-built 100% Electric propulsion vehicle
  - All-new exterior and interior designs
  - 27-30 cu.ft of cargo volume (estimated, with second row seats up)
- Optional driving ranges available from 250-300, FWD standard with eAWD optional
- Uses GM's latest Ultium Cells and Ultium motors, common GM powertrain parts shared across many vehicle platforms (knowledgeable dealers with common parts in stock, readily available)



1LT (Q1 2024)

1LT

gm FLEET

SAFETY FEATURES

Standard Safety Equipment

Base / Front

- Auto Emergency Braking
- Forward Collision Alert
- Following Distance Indicator
- Front Pedestrian Braking with Bicyclist Detection
- Lane Keep Assist with Lane Departure Warning
- Auto High Beam Assist (Intellibeam)
- Rear Vision Camera
- Rear Park Assist

Rear & Side

- Reverse Auto Braking
- Safety Alert Seat
- Lane Change Alert with Side Blind Zone Alert
- Rear Cross Traffic Alert with Braking
- Blind Zone Steering Assist

Available Safety Equipment on 2LT

Adaptive Cruise Control & Surround Vision

- Surround Vision Camera
- Rear Pedestrian Alert
- Enhanced Auto Emergency Braking and Adaptive Cruise
- Intelligent Speed Assist/Limiter
- Forgotten Cyclist Detection (Door/hooking)
- Intersection Collision Mitigation
- Enhanced Lane Keep Assist






BLAZER EV

Production Starts 6/23

Battery Manufactured in the U.S.

CHEVROLET BLAZER EV MID-SIZE SUV

- All-new, all-electric SUV, similar in dimensional size to a current Chevy Blazer
  - An all-new design purpose-built 100% electric vehicle
  - All-new exterior and interior designs, different than Blazer ICE vehicles
  - ~30 cu/ft of cargo volume (estimated, with second row seats up)
- **Driving range:**
  - FWD: 250 and 300 miles
  - RWD: 300 miles
  - AWD: 280 miles
- Uses GM's latest Ultium Cells and Ultium motors, common GM powertrain parts that are shared across all GM EV's
- Use of common parts and technology improves aftersales experience through knowledgeable dealers with parts in stock (maximum uptime for fleet customers)

BLAZER EV

Production Start 6/23

SS Model Shown

PPV (Q1 2024)

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1LT

- 11-inch driver information screen
- 17.7-inch diagonal touch-screen display
- Intuitive interior design

SAFETY FEATURES

Standard Safety Equipment

Base / Front

- Auto Emergency Braking
- Forward Collision Alert
- Following Distance Indicator
- Front Pedestrian Braking
- Bicycle Collison Mitigation
- Lane Keep Assist with Lane Departure Warning
- Auto High Beam Asist
- Rear Vision Camera
- Rear Park Assist

Rear & Side

- Reverse Auto Braking
- Safety Alert Seat
- Lane Change Alert with Side Blind Zone Alert
- Rear Cross Traffic Alert with Braking
- Lateral Impact Avoidance/Side Collision Assist

Available Safety Equipment on 2LT

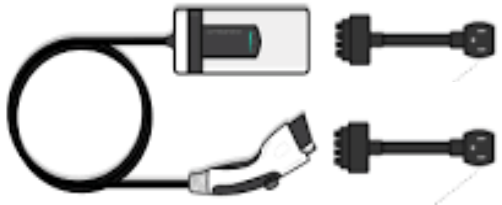
Adaptive Cruise Control & Surround Vision

- Surround Vision Camera
- Rear Pedestrian Alert
- Enhanced Auto Emergency Braking and Adaptive Cruise
- Intelligent Speed Assist/Limiter
- Forgotten Cyclist Detection (Door/hooking)
- Intersection Collision Mitigation
- Enhanced Lane Keep Assist

CHARGING

AC – J1772

Level 1 & 2 (portable)



120 or 240 Volt

Level 2 (Hardwired)

Up to 19.2kW

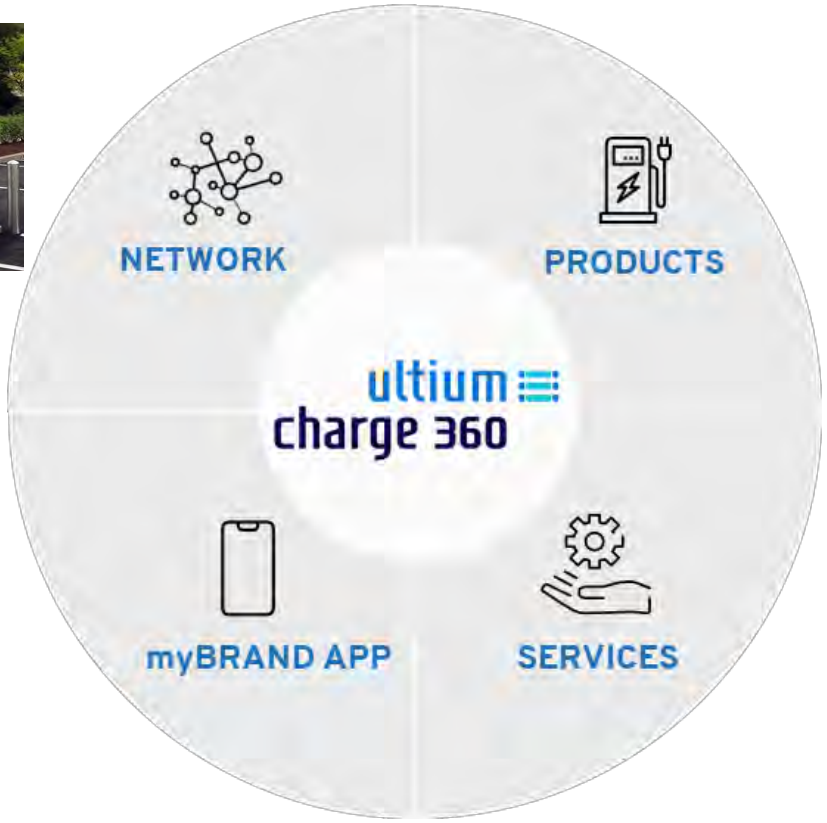
DCFC – CCS1

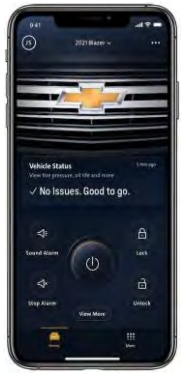
DC Fast

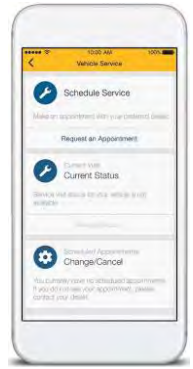
Up to 350kW

	120V		240V		Level 2 (Hardwired)		DCFC	
	Charger Max kW	Range per hour	Charger Max kW	Range per hour	Vehicle Max kW	Range per hour	Vehicle Max kW	Miles added at Max kW
MY24 Silverado EV WT	1.4kW	4 Miles	7.7.kW	11 Miles	19.2kW	35 Miles	350kW	100 in 10 min
MY 24 Equinox EV	1.4kW	4 Miles	7.7kW	24 Miles	11.5kW	37 Miles	150kW	70 in 10 min
MY24 Blazer EV	1.4kW	4 Miles	7.7kW	23 Miles	11.5kW	37 Miles	190kW	82 in 10 Min
MY23 Bolt EV	1.4kW	5 Miles	7.7kW	28 Miles	11.5kW	39 Miles	55kW	100 in 30 min
MY 23 Bolt EUV	1.4kW	5 Miles	7.7kW	28 Miles	11.5kW	39 Miles	55kW	95 in 30 min

ULTIUM CHARGE 360







Charging plays significant role in adoption

- Ultium Charge 360 is a holistic approach to charging
- Inclusive of home, public, depot, & road-trip charging
- Differentiation through seamless experience

ULTIUM CHARGE 360 FLEET SOLUTIONS

TURNKEY SOLUTIONS THROUGH PREFFERED PROVIDERS

Depot

Schneider Electric · eTransEnergy · EVgo · In-Charge

Turnkey charging solutions suited to assess initial options, identify opportunities, and tailor solutions that address today and future goals.

GM & depot provider enabled tools that reduce cost, like managed charging & grid services. We can connect your team immediately to providers!

Home

Qmerit

Co-Design home installation program for employees tailored to company goals; pre-qualified electricians complete the install and program is tracked to SLAs.

GM leveraged telematics to track vehicle energy usage (kWh) and enable reimbursement.

Public

EVgo

Whether reliant or complimentary to home and public solutions, ensure access to public charging to solve on-the-go use-cases in the locations that matter to fleets.

GM integrated tools, such as Energy Assist, that allow drivers to find & use public charging.

GM and Pilot Company to build a coast-to-coast fast charging network.

- 2,000 EV charging stalls will be installed at up to 500 Pilot and Flying J travel centers
- Will help enable coast-to-coast EV travel and connect communities across America
- Initial Phase 1 EV charging stalls (shown in reference map) expected to be operational in 2023
- Chargers will be capable of delivering up to 350kW*

gm | Pilot. FLYING J. | EVgo FAST CHARGING

*Actual charge times will vary based on vehicle capabilities and settings. Locations intended to provide an approximation of future charging sites.


THANK YOU!
We want to partner with you!
general motors
everybody in.

Topics for Stationary Fuel Cell Power Generation and EV Fast Charging

1. Benefits of Fuel Cells for Power Generation
2. Products being Planned
3. Refueling of Fuel Cell DC Fast Chargers
4. Economics of Fuel Cell DC Fast Charging

IBTTA Emerging Technologies EV & Infrastructure Work Group Meeting
October 20, 2022, 11 AM – 12 PM EDT

HYDROTEC
GENERAL MOTORS

HYDROGEN
FUEL CELL SOLUTIONS
ZERO EMISSIONS • MAXIMUM CAPABILITY

FUEL CELL VERSUS DIESEL AND OTHER OPTIONS FOR POWER GENERATION

Fuel Cell versus Diesel for Power Generation

- Fuel cell power generators emit only water vapor
- Fuel cell power generators operate at significantly lower noise levels (can have a conversation next to a FC generator)
- FC generators do not require frequent/costly emissions compliance maintenance

General Motors

Fuel Cell versus a Utility Connection for DC Fast Charging EVs

- Fuel cell DC fast chargers can be deployed in days versus months
- Using a Fuel Cell DC fast charger avoids grid upgrade charges and electricity demand charges
- Fuel cell DC fast chargers can be relocated without giving up on major investments associated with electrical installations

Renewable Innovations

Fuel Cell versus using batteries for DC Fast Charging EVs

- Fuel cell DC fast chargers can run continuously versus batteries needing frequent down time to charge

Renewable Innovations

PRODUCTS AVAILABLE FROM RENEWABLE INNOVATIONS

Mobile Power Generator (MPG)

- Can be towed with a standard pickup truck
- Power available – 60 kW AC or 180 kW DC
- Utilizes (1) fuel cell PowerCube and (1) Bolt battery
- Stores 40 kg H2 at 700 Bar (approx. 35 DC fast charges)
- Requires hydrogen refill about weekly
- 20 feet in length, 14,000 pounds fully loaded

EMPOWER Rapid EV Charger

- Can be delivered with a Class 8 flatbed
- Power available – 150 kW DC fast charge four vehicles
- Utilizes (8) PowerCubes and (4) Bolt batteries
- Stores 500 kg H2 at 700 Bar (approx. 350 DC fast charges)
- Requires hydrogen refill about weekly
- 40 foot container, approx. 30,000 pounds
- Also capable of providing building backup power

HYDROGEN RESUPPLY FOR FUEL CELL CHARGING SYSTEMS

Hydrogen Refueling of the MPG and EMPOWER Rapid Charger

- Both the MPG and EMPOWER Rapid Charger will require a hydrogen refill approximately once a week

Near Term

- OneH2 currently provides hydrogen for thousands of fuel cell forklifts primarily at distribution warehouses across the U.S.
- Utilizes a hub and spoke production and delivery model
- Hydrogen is centrally produced from natural gas and delivered using a pickup truck and trailer

Long Term (by 2025)

- Long-term, purpose-built Class 8 tractors and trailers are expected to be utilized (Renewable Innovations and/or other H2 companies)
- Long-term conversion to green hydrogen from wind and solar
- Trailer will hold 1,000 kg which will fill two systems
    - Utilizes a fuel cell to power both a compressor and chiller for fast dispensing (30-45 minutes)

OneH2 Solution using Pickup Trucks & H2 Trailers

Renewable Innovations Solution using a Class 8 Tractor & Trailer

ECONOMICS OF STATIONARY FUEL CELLS

General

- TCOs have been calculated for multiple scenarios
- TCO driven mainly by the cost of hydrogen
- High sales volume required to reduce product cost
- Can benefit from existing hydrogen infrastructure
- Opportunity to offset costs with carbon credits

DC Fast Charging of EVs

- Favorable TCO when:
  - Grid upgrades are required and
  - Demand charges are high
- Minimal sunk cost for infrastructure

AC Power Generation

- Favorable TCO driven by high cost of maintaining diesel engines to meet emissions standards
- Only feasible zero emissions solution for large installations like data centers (10 to 100 MW)

MPG – Mobile Power Generator (operational in November 2022)

An Overview of FLO EV Charging

Rose Lenoff, Business Development Manager – Smart Cities & Government
Cory Bullis, Senior Public Affairs Manager

July 2022

Relentlessly Focused On Up-Time

98%+ Uptime

Top 3
Network operator in North America

#1 in Canada
65% Market share(1)

750,000
Charging events made possible per month(2)

100,000+
Members and 92%+ EV driver satisfaction

65,000+
Chargers sold (public/private)

69 / 52
B2B / B2C Net Promoter Score(4)

61,000+
Total North American public EV chargers available to FLO members

98%
FLO North America Network Uptime(5)

Note: All data as of 12/20, unless otherwise specified
Source: Company estimates and energy.gov data
1. Public charger installed base. Excludes Tesla & non-networked chargers
2. 12/20 data and company estimates for non-connected chargers
3. As of 5/21, post signing of additional interoperability agreements
4. As of 7/20
5. Company methodology and data as of 5/21; trailing 12 months, with standard waiting-on-customer exclusion
6. Installed DC and L2 chargers accessible via FLO and interoperability; excludes Tesla & non network chargers

Our Solutions

Expert Provider Across the Entire Charging Station Value Chain

Charging Solutions Provider (CSP)

Connected Hardware

DCFC 50Kw 100Kw | L2 City Curbside | L2 Public | L2 Private | L2 Residential

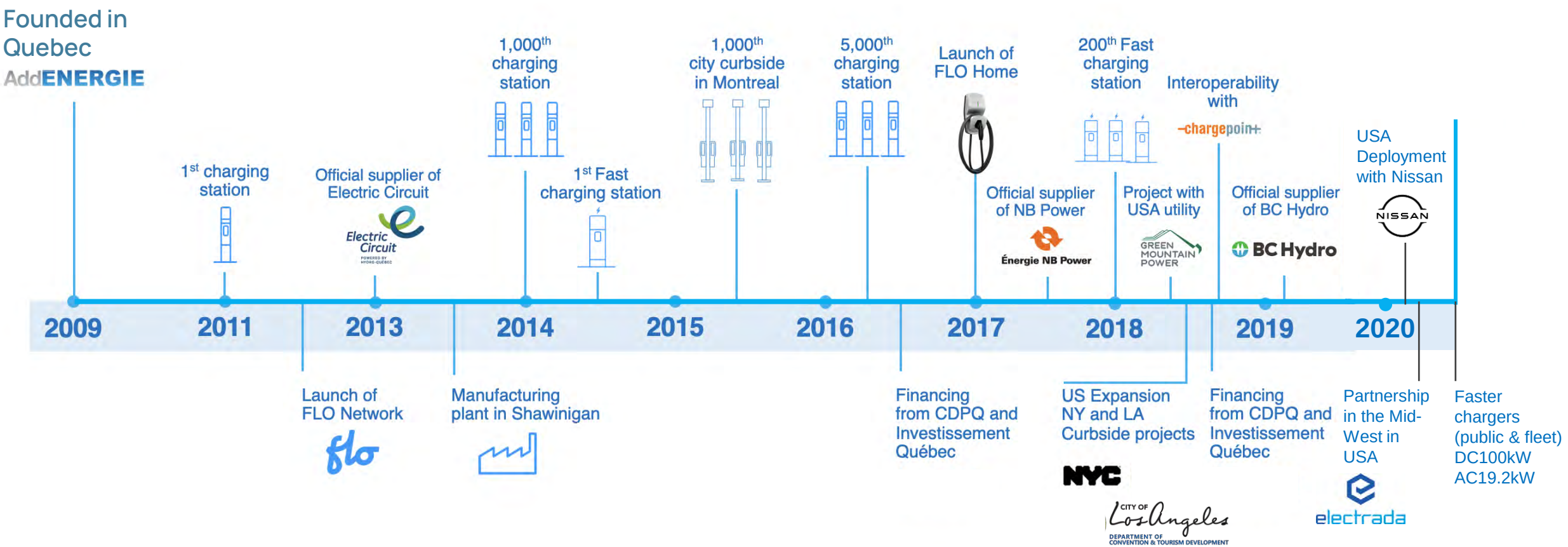
Charging Point Operator (CPO)

- Energy management
- EVSE reporting
- EVSE commissioning
- Firmware updates & cellular connectivity
- Cybersecurity & personal data protection
- Customer service & maintenance

Site Host & Driver Services (eMSP)

- Network and owner web portal
- User web portal and mobile app
- Mapping and status
- Payment billing, Taxes and remittance
- EVSE interoperability
- Usage reporting
- 3rd party integration (OEM, Google maps)
- Cybersecurity & personal data protection
- Customer service & maintenance

A Pioneer in EV Charging Since 2009



Seamless Roaming Network

Over 65,000 charging locations in North America

In partnership with:

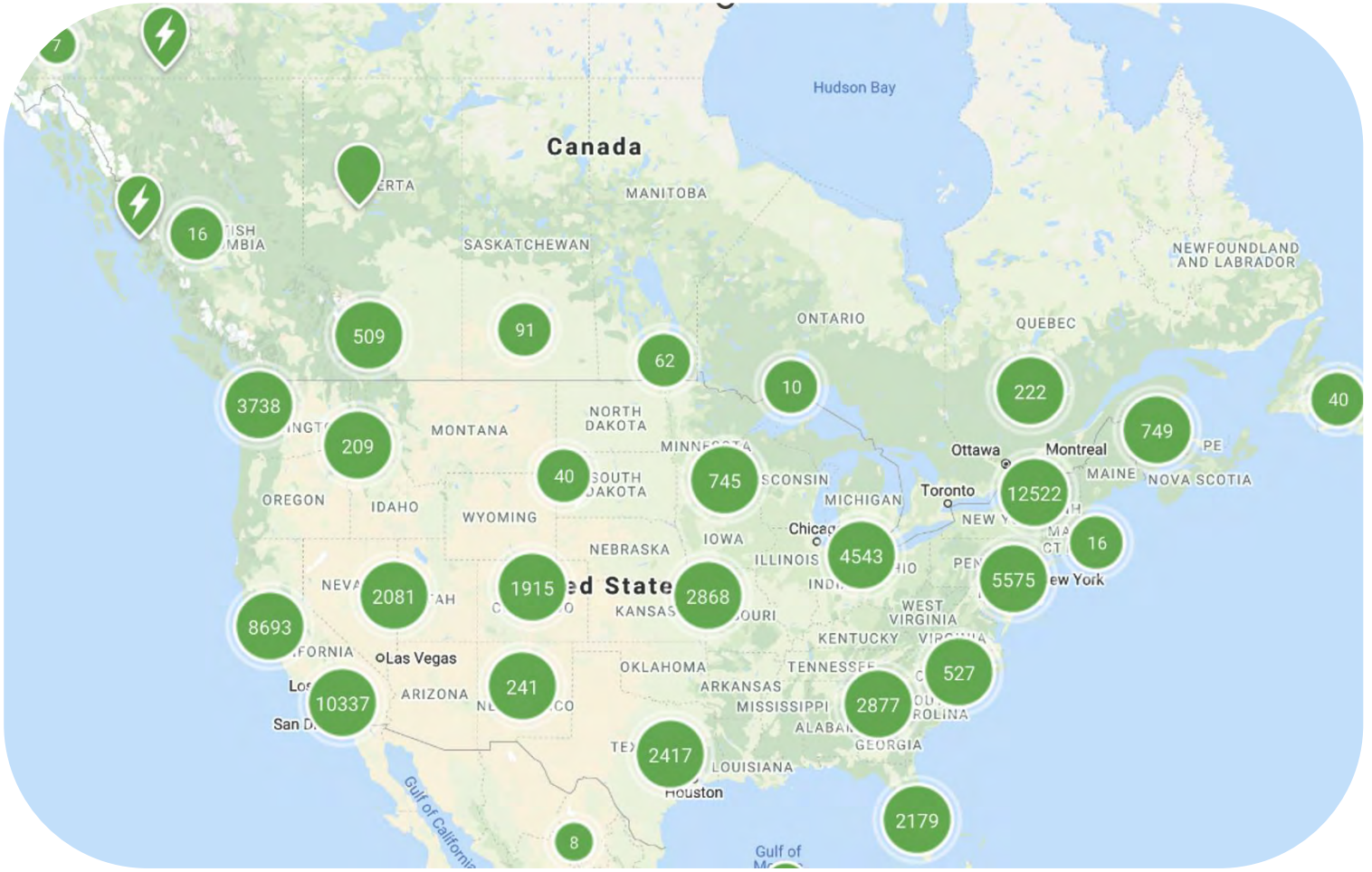
chargepoint

greenlots

Electric Circuit

BC Hydro

enCharge NETWORK



Charging Stations Built for Purpose

Our Customers Include:

- Cities and Municipalities
- Workplace
- Fleet
- Residential
- Automakers
- Utilities
- Apartments
- Retailers

CoRe+ | CoRe+ Max | SmartTWO | SmartTWO-BSR

Smart DC

Level 2 Charging Stations

DCFC

Comprehensive Deployment

From planning to support, we've got you covered

Plan

- Helping clients plan their EV infrastructure
- Engineering team to guide you through the complete process

Deploy

- Tier one installation and commissioning
- Professional network to install, connect and maintain chargers

Operate

- On-going network monitoring
- 24/7 Support
- Preventative and corrective maintenance services

Find, charge, pay

- Find a station, know its status, start + pay for session
- Interoperate with other networks via roaming

Report

- Usage & performance
- Payment & billing
- Energy
- Uptime

Support

- 24/7/365 front-line support
- Remote troubleshooting
- Road assistance

But Don't Take Our Word For It

Residential

Demand Response

BC Hydro Power smart

alectra

GREEN MOUNTAIN POWER

Workplace

AIR CANADA

IBM

Bell

Cascades

BOMBARDIER

Fleets

Société québécoise des infrastructures Québec

BRITISH COLUMBIA

VIDÉOTRON

Ville de Montréal

Public

TORONTO HYDRO Corporation

Ivanhoé Cambridge

ATCO

Cominar

FORTIS BC

CF Cadillac Fairview

GREEN MOUNTAIN POWER

Desjardins

alectra

conEdison, inc.

CANADIAN TIRE

SOUTHERN CALIFORNIA EDISON An EDISON INTERNATIONAL Company

electrada

City Curbside

Ville de Montréal

TORONTO

CITY OF VICTORIA

End-to-end solutions for Utilities

Electric Circuit
POWERED BY HYDRO-QUÉBEC

Énergie NB Power

BC Hydro Power smart

Thank You

Email:

rlenoff@flo.com
cbullis@flo.com

Deloitte.

EV Charger Types and Modeling

Adrian Rouse

Odysseus Bostick

Today's Speakers

Adrian Rouse
Specialist Leader
Enterprise Performance, Government and Public Services

Energy specialist, with 20 years experience in the sector having worked for commercial and government clients, with a focus on grid modernization/digitalization, and transportation electrification.

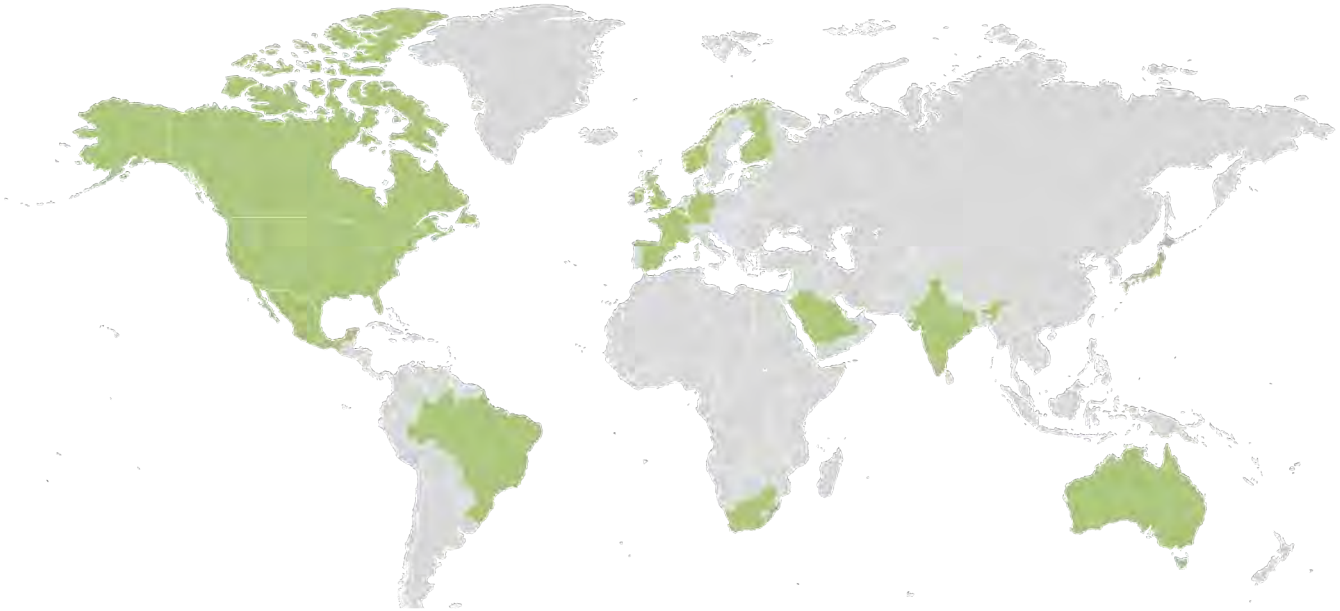
Odysseus Bostick
Senior Consultant
Strategy and Analytics

Data-driven economist focused on technical analysis and strategic thinking with broad-based professional experiences in research, government, politics.

MAKING AN IMPACT THAT MATTERS since 1845

Deloitte helps transportation leaders address their biggest challenges.

Deloitte's advisors and subject matter experts work with our clients to respond to technological disruption and shifting customer preferences. Our multifaceted approach helps agencies quickly evolve and plan for the future of mobility.



56 ***Cities & countries around the world*** where Deloitte serves transportation clients

1,5k+ Experienced ***transportation professionals***

$2B+ ***Annual revenue*** in Global Transportation & Infrastructure practice

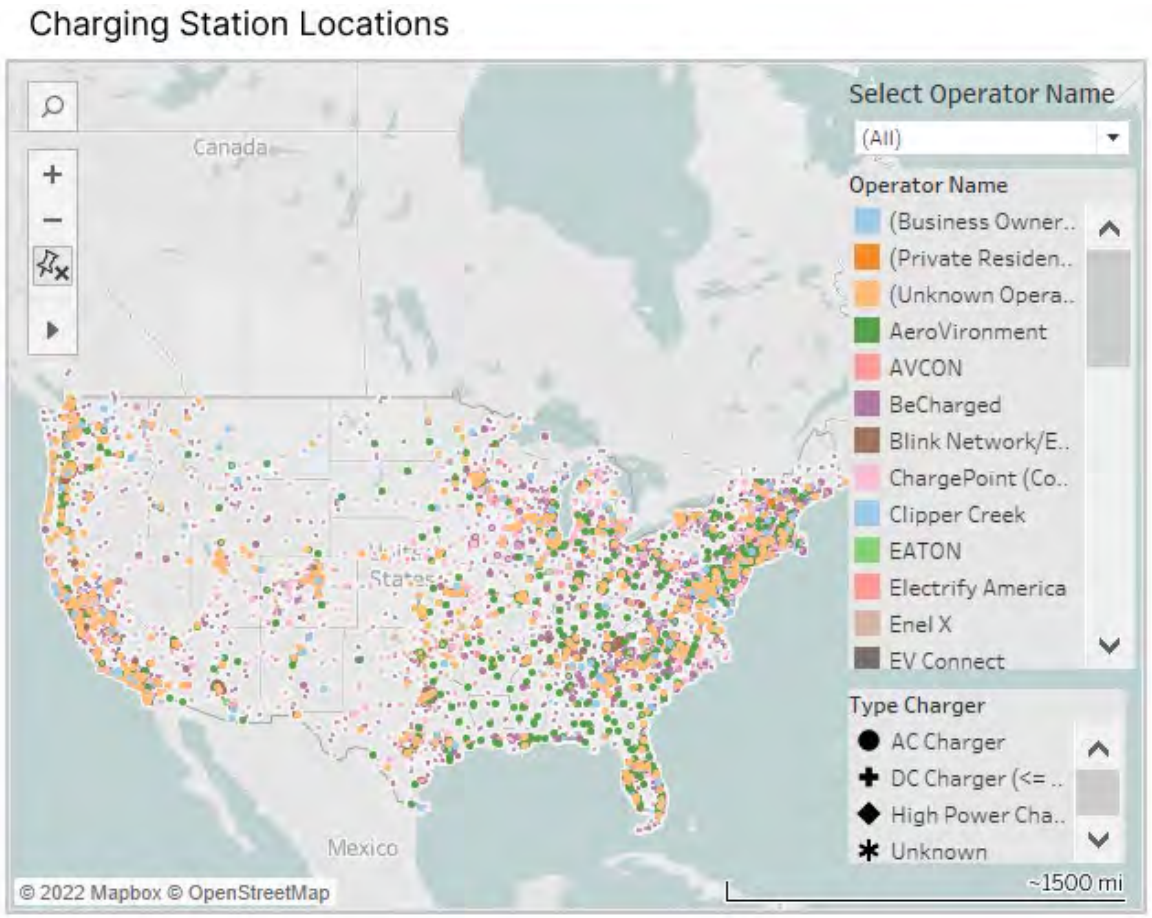
6M ***Daily drivers*** pass through Deloitte-designed tolling and roads systems

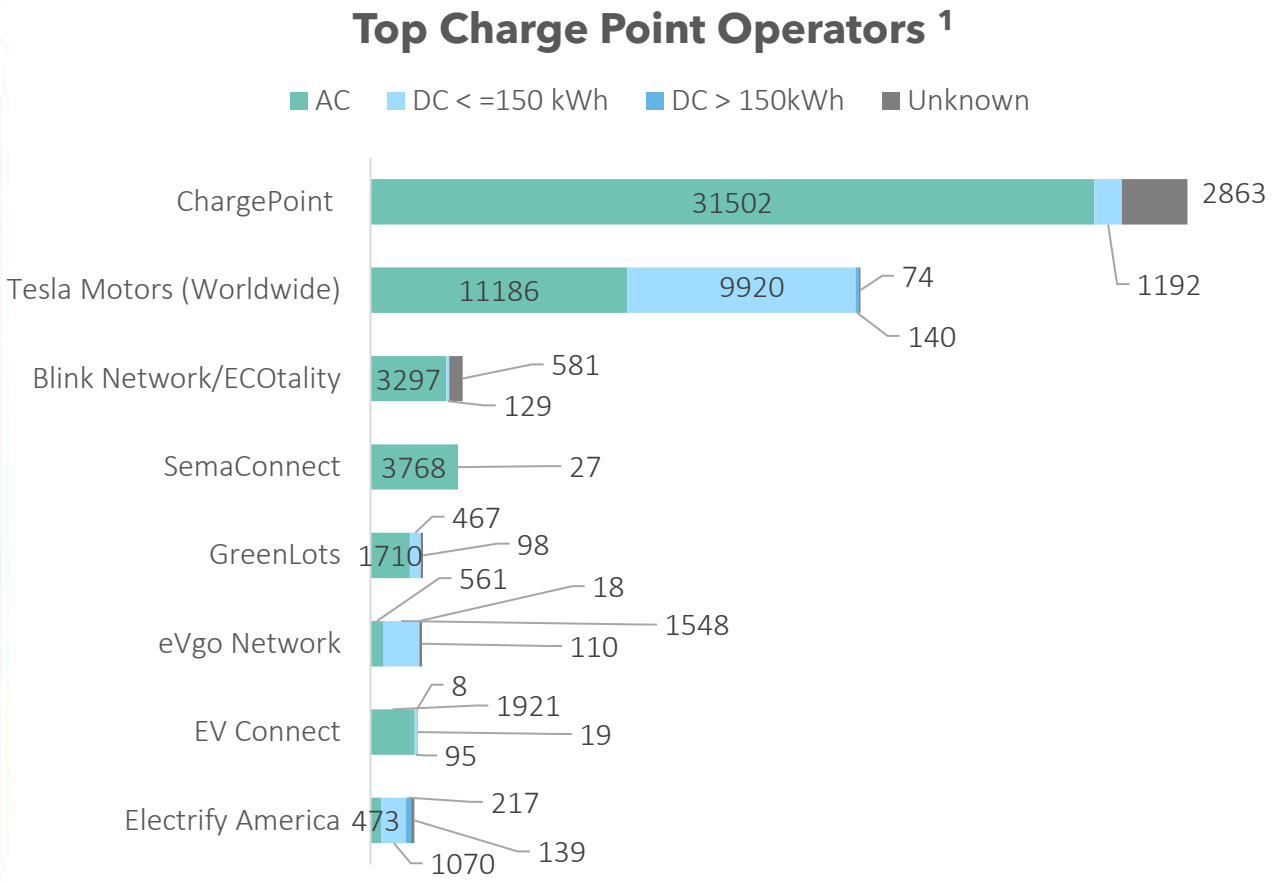
Focus Areas	Mobility Strategy & Analytics	Real-Time Operations	Tolling & RUC	Resilience, Sustainability, & Equity	Digital Transformation & Customer Design

Agenda

United States

Number of Chargers and Network share





EV Charging Types

EV chargers are differentiated across three tiers: Level 1, Level 2, and Level 3 (DCFC). The Level charging varies in voltage, electrical power/ current output, connection type, and hourly charge rate.

Level 1

kW: 1.3 – 2.4
Voltage: 110 or 120 volts
Charging Rate: 2 – 6.5 miles per hour
Cost: No additional cost

Summary: An estimated *40% of EV drivers utilized Level 1 chargers* for at-home charging, as it relies existing infrastructure and standard domestic electrical outlets via a J1772 plug (J-plug).[1] Estimated *87,000* Level 1 chargers were active in 2020.[2]

Level 2

Operate between 208 - 240 volts which can provide approximately 80 miles of range per hour of charging

DCFC

Most powerful and fastest charger, operating at 400 to 900 volts with a range of up to 1,200 miles per hour of charging

EV Charging Types

EV chargers are differentiated across three tiers: Level 1, Level 2, and Level 3 (DCFC). The Level charging varies in voltage, electrical power/ current output, connection type, and hourly charge rate.

Level 1

Chargers carry a voltage of either 110 or 120 volts, and draw electricity from a standard domestic outlets

Level 2

kW: 3 – 19
Voltage: 208 or 240 volts
Charging Rate: 25 – 80 miles per hour
Cost: Capex/Charger is $1,000; $0.2 - $0.25 per kWh

Summary: Level 2 chargers reach *minimum efficiency when stationed with 4-6 charger points*. Level 2 chargers are the *least expensive to build based on a per-KW basis*, but can be expensive to operate. This charger is often utilized around shops, restaurants, and other vendors. An estimated *106,000* Level 2 chargers were active in 2020, with a 24% annual increase.[1]

DCFC

Most powerful and fastest charger, operating at 400 to 900 volts with a range of up to 1,200 miles per hour of charging

EV Charging Types

EV chargers are differentiated across three tiers: Level 1, Level 2, and Level 3 (DCFC). The Level charging varies in voltage, electrical power/ current output, connection type, and hourly charge rate.

Level 1

Chargers carry a voltage of either 110 or 120 volts, and draw electricity from a standard domestic outlets

Level 2

Operate between 208 - 240 volts which can provide approximately 80 miles of range per hour of charging

DC Fast Charging

kW: 50 – 350+
Voltage: 400 – 900 volts
Charging Rate: 150 miles per hour

Cost: Capex/Charger is $81,600; $0.20 - $0.25 per kWh

Summary: DCFC reach *minimum efficiency when stationed with 4-6 charger points*. DCFC plug types vary and support three different levels of kW power (50, 150, and 350). DCFC most often accommodate the "out-of-town" long distance traveler. As of 2020, there were 177,000 DC fast chargers, demonstrating a 22% annual increase.[1]

EV Challenges

Various challenges inhibit the efficient deployment of EV charging stations.

Utilization and O&M

- EV charger utilization remains well below break even (b/e is est. ~30%); public network of DC fast chargers in CA, for example, 1-5% utilization
- Unclear division of operating and maintenance responsibilities result in charger downtime

Collaboration and Coordination

- Commercial / non-strategic interest in DC fast charger investment is limited, despite subsidies
- There are numerous EV programs in place, coordination among them is partial at best

Usage Data and Timeframes

- Site usage data is valuable for planning purposes, including need for ongoing subsidies, but station owners don't want to share
- Soft costs, permitting and utility interconnection timeframes remain barriers to charging station deployment

State Experience

- EV advanced states, CA and NY, are both making significant legislative changes to promote EV growth, focusing on lowering cost of EV ownership, e.g. removing demand charge
- CA is deploying Level 2 solar powered chargers in rural locations

Deloitte.

Electric Vehicles
Center of Excellence

Electric Vehicle
"Equity Driven Electrification"

Deloitte's Approach to Electric Vehicle Adoption Trends

May 2022

Bottom-Up Gravity Model

Building zip code data into county-level profiles of EV adoption trends to inform regional forecasts of EV consumer preference.

Community Profiles 1

Beginning at the community-level, we build county profiles of existing public and private EV charging infrastructure and service demand to establish a baseline of local EV penetration and community interest. Overlaying those profiles with economic and demographic data at the zip code/city/county levels, we build out community characteristics underpinning the potential distribution of EV demand within counties.

EV Demand Forecasting 2

Hybrid modeling approach that merges results from a suite of models such as Multivariate Least Squares (MLS), the Autor-Regressive Integrated Moving Average (ARIMA) family, and Vector Autoregression (VAR), we take our geographic profiles as inputs to support time series data on Georgia's historical EV sales rate relative to overall vehicle registrations and state subsidies to forecast future adoption estimates at the local-level. This produces a county-level scoring mechanism for infrastructure prioritization.

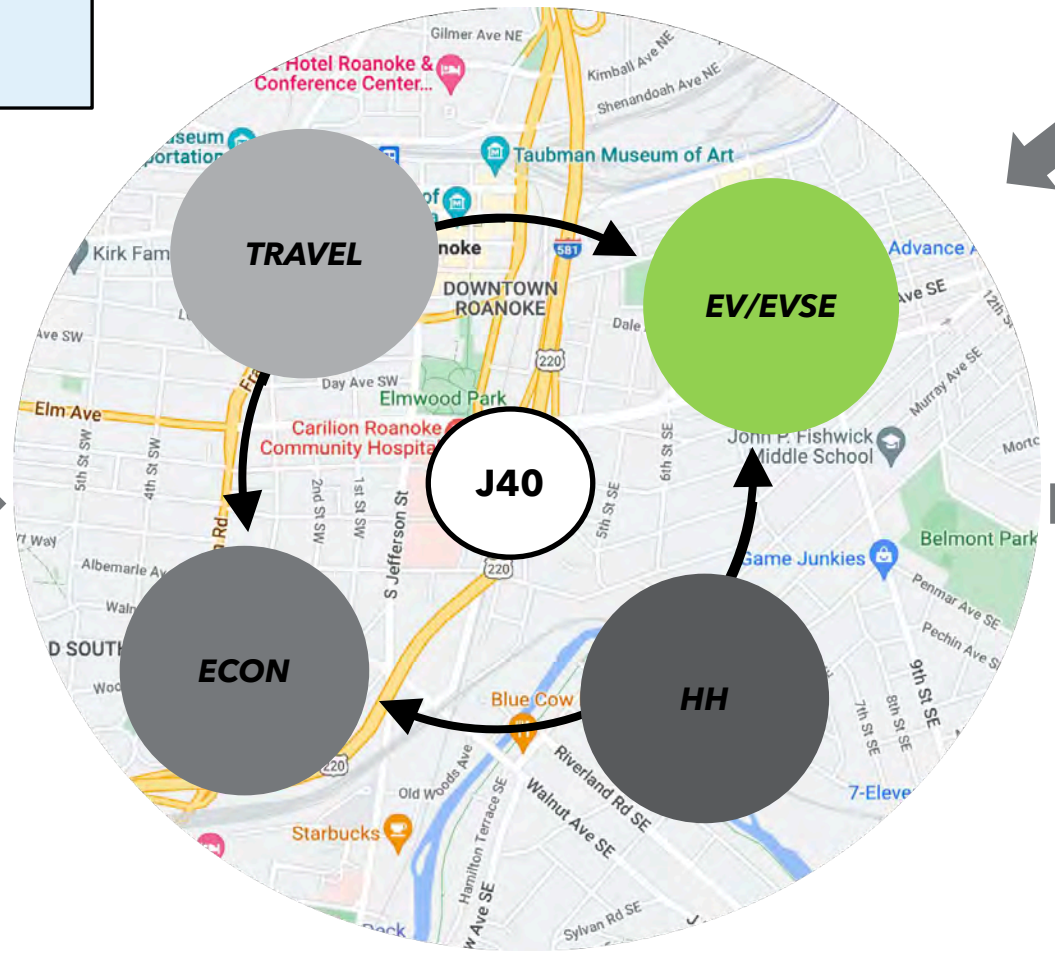
Gravity Modelling to Identify Web Spread 3

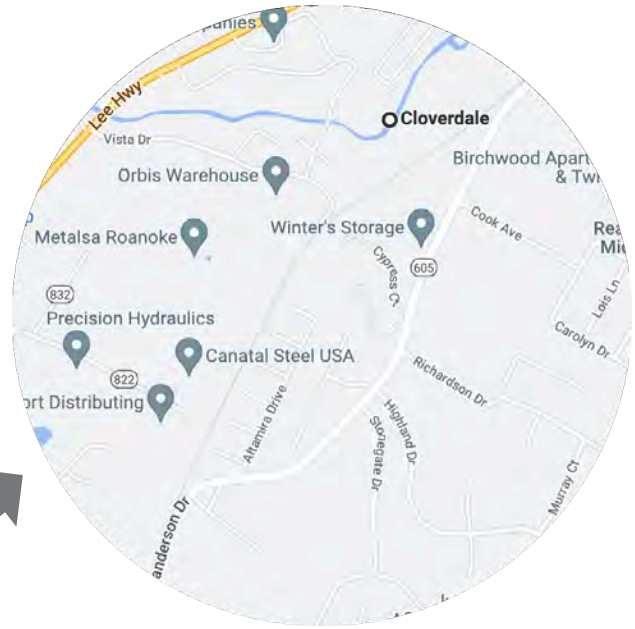
Applying the gravity model approach to identify networks of regional connectivity demand, we produce a connectivity score for cities within prioritized counties based on travel pattern data to identify the depth and distribution of EV infrastructures demand within counties and a separate score for demand across counties to identify regional network needs. Finally, within state seasonal travel data is used to extend the web of demand across the state.

Bottom-Up Gravity Model

JUSTICE 40 (J40) METRICS FRAME RELATIONSHIPS BETWEEN DATA AND CITIES

Data Types
Travel patterns and vehicle modes
Economic indicators (ECON)
Household and demographic (HH)
Electric Vehicle (EV/EVSE)





Outputs	
10-Year EV and EVSE Adoption Schedule by Region	✓
J40 Distribution Score	✓
Regional Connectivity Score	✓

J40 Methodology for Estimating Disadvantage

Estimate community wide disadvantage relative to Economic, Social, and Mobility measures of disadvantage.

Develop data layers to describe community disadvantage across three broad themes (Economic, Social, and Environmental)

Each of the disadvantage theme layers are assembled at the County (or zip code when available) using data from the US Census American Community Survey (ACS).

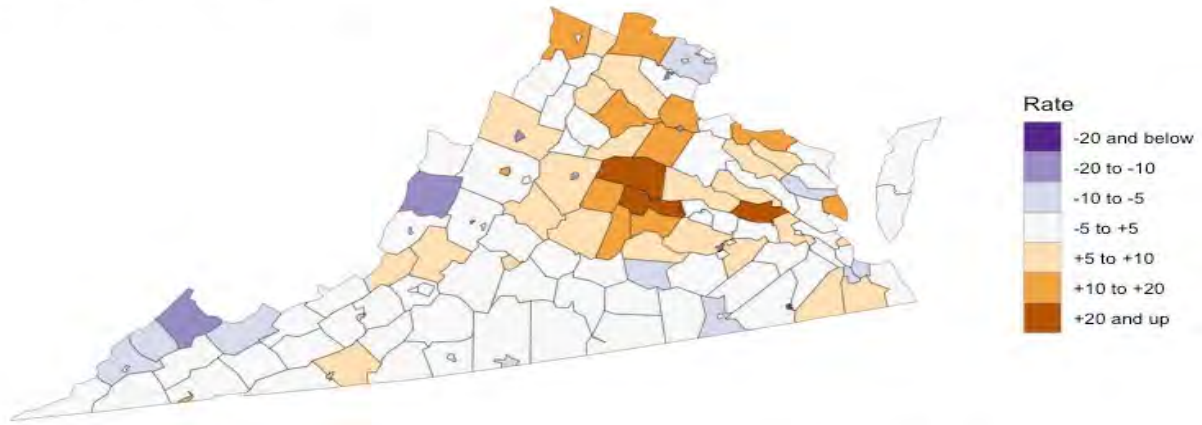
Each County/Zip Code is given a percentile ranking where 100 is highly disadvantaged and 0 is not disadvantaged.

Disadvantage Indicators
- Economic
- Social
- Environment

Economic	Social	Environmental
Personal Use Vehicle Access	Housing Occupant Density & Estimated Youth Labor Supply	SSA Disability Uptake
Community Housing Values & Mortgage Data	Crime & Premature Deaths	Home Amenity Access (Kitchens,' etc…)
Educational Attainment, Income Inequality, Median Earnings, SNAP uptake, Subprime Credit Population, & Poverty Rates	Disconnected Youth & Single Parent Households	Food Environmental Atlas (USDA)
Monthly Home-Owner/Renter Costs & Burdened Households Rates	Community Demographics & Housing Stability	CDC Health Indicators, SAHIE Insurance Coverage, & Criteria Emissions

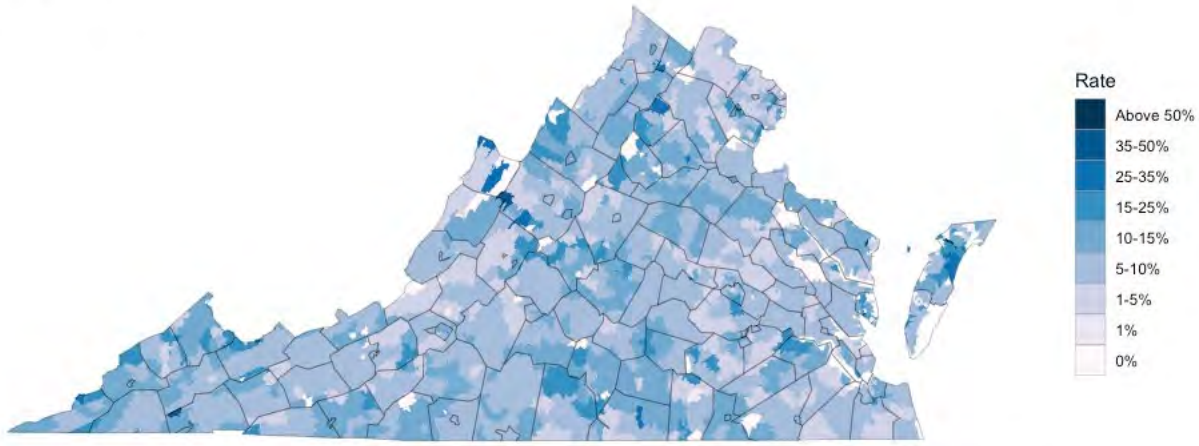
Layers of Data

Net Migration
by County
(per 1000 residents)



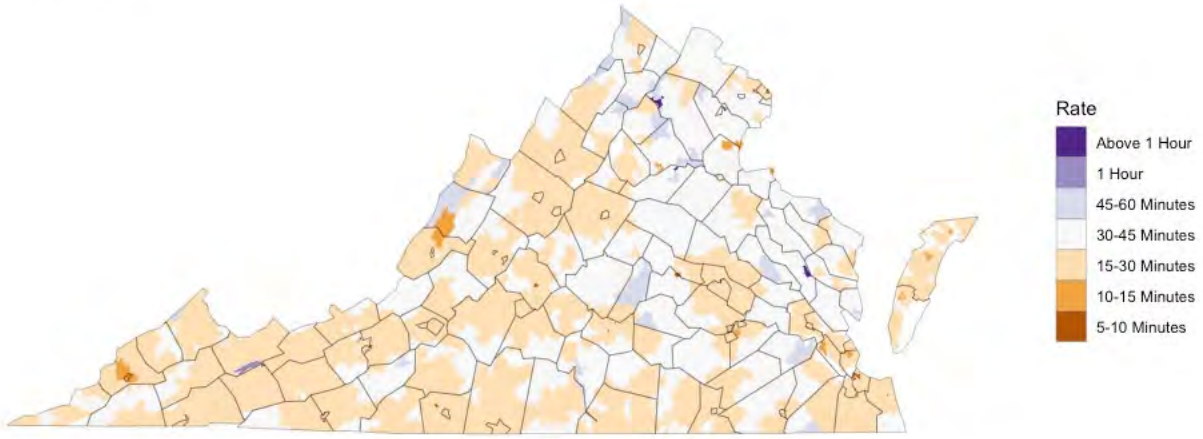
(US Census Bureau 2019)

Uninsured
Population (%)
by ZCTA



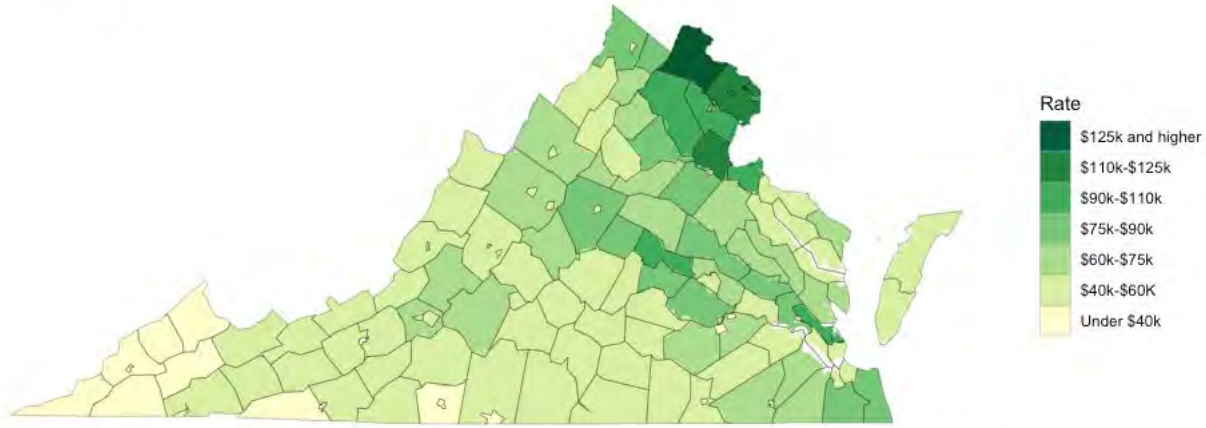
US Census Bureau 2019 Population Estimates

Commute
Time
by ZCTA



US Census Bureau 2019 Population Estimates

Median
Household
Income
by County



(US Census Bureau 2019)

Implications and Opportunities

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Contact

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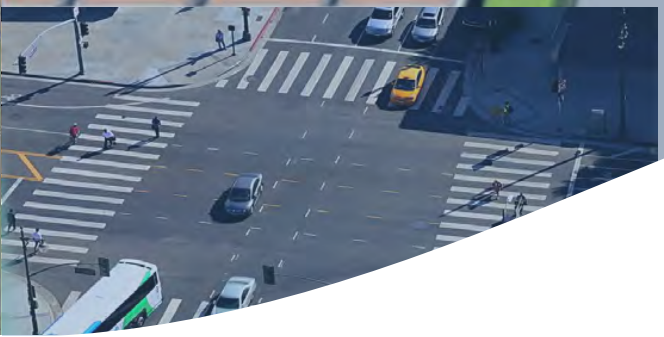
obostick@deloitte.com

Digital Simulation Solutions



DATA DRIVEN SOLUTIONS

Production Modeling Corporation

www.pmcorp.com | David Stone | Director of Simulation| dstone@pmcorp.com

About PMC

- Operations Improvement & Consulting
- PMC since1979 in USA
- 7000 + projects completed
- 150 + diverse employees
- Siemens Solution Partner
- Autodesk Solutions Partner
- Global company

We Provide:

Solution Partner

PLM

SIEMENS

Clients

7000+ Projects Completed
600+ Clients Served
across many industry verticals

Mercedes-Benz

PMC's Expertise

Industrial Engineering

- Ergonomic Improvements
- Material Handling & Material Flow Analysis
- Time Studies
- Work Sampling
- 5S Implementation
- Layout Planning
- Line Balancing
- Workstation Design
- Value Stream Mapping

Laser Scanning & CAD

- Terrestrial Laser Scanning
- Facility Laser Scanning
- Drone Scanning
- Part Scanning
- As-Built Modeling
- Facility Layout Design
- 2D/3D Modeling
- Autodesk Training

Dynamic and Static Simulation

- Ergonomic Simulation
- Static and Dynamic Simulation Modeling
- Throughput Analysis
- Scheduling
- Resource Optimization
- Material Scheduling
- Material Storage
- Bottleneck Analysis
- Process Simulate

Quality & Operational Excellence Services

- Quality Services & Training
- International Standards
- Automotive Quality Core Tools
- 2nd Party Auditing
- Six Sigma
- Lean Manufacturing
- Environmental Management
- Occupational, Health, and Safety Management

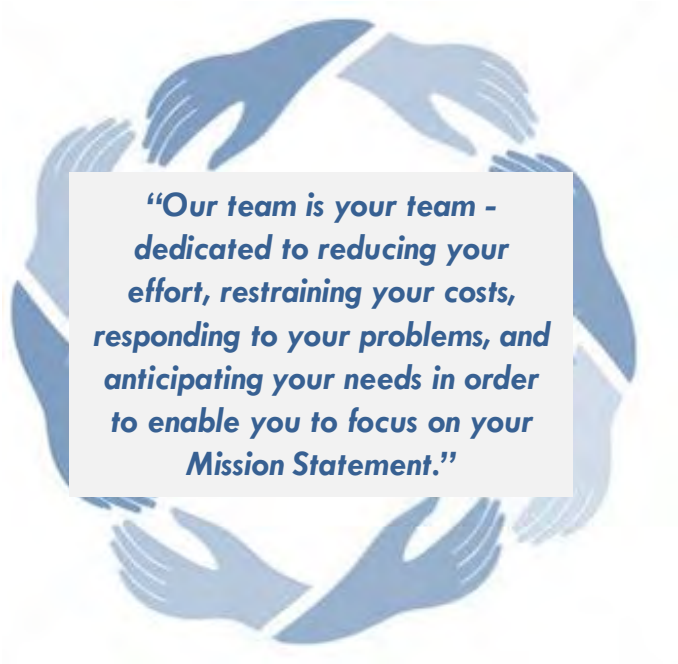
Presenter

David Stone
Director of Simulation

Production Modeling Corporation

Master Degree in Operations Management from Kettering University. I have over thirty years' experience in manufacturing. More than 10 years' experience leading simulation engineers in the development of digital solutions.

What makes PMC Different?

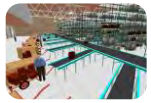


"Our team is your team - dedicated to reducing your effort, restraining your costs, responding to your problems, and anticipating your needs in order to enable you to focus on your Mission Statement."

Why PMC for Simulation Services?

PMC is the one of the largest independently owned discrete-event simulation software consulting firm in North America and can provide the following services for all the leading discrete-event simulation products to include: Siemens Plant Simulation, Simul8, AnyLogic, Pedestrian Dynamics, AutoMod, ProModel, Arena, Enterprise Dynamics, ExtendSIM, SIMIO, Witness, and others.

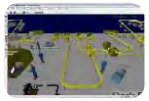

WITNESS


Enterprise Dynamics (ED)


Simul8


Siemens Plant Simulation

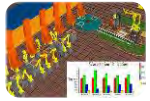

AutoMod


ProModel


Arena


ExtendSim


3DCreate


QUEST


Simio


AnyLogic

Strategic and Tactical Enterprise Consulting Services

Modeling Services:
Full Model Building: Short- and Long-Term
Initial Project Model Building
Sub-Set Project Model Building

Building Custom Object Libraries

Simulation Methodology Training

Software Sales & Custom Software Training

Mentoring/Support

For more information, please visit our website at: PMC's Simulation Services

PMC: Simulation Expertise

The top five differentiators that set us apart from our competition include:

1. Over 35 years of experience in dynamic and static simulation. Deep knowledge and skills of many different software products - Siemens Plant Simulation, AnyLogic, AutoMod, Witness, Simul8, Enterprise Dynamics, Simio, etc.
2. Quick turn around and high-quality control standards
3. World renown, global staff with a combined experience of over 150 years
4. More than 7000 projects of experience in many business verticals enables us to bring unique productivity improvement ideas across business verticals
5. In addition to simulation, PMC provides services in Lean systems implementation, material handling engineering, time study, scheduling optimization, ergonomic simulation, laser scanning/CAD modeling, and other industrial engineering methods which supports our simulation services and enables us to solve problems in an integrated fashion

Discrete-Event Simulation

"Simulation is the process of building a model of a real system and conducting experiments with this model for the purpose of understanding the behavior of the system and/ or evaluating various strategies for the operation of the system."

Reduces Cost

Increase Accuracy

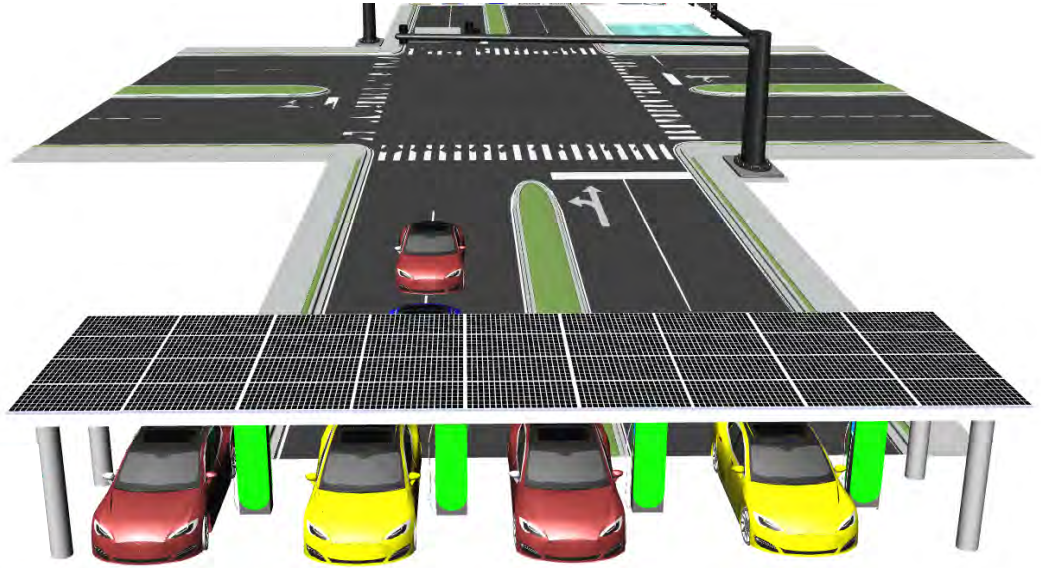
Reduces Time

Insights into Dynamics

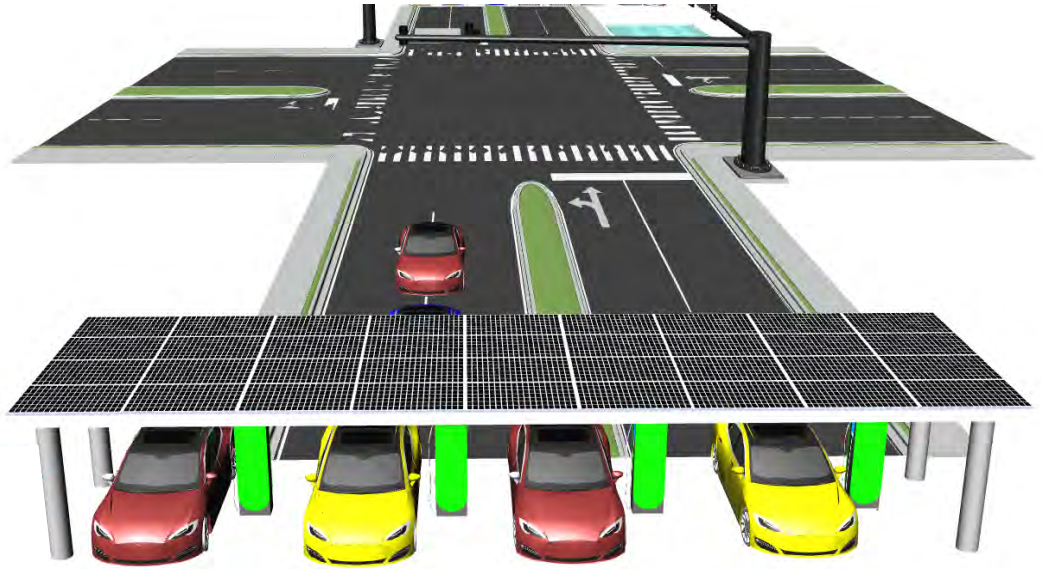
Reduces Uncertainty

Risk-Free Environment

EV charging solution choosing the right location

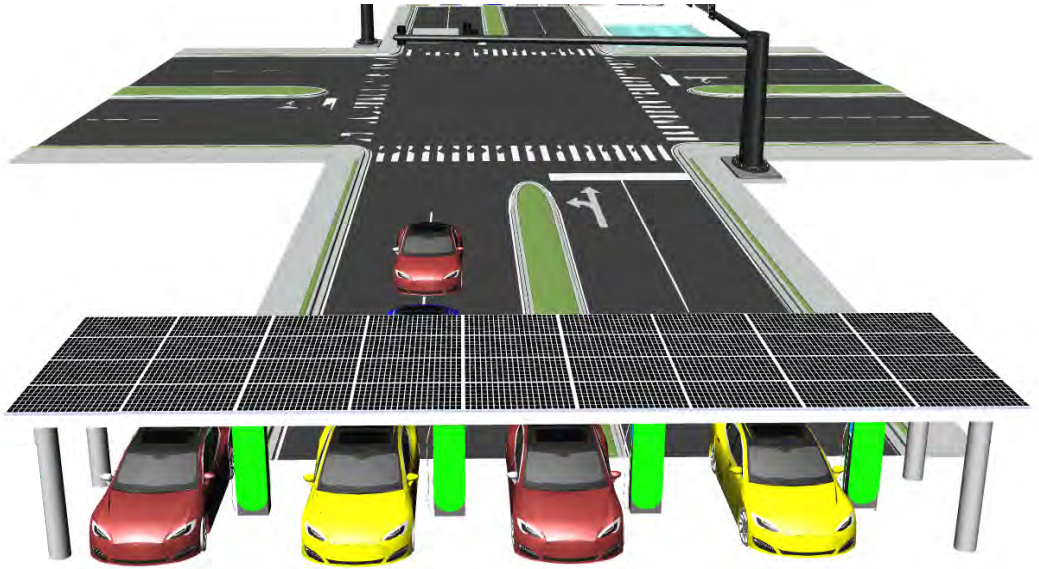


EV charging what is the right location?



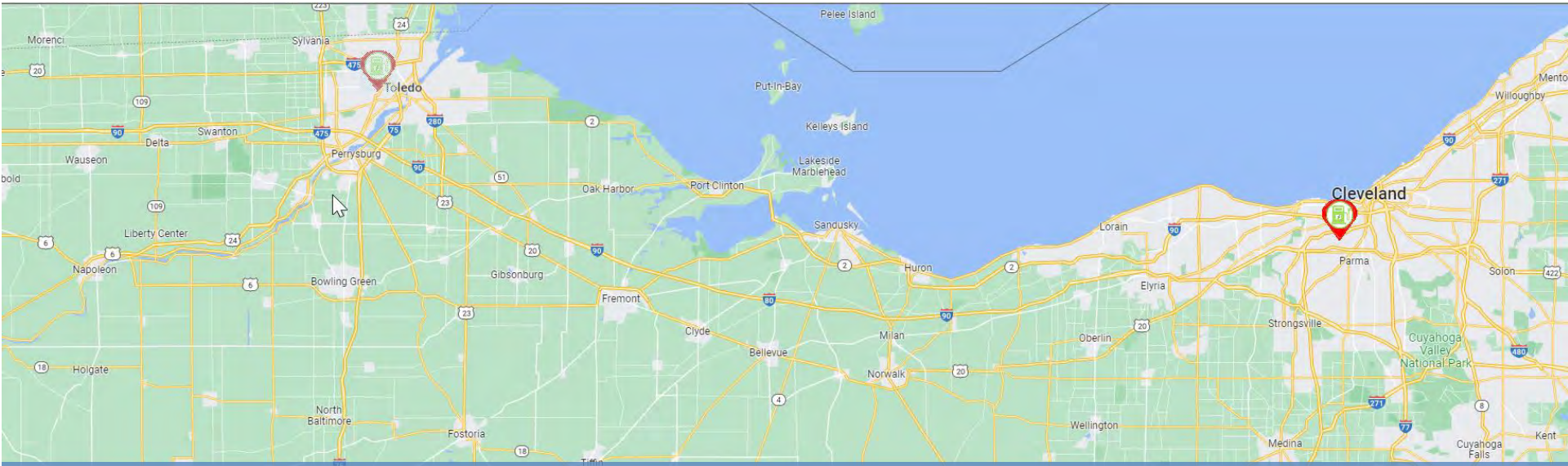
Dynamic Simulation

- Creates dynamic view of Vehicle flow
- Uses distance, cost and time with variation to develop optimal condition
- Includes dynamic interactions which leads to optimum (lower) safety factors
- Optimizes line side inventory levels based on actual dynamic of the operation



EV Charging Stations Simulation

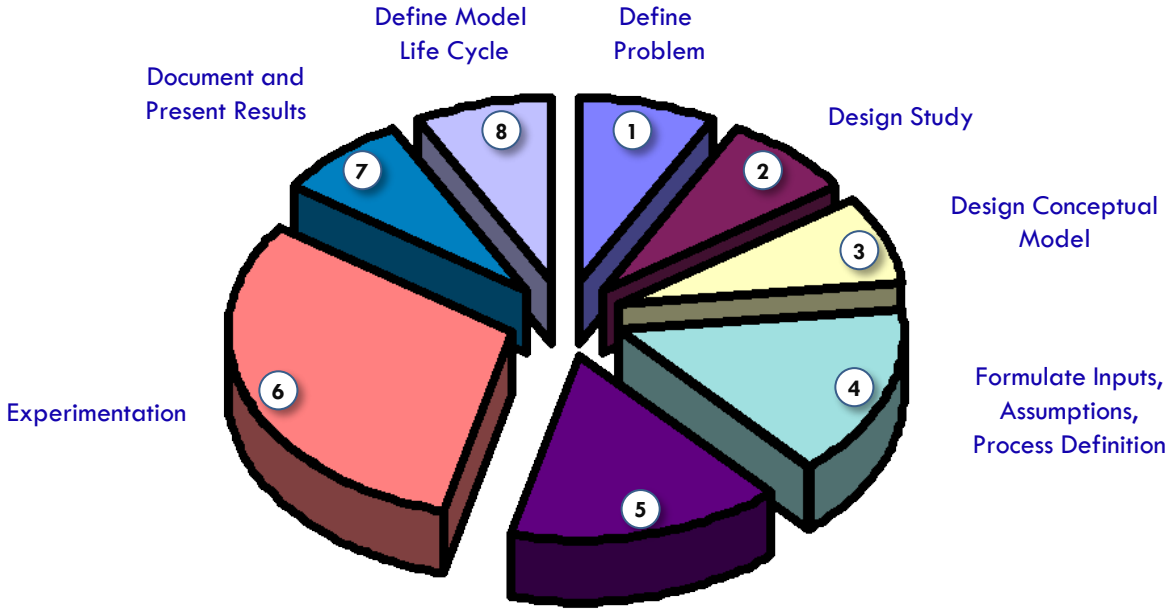
Version 1.0



Electric Vehicle charging points

PMC: TECHNOLOGY Simulation Methodology*

Eight (8) Major Phases for Proper Application of Simulation



* *Based on the white paper "SIMULATION METHODOLOGY - A PRACTITIONER'S PERSPECTIVE." Onur M. Ulgen, John J. Black, Betty Johnsonbaugh, & Roger Klungle*

PMC Simulation Methodology

- **Establish Objectives, Scope, & Deliverables**
- Identify key stakeholders, team, roles and **designate SPOC from the client & PMC**
- Establish logistics of team communication
- Review & agree work plan
- Identify the outputs required from the study

- Understand the study area and scope of work
- Based on the process flow identify key data requirements
- Make assumptions where necessary
- Design the study

- Obtain data from client for the model – cycle time, MTBF/MTTR, setup time, etc.
- If required, conduct observational studies
- Analysis of the input data

- Build the model to replicate the system with required outputs from the model
- Verify & validate the model
- Analyze the results and identify cause & effect relations among input and output variables

- Document & present the results to all the stakeholders
- Identify areas for improvement
- If required, recommend further areas of study

PMC's Guiding Principles

We, at PMC,

Keep In Touch With Us

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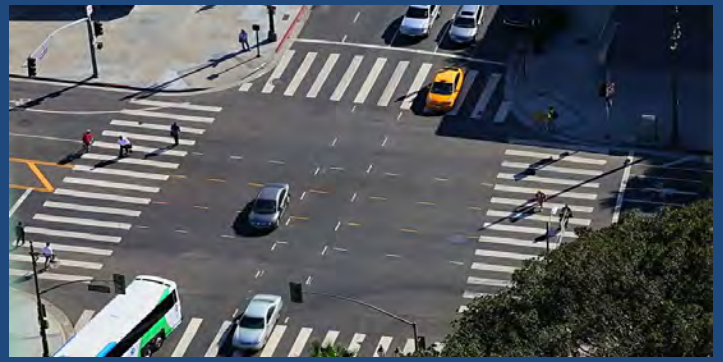
Dearborn, MI 48126
+1-313-441-4460



Wherever PMC Goes, Productivity Happens.

Digital Simulation Solutions

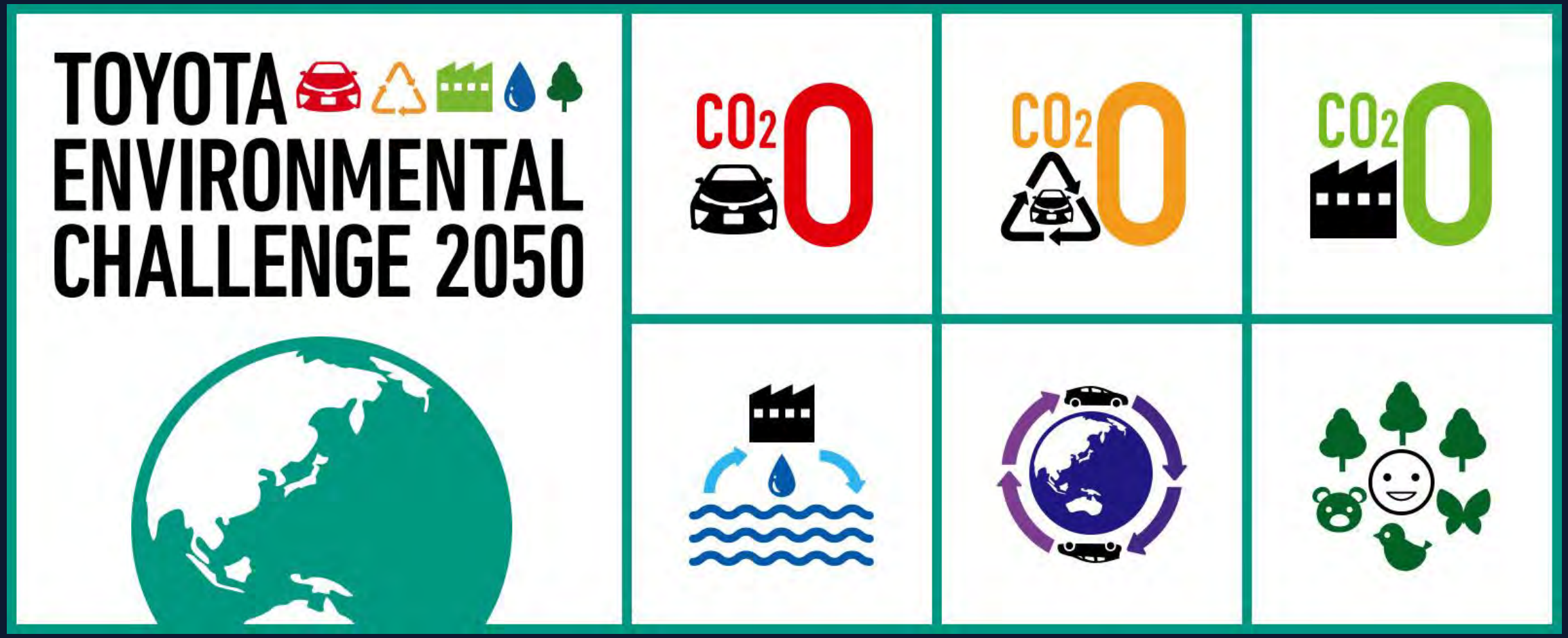
Dave Stone

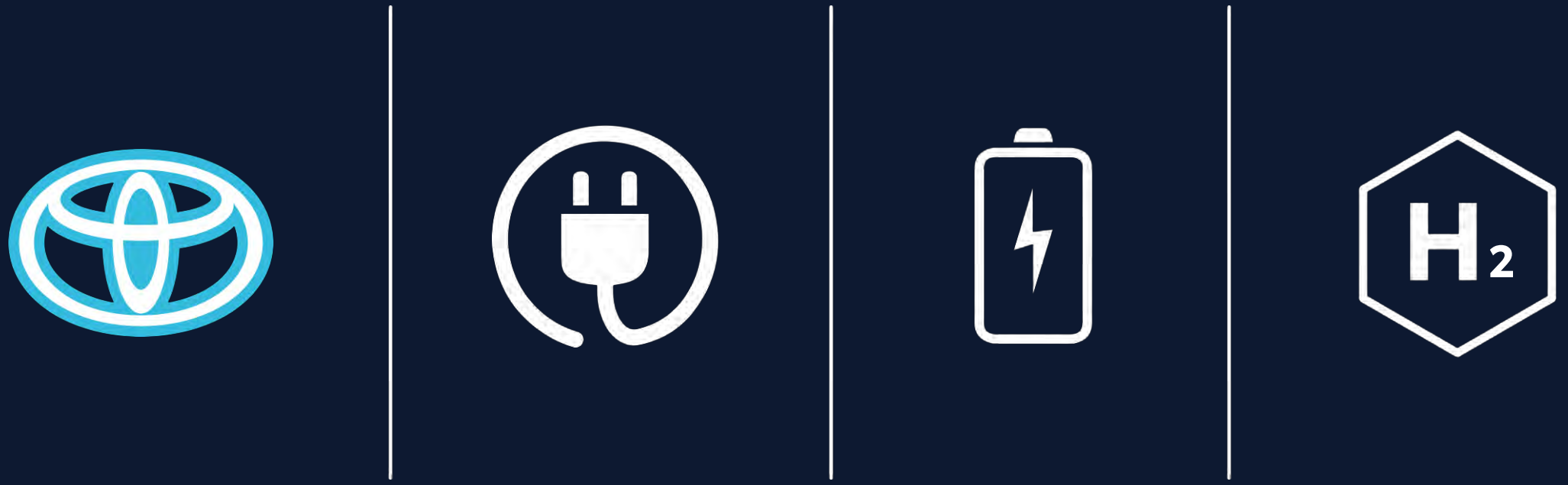
Director of Simulation

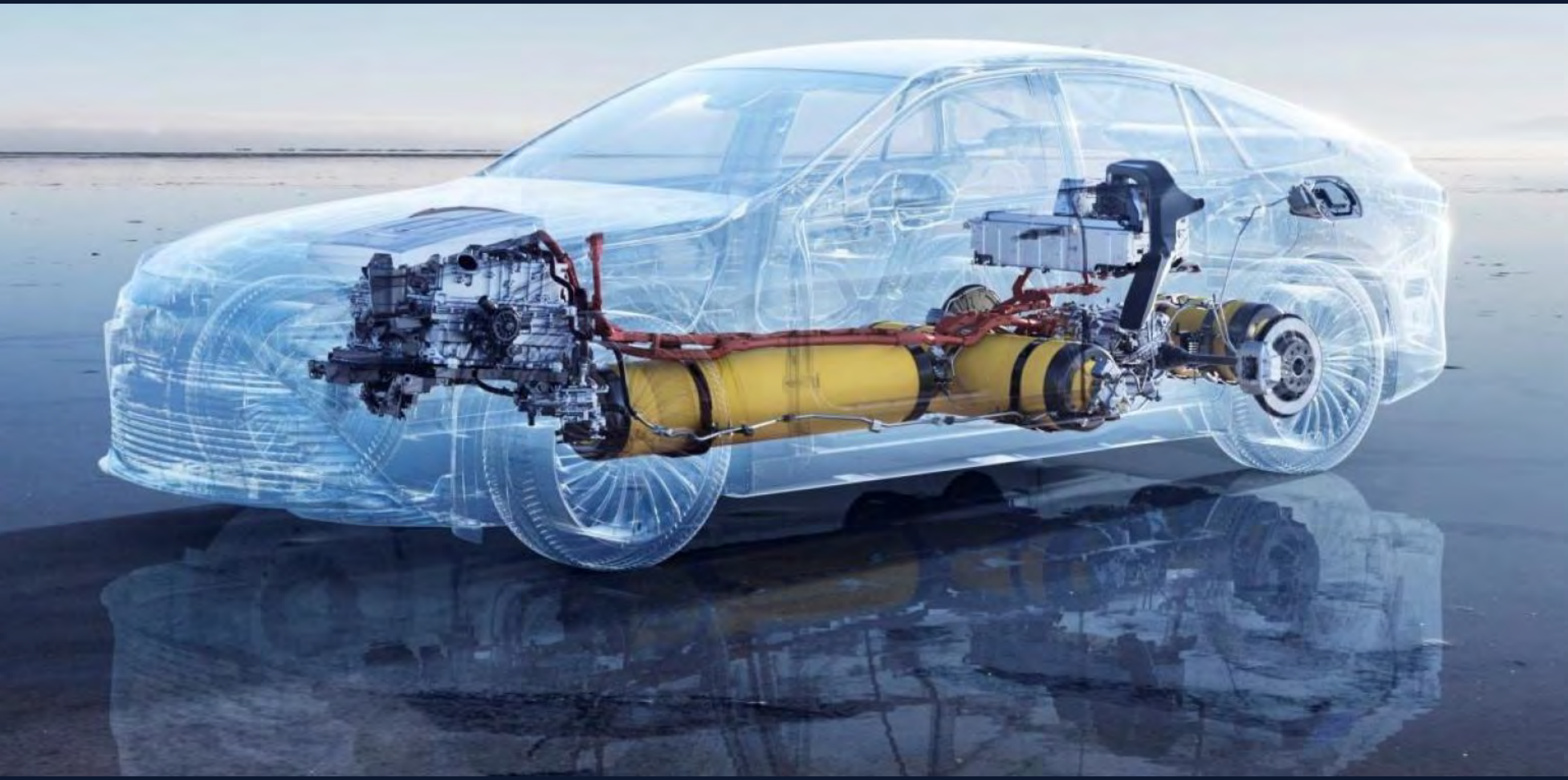
dstone@pmcorp.com

Toyota Fuel Cell Overview

IBTTA
SEPTEMBER 15, 2022




H2



Annual Production Capacity


H2
H2


Hydrogen
Hydrogen


Iwatani
Hydrogen Station
Iwatani


Hydrogen


ITM POWER
Energy Storage | Clean Fuel
HYDROGEN PRODUCED
ON-SITE
ITM POWER
Energy Storage | Clean Fuel

Initial Prototypes

10 Truck Pilot

Production Intent
2023 TMMK


Zero Emissions Kenworth T680 FCEV on the Climb to 14,115-Foot Pikes Peak Summit
Watch later
Share
DRIVING TO
ZERO
EMISSIONS
KENWORTH T680
FUEL CELL EV
470HP | 350 MI RANGE | 15 MIN REFILL
2:21 / 2:31
YouTube

2

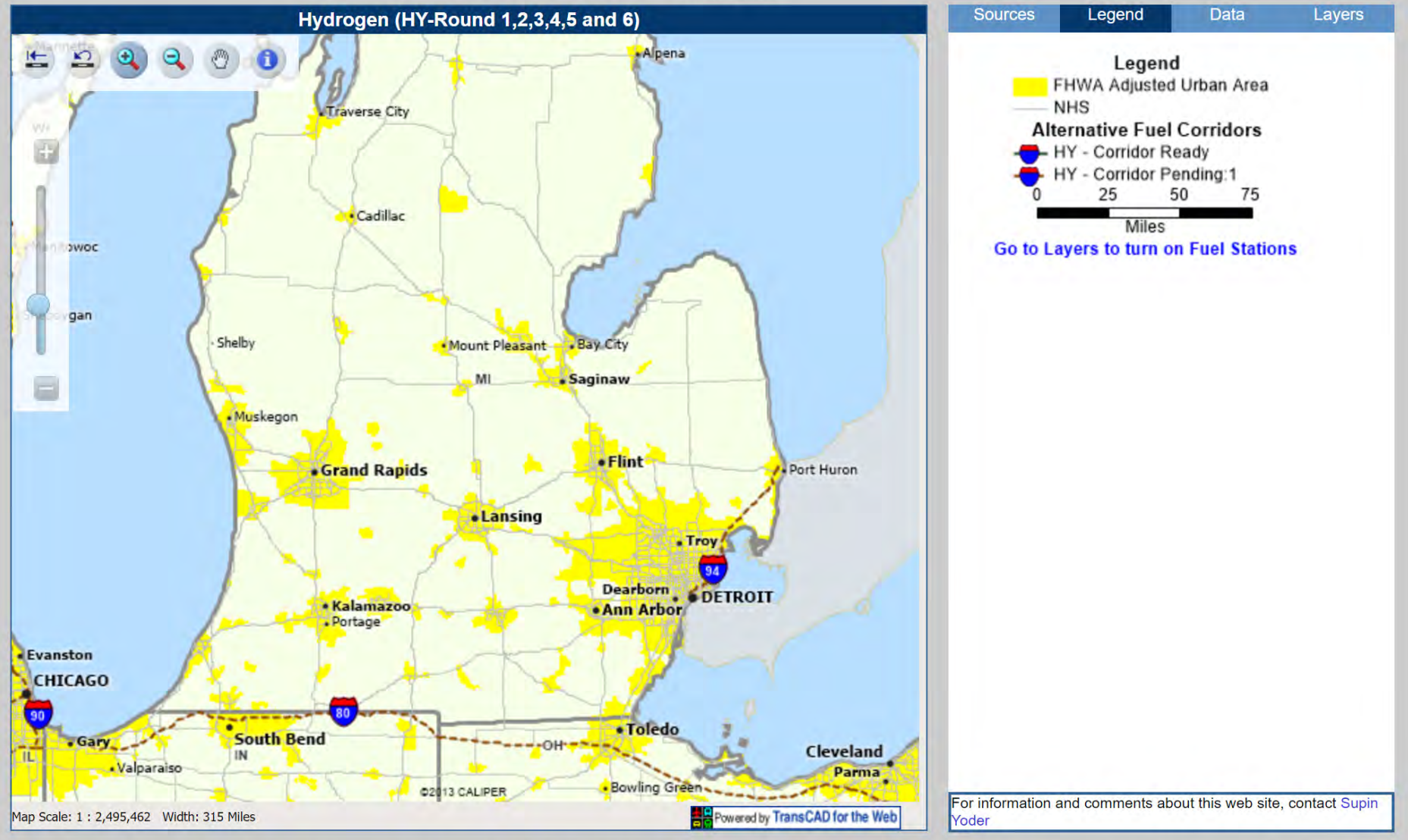
INITIAL HEAVY-DUTY STATIONS

3

NEW HEAVY-DUTY STATIONS

IIJA §11401
$2.5B for
EV charging,
Hydrogen refueling,
propane and natural gas infra grants for FY22 – FY26

- Discretionary grant program
- $15 million / 80% of project costs
- Hydrogen Alt Fuel Corridor designation critical
- Only state, municipal, regional governments can apply



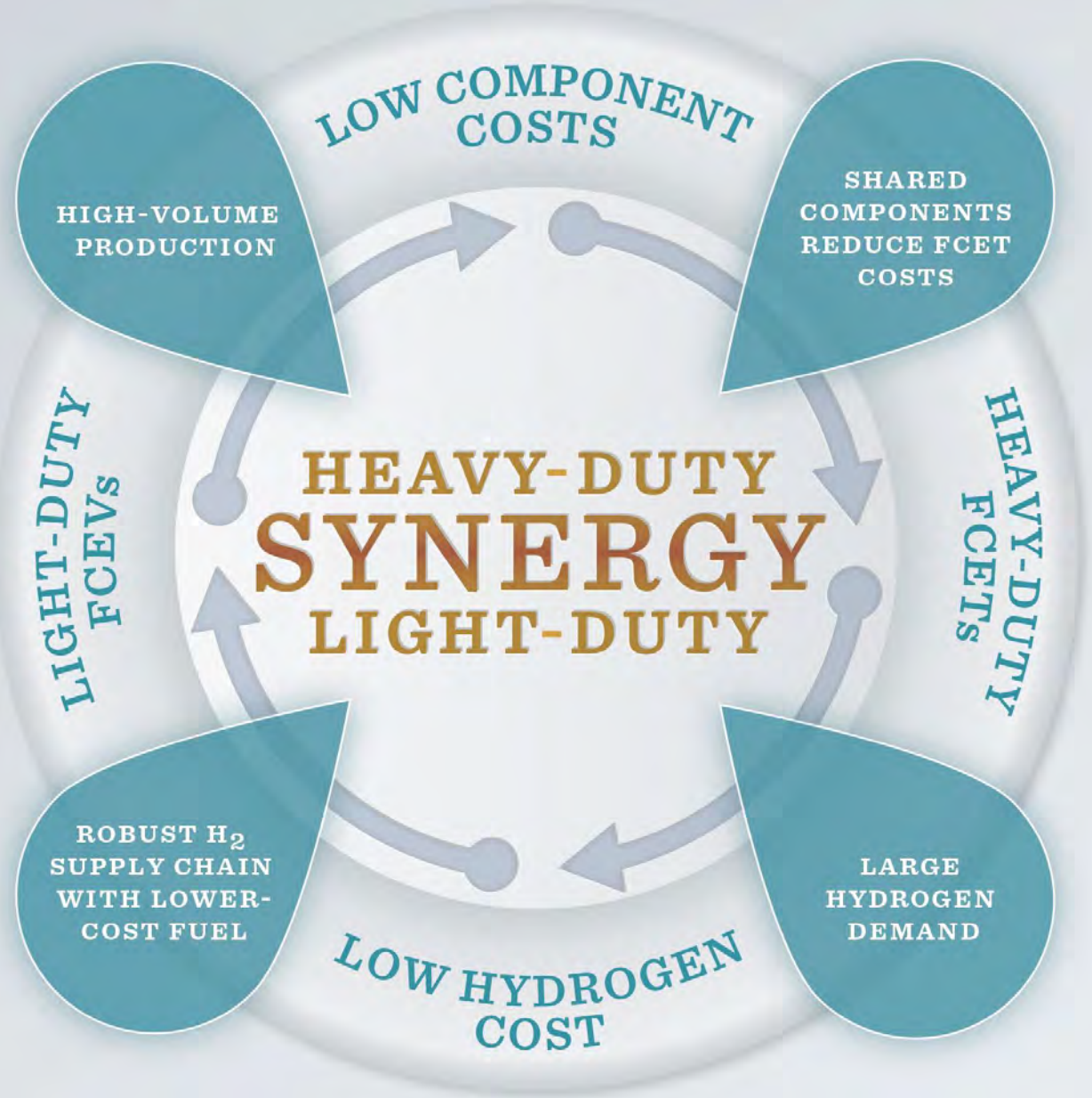
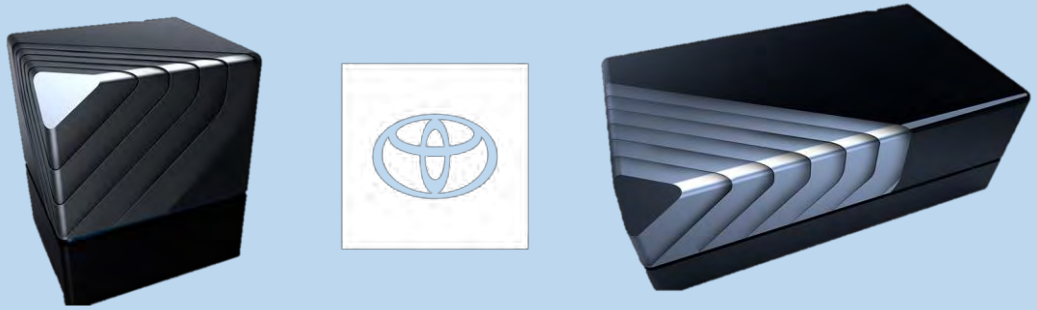


FIGURE 9 | *Economies of scale reduce cost*


FCV
ZERO EMISSION
TOYOTA

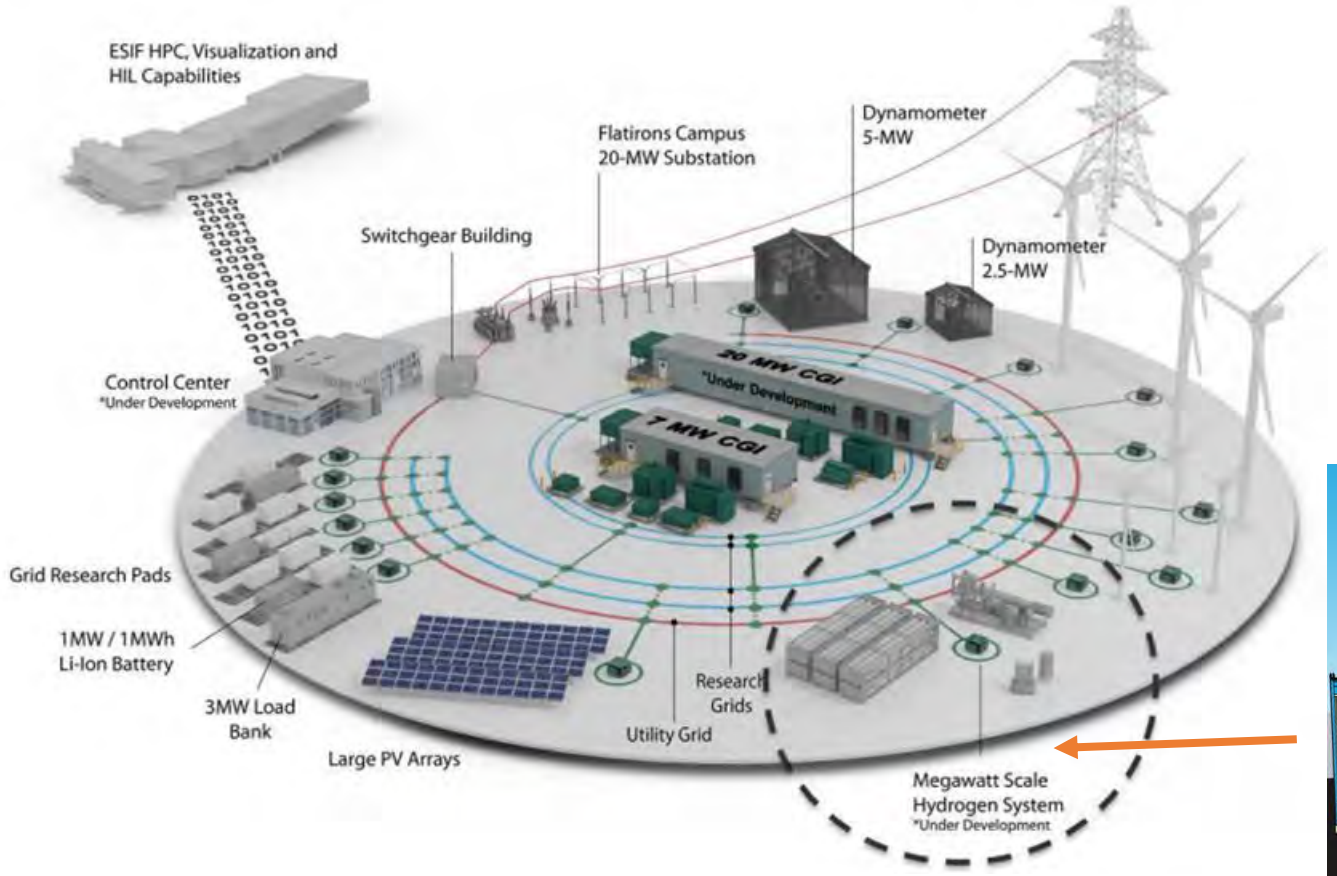

TOYOTA

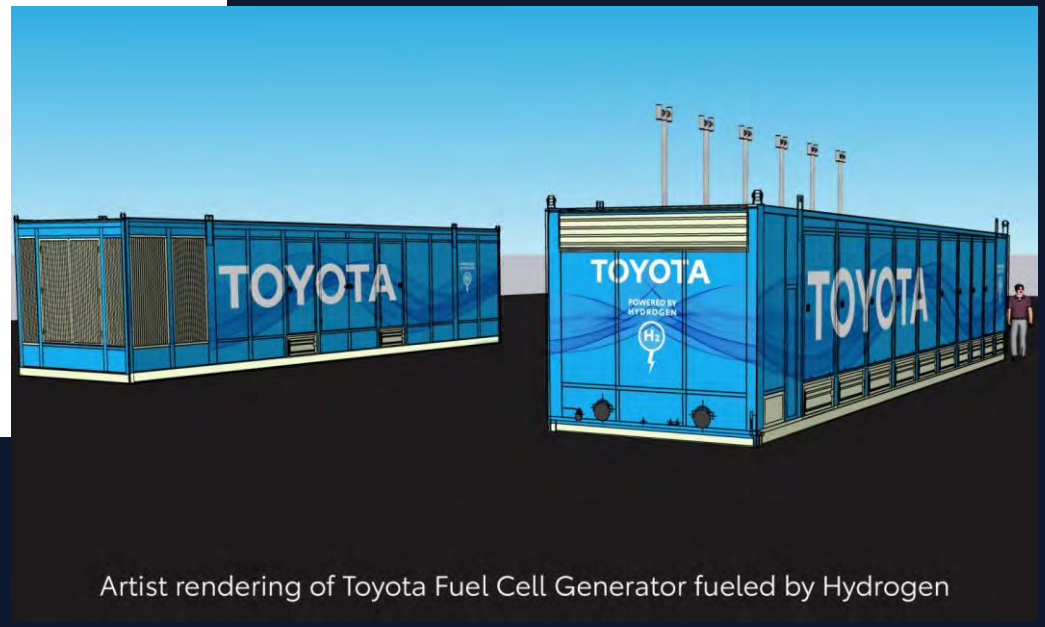

Iwatami
FUEL CELL BUS
TOYOTA




MOTOMACHI
TOYOTA
FUEL CELL

Toyota, NREL Collaborate to Advance Megawatt-Scale Fuel Cell Systems





Artist rendering of Toyota Fuel Cell Generator fueled by Hydrogen

https://pressroom.toyota.com/toyota-nrel-collaborate-to-advance-megawatt-scale-fuel-cell-systems/


Zero Emissions Kenworth T680 FCEV on the Climb to 14,115-Foot Pikes Peak Summit
14,115 ft SUMMIT
14,115
14,000
6°
2:13 / 2:30