

STARTING AT 2:10PM:

SESSION 4

**CHARGING INFRASTRUCTURE NEEDED FOR
SUCCESSFUL DEPLOYMENT**



SESSION 4: CHARGING INFRASTRUCTURE NEEDED FOR SUCCESSFUL DEPLOYMENT



John Havrilla, Director of Alternative Fuel Services at Wendel

John Havrilla is the Director of Alternative Fuel Services at Wendel, which provides consulting, design and construction services to public and private organizations looking to build alternative fuel facilities for their fleets, including Compressed Natural Gas (CNG/RNG), propane and electric vehicles. John is also the Secretary and Board member of Clean Communities of Western NY. With over 30 years of industry experience, John is a seasoned energy executive with a strong financial background.



Ruslan Belous, Associate Principal and Electrical Engineer at Wendel

Ruslan Belous is an Associate Principal and electrical engineer at Wendel with more than 13 years' experience in electrical design. His design experience includes battery electric vehicles and charging infrastructure, lighting, power, fire alarm and system for new and existing buildings. He has worked on numerous school renovation projects, new building utilities, primary and secondary power distribution, emergency generator installations both for private and public installations.



Keith Dickerson, Director of Transformative Technologies at Black & Veatch

Keith Dickerson is the Director of Transformative Technologies at Black & Veatch. Keith's focus areas include planning and building sustainable transportation and distributed clean energy infrastructure. He brings 30 years of expertise in engineering, operations, sales and strategic business development with companies such as Siemens, Schneider Electric and Verizon.



Alex Bettencourt, Senior Managing Director of Management Consulting at Black & Veatch

Alex Bettencourt is Senior Managing Director of Management Consulting at Black & Veatch. Alex is a recognized thought leader in the field of grid modernization and a pioneer in fleet electrification. He has worked with transportation and logistics companies to establish their business case for electrifying their fleets and to structure the potential deal for utility-provided charging infrastructure.

Charging Infrastructure

Electrifying Medium and Heavy-Duty Trucks in New York

December 9, 2020



Introductions



John Havrilla, PE



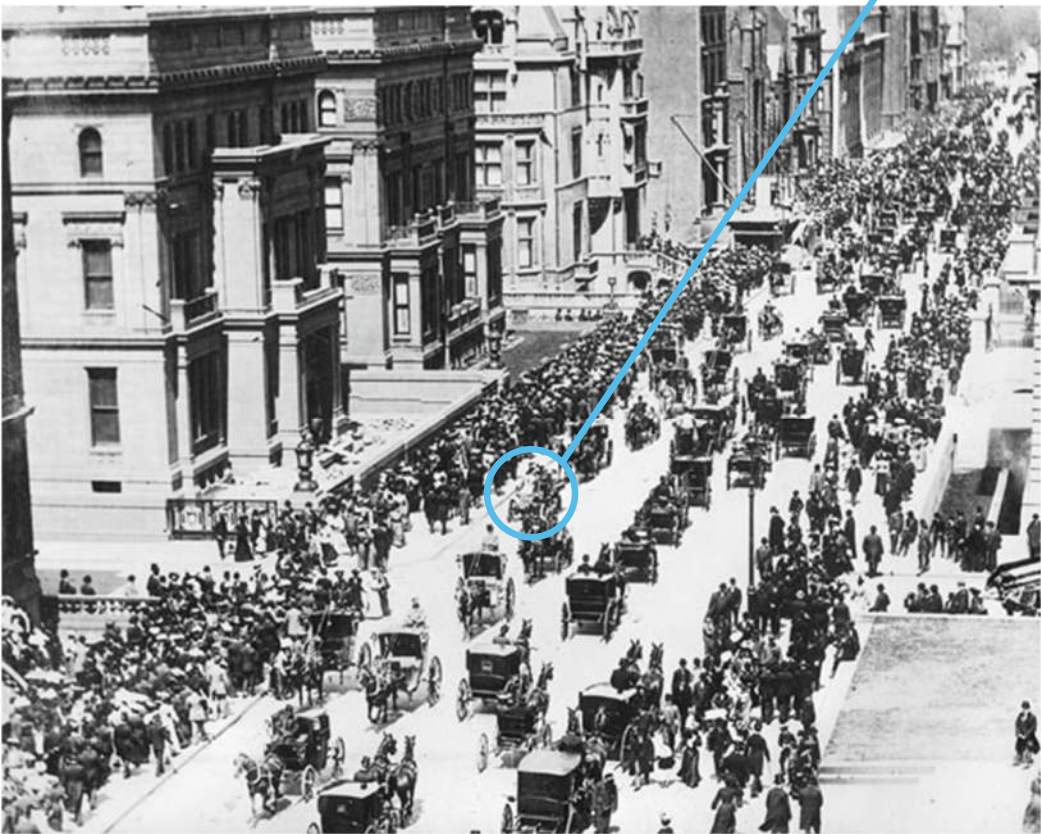
Ruslan Belous



[Image and Content Source: Tony Seba, Clean Disruption of Energy and Transportation]

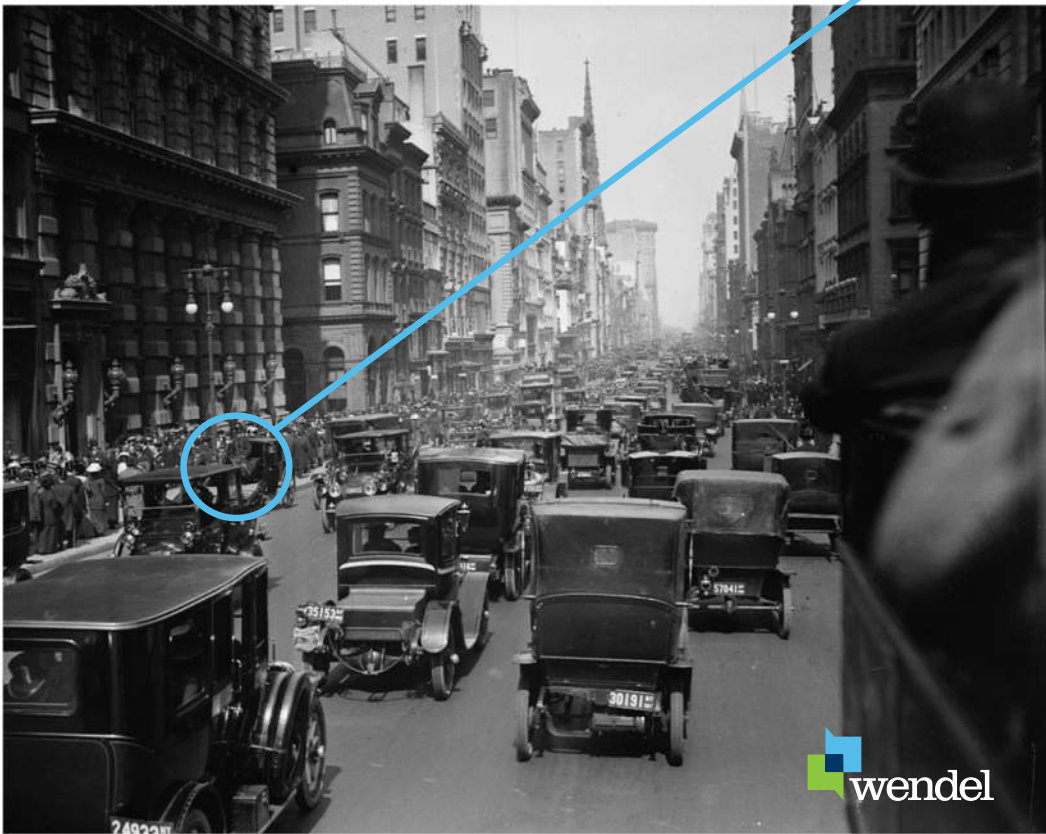
A Sign of the Times

5TH AVE NYC CIRCA 1900



One Car

5TH AVE NYC CIRCA 1913



One Horse

Charger Considerations

Charging Options

BEV OVERVIEW

Pantographs

Advantages	Disadvantages
High Capacity Charge	High maintenance – particularly in winter climates
Can be used for On-Route charging	Difficult to install in existing depots
May reduce battery size	Large footprint with associated equipment

Inductive Charging

Advantages	Disadvantages
High Capacity Charge	Large footprint with associated equipment
Can be used for On-Route charging	Vehicle placement critical to efficiency
May reduce battery size	
No moving parts, less maintenance	

Charging Systems



Inverted Pantograph



Roof Mounted Pantograph



Inductive Charging



Plug-in Charging

Plug-in Charging

Advantages	Disadvantages
Simple, low cost option	Manually operated (plug in)
Low maintenance	Placement in tight garages can be a challenge
Can be used for both on-route and depot charging	Drop down reel options limited due to cable lengths – but improving
Chargers are similar to other options	

Depot Charging Options



PRODUCT	PROTERRA® POWER CONTROL SYSTEM 60KW	PROTERRA® POWER CONTROL SYSTEM 125KW	PROTERRA® POWER CONTROL SYSTEM 500KW
MAX POWER LEVEL AVAILABLE (KW)	60	125	500
PCS LOCATION	DEPOT	DEPOT	DEPOT / ONROUTE
DISPENSER TYPE	PLUG IN / OVERHEAD	PLUG IN / OVERHEAD	OVERHEAD
CONNECTION STANDARD	J1772 CCS PLUG IN J3105 INVERTED PANTOGRAPH J3105 BUS-UP PANTOGRAPH	J1772 CCS PLUG IN J3105 INVERTED PANTOGRAPH J3105 BUS-UP PANTOGRAPH	J3105 INVERTED PANTOGRAPH J3105 BUS-UP PANTOGRAPH
VEHICLES	CHARGING TIME OR MILEAGE PER CHARGE*		
FC	1.1 HOURS	0.9 HOURS	19 MILES PER 10 MINUTES
FC+	1.5 HOURS	0.7 HOURS	38 MILES PER 10 MINUTES
XR	2.9 HOURS	2.4 HOURS	9 MILES PER 10 MINUTES
XR+	4.4 HOURS	2.4 HOURS	13 MILES PER 10 MINUTES
E2	5.9 HOURS	2.8 HOURS	17 MILES PER 10 MINUTES
E2+	7.3 HOURS	3.5 HOURS	20 MILES PER 10 MINUTES
E2 MAX	8.8 HOURS	4.2 HOURS	24 MILES PER 10 MINUTES

* Efficiencies based on DuoPower drivetrain; FC series charges at max overhead power limit; XR/E2 series charges at continuous power limit for plug-in; all charge times are approximate.

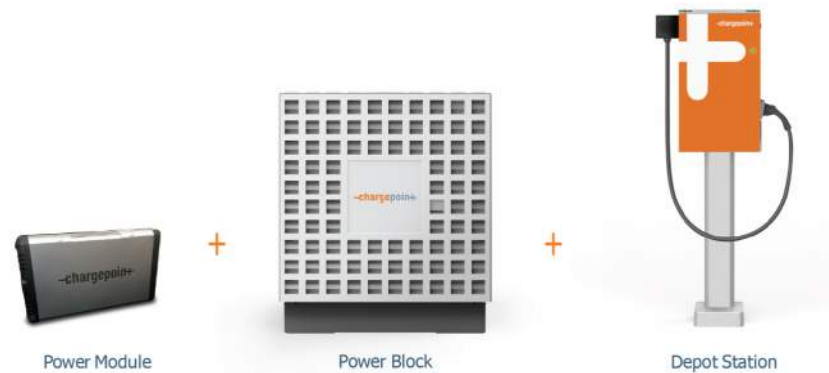




CPE 250

62.5 kW or 125 kW
Shared between 2 – CPE 250's

-chargepoint+



Station Electrical Output

Max Output Power	500 kW with Power Blocks
Output Voltage, Charging	200-1,000V DC
Max Output Current	500A with Power Blocks

Available late spring 2020

Typical ABB Large Vehicle Charging



ABB Connector Charger

Power range of 24 kW, 50 kW with Voltage range from 150-920 V DC
Power range of 100kW, 150kW with Voltage range from 150-850VDC
Sequential charging with up to 3 outlets with 100 kW and 150 kW per vehicle

Case Studies

Case Study 1

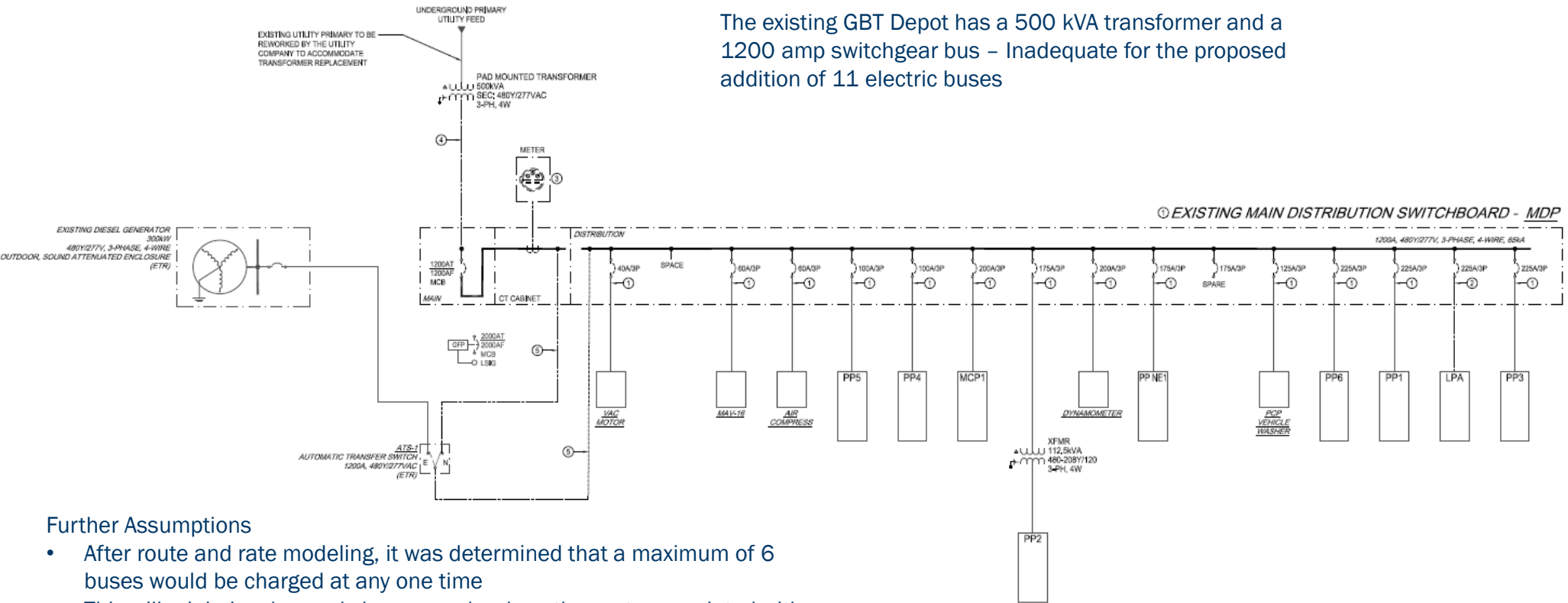
Greater Bridgeport Transit (GBT)

- (2) BEV chargers, 1 charger per bus.
- Depot Peak Demand was 119 kW. At full 11 BEV build out it will be 1,659 kW, an increase of over 1.5 MW of power.
- Service Upgrade (up to 11 BEV capability).
- Outdoor charger location.



Impacts to Depot Distribution System

The existing GBT Depot has a 500 kVA transformer and a 1200 amp switchgear bus – Inadequate for the proposed addition of 11 electric buses

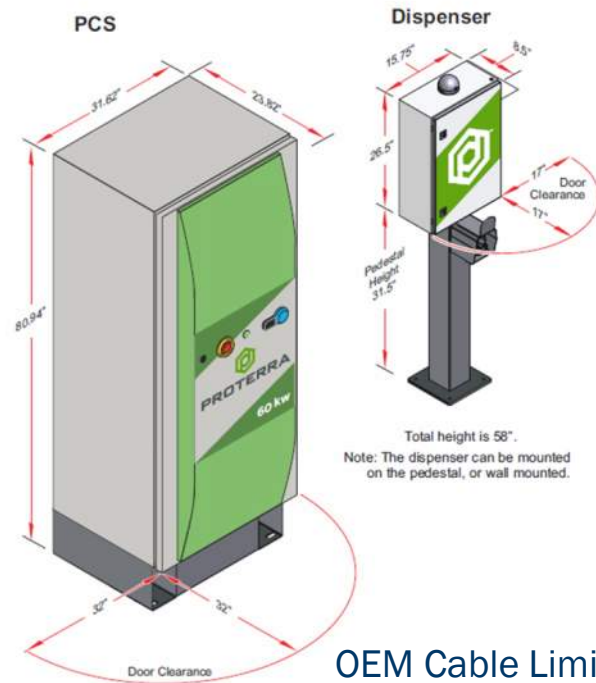
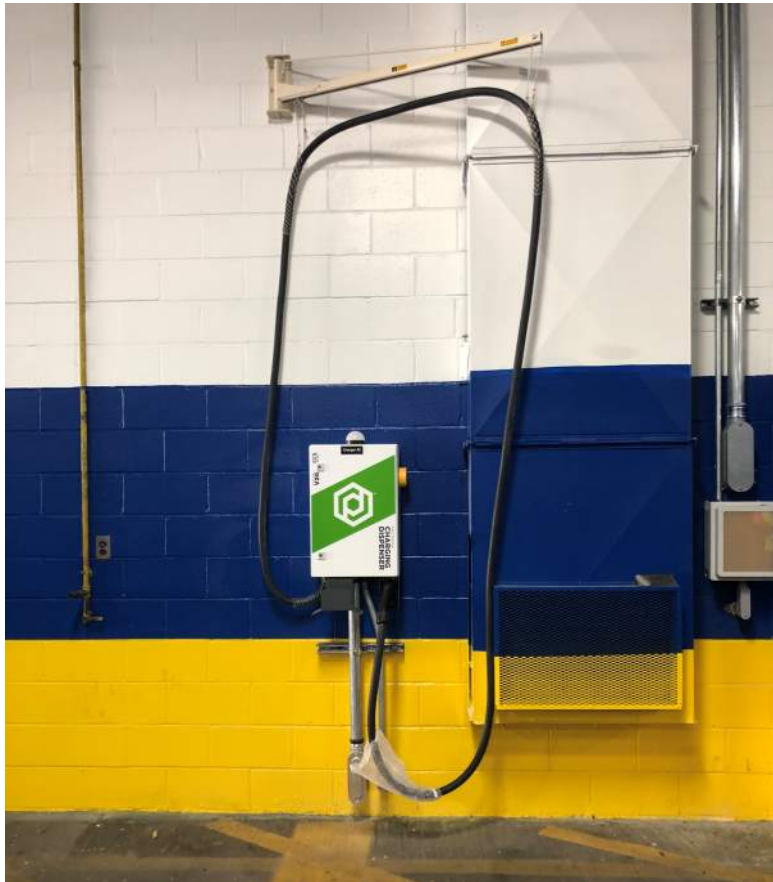


Further Assumptions

- After route and rate modeling, it was determined that a maximum of 6 buses would be charged at any one time
- This will minimize demand charges and reduce the costs associated with the depot electric distribution system upgrades
- Electric bus charging would not occur when on emergency power

① PARTIAL SINGLE LINE DIAGRAM - DEMOLITION
SCALE: NO SCALE

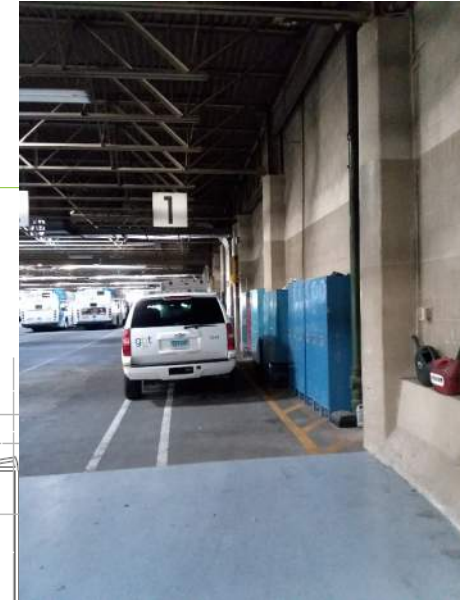
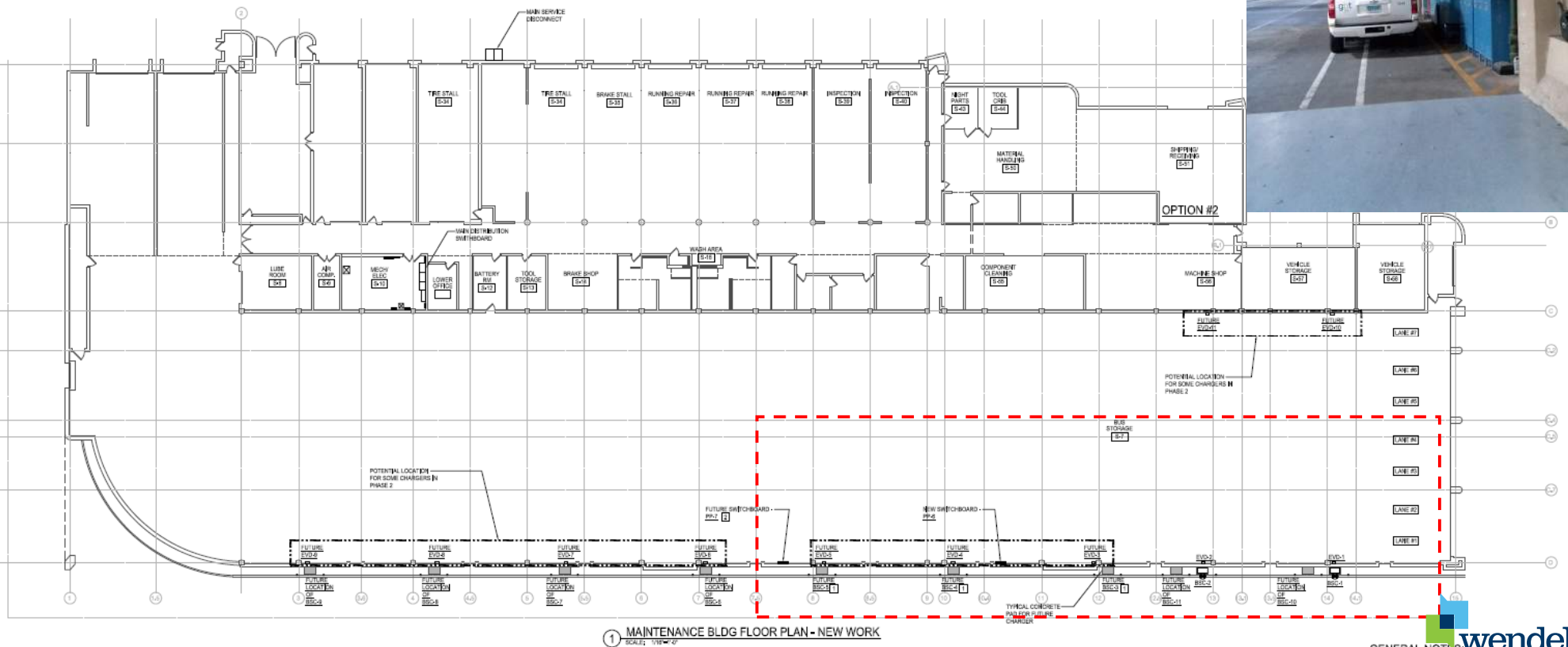
Charging System - Proterra



OEM Cable Limits:

- Max 492' from PCS to Dispenser
- 25' from Dispenser to Bus

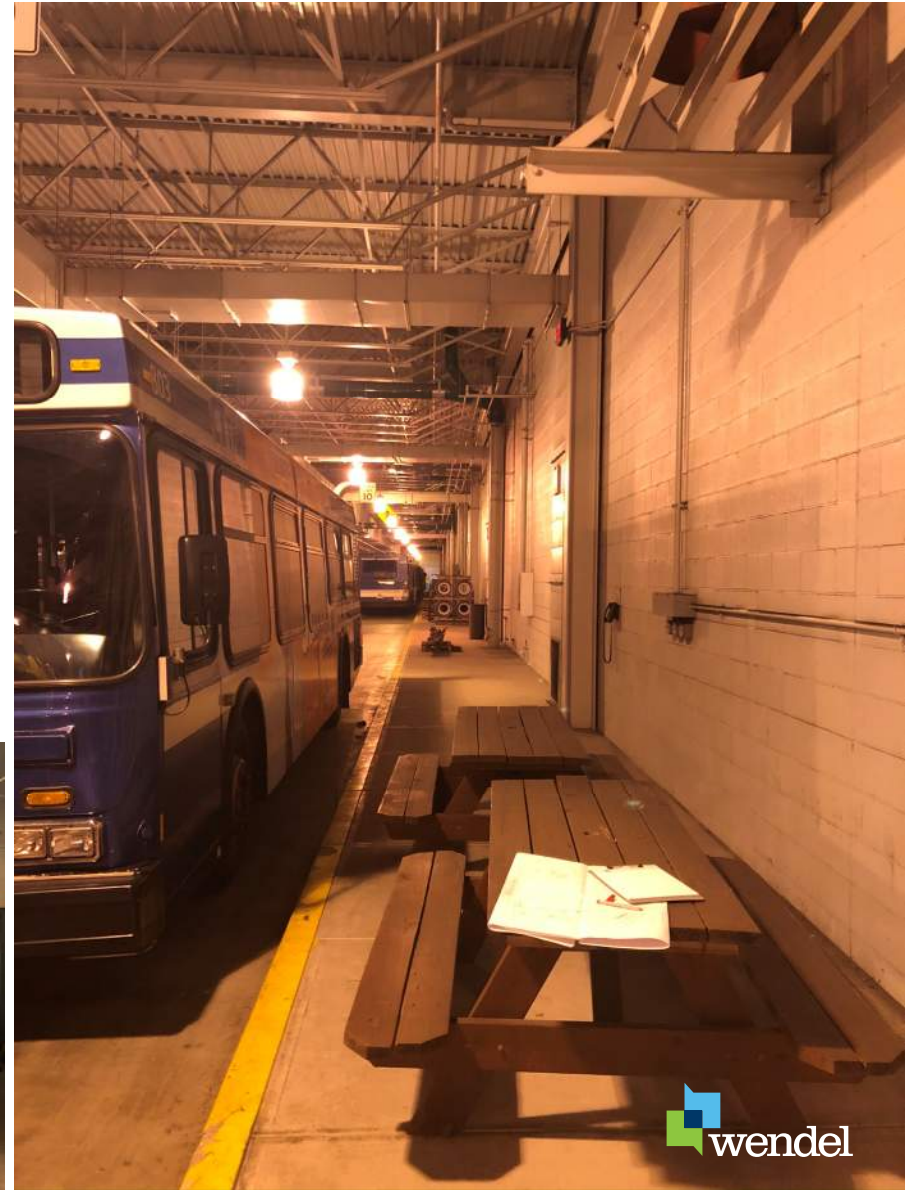
Charger Layout



Case Study 2

CTtransit - Hamden

- (10) BEV chargers, 1 charger per bus.
- Depot Peak Demand was 1,223 kW. At 100% BEV build out (129 buses) it will be 10,253 kW, an increase of over 9.0 MW of power.
- Chargers connected to existing services (5 and 5).
- New service for fire pump including dedicated backup generator.



Current Loads

Electric Service #1

664.4 Peak kW

859,963 Estimated kWh

Electric Service #2

516.4 Peak kW

3,342,147 Estimated kWh

1.18 Peak MW
4,202,110 Est kWh

Existing Fuel Cell

471 kVA/400 kW Doosan Fuel Cell

Backup Generator

2500 kW diesel generator

Summary of Costs by Scenario

Scenario	# of BEB's	Utility Costs	Facility Costs	On Route Charging	Induction Charging
1 – 10 Bus	10	-	\$1,189,296	No	No
2 – 20%	26	-	\$1,618,442	No	No
3 – 30%	39	\$24,000,000	\$2,053,777	No	No
4 – 50%	65	-	\$4,815,070	Yes	No
5 – 100%	129	\$3,000,000	\$7,166,058	Yes	Yes
		\$27,000,000	\$16,842,643		

Note: The costs for the scenarios are additive. Each scenario builds on the scenario before it so the cost of each scenario must be included in the total build-out.

Expected Loads

Scenario	All Charged at Once	Half Charged at Once
Pilot – 10 Buses	1.40 MW	700 kW
20% - 26 Buses	3.64 MW	1.82 MW
30% - 39 Buses	5.46 MW	2.73 MW
50% - 65 Buses	9.10 MW	4.55 MW
100% - 129 Buses	18.06 MW	9.00 MW

1 MW can power approximately 500 Homes

Chart 1: Land Use by Electricity Source in Acres/MW Produced

Electricity Source	Acres per Megawatt Produced
Coal	12.21
Natural Gas	12.41
Nuclear	12.71
Solar	43.50
Wind	70.64
Hydro	315.22

The Footprint of Energy: Land Use of U.S. Electricity Production STRATA – June 2017

Charging Infrastructure for Hamden

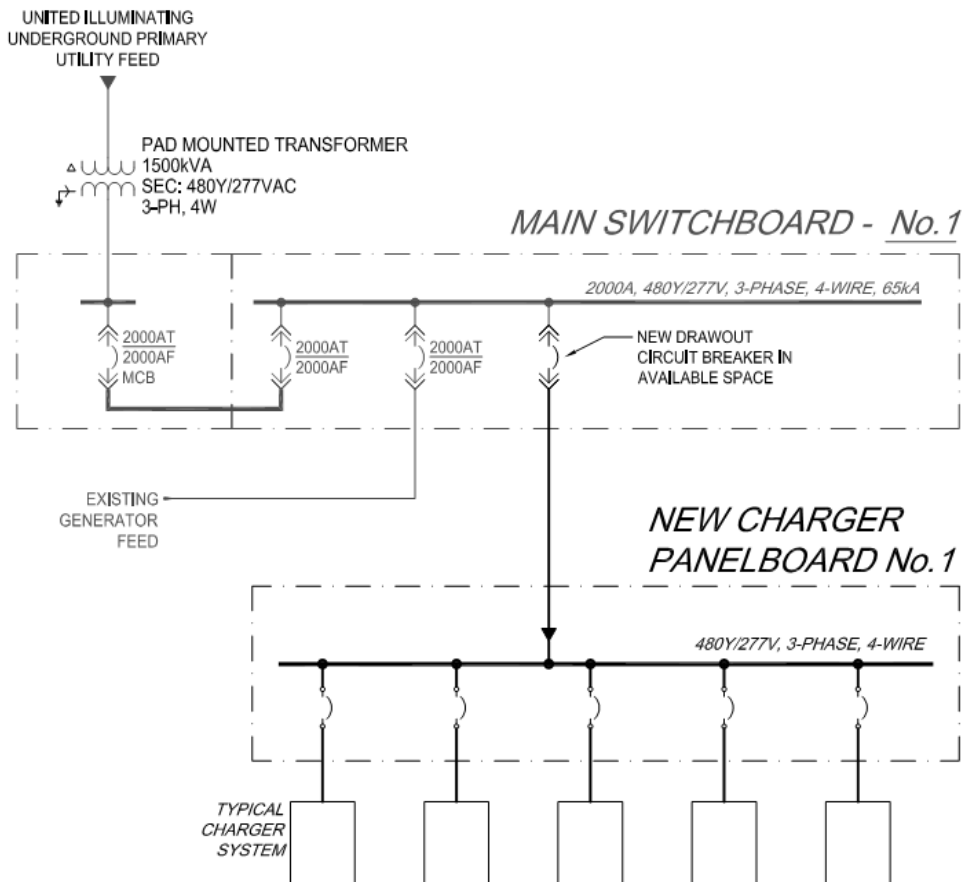
Scenario	# of BEB's	Charger Size	Charger Type	On-Route Charging	On-Route Charger Size	# of On-Route Chargers
1 - Pilot	10	125 kW	Plug in	No	NA	0
2 – 20%	26	125 kW	Plug in	No	NA	0
3 – 30%	39	125 kW	Plug in	No	NA	0
4 – 50%	65	125 kW	Plug in	Yes	500 kW	2
5 – 100%	129	125 kW	Induction	Yes	500 kW	2

Charging Infrastructure Strategy

A typical 440 kW battery electric bus has a usable battery capacity of about 327 kWh of energy. The efficiency of the bus is around 2.2 kWh/mile, resulting in a range of 149 miles per bus per charge.

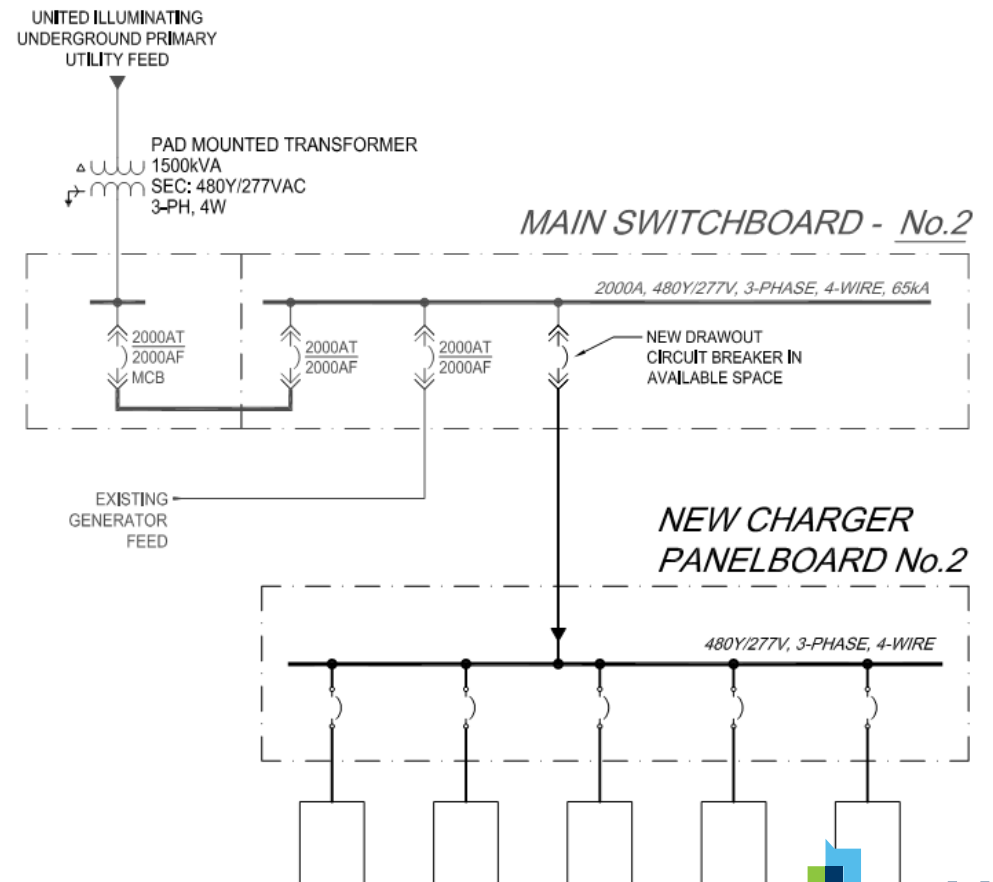
Existing Facility:

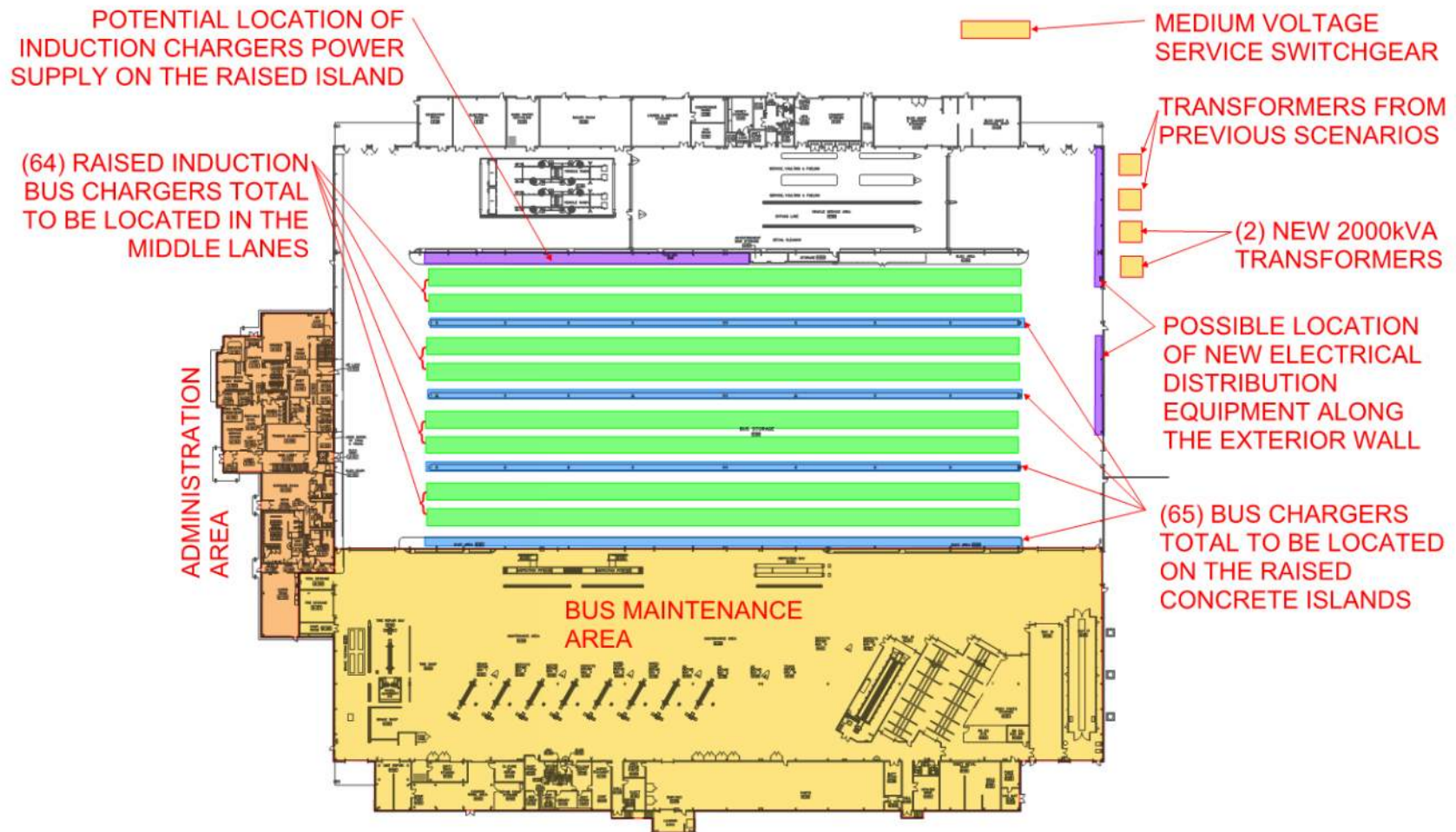
- 2 Electrical Services
- 4000A Total Capacity



Proposed Modifications:

- Add 10 BEV chargers (5 charged at once)
- ~900A required to charge 5 buses





TOTAL OF (129) BUS CHARGERS WILL BE PROVIDED UNDER 100% FLEET ELECTRIFICATION SCENARIO

Case Study 3

CTtransit - Stamford

- (5) BEV chargers in phase 1.
- New service for support up to (22) BEVs, outdoor charger farm with interior plug-in connections.
- Depot Peak Demand was 235 kW. At 47% BEV build out (28 buses) it will be 2,195 kW, an increase of over 1.9 MW of power.
- New service for fire pump including dedicated backup generator.



Case Study 4

Pioneer Valley Transit Authority (PVTA)

- (6) 60kW chargers and dispensers.
- Utilized existing service for charger connections.
- Designed charger power distribution to accept future PV system (to be provided by owner later).

Wendel was also the lead architect and engineer for the entire facility.



Case Study 5



Worcester Regional Transit Authority (WRTA)

- (1) 500kW On-Route charger at an intermodal hub.
- Dedicated charger electrical service and distribution.
- Outdoor charger with drop down pantograph.
- Attached to canopy structure.



Interior 120kW chargers (ABB)



Interior 60kW chargers (Proterra)

Typical Dispenser





Typical "Charger Farm"
Right to Left - Transformer, Main Service Gear,
Charger Panelboard, Chargers, and Dispenser



“Charger Farm”



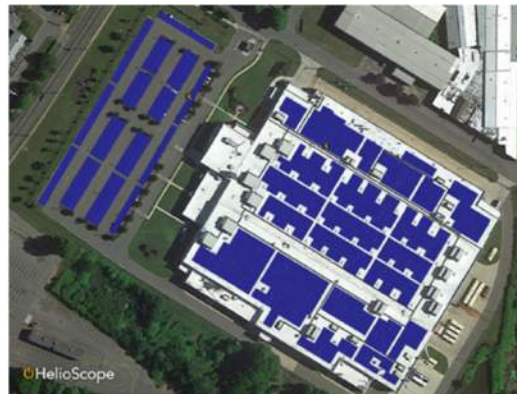
Alternative Energy

- Fuel Cells
 - Expensive - \$11,441.00/kW
 - Reliability issues
 - Space issues
- Solar Arrays
 - Most cost-effective solution
 - Third party BOOM – no up-front costs to transit agency.
 - Space available if roof can support
- Battery Storage
 - Good for peak shaving/load shifting
 - Space is an issue
 - Third party BOOM available in some states
- Generation
 - Not feasible to back up 100% of the fleet – transit agency will be grid dependent.
 - Space is the biggest constraint.
 - Diesel or natural gas fired units.
 - Third party BOOM available in some areas

Fuel Cell – 1.4 MW fuel cell – Requires the space of a tennis court



Fuel Cell Energy SureSource 1500



NextEra solar plan for Hamden. 2.22 MW

Tesla 20 MW battery storage facility in California. 1.5 acres of land.





Do you have
any
questions?



Charging Infrastructure

Electrifying Medium- and Heavy Duty
Trucks in New York

December 9, 2020



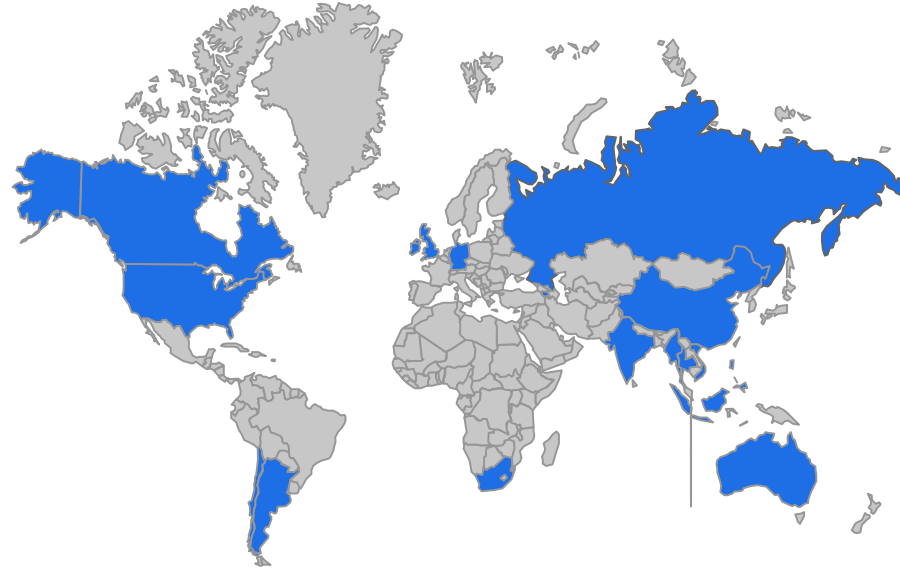
Introduction & Experience

Keith Dickerson, Transformative Technologies, Black & Veatch

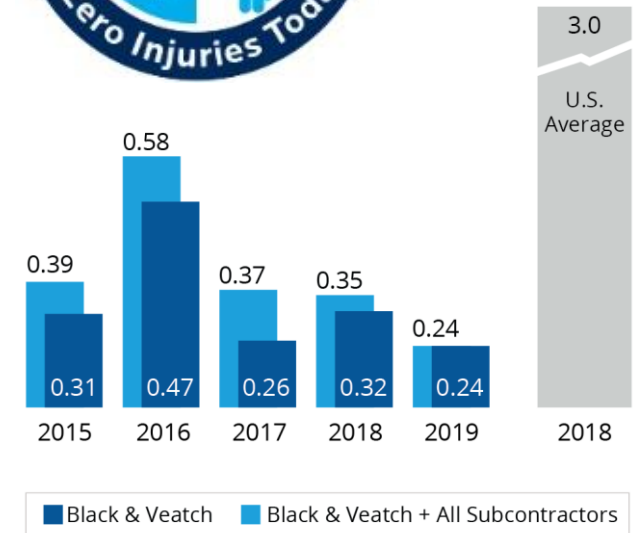
ABOUT BLACK & VEATCH



CEO **ACT!ON** FOR
DIVERSITY & INCLUSION



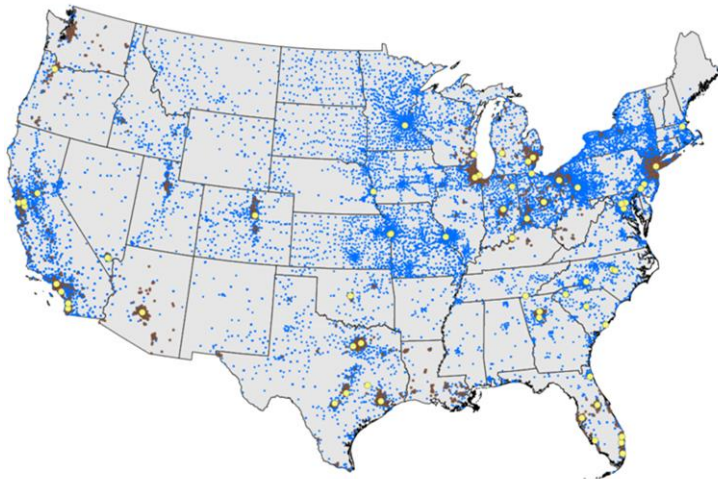
- 10,000+ professionals
- \$3.7 billion in 2019 revenue
- Work in 100+ countries on six continents
- Consistently high industry rankings in Power, Telecom, Water and more



Everybody returns home
safely each day

Black & Veatch has the local area knowledge and delivery capability around the world to strategize and **BUILD** charging infrastructure.

- Proven success with deployment of high-power charging at scale throughout North America
- Focus on speed, safety, and quality
- Network of experienced, capable contractors
- Extensive utility relationships



1200+

EV Charging
Sites
Deployed

100
MW

Transit & Fleet
Charging
Engaged

150+
MWh

Behind-the-
Meter Battery
Installations

25,000
MW

Solar Capacity
Installed

8,000+
MW

Combined Heat
& Power (CHP)
Experience

~40
MW

Largest Data
Centre
Designed

Black & Veatch is Well-Established in NY

- Proud Member



- Make Ready Approved Contractor



JOINT UTILITIES
OF NEW YORK

Office in New York City, and 69 locations across the United States.

Turnkey Solution for Complete Program Management

Integrated Solution Delivers Speed and Quality

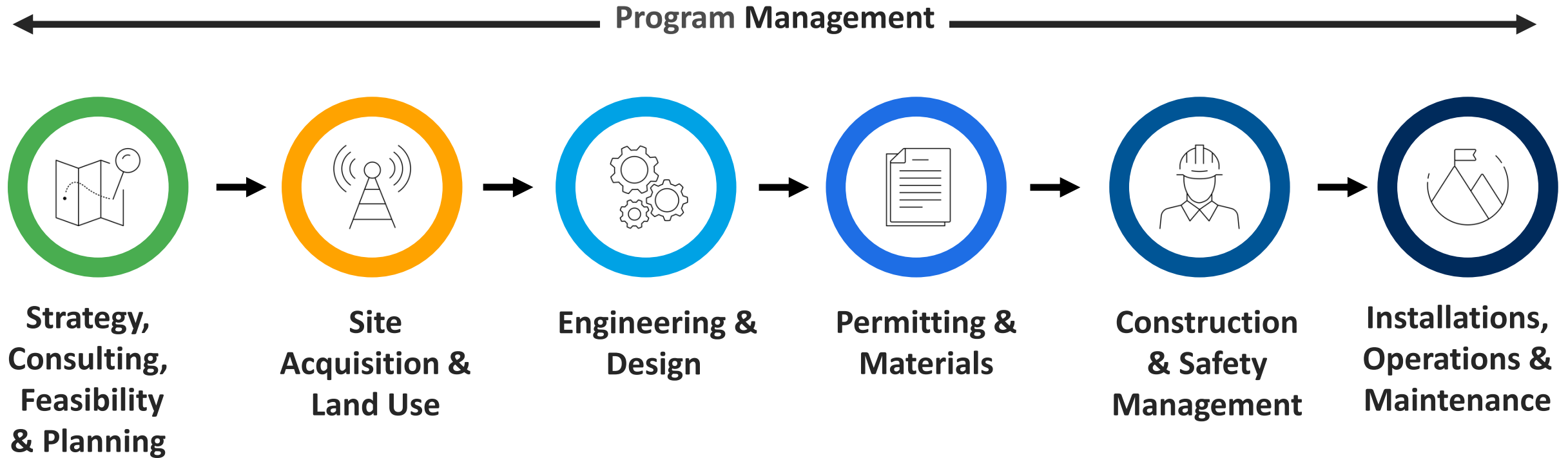




Image Source: Daimler Trucks North America

Building Charging Networks

Tesla Supercharger Network

Since 2015, Black & Veatch has designed, engineered, permitted and/or constructed 1,680 charging posts at over 600 Tesla Supercharger sites in North America.

Electrify America Network

Black & Veatch is deploying over 3,800 high-powered DC Fast Charger posts for 475+ Electrify America sites in eight U.S. regions.





Image Source: Daimler Trucks North America

Fleet Charging Infrastructure

Black & Veatch has been working with top vehicle OEM & EV leaders to design and build charging infrastructure across the country for:

- Class 8 Truck OEM and Logistics Clients, multiple sites and technologies with integrated resilience
- Depot and on-route charging for Transit Agencies
- Utility EV programs and rebates support charger installation for workplace and corporate fleets

Building High-Power Charging for Fleets

Energy Storage, Distributed Generation & Resilience

Black & Veatch has designed and built a large portfolio of battery Energy Storage, Solar, and micro-grid projects. Many fleet programs are seeking integrated approach increase up time and use of renewable energy.



Strategy & Total Cost of Ownership

Alex Bettencourt, Management Consulting, Black & Veatch

Greenhouse Gas Emission Comparison



Freight
Transportation

11%

Electricity
Generation

12%

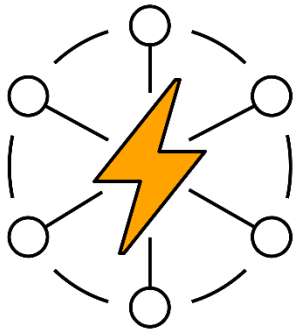


9%

32%

There is a wider transformation occurring in transportation

This transformation will drive down costs and increase utilization – it will be a good time to operate a fleet



Electric

**Cost
Savings**



Connected

**Improve
Decision
Making**



Autonomous

**Cost
Savings**

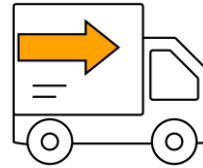


Shared

**Increase
Capacity
Utilization**

Capital costs are higher

States costs for Ford eTransit and Tesla Semi are coming in at about 30-50% on the capital cost side.



Gas Van
\$36K



Diesel Truck
\$135K



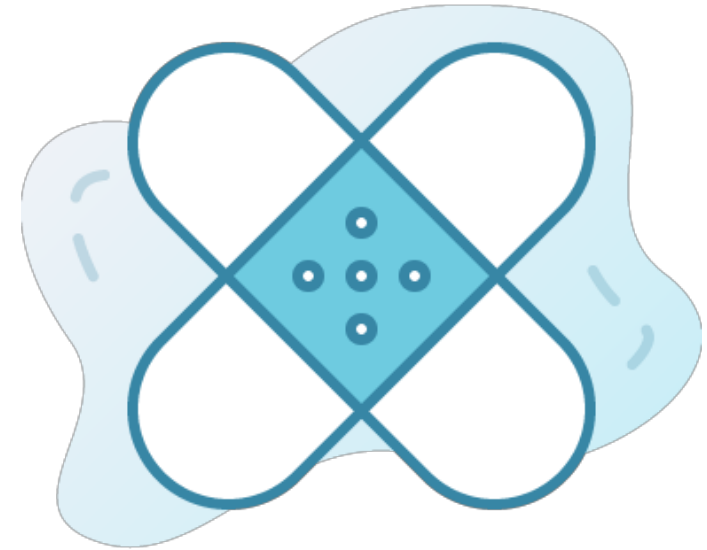
Electric Van
\$45K



Electric Truck
~\$180K

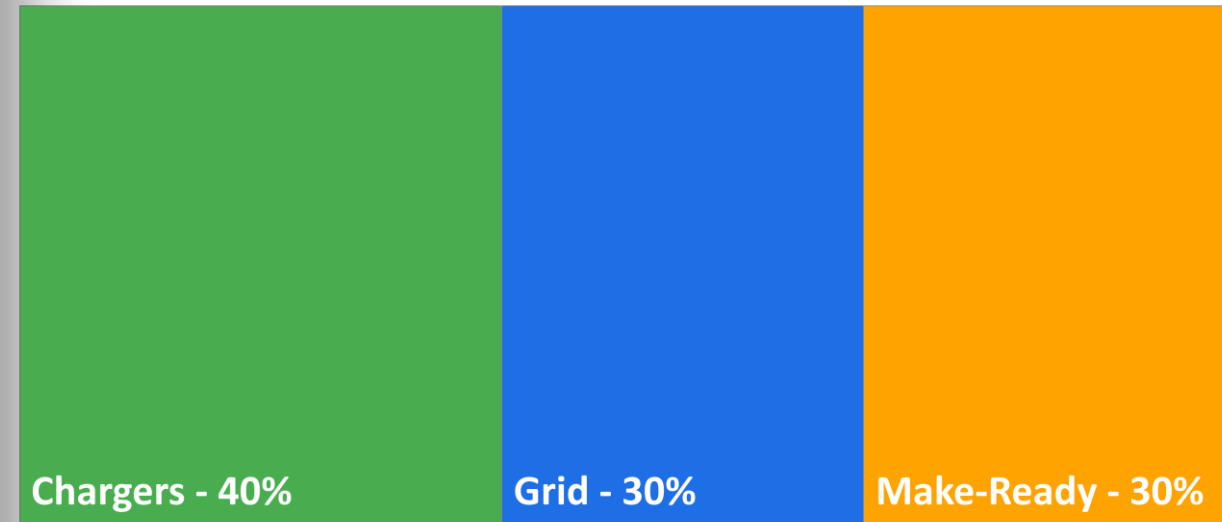
Charging is hard

Many of the early adopters of electric vehicles have the scars from building charging. While many have been successful, they know it will be difficult to scale.



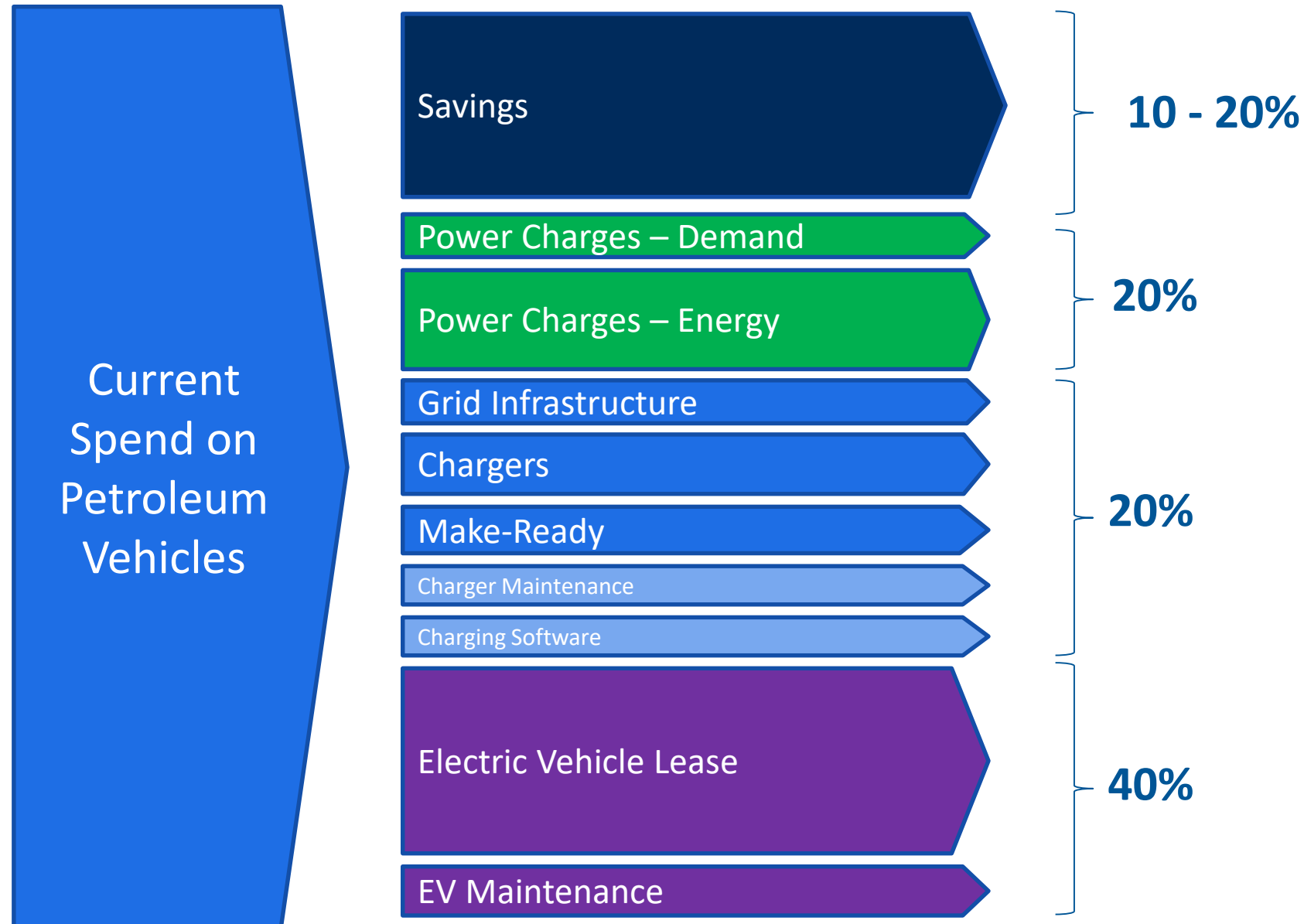
Charging costs are unknown

Many fleet operators have run the model for fuel savings but it is hard for them to understand the cost of charging without performing some detailed onsite work



VALUE FLOWS

How does the flow of value change when moving to electrification

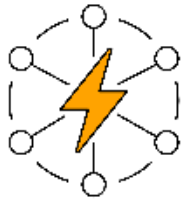


Competition For Electrons

There will be competition for electrons and the first to electrify will gain the cheaper grid capacity – need to be willing to invest capital and make decision on EVs soon



Key Takeaways

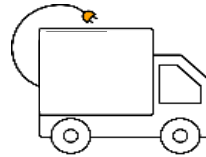


Utility Relationship

Fleets and utilities start to see each other in a different light.

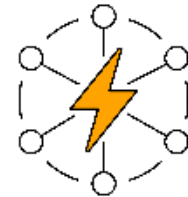
Utilities need to see fleets as key customers.

Fleets need to see utilities as critical suppliers.



Planning Ahead for Power

Planning for broad electrification will require a years of foresight to ensure the infrastructure is in place for electrification.



Get Grid Capacity Early

Utility regulations allocate grid capacity on a first-come, first-serve basis.




Need to demonstrate that load will materialize as per your schedule.

Working With Your Utility

Keith Dickerson, Transformative Technologies, Black & Veatch

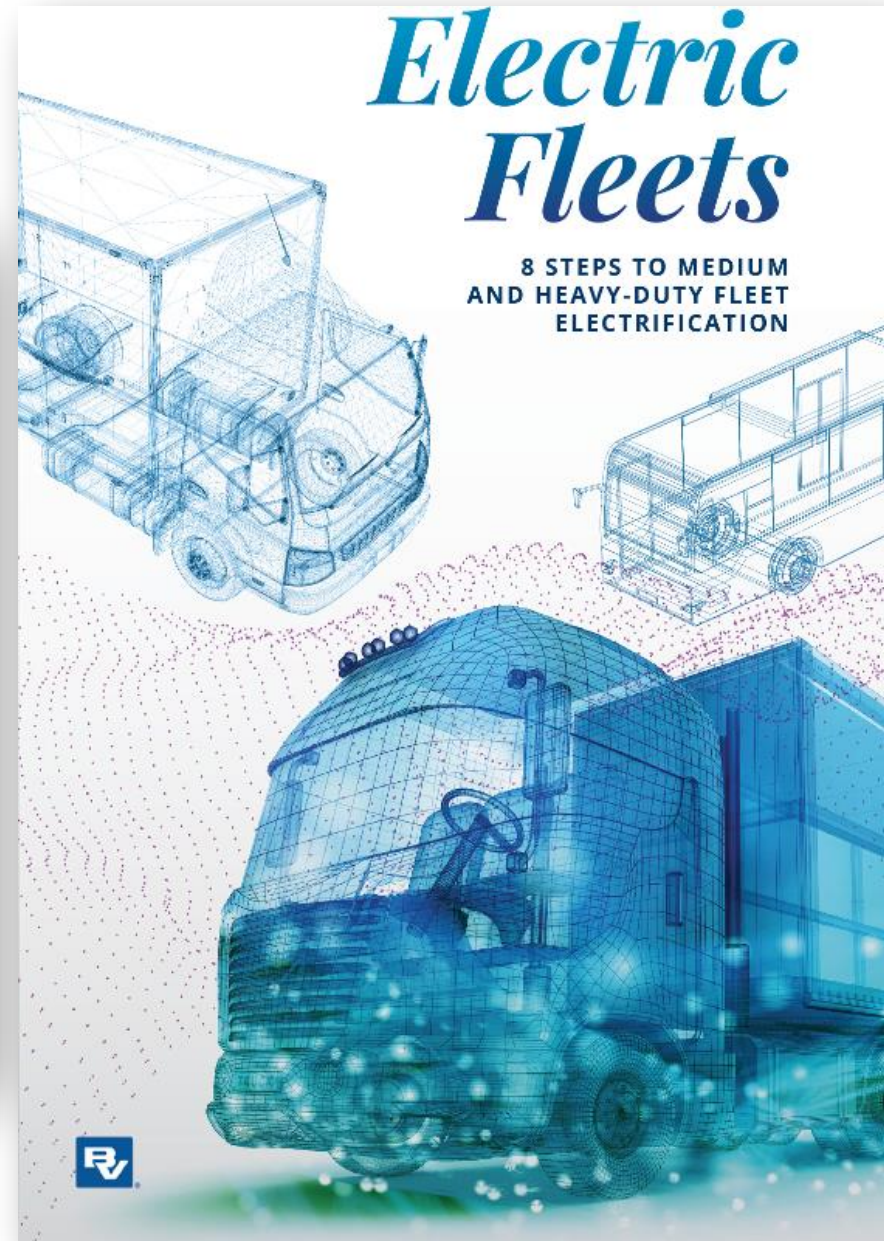
Grid Connection Lead Times

Understanding the complexities and timing for fleet infrastructure can inform your investment and scale-up roadmap

SAMPLE FLEET	CAPACITY REQ'D	GRID UPGRADE	EXAMPLE TIMELINE REQUIRED
 20 overnight charging medium-duty delivery trucks	1MW Charging Site	Service Transformer	3 MONTHS
 200 overnight charging light-duty delivery vans	5MW Charging Site	Feeder Upgrade	12 MONTHS
 200 daytime fast charging heavy-duty trucks	20MW Charging Site	Substation Upgrade	24 MONTHS OR MORE

8 Steps To Fleet Electrification

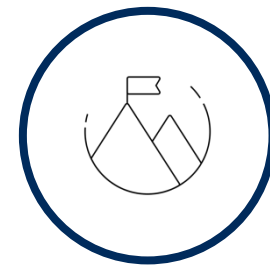
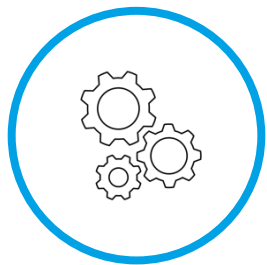
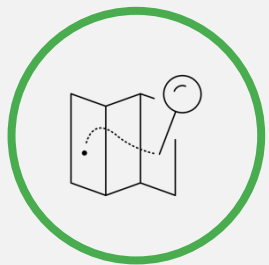
1. Define Drive Cycles, Duty Cycles and Operational Considerations
2. Review and Select Technology Options
3. Understand Charging Loads and Power Delivery
4. Site Planning
5. Conduct Utility Coordination, Engineering and Design
6. Apply for Permit and Approvals
7. Distribution Grid Upgrades
8. Obtain Equipment, Construct and Commission



Fleet Electrification Journey

BUSINESS CHOICES

EXECUTION



Strategy

- Market view
- Customer markets & buying proposition
- Competitive model
- Provider landscape
- Economic model
- Financial targets
- Competitive strategy

Go-to-Market Deployment

- Customer value proposition
- Target customer segments
- Deal strategy for tenants
- Deal strategy for new customers

Prelim. Feasibility & Design

- Detailed site assessment
- Grid capacity check & load letter submission
- Customer transportation operations survey
- Go/No-Go decision on site

Detailed Engineering

- Engineering designs
- Zoning and permitting research, submittal, and approval
- Utility interconnection
- Procurement & purchasing
- Inventory Control
- Qualify and manage subcontractors

Construction & Commissioning

- Mobilization
- Site kick-off
- Site prep/civil works
- Skid installation
- Electrical
- Mechanical
- Communications

Operation & Maintenance

- Site turn-over
- Testing and training
- Startup and commissioning
- Project closeout
- Alarms and monitoring
- Infrastructure management

12 WEEK ENGAGEMENT

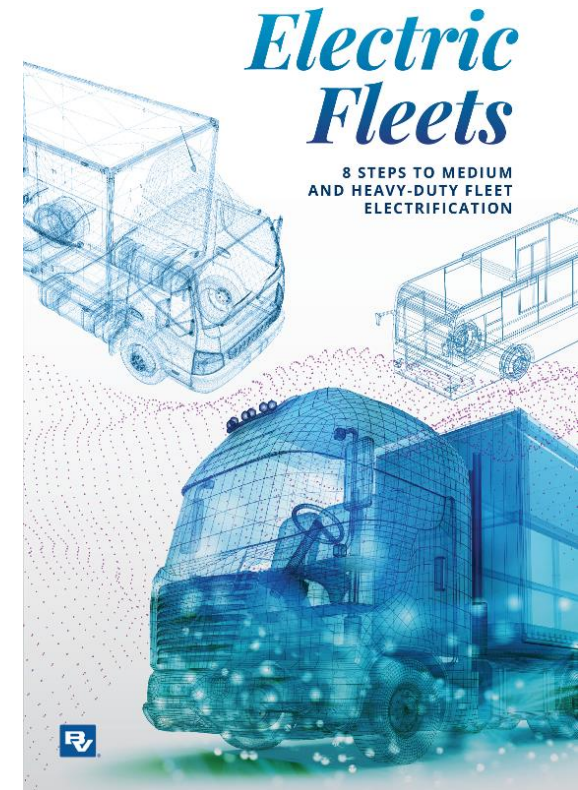
Discussion.

Keith Dickerson, Transformative Technologies

P +1 913-458-2332 E DickersonK@bv.com

Alex Bettencourt, Management Consulting

P +1 905-370-1230 E BettencourtA@BV.com



Download the eBook:
bv.com/ElectricFleets

SESSION 4: CHARGING INFRASTRUCTURE NEEDED FOR SUCCESSFUL DEPLOYMENT

Q&A

This was the final session. Thank you for joining us!



THANK YOU FOR ATTENDING!



Central New York: Clean Communities of Central New York
Coordinator: Barry Carr
Contact: Coordinator@ccofcny.com
Website: www.ccofcny.com

Capital District: Capital District Clean Communities
Coordinator: Jacob Beeman
Contact: jbeeman@cdtcmpo.org
Website: www.capitalcleancommunities.org

Long Island: Greater Long Island Clean Cities Coalition
Coordinator: Rita Ebert
Contact: rebert@gliccc.org
Website: www.gliccc.com

NYC & Lower Hudson Valley: Empire Clean Cities
Coordinator: Joy Gardner
Contact: joy@empirecleancities.org
Website: www.empirecleancities.org

Western NY: Clean Communities of Western New York
Coordinator: Craig Jackson
Contact: cjackson@ccofwny.org
Website: www.ccofwny.org

Rochester: Greater Rochester Clean Cities
Coordinator: David Keefe
Contact: dlkeefe@rochester.rr.com
Website: www.grcc.us