

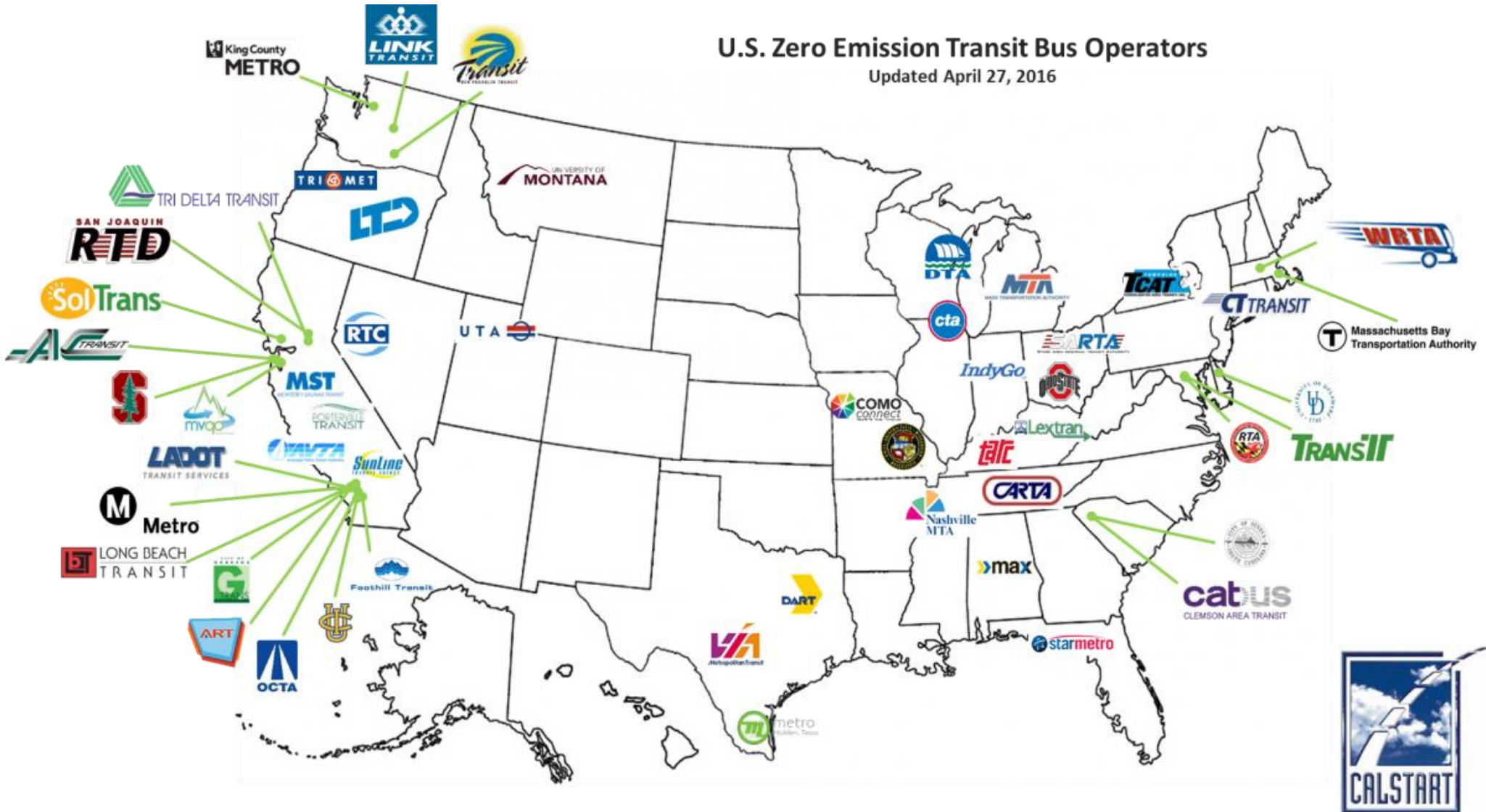
# Challenges & Issues with Operating a Fleet of Battery Electric Buses (BEBs)

May 2017

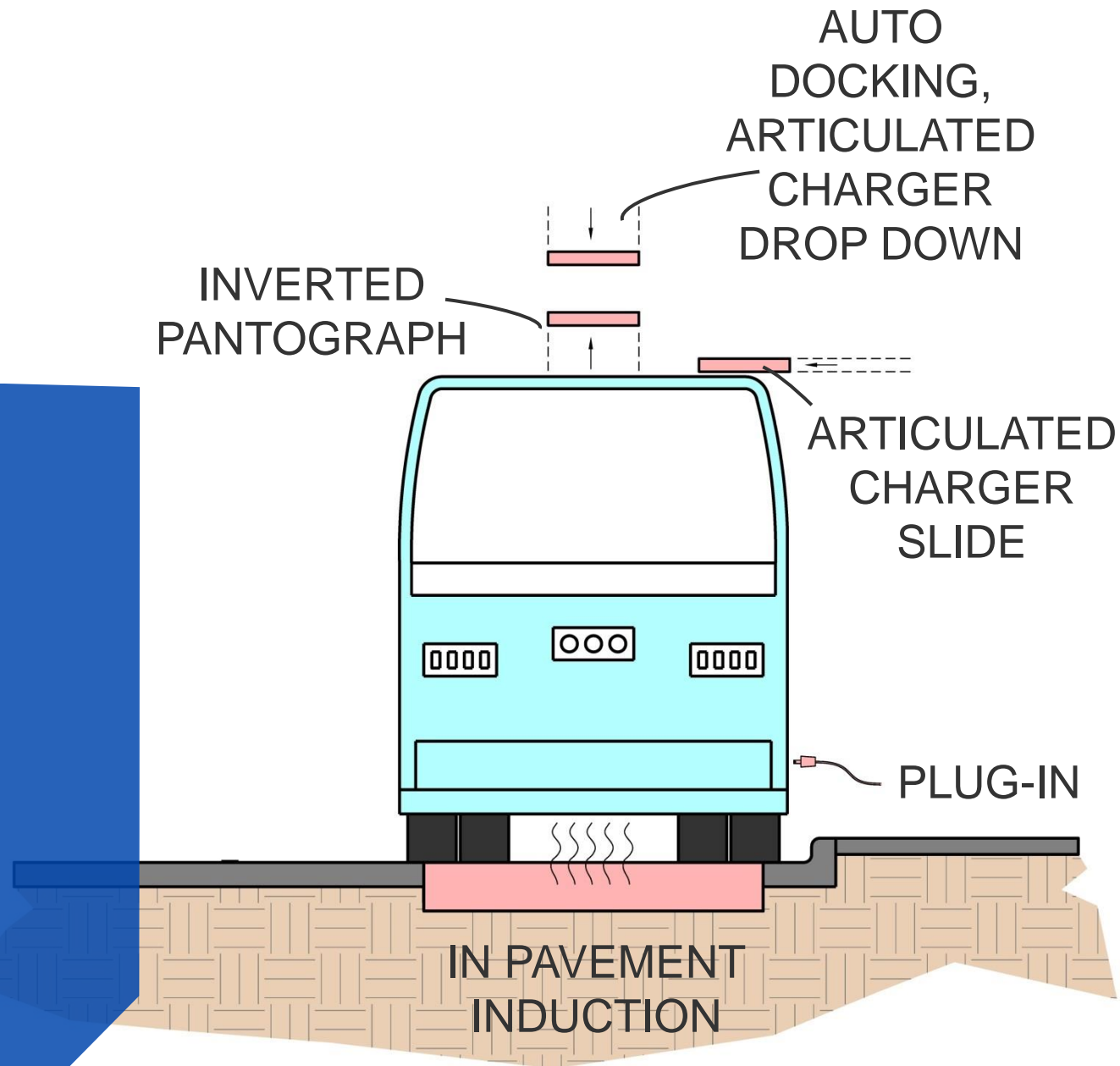
# TEST BEB's 1 - 3

VS

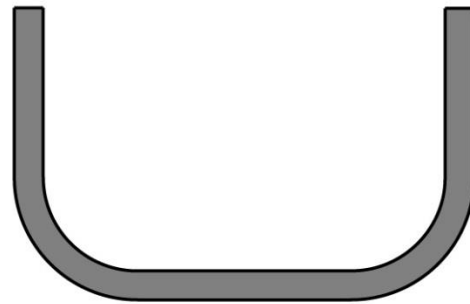
# FLEET OF BEB's 15+



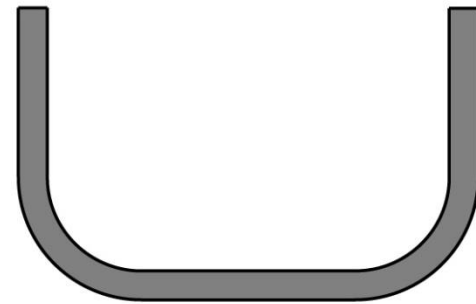
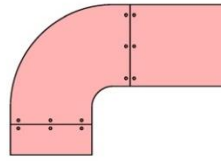
# CHARGER TYPE



# CHARGE SPEED

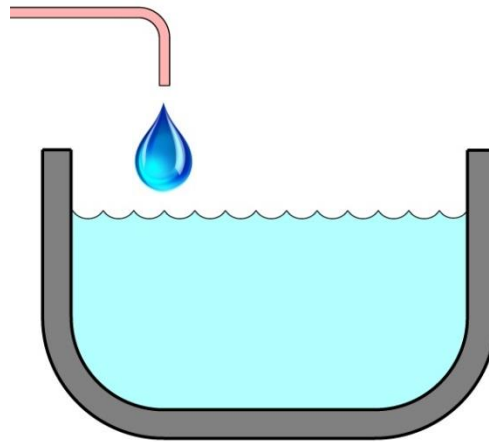


SLOW CHARGE

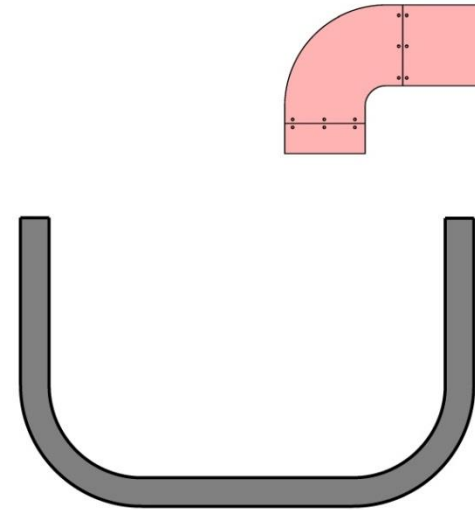


FAST CHARGE

# CHARGE SPEED

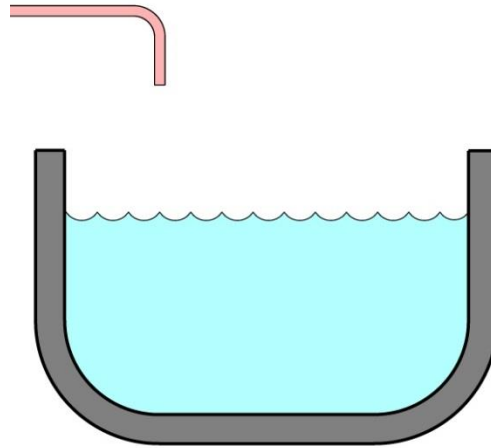


SLOW CHARGE  
Smaller Electrical  
Requirement  
Lower Capital Cost  
Needs Longer  
Charging Duration

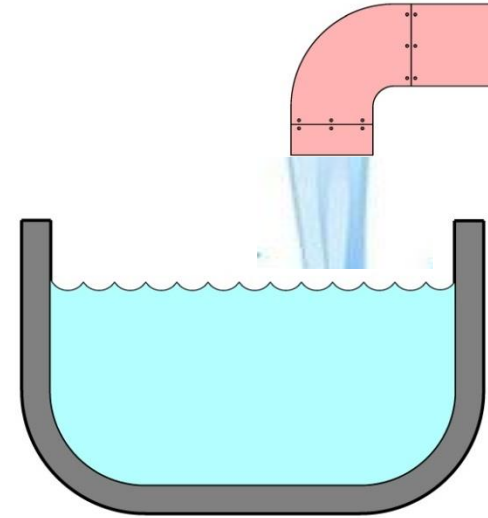


FAST CHARGE

# CHARGE SPEED



SLOW CHARGE



FAST CHARGE

Larger Electrical  
Requirement

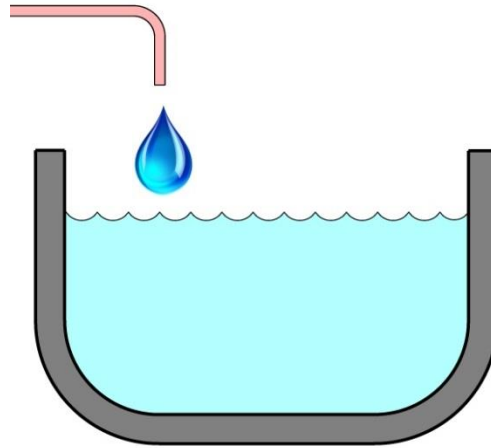
Higher Capital Cost

Shorter  
Charging Duration

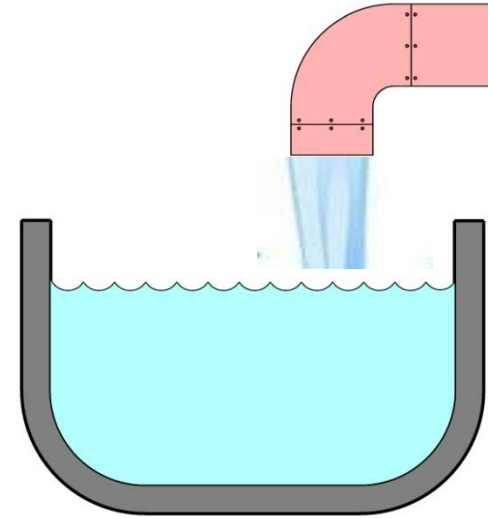
SAME RESULTS

DIFFERENT APPROACH  
DIFFERENT REQUIREMENTS

# CHARGE SPEED



SLOW CHARGE  
Smaller Electrical  
Requirement  
Lower Capital Cost  
Needs Longer  
Charging Duration

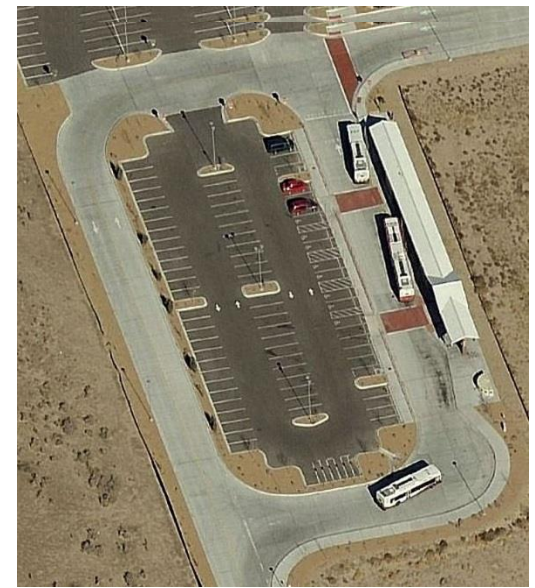


FAST CHARGE  
Larger Electrical  
Requirement  
Higher Capital Cost  
Shorter  
Charging Duration



En Route At Stop

EN ROUTE  
CHARGING



En Route At Transit Center

# CHARGER LOCATION

DEPOT  
CHARGING

In Parking Space  
or

Dedicated Shared Charge Position





## SIMPLE WIRE

- Single Voltage
- Can be on Reel
- Requires Inverter on Bus



# CHARGER WIRE

## COMPLEX WIRE

- Multi-Voltage
- Cannot be on Reel
- Inverter on / off Bus



# COMPLEX WIRE EXAMPLE

## IndyGo, Indianapolis

In Parking Charging  
Overhead Distribution Power  
Drop to Contactor Box  
Hook Charging Cable Management

# CHARGER WIRE MANAGEMENT

- Reels
- Retractors
- Hooks
- Suspended

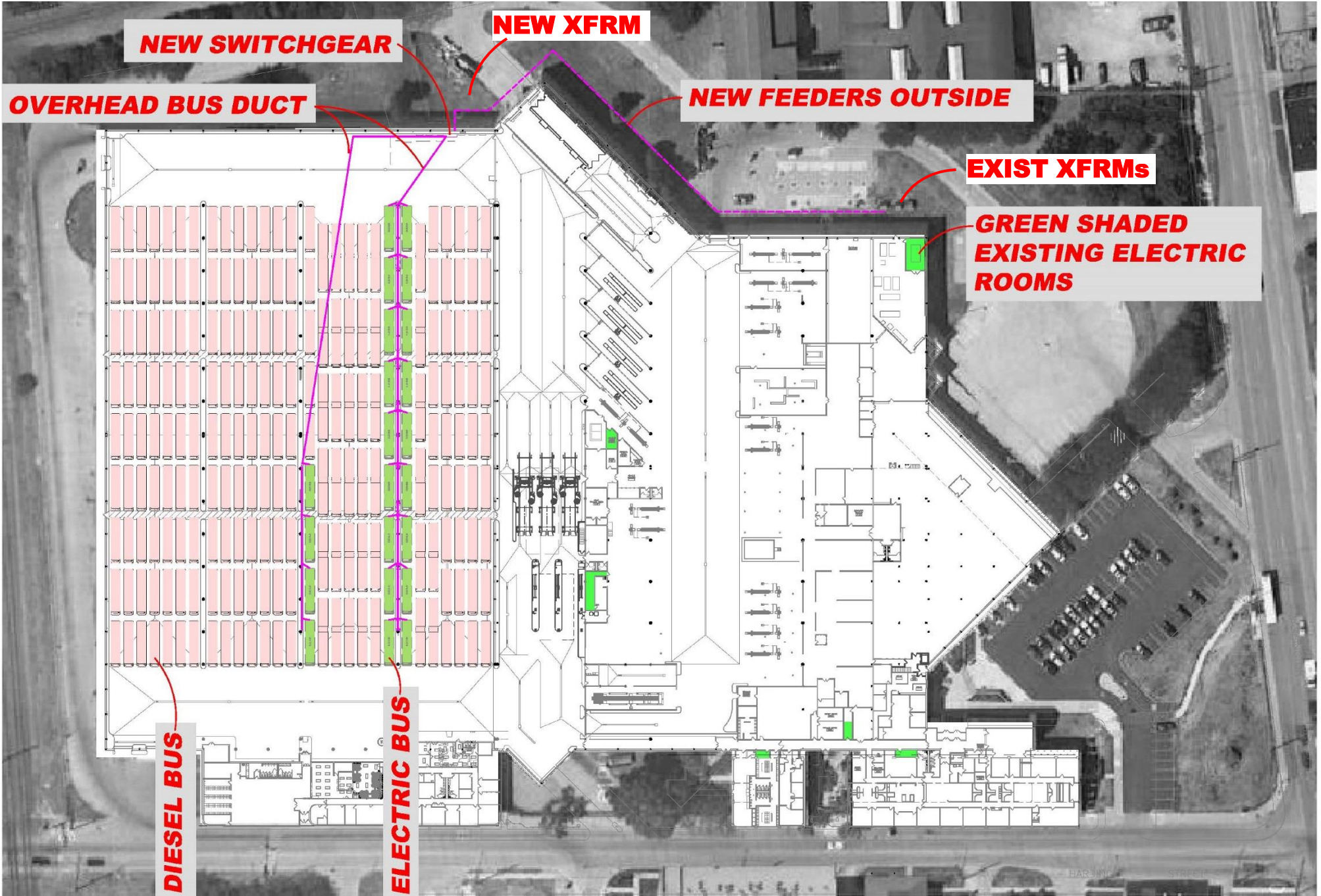




# CHARGER BRICK

## CONCEPT

- Charger Controls
- AC / DC Inverter
- Docking Controls
- Charge Management
- Pneumatics / Charger Movement
- Cooling
- Transformer / Switch Gear
- Backup Generator

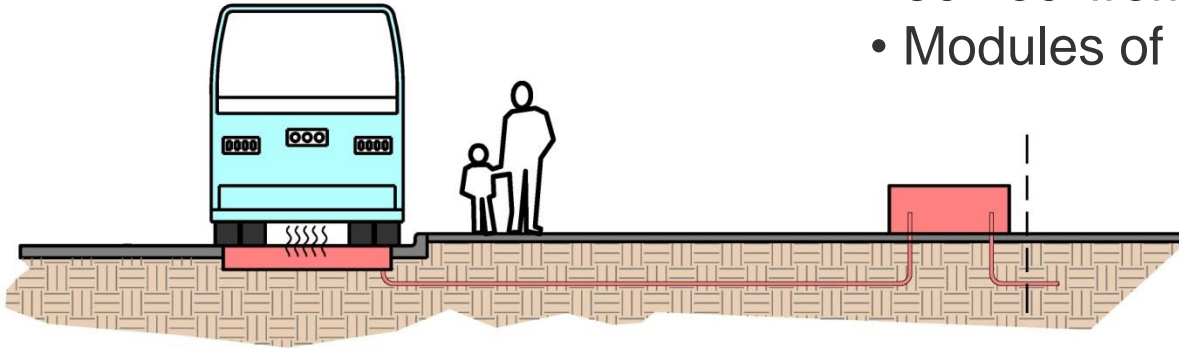


IndyGo, Indianapolis - Brick

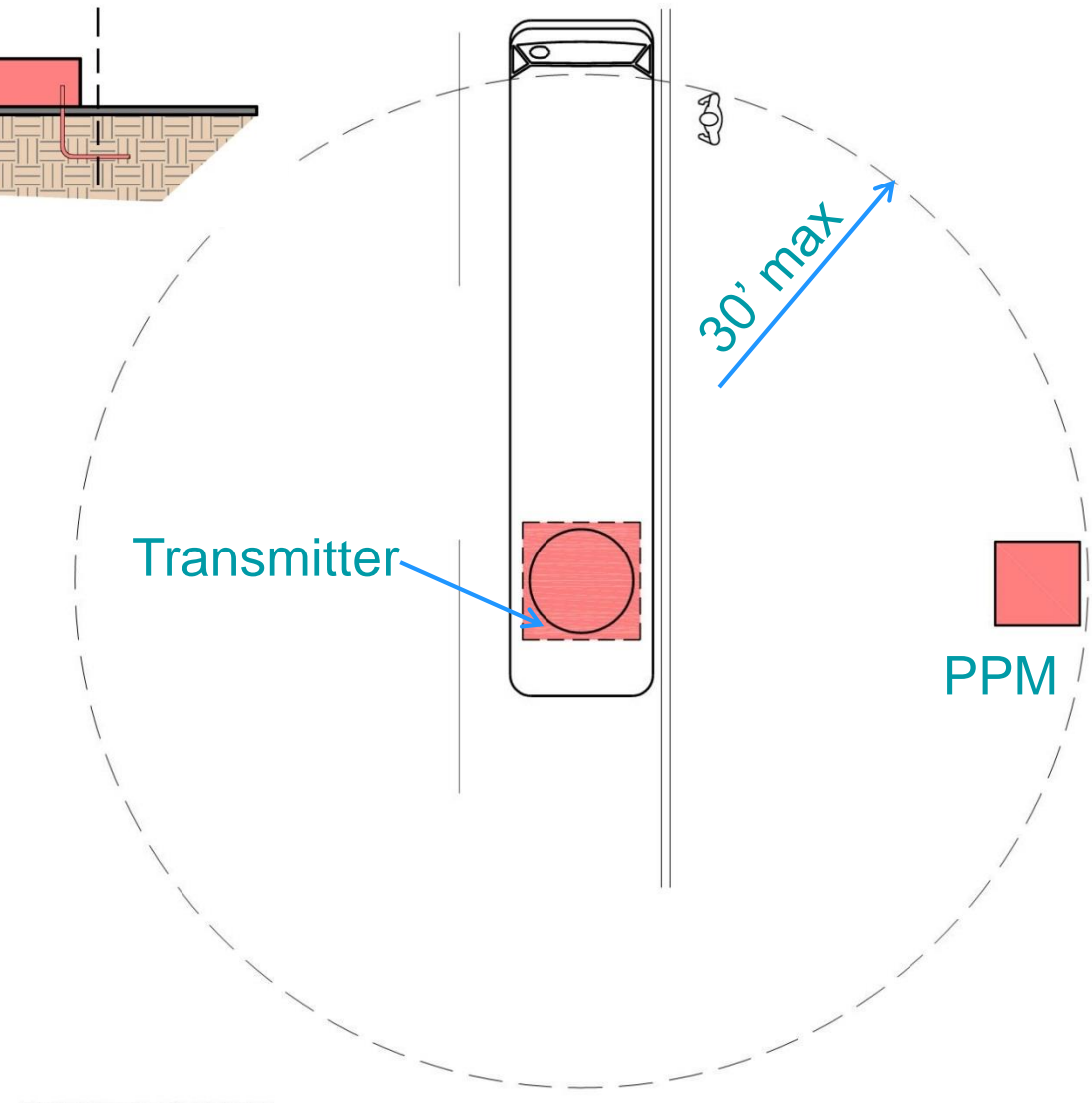


IndyGo, Indianapolis - Brick

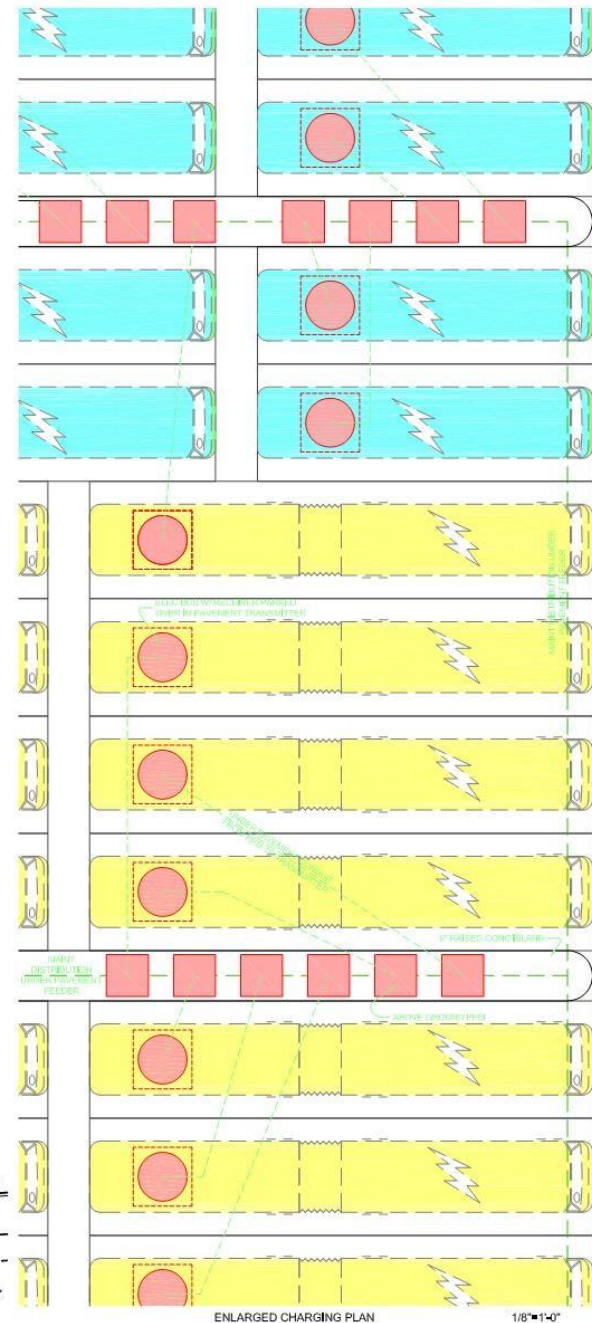
- Primary Power Module – 5'x5'x2'
- 30' -60' from Transmitter
- Modules of 50 – 250+ kw



# CHARGER BRICK INDUCTION

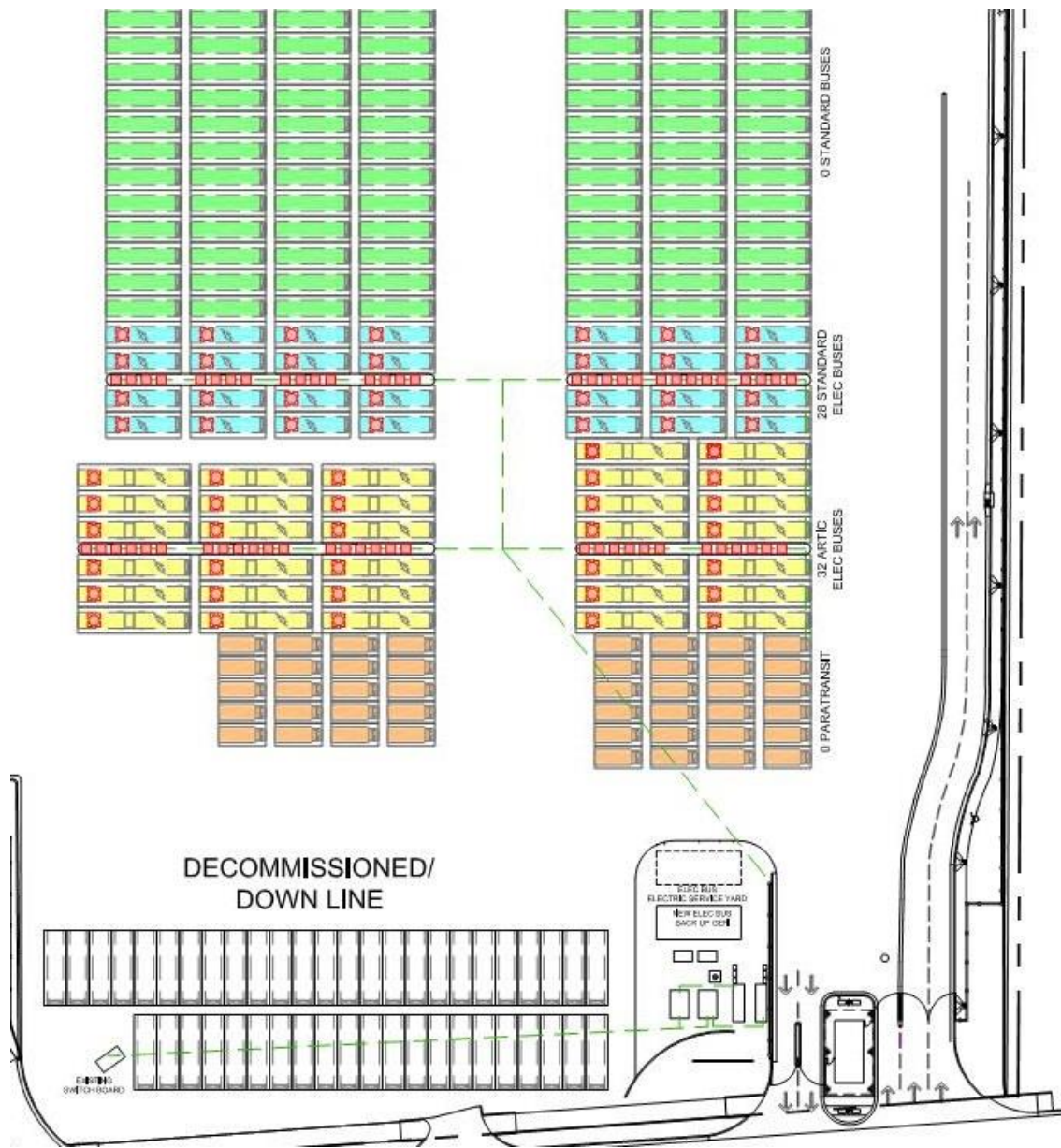


2025  
**FLEET ASSIGNMENT**  
 110 - 40' STD BUS  
 28 - 40' ELEC BUS  
 138 - 40' BUS TOTAL  
 32 - 60' ELECTRIC BUS  
 46 - PARATRANSIT

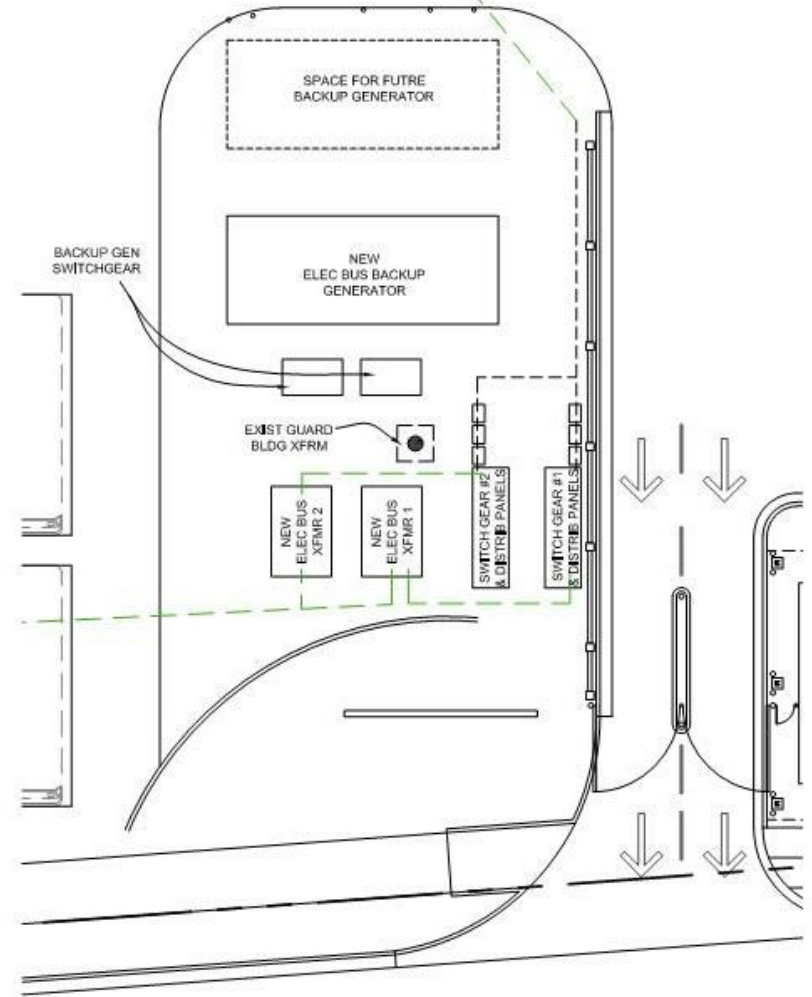


ABQRIDE, Albuquerque – Induction,  
 In Place, Slow Charge





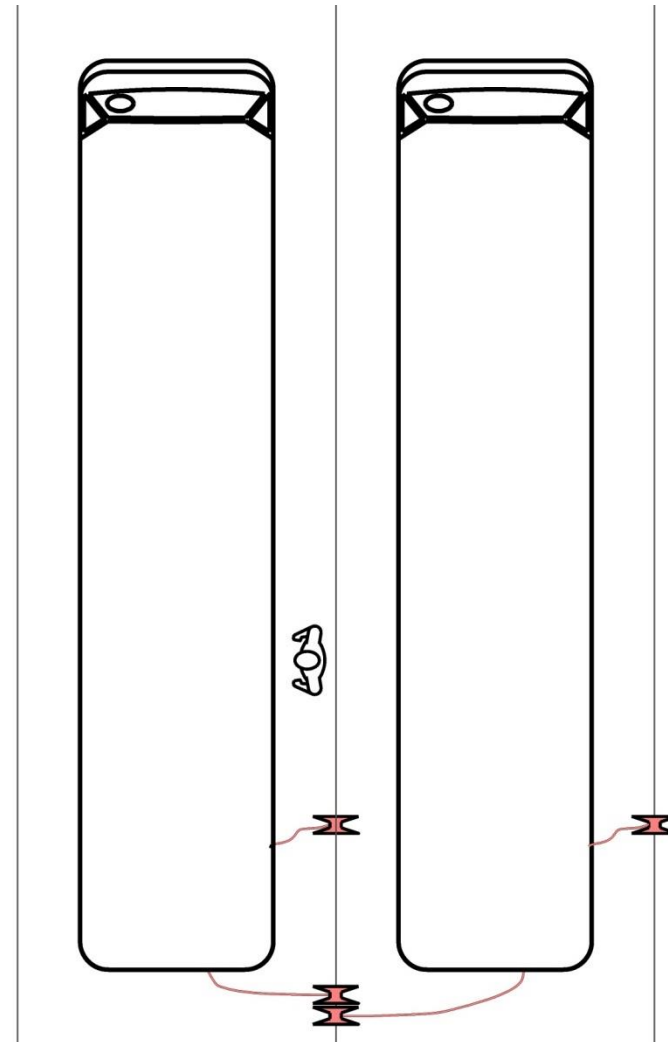
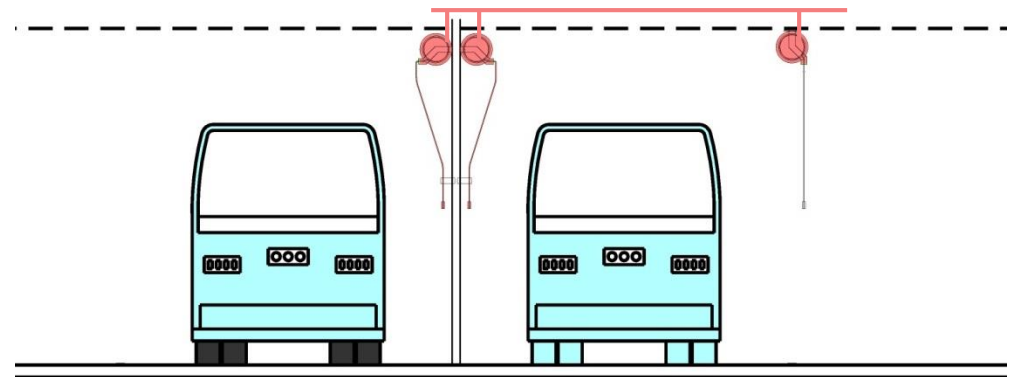
NOTE:  
LAYOUT ASSUMES ABQ RIDE PURCHASED TRANSFORMERS.  
IF PNM PROVIDES TRANSFORMERS ADDITIONAL CLEARANCE  
SPACE WILL BE REQUIRED AROUND UNITS.



ABQRIDE, Albuquerque – Induction,  
In Place, Slow Charge



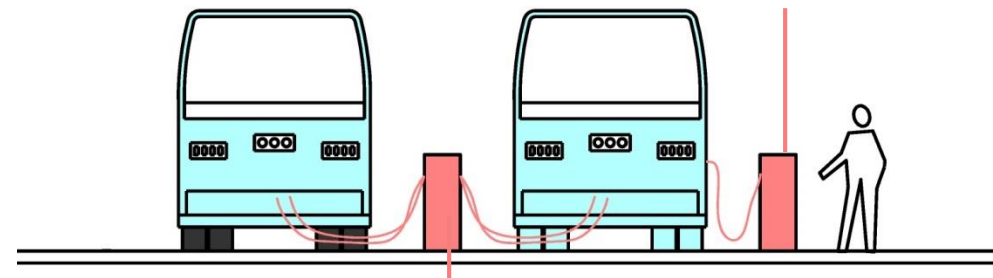
- Overhead on Reels or Tensioner
- Power from Above or Below
- 35kw 100 amps 3 ph



# CHARGER BRICK

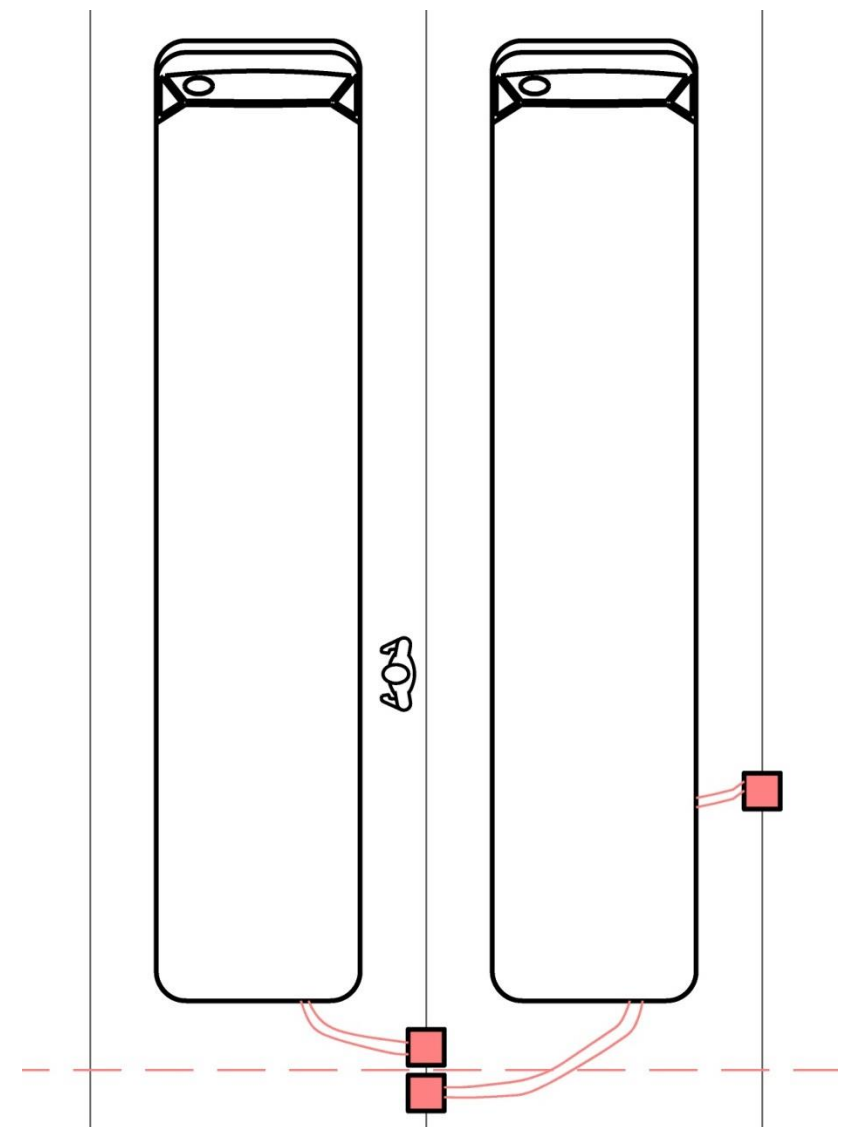
PLUG-IN  
SIMPLE

- Manufacturer / Fabricated / Universal
- Power from Above or Below
- Power varies – 100 amp to 200 kw



# CHARGER BRICK

## PLUG-IN COMPLEX





# CHARGER BRICK

## PLUG-IN COMPLEX



### PLUG-IN SHOP CHARGING TIMES

100 kW Charge Times - 10% State of Charge (SOC) to 90% SOC	
100 kWh ESS	48 minutes
150 kWh ESS	72 minutes
200 kWh ESS	96 minutes
250 kWh ESS	120 minutes
300 kWh ESS	144 minutes



2025  
**FLEET ASSIGNMENT**  
 110 - 40' STD BUS  
 28 - 40' ELEC BUS  
 138 - 40' ARTIC BUS  
 32 - 60' ELEC ARTIC BUS  
 46 - PARATRANSIT

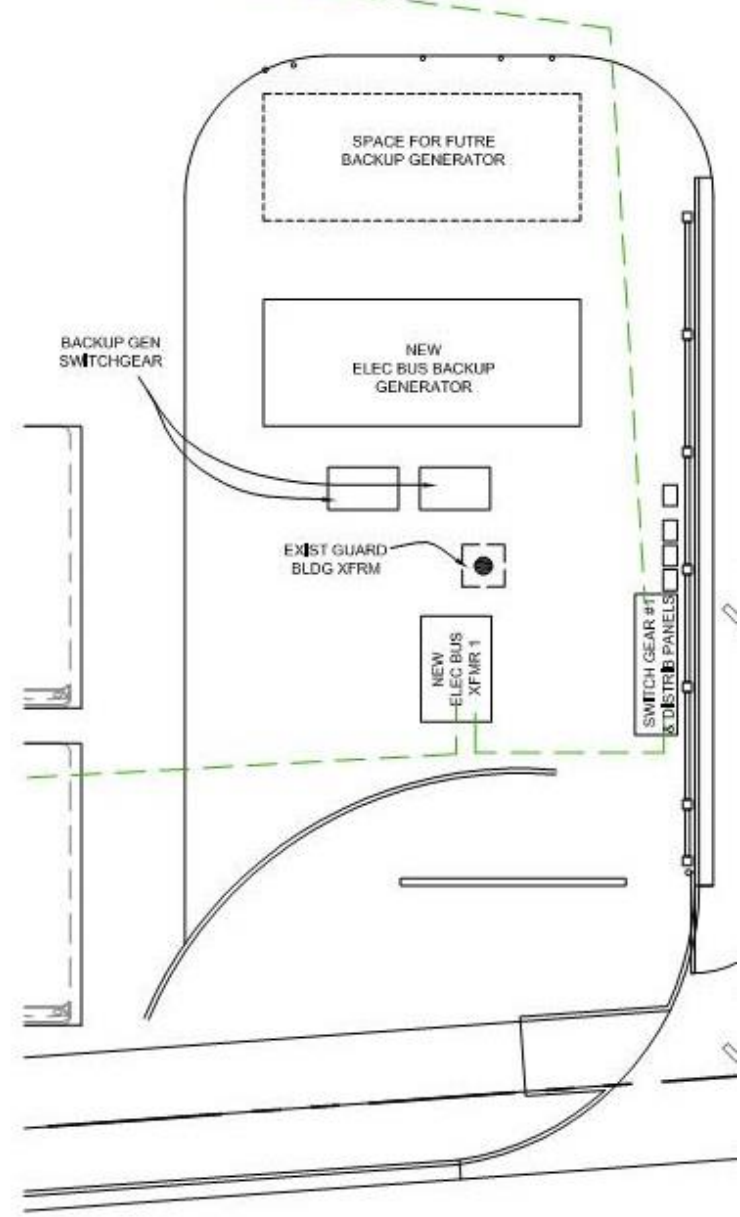
ENLARGED CHARGING PLAN 1/8"=1'-0"

# ABQRIDE, Albuquerque – Plug In, Shared Position, Fast Charge

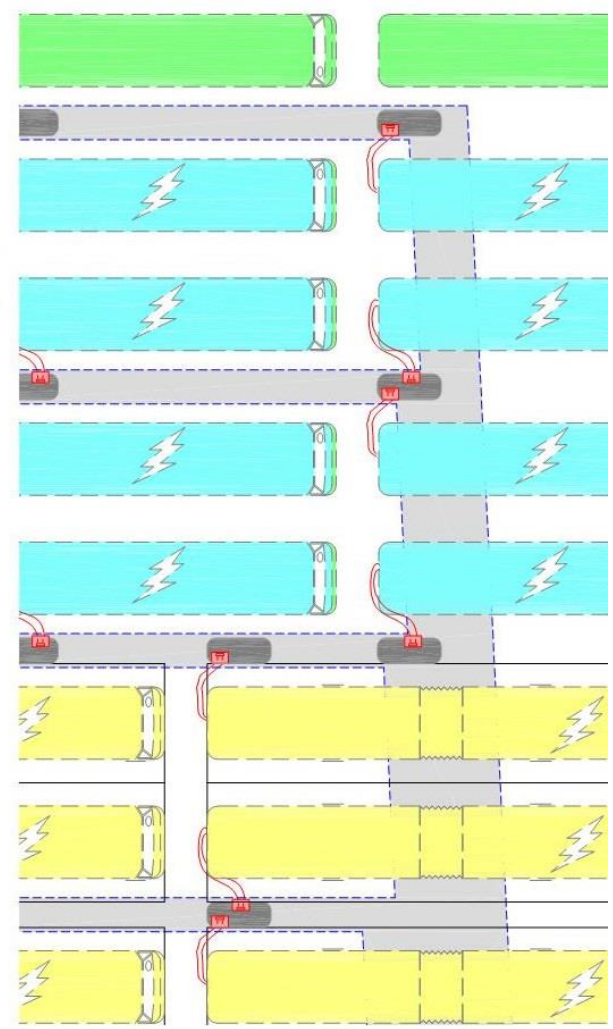




NOTE:  
 LAYOUT ASSUMES ABQ RIDE PURCHASED TRANSFORMERS.  
 IF PNM PROVIDES TRANSFORMERS ADDITIONAL CLEARANCE  
 SPACE WILL BE REQUIRED AROUND UNITS.

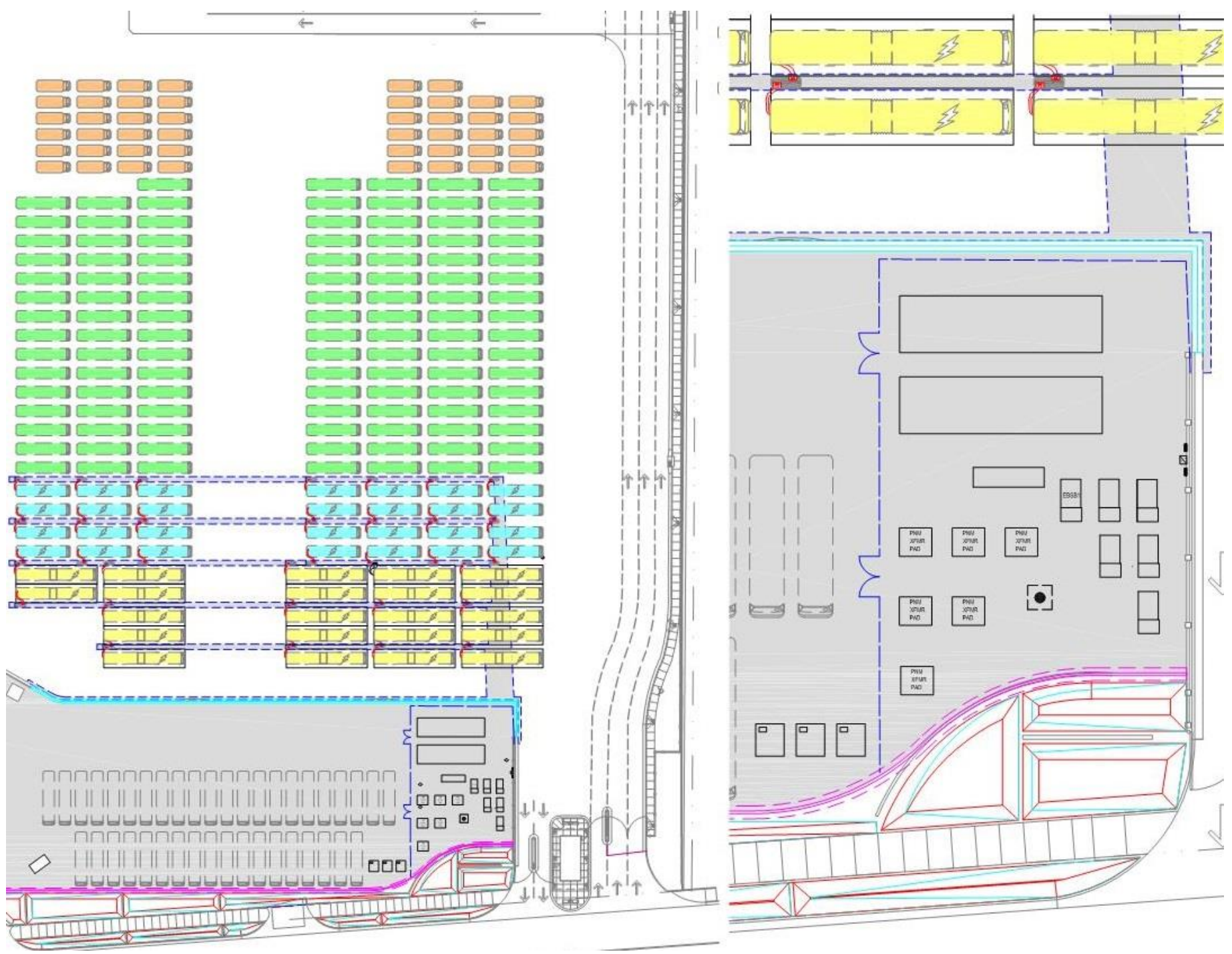


ABQRIDE, Albuquerque – Plug In,  
 Shared Position, Fast Charge

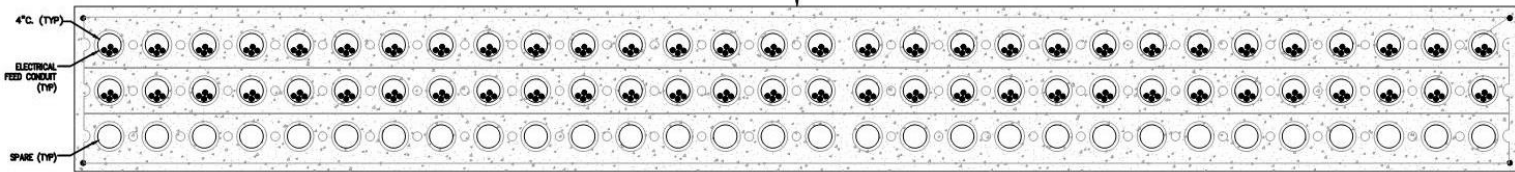
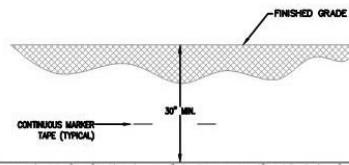
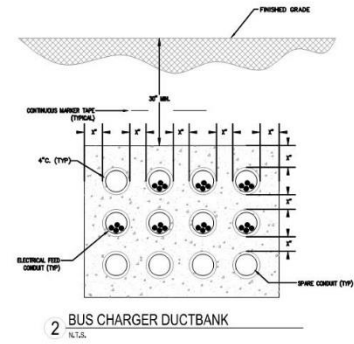
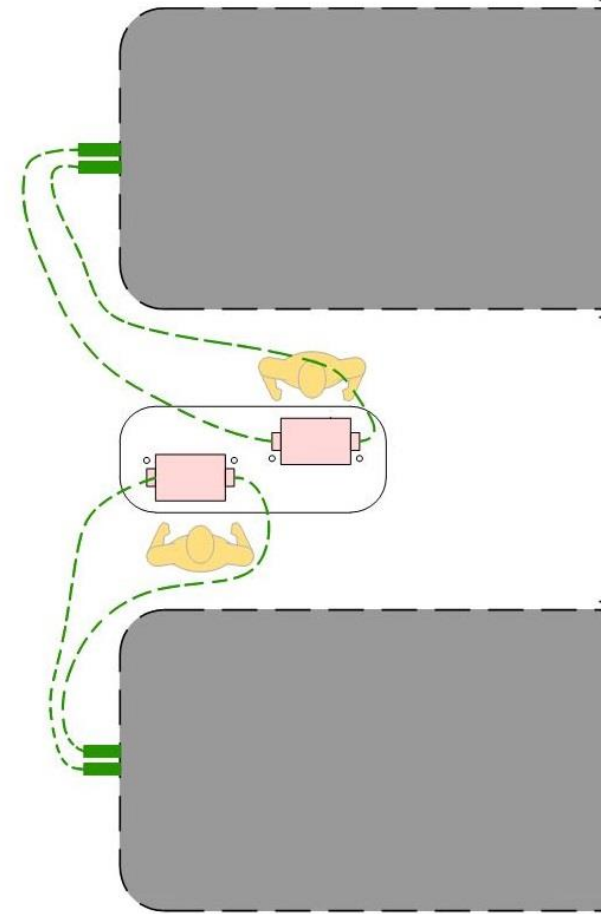
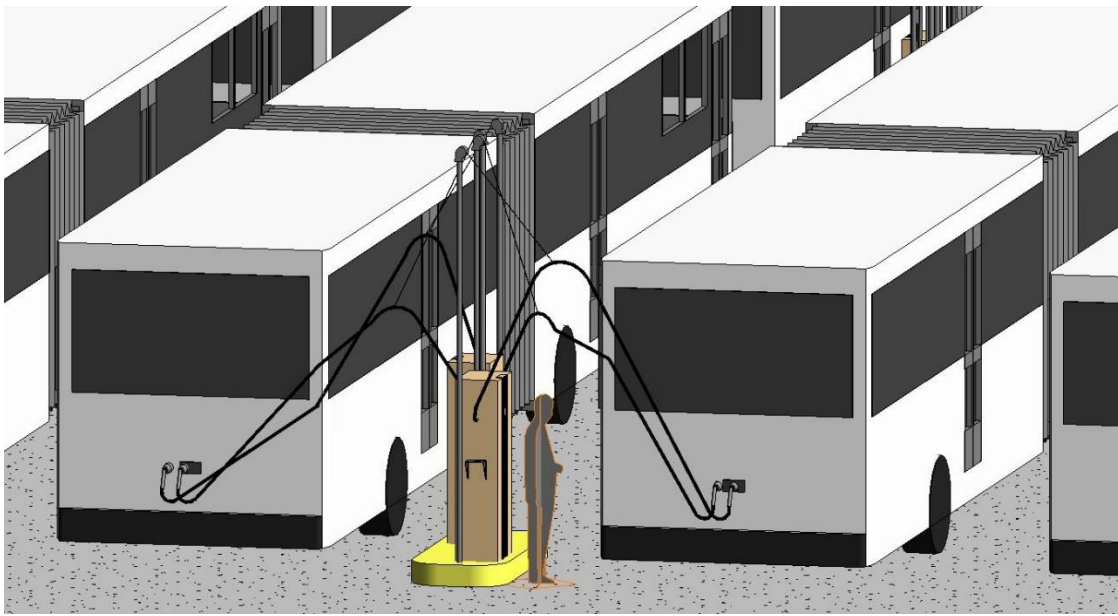


ENLARGED CHARGING PLAN 1/8"=1'-0"

ABQRIDE, Albuquerque – Plug In,  
In Place, Fast Charge



ABQRIDE, Albuquerque – Plug In,  
In Place, Fast Charge



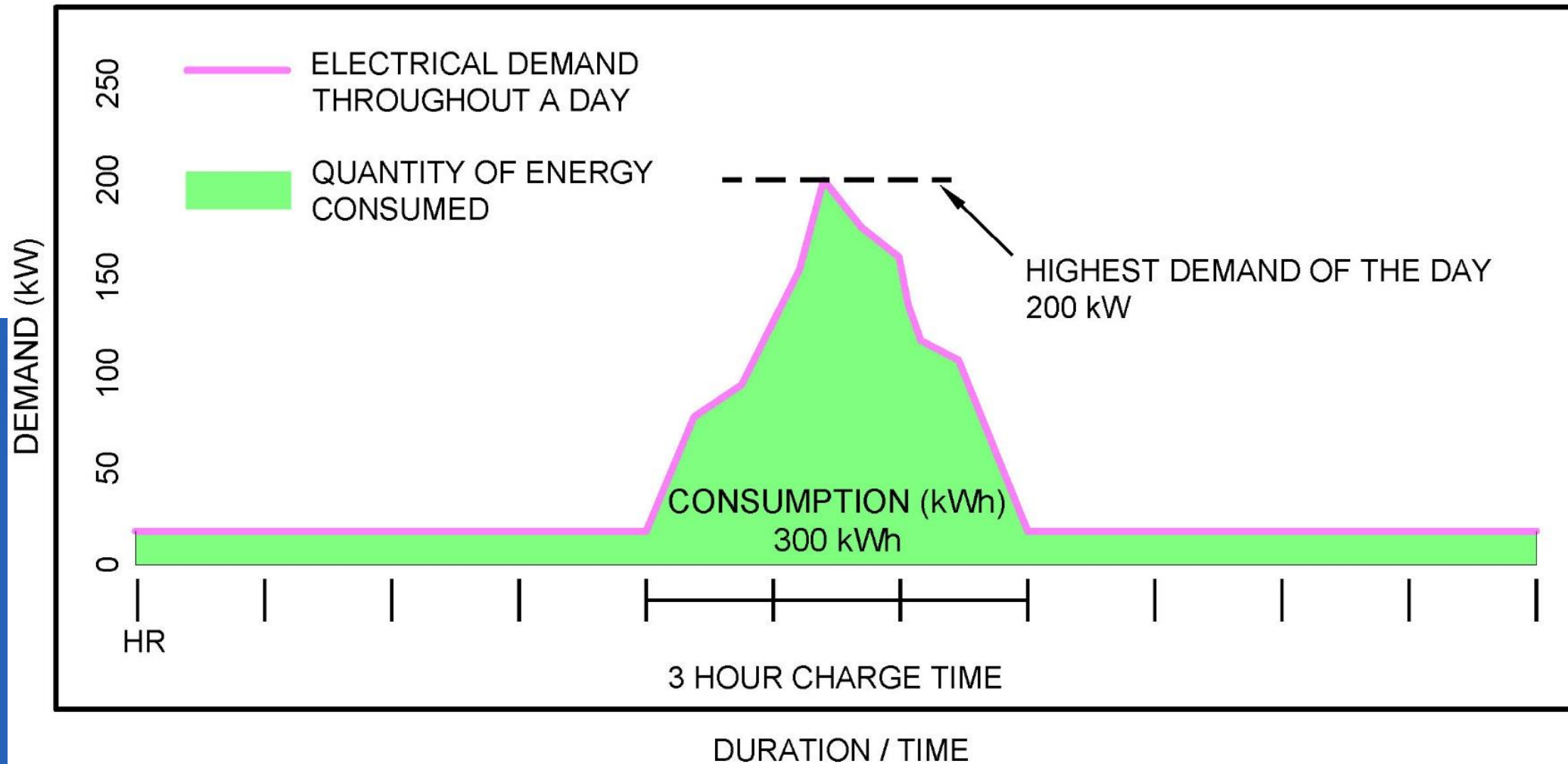
ABQRIDE, Albuquerque – Plug In,  
In Place, Fast Charge



# In Place Diagnostics



# EXAMPLE: DEMAND VS CONSUMPTION FOR A SINGLE CHARGER



Electrical Utility  
Demand Charge

[Jewels.Carter@wsp.com](mailto:Jewels.Carter@wsp.com)  
281-589-5878