Generation ZEB

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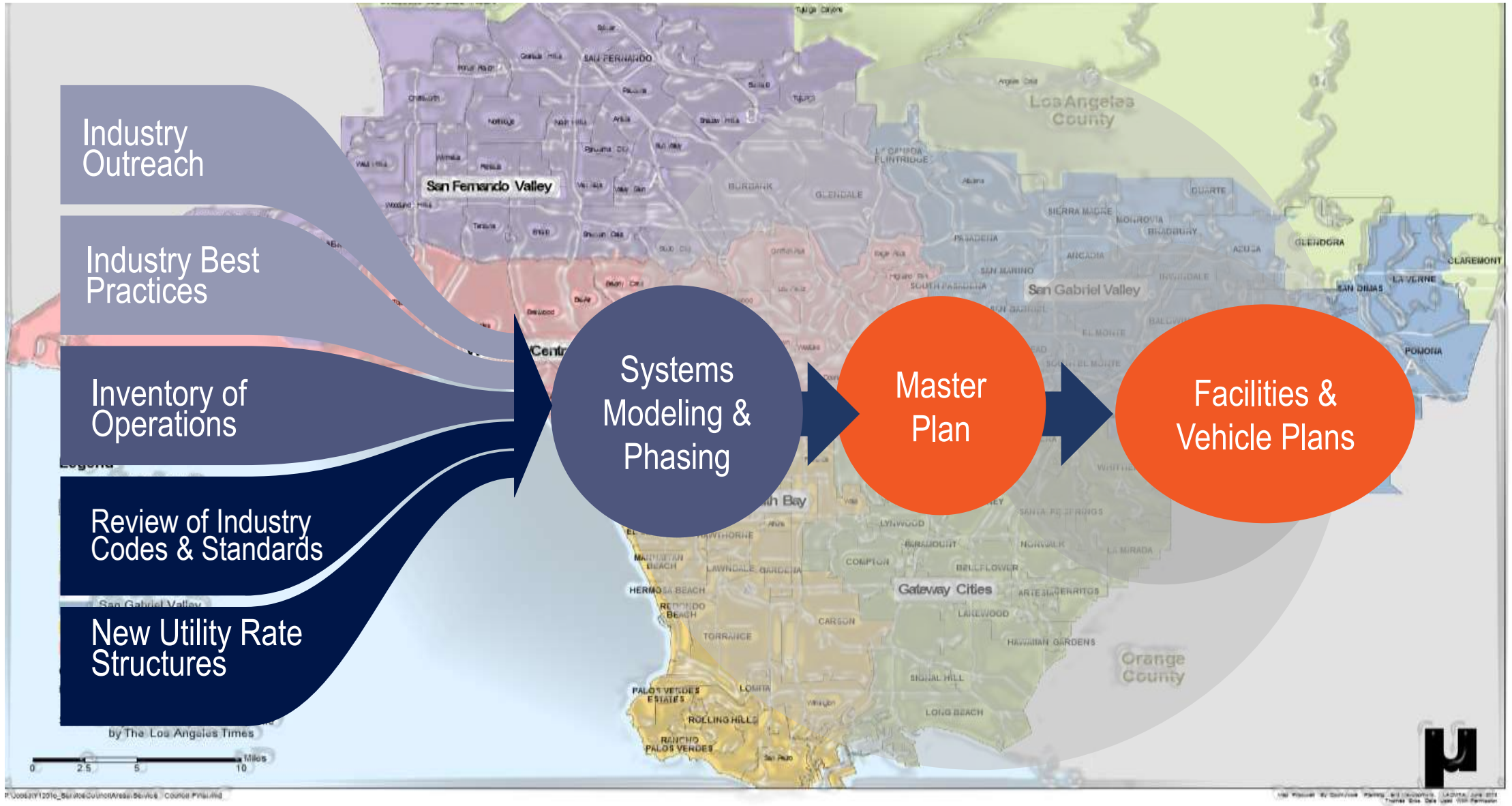
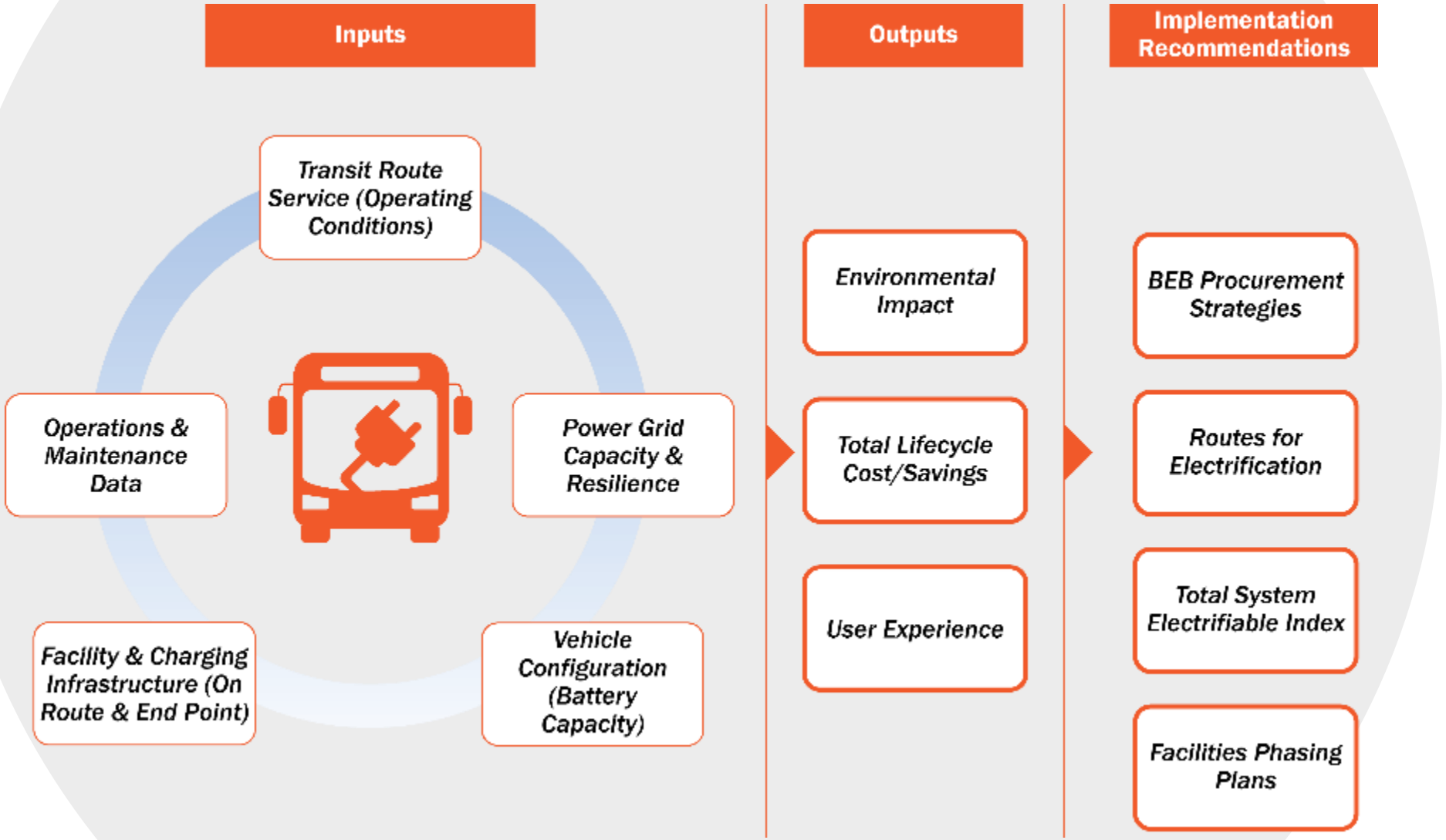
November 2019

Phases of designing a ZEB Program



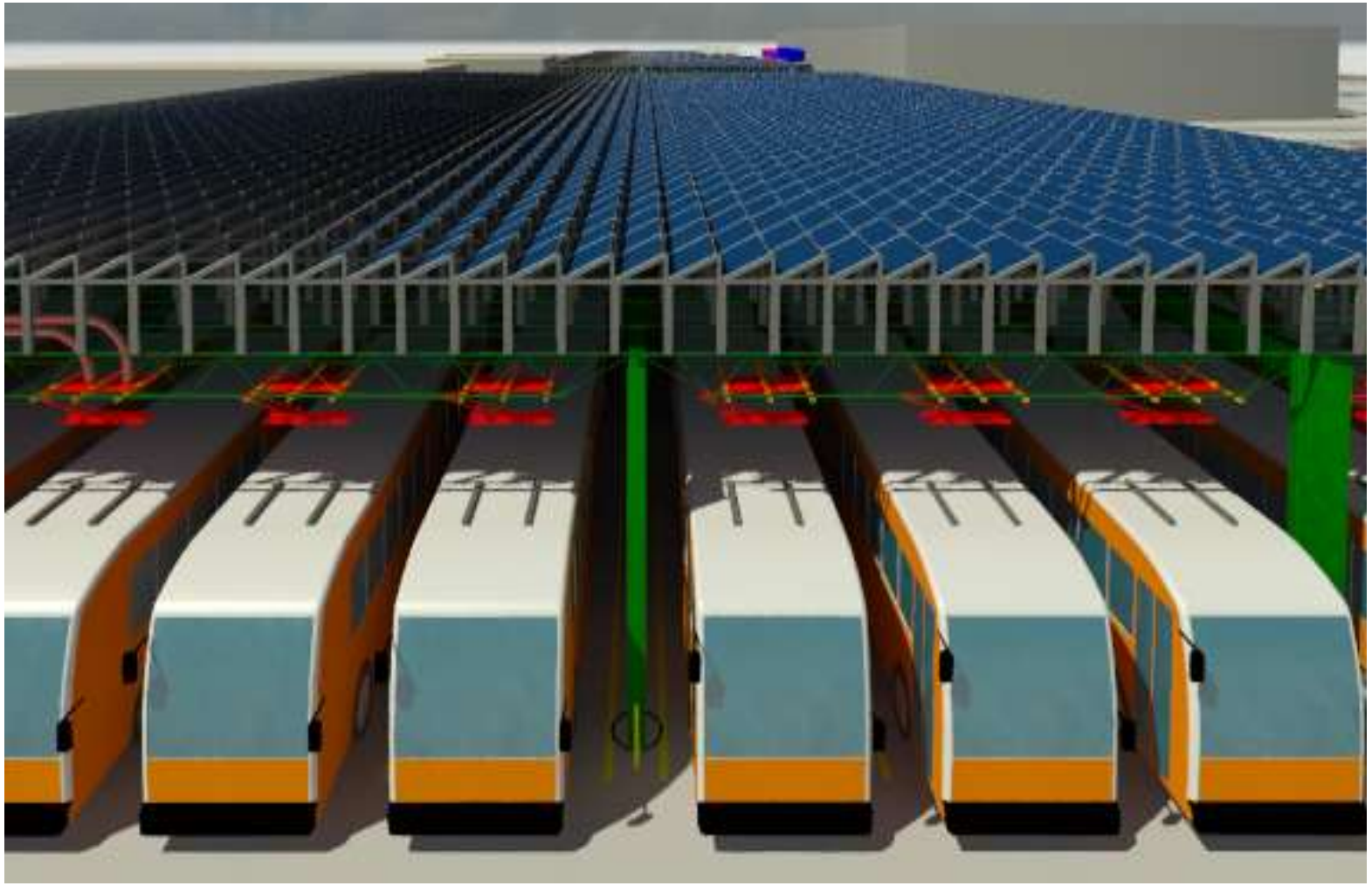
ZEB System Modeling and Phasing



ZEB Equipment Procurement

Manufacturer	ZEB Models	Annual Production 2017	Annual Production 2018	Deliveries of ZEBs (2009-2017)
New Flyer	XE-60, XE-40 BEB/FCEB	2,105	2,238	71
Gillig	35 ft., 40 ft. low floor BEB	1,753	1,877	4
Proterra	Catalyst FC, Catalyst XR, Catalyst E2	48	135	248
BYD USA	K7, K9, K11, C10	114	128	377
El Dorado National	40 ft. FCEB	369	236	26
Nova BUS	40LFSe, 60LFSe in dev.	1,246	1,205	0
TOTAL		**5,636**	**5,819**	**726** (6%)

ZEB FACILITY PLANNING



Power System Components

Switch

Transformer

Meter, Disconnect & Switchgear

Power Resilience

(Could be trailer mounted, portable)

Redundant Service or On-site Generation

BEB Specific Power | Generic Power

Dispenser

Dispenser

Charging Station(s)

Power Reliability

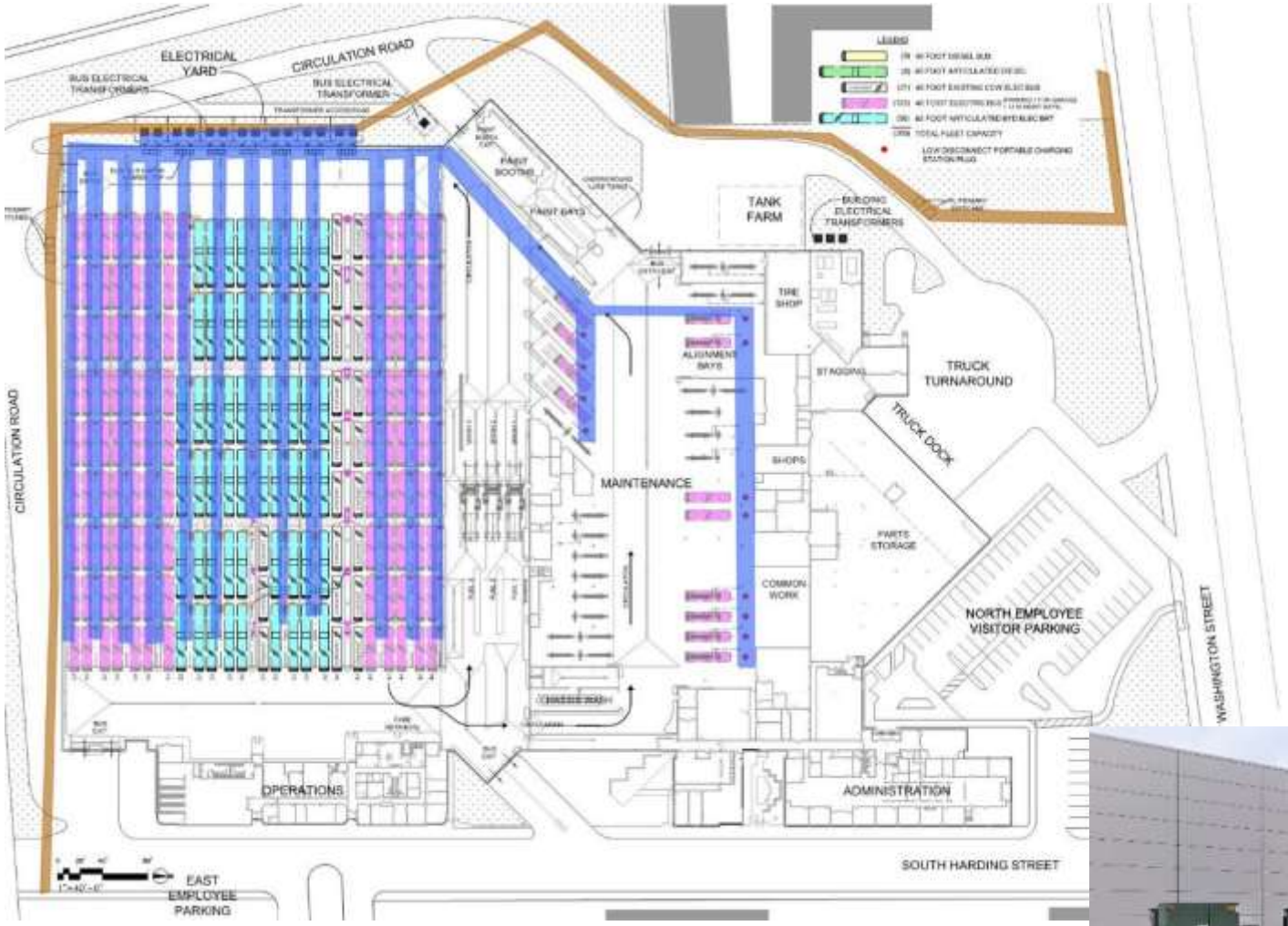
PG&E in its East Bay Division * has:

- **Average time to restore power after an outage at less than 1.5 hours**
  - ✓ Charge time per bus: 2 to 3 hours
  - ✓ Charging window: 8 hours / night
- **Average of 0.761 outages per year**

* Per recent report on reliability in California investor owned utilities

CASE STUDY: INDYGO

Getting enough power to the facility



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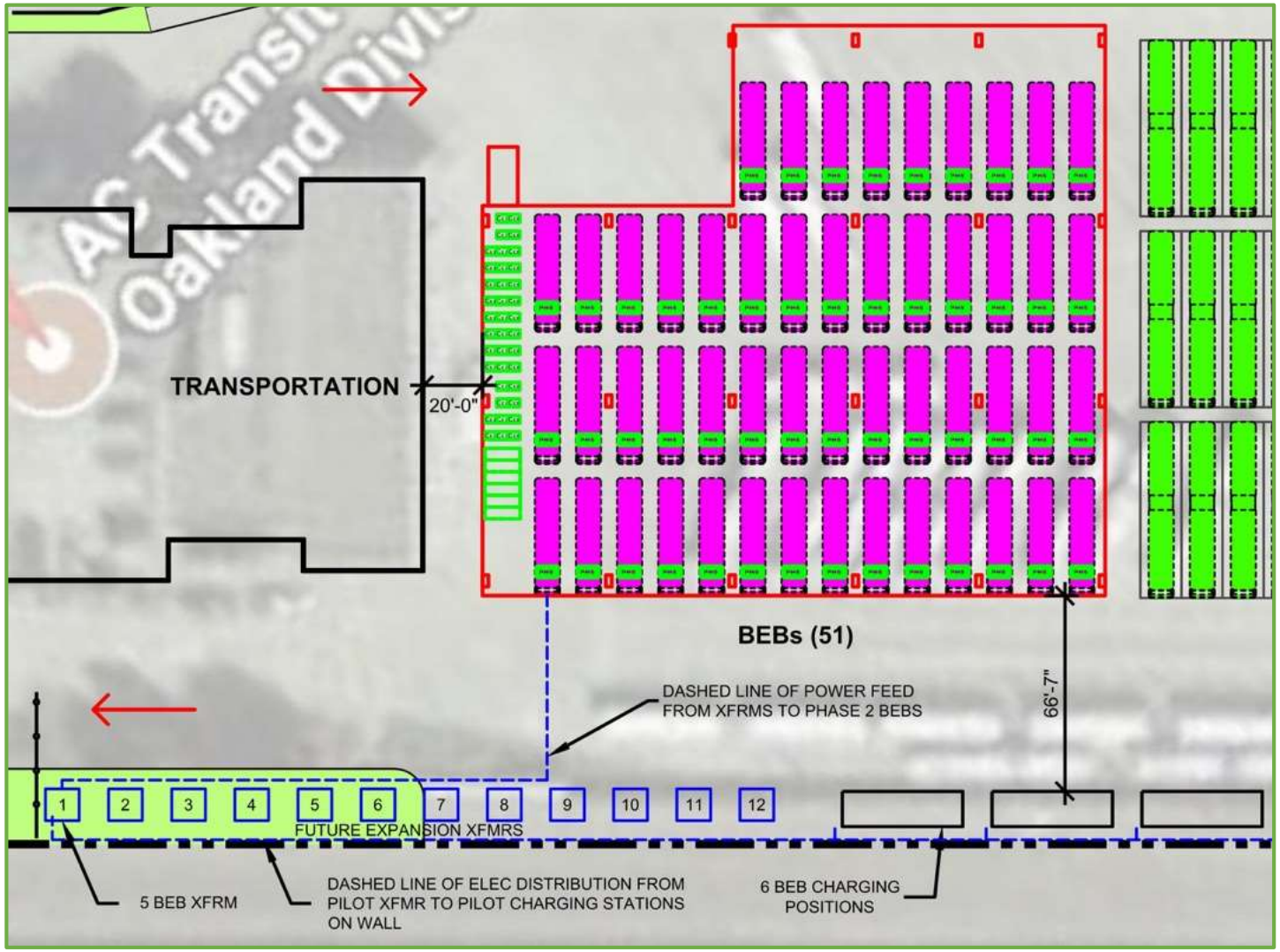


Scalable Solutions

Transformer 1: Installed for 5 BEBs

Transformer 2: For 45 ZEB Project (all options)

Transformer 3: For Options B & C

Transformers 4 thru 12: Future

Emergency Power/Resiliency

- 30 BEB fleet needs approximately 1.8mW to charge within the nightly charging window.
- 2mW generator costs approximately $1.5M.

- As battery prices drop, we may see large scale battery storage systems being deployed in the future as part of our BEB programs.

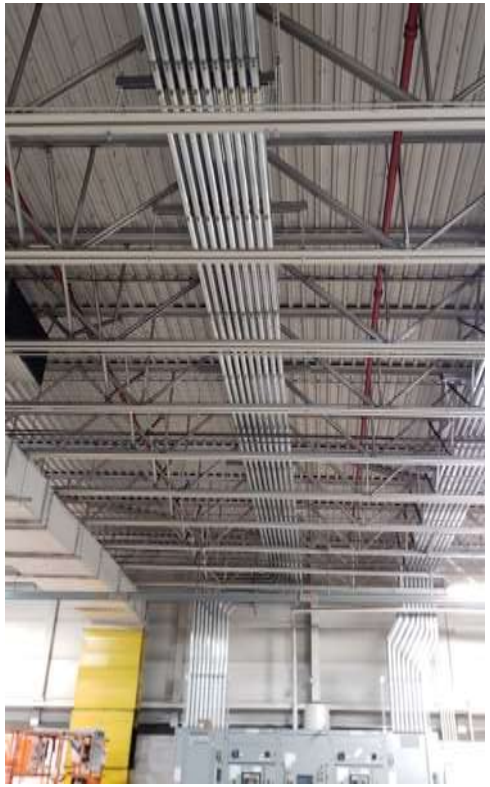
Division Charging – Overhead Charging (Recommended)

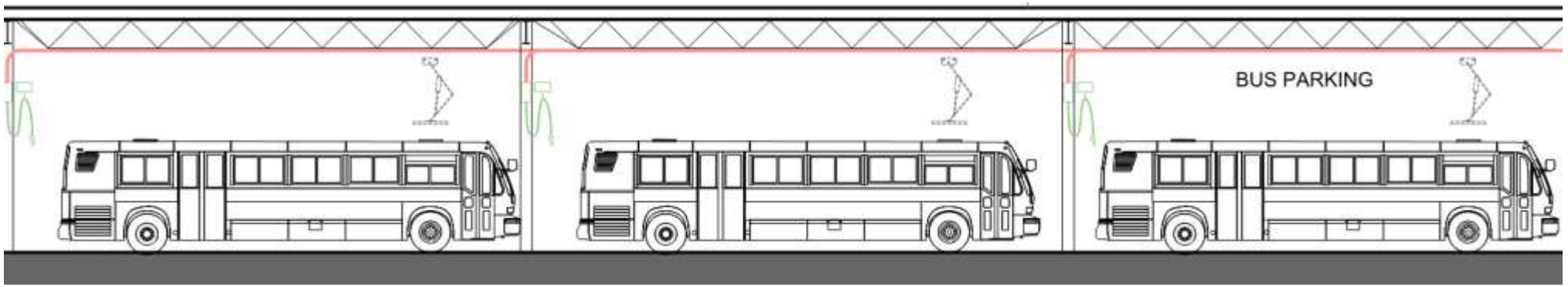
Pros

- Supports variable length vehicles if overhead support continuous
- Structure can support both overhead plug-in drops & pantograph if continuous
- Allows overhead distribution in lieu of under ground distribution
- Provides flexibility for future charging improvements
- Current pantograph 17’-0” clear allows for double deckers under structure

Cons

- Add cost for overhead structure if not shared / double utilized
- No large quantity of inverted pantograph depot installs





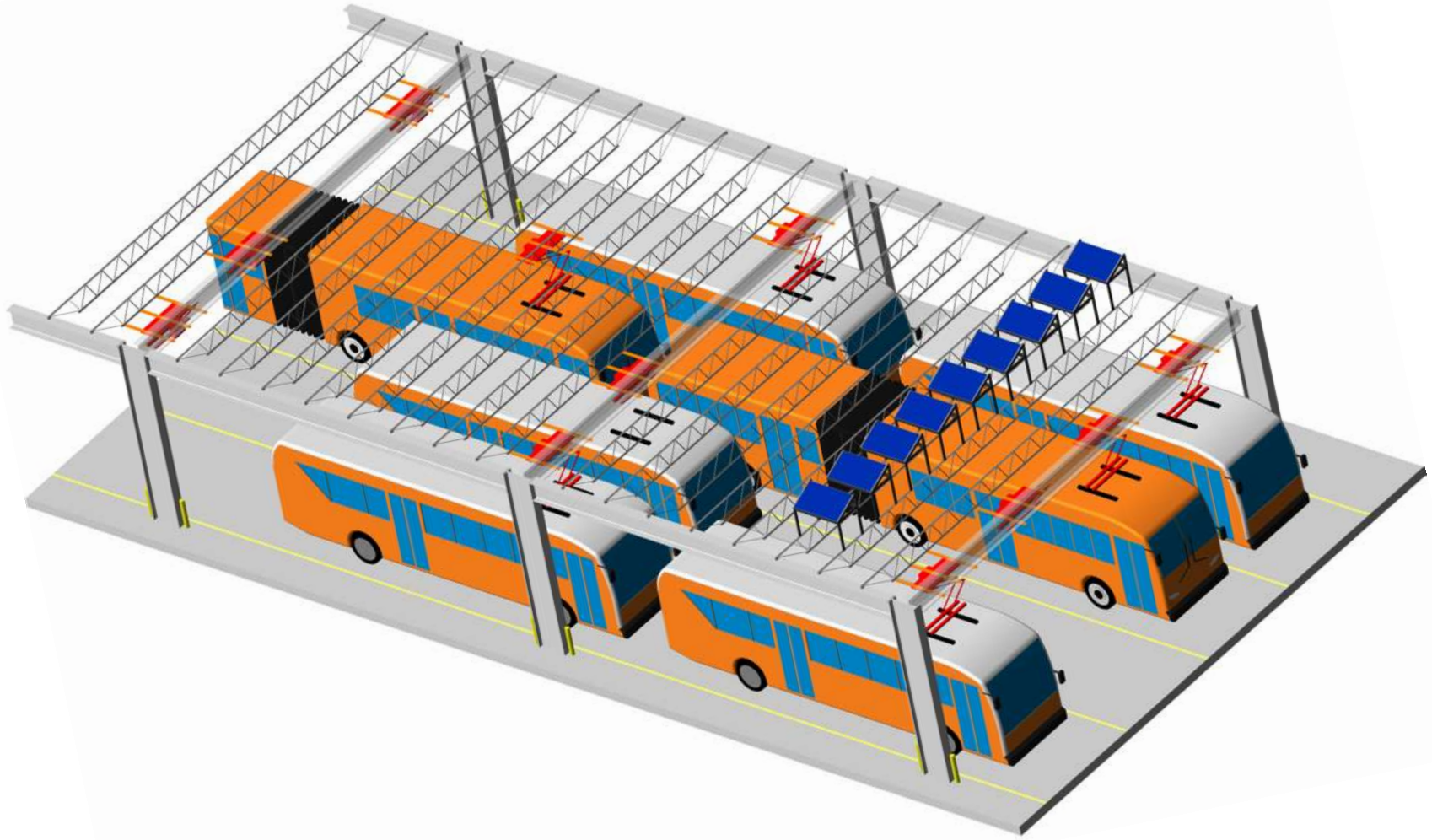
AC Transit - D4 BEB Infrastructure

CASE STUDY: ABQRIDE (NM)

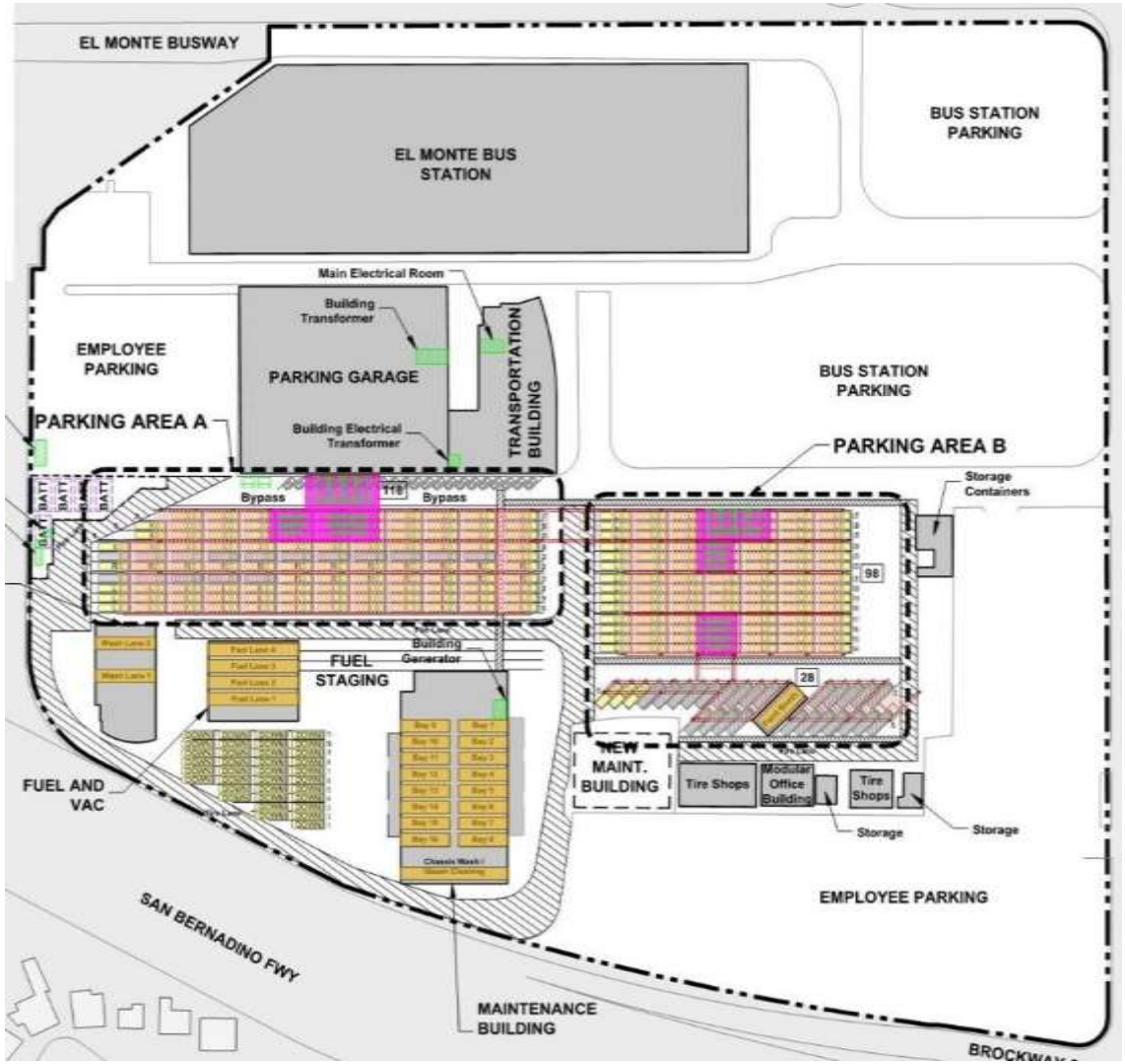
In-ground Power Distribution

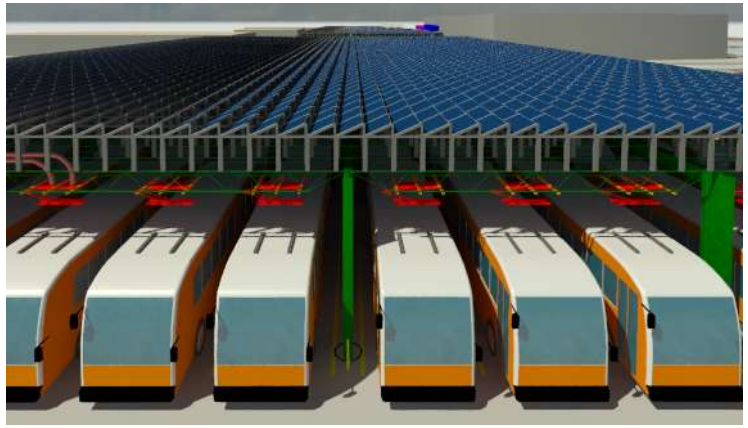
Example of Innovative Charging Solution

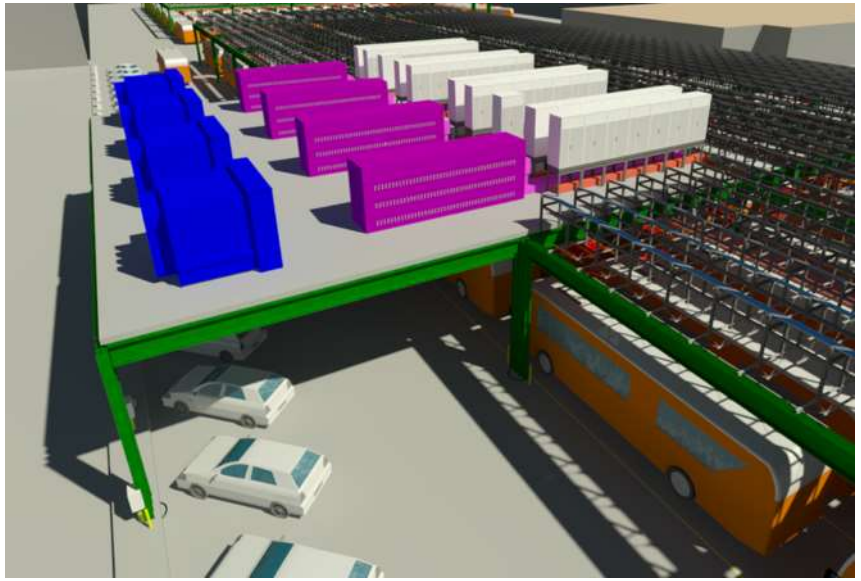
Mixed-vehicle size dynamic charging to preserve flexibility to accommodate 40 ft., 45 ft. and articulated buses



Innovative Bus Charging Infrastructure







Questions?

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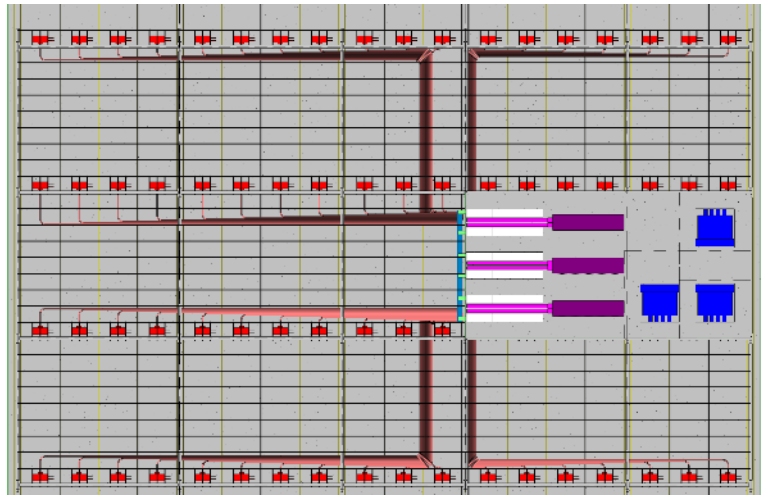
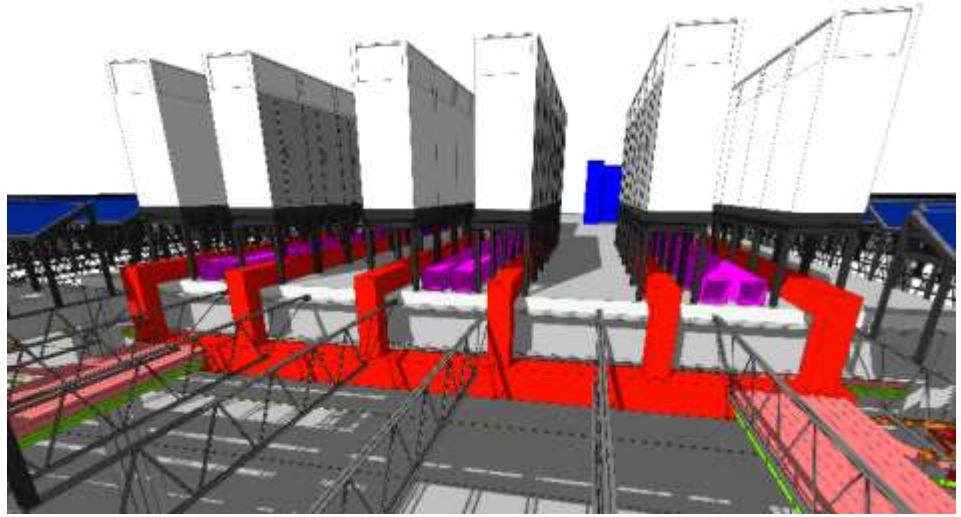
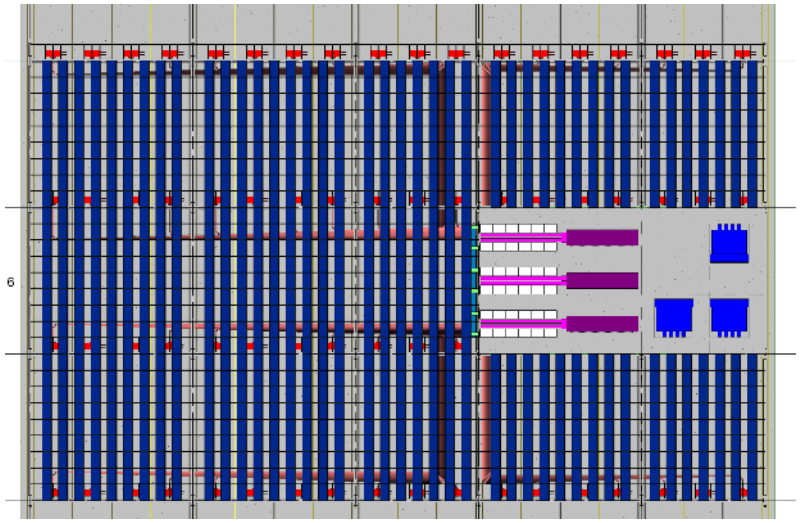
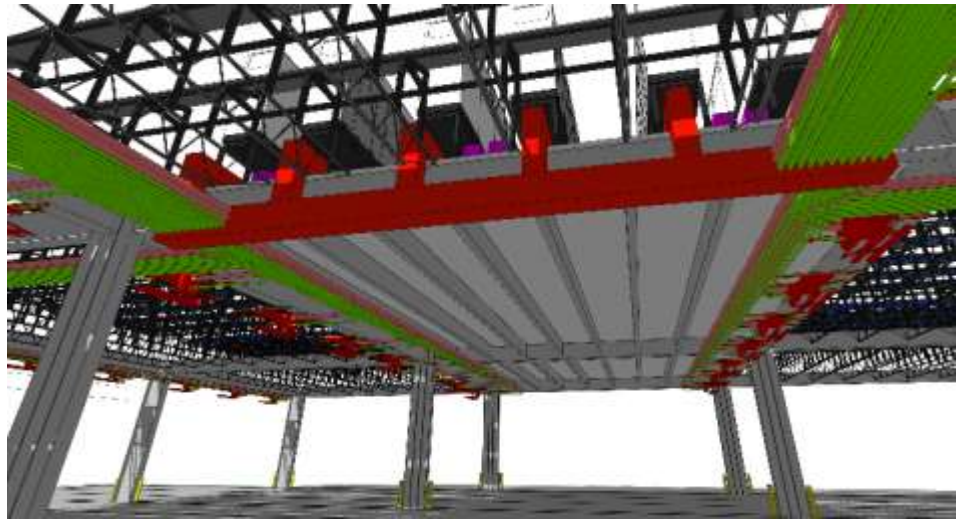
Innovative Bus Charging Infrastructure









CASE STUDY: San Bernardino ZEB Master Plan

- Analysis for transition from existing fleets (six operating agencies) to 100% Zero Emission Buses (ZEBs) by 2040
- 12-month Project covering 5 Operators
- Deliverables:
  - Existing Operations Assessments
  - ZEB requirements to meet existing service
  - Service block analysis (BOLT Model) and recommended modifications
  - O&M cost comparisons (BEB vs. HFC vs CNG/Diesel)