Los Angeles County
Metropolitan Transportation
Authority
One Gateway Plaza
3rd Floor Board Room
Los Angeles, CA

Metro

Board Report

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OPERATIONS, SAFETY AND CUSTOMER EXPERIENCE COMMITTEE
JULY 18, 2019

SUBJECT: METRO BUS FLEET FORECAST AND ZERO EMISSION BUS PROGRAM UPDATE

ACTION: RECEIVE AND FILE

RECOMMENDATION

RECEIVE AND FILE status report on the Zero Emission Bus Program and Bus Fleet Management Plan (BFMP) which summarizes Metro's directly operated and purchased transportation bus vehicle requirements over the next ten years.

ISSUE

In April 2016, Metro's Board of Directors approved a motion to convert Metro's bus fleet to Zero Emission Buses (ZEB) by 2030. Also, in December 2018, the California Air Resources Board (CARB) approved the Innovative Clean Transit (ICT) Regulation that sets a statewide goal for public agencies to gradually transition to 100% ZEB fleet by 2040. Further, Metro's bus vehicle requirements indicate a need to replace 834 buses by 2022. To ensure the fleet is maintained in a State of Good Repair and sufficient quantities are available for service, Metro will need to effect a procurement by September 2019.

DISCUSSION

In April 2016, Metro's Board of Directors approved a motion to convert Metro's bus fleet to Zero Emission Buses (ZEB) by 2030. Also, in December 2018, the California Air Resources Board (CARB) approved the Innovative Clean Transit (ICT) Regulation that sets a statewide goal for public agencies to gradually transition to 100% ZEB fleet by 2040. The ICT Regulation includes the following purchase requirement timeline:

- 2023 - 2025: 25% of buses purchased in this period must be ZEB
- 2026 - 2028: 50% of buses purchased in this period must be ZEB
- 2029 - onward: 100% of buses purchased in this period must be ZEB

Metro has been working to comply with both the Metro Board directive and CARB's ICT Regulation by implementing a two-phase approach. Phase 1 focuses on implementing near-term changes that can be readily applied with existing technology, with minimal impact to service, and minimal risk. It also includes the development of a Master Plan for the transition of the balance of Metro's system.

Specifically, in Phase 1:

- Electrification of Metro Orange Line by 2020
  - Delivery of New Flyer and BYD battery electric buses; quantities of 40 and 5, respectively.
  - Terminal charging installation at North Hollywood and Chatsworth Stations.
  - Overnight charging installation at Division 8 in Chatsworth.
- Electrification of Metro Silver Line by approximately 2021
  - Delivery of BYD battery electric buses, quantity of 60.
  - Terminal charging installation at El Monte Bus Station and Harbor Gateway Transit Center.
  - Overnight charging installation at Division 9 in El Monte.
- Development of Zero Emission Master Plan (Plan)
  - The Plan will define where and how to expand electric bus service by division given current technology and infrastructure capabilities.
  - The plan will be developed iteratively as information becomes available (e.g. NextGen).
  - The first iteration is expected to be completed by September 2019.

In Phase 2, Metro will implement the Zero Emission Master Plan as approved by the Board, will continue to assess ZEB technologies as they mature, and take measured steps toward full transition to 100% ZEB fleet for use throughout Metro's operating region.

Challenges to transitioning to 100% ZEB operation include:

- Infrastructure:
  - Power to the divisions needs to be increased to maintain existing levels of transit service capability. For divisions in SCE territory, the average increase is from 5 MW to 15 MW. Risk is time required by utilities to implement upgrades.
  - Charging infrastructure needs to be added to divisions. The very limited space constraints at the divisions dictates that work must be done in stages to preclude impact to service. The risk is the time needed to complete work.
- Vehicles and technology:
  - Procurement of ZEB's cannot exceed capacity of infrastructure to charge them. Risk is that over-capacity of ZEB's will result in them being severely underused and the warranty period being wasted.
  - Per CA regulations, by 2022 curb weight limits will drop from 24,000 lb. to 22,000 lb. The risks are that currently compliant ZEB configurations will not comply in 2022 or will not be able to add batteries to increase range.
  - Performance of ZEB's still does not match that of CNG buses. Risk is that number of ZEB's procured will need to exceed number of CNG buses being retired just to maintain existing levels of transit service
  - ZE vehicle and charging strategies are still not fully mature or service proven. Risk is the limited interoperability between vehicles and charging equipment will impact service.
- Costs:

- Infrastructure: The estimated cost to transition Metro's divisions to 100% ZE operations is approximately between $700M to $1B.
- Vehicles: ZE buses are currently $100,000 to $300,000 more expensive than conventional 40 ft. CNG buses.
- Operating Costs: are not fully known at this time
- Utility Costs: are not fully known at this time.

BUS FLEET MANAGEMENT PLAN

Metro also maintains a Bus Fleet Management Plan (BFMP) that provides a long-term outlook on bus replacement requirements based on service needs, State of Good Repair (SGR) and life-cycle.

Assumptions to the BFMP include:

- Life Cycle - Federal Transit Administration (FTA) defines a bus life cycle at 12 years. Metro allows buses to extend to 15 years. However, Metro recently has extended buses to 18 years to maintain the fleet requirement.
- Spare Ratio - FTA recommends an additional 20% fleet above the peak vehicle requirement (PVR) to accommodate regular maintenance of transit vehicles and ability to scale transit service when needed. While Metro aims to provide a 20% spare ratio, it is allowable to drop to 15%.
- Fleet Requirement - based on current peak hour service levels
- New Projects - Upcoming initiatives such as future Bus Rapid Transit (BRT) lines or new services are also considered

Based on the BFMP, our peak vehicle requirement (PVR) is 1,961 buses. Added with a 20% spare ratio, our total fleet size is currently 2,368 buses.

DECOMMISSIONING OF BUSES AND FUTURE IMPACTS

Between 2018 and 2022, Metro anticipates decommissioning of 834 buses. An additional 351 buses will also be eligible for decommissioning by 2024. However, Metro's current order of electric and CNG buses approved in 2017 will result in delivery of only 470 new buses. Therefore, Metro will be 364 buses short in 2022 without additional action taken.

OPTIONS TO BRIDGE THE GAP

In 2020 there will be a shortage of 364 buses if no additional action is taken. The need may be greater if the ZEB to CNG replacement ratio exceeds 1:1, there are reliability issues due to the introduction of new technologies, or if there are unexpected operational challenges. The following options exist to mitigate the anticipated shortage:

- Exercise existing CNG bus option for 440 buses (205 40 ft. + 235 60 ft.)
- Exercise existing Electric bus options for 100 options (forty 40 ft + sixty 60 ft)
- Re-tank buses due for retirement
    - Impacts include extending a component of the existing bus fleet while other key operational components continue to age;
    - No improvement to emissions levels

- Reduce Service to match bus fleet availability
    - Impacts include more crowding, longer wait times, shorter spans, and/or less geographic coverage, as well as reduced customer satisfaction.

DETERMINATION OF SAFETY IMPACT

This will report will have a positive impact on system safety, service quality, and system reliability for our customers.

FINANCIAL IMPACT

Currently, this report does not have a financial impact.

IMPLEMENTATION OF STRATEGIC PLAN GOALS

This item supports the following Strategic Goals 1) Provide high-quality mobility options that enable people to spend less time traveling and 5) Provide responsive, accountable, and trustworthy governance within the Metro organization.

NEXT STEPS

Staff will continue to monitor and update the Bus Fleet Forecast as data are available and projections revised, reflecting any new Board approved projects, operating results, and proposed bus procurement program. In September 2019, staff will return to the Board with a recommended bus procurement program to fulfill the near-term gap in fleet requirement.

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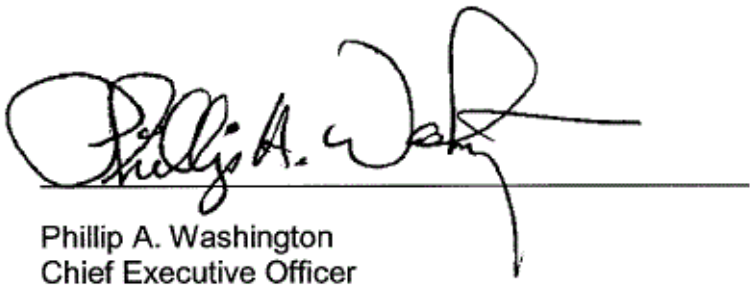
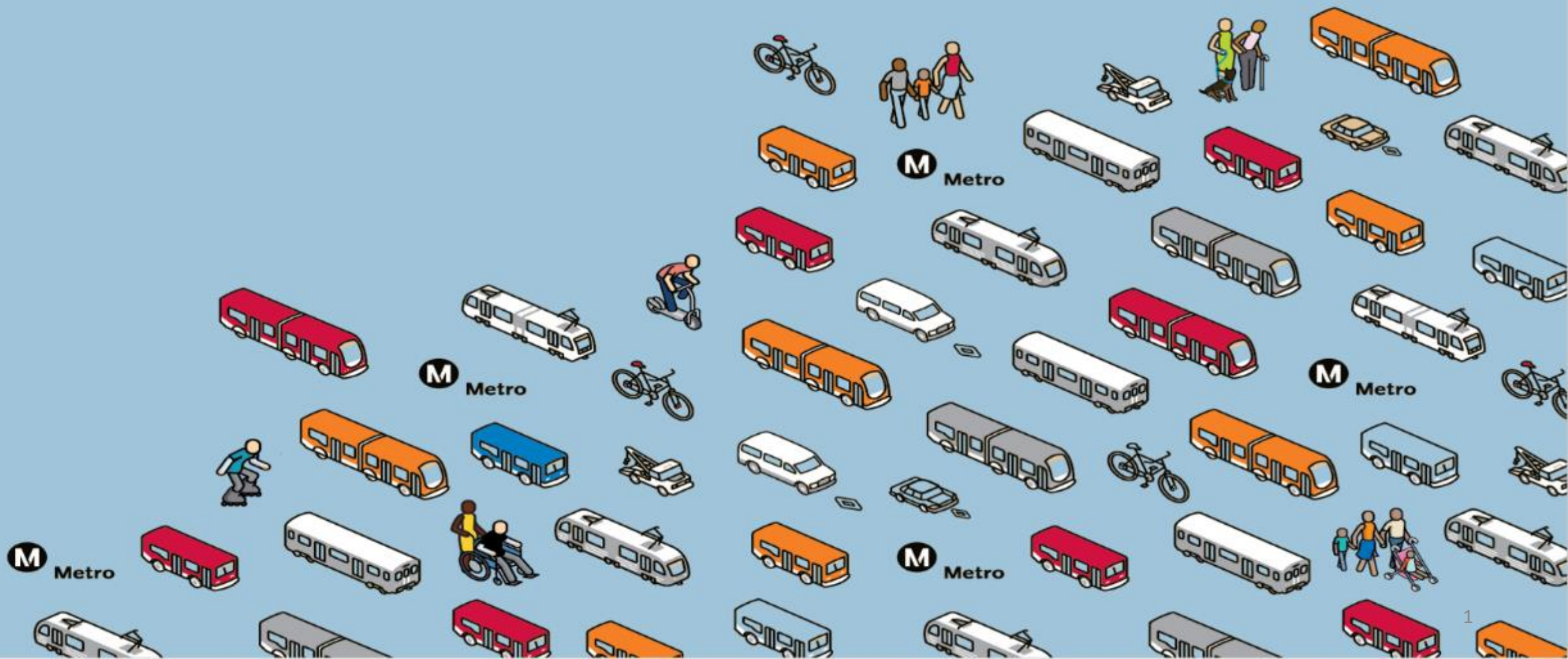


Phillip A. Washington
Chief Executive Officer

Zero Emission Bus (ZEB) Program Update

Operations, Safety, and Customer Experience Committee
July 18, 2019



Presentation Overview

- Transition to ZEB Operations - Guiding Principles
- Bus Fleet Requirements & Availability
- Current Background & Timeline
- Strategic Plan for ZEB Implementation
- Phase I | Update on Near-Term Activities
  - Silver and Orange Line Electrification
  - ZEB Master Plan
    - Challenges
    - Utility Grid Modeling
    - Conversion of Operating Divisions

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Transition to ZEB Operations – 2017 Guiding Principles

- Continue to replace aging bus fleet (~200 Buses per Year)
  - Status: 465 buses ordered in 2017.
    - ~350 buses to be delivered in 2019.
- Upgrade current CNG buses to "Near-Zero" Low NOx engines
  - Status: 196 buses upgraded at Mid-life (On-Target)
- Maintain existing bus fleet in a "State of Good Repair"
  - Status: Fleet age is increasing.
    - Extend Life (re-tank & recycle into "mid-life") or replace additional 369+/- buses by 2022
    - Assumes 1:1 replacement of CNG to Electric
- Improve Service Quality and Reliability
  - Status: New CNG Buses placed into service in 2019.
- Transition Metro Orange Line (MOL) to Zero-Emission by 2020
  - Status: On Target for Completion
- Transition Metro Silver Line (MSL) to Zero-Emission by ~2021
  - Status: On Target for Completion
- Goal of 100% Zero -Emission Bus Fleet by 2030
  - Status: Master Plan addresses implementation roadmap.

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Bus Fleet Requirements & Availability

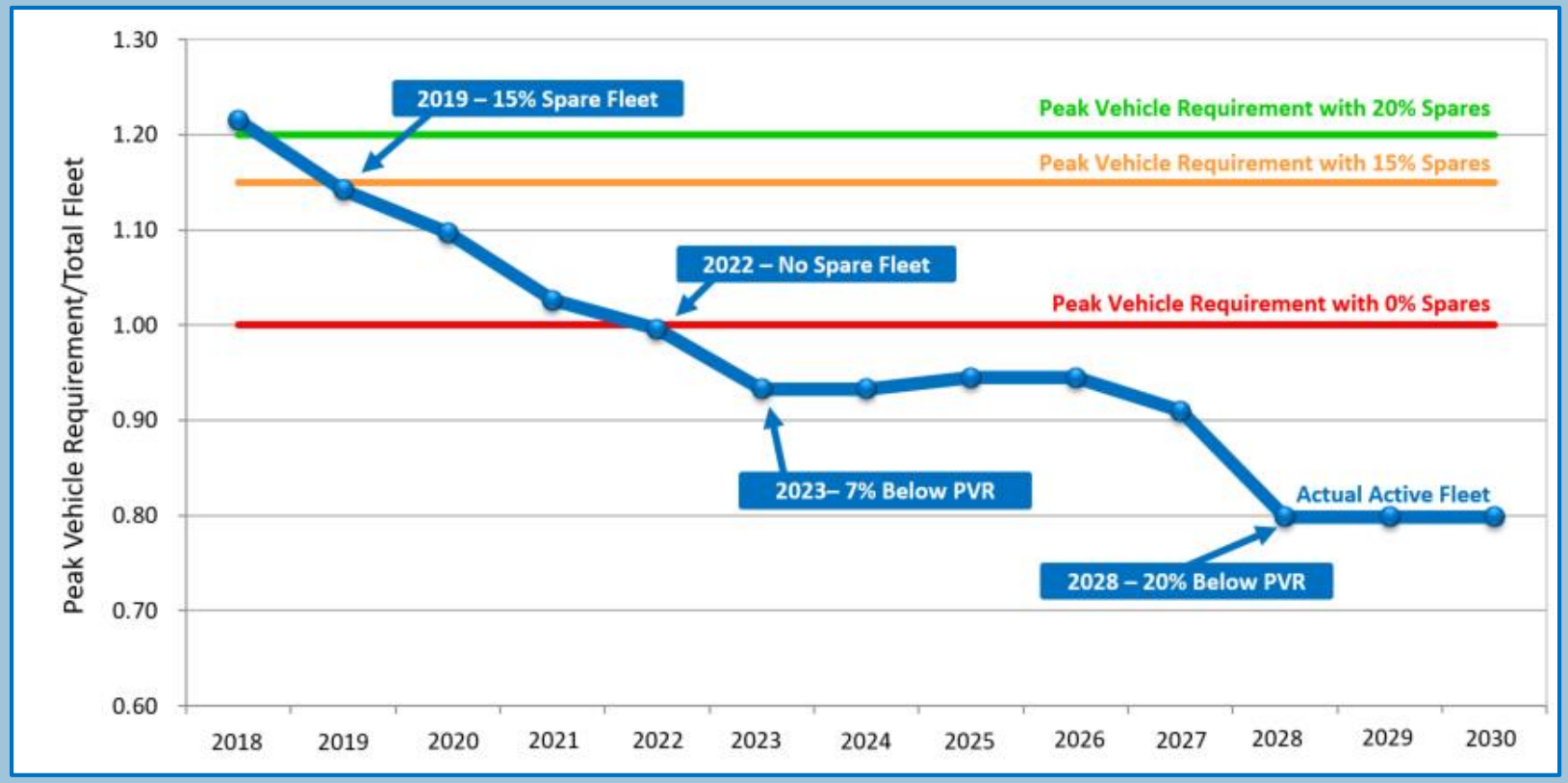
Fleet Planning Parameters

Peak Vehicle Requirement
- 2,300+ buses (scheduled service + spares)
- 1,900+ buses (scheduled service only)

Spare Ratio
- 20% > (FTA requirement)
- 15% - 20% (Metro policy)

Bus Retirement Age
- 12 years (FTA requirement)
- 15-18 years (Metro Policy)

Metro Bus Fleet Decommissioning Forecasts



- 834 additional buses needed by FY2022 to meet current service levels with exceeding FTA spare ratio and age requirements
- 465 buses on order (~350 buses to be delivered in 2019)

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Current Background & Timeline

- **January 2019**
  - Provided Preliminary update to Board Staff to indicate need for procurement actions

- **July 2019**
  - Provide Metro Board with a ZEB Master Plan update
  - Evaluate opportunities to expedite transition
    - Bundle division conversions to single procurements
    - Acquire or lease additional operating space

- **September 2019**
  - Refine cost estimates, infrastructure phasing schedule, and procurement strategies
  - Procurement Decision (using contract Options)

- **Spring 2020**
  - Provide Metro Board with a ZEB Master Plan update
  - New Bus Procurement Decision – Fleet Mix (TBD)
    - Delivery in 2023 and later.

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Strategic Plan for ZEB Implementation

- Phase 1: Near-Term Activities (2020 – 2021)
  - Orange Line Electrification – Charging Infrastructure & Vehicles
  - Silver Line Electrification – Charging Infrastructure & Vehicles
  - Upgrade Near-Zero CNG Engines to RCNG at mid-life
  - Refine & Develop Master Plan Details

- Phases 2/3: Long-Term Activities (2022 – 2030, and beyond)
  - Conversion of Divisions from CNG Fueling to Battery Charging
  - Procurement of Vehicles

- Key Milestones 2019:
  - ZEB Technology Assessment/ZEB Master Plan
  - Dimensions of Phases 2 and 3

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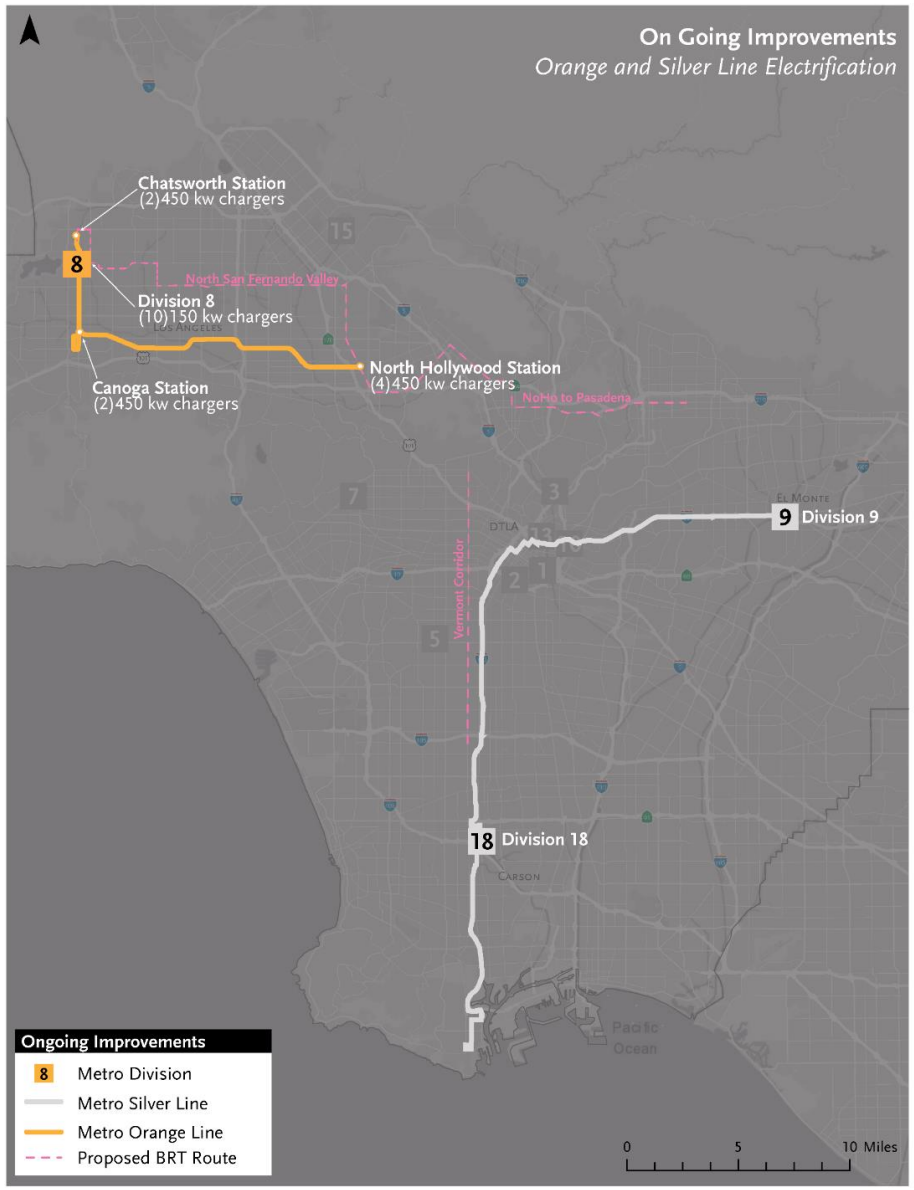
Silver and Orange Line Electrification



- Orange Line (60-foot BEBs)
  - 45 Buses (40 New Flyer, 5 BYD)
    - NF Pilot bus due Summer 2019
    - NF and BYD Production Complete Fall 2020
  - Depot Charging (Division 8)
    - Charger Commissioning: July 2019
  - En Route Charging
    - Expected Completion: Fall 2020
- Silver Line (40-foot BEBs)
  - 60 Buses (BYD)
    - Pilot: TBD
    - Production Completed by Winter 2021
  - Depot Charging (Division 9)
    - Design considers full-scale deployment and upgrading capacity to 18 MW. (Current Limit of 5 MW)
    - Applied for SCE Charge-Ready Transport
  - En Route Charging
    - Design On-going for El-Monte & Harbor Gateway



ZEB Master Plan - Challenges

1. Bus-Related Challenges:
   - Performance Standard: 65mph top speed; sustain 10% grade; 250+ mile range
     - Currently, up to 120 mile range with Full HVAC, Passenger Loading
   - Curb Axle Weight : Current limit is 24,000 lbs.
     - In 2022 limit drops to 22,000 lbs.
     - Limits ability to add batteries to increase range
   - Technology reliability risks – not service proven
2. Division Charging Infrastructure Challenges:
   - Limited grid capacity at divisions
     - Limits number of BEBs that can be assigned
   - Long lead times for utilities to implement necessary grid upgrades
     - Need to increase capacity from ~5 MW to ~15 MW
     - 3 to 5 year cycle from planning to deployment
   - Limited space at divisions
     - Conversion must be done sequentially, adding time to schedule

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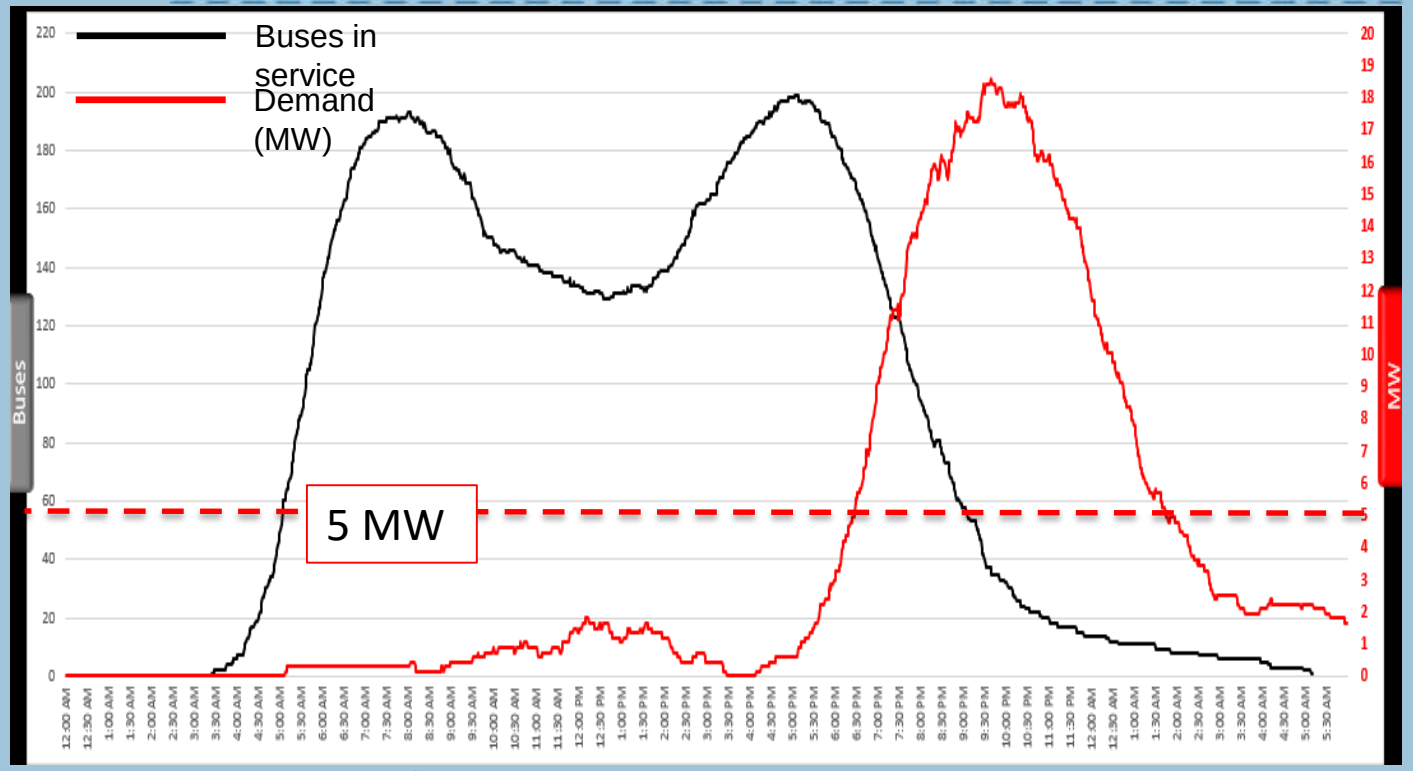
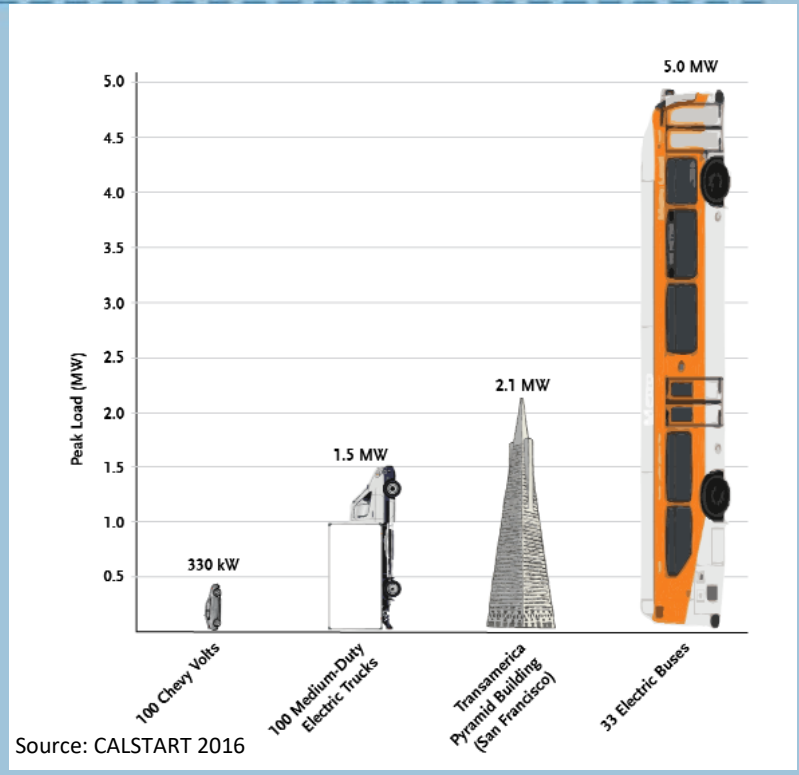
ZEB Master Plan - Challenges

3. Funding Challenges:
   - Additional capital funding required for 100% ZEB program
   - Preliminary Capital Cost Estimates
     - ~$700 Million to ~$1 Billion in Infrastructure costs
     - ~$400 Million in additional vehicle costs.
   - Operational:
     - Utility Rates and resulting costs are under revision.
     - Operating Costs are not fully known at this time.

Need to optimize depot and en route charging strategies; vehicle performance; service block ranges; and costs.

ZEB Master Plan – Utility Grid Modeling (Division 9 Example)





Source: CALSTART 2016

- Modeling is Basic Input to Utility Planning
- ~18 MW needed at Division 9 with no En Route Charging
  - Transamerica Pyramid Building requires 2.1 MW
  - Only 5 MW is capacity currently available

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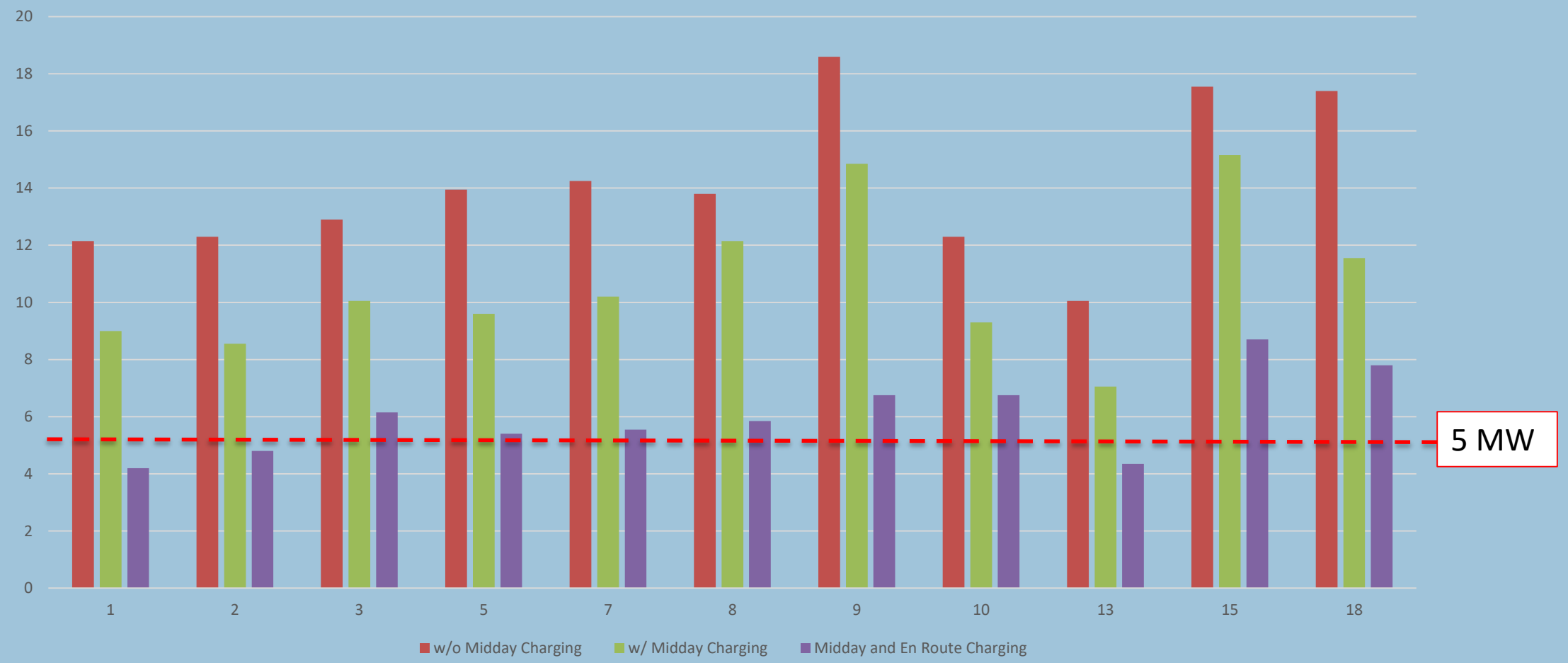
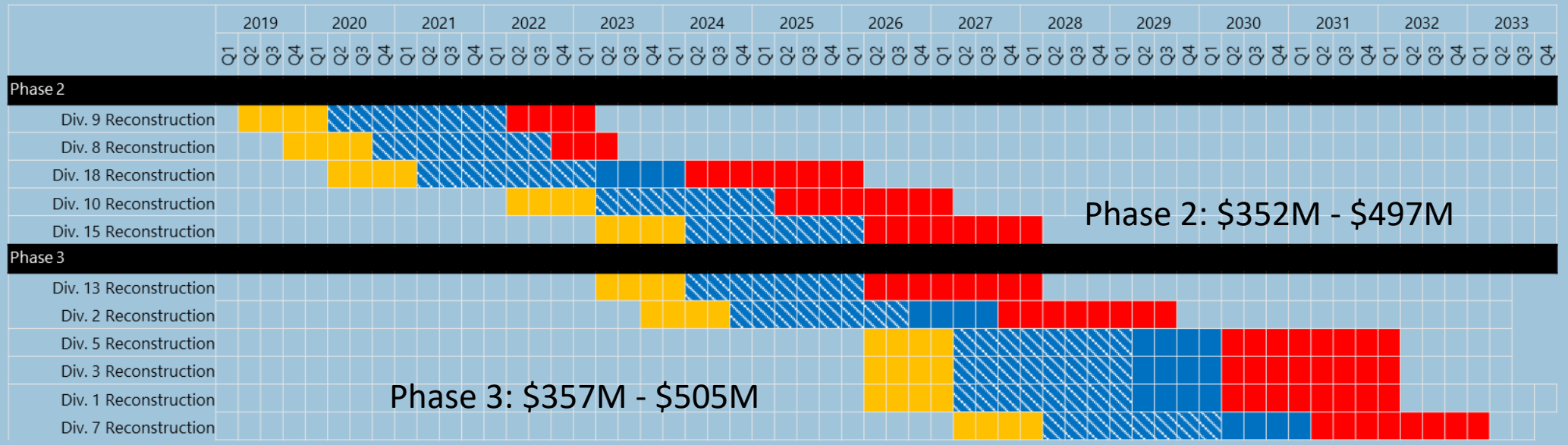
ZEB Master Plan – Utility Grid Modeling (All Divisions)



- Mid-day and en route charging can optimize:
  - Power limitations
  - Range and weight
- Sub-optimal for fleet size, operating costs, and bus parking

ZEB Master Plan - Conversion of Divisions (Phasing Schedule)



- Procurement (12 Months)
- Design and Utility Agreements/Approvals (24 Months)
- Division Staging and Construction (24 – 36 Months) with existing power
- Utility Upgrades and Construction (24 Months) with optimal power

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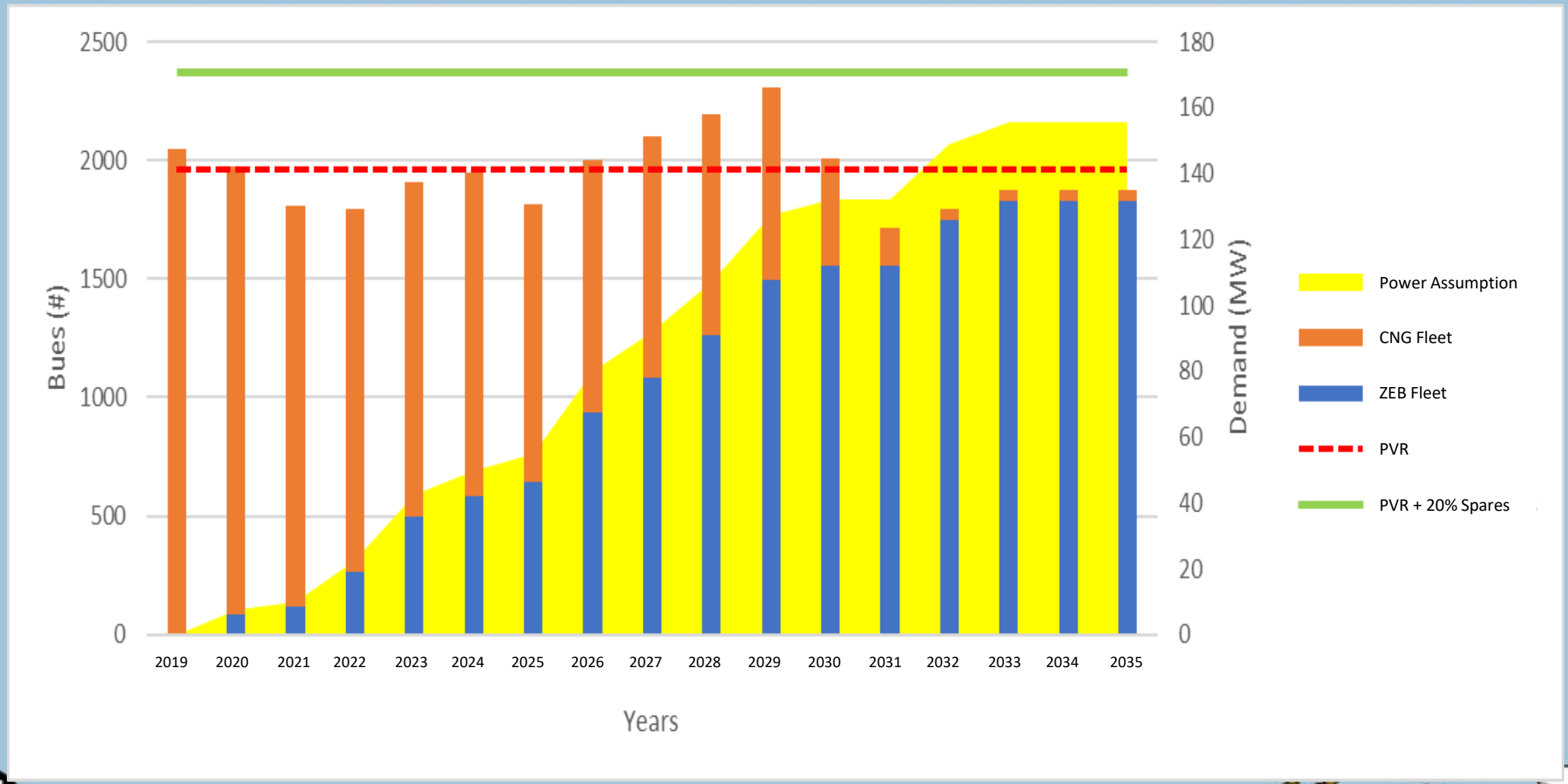
ZEB Master Plan – Conversion of Divisions (Phasing Schedule)



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ZEB Master Plan - Conversion of Divisions (Phasing Schedule)

- Division overhead charging
  - Gantry is lower-cost design
  - Gantry optimizes space
  - Gantry with platform:
    - Saves space
    - Provides for equipment, solar and battery storage
    - More expensive

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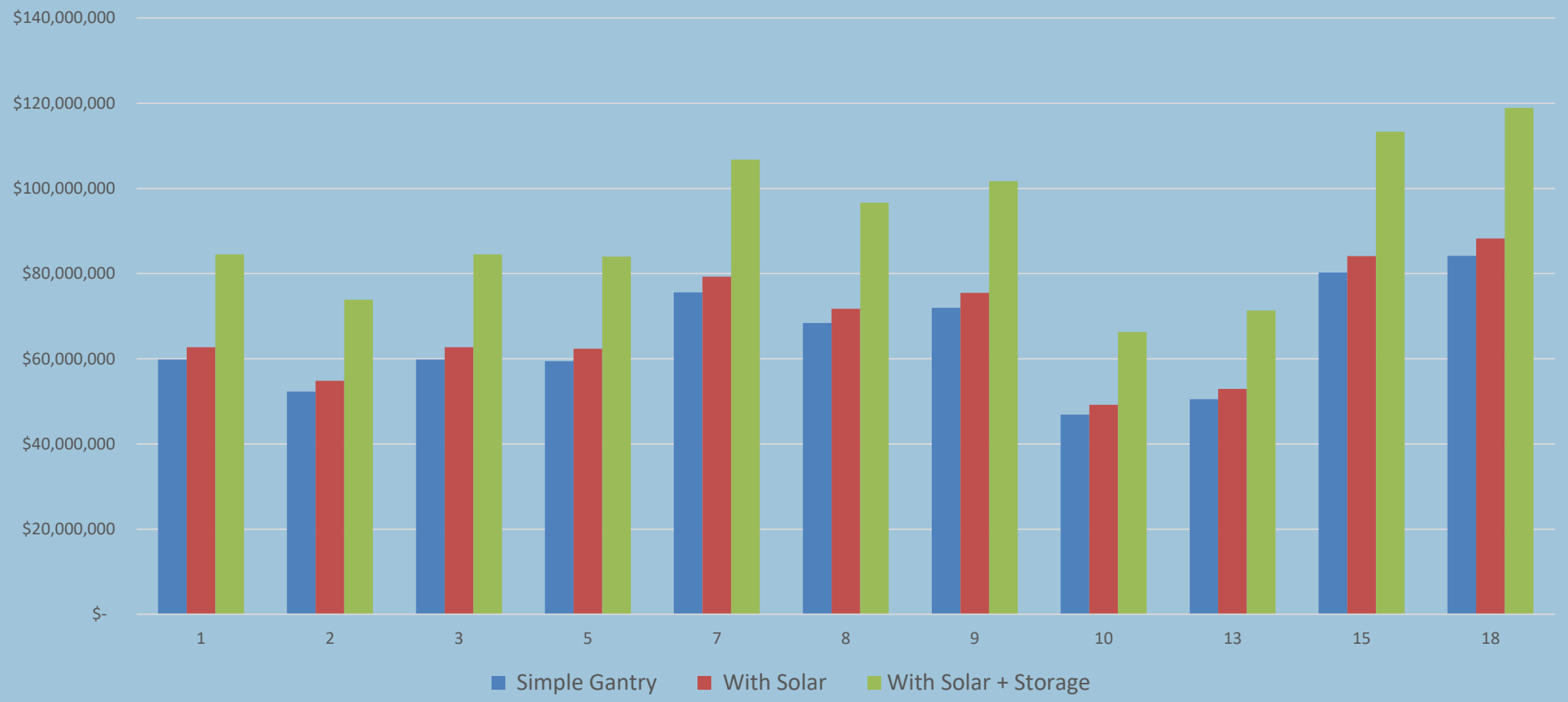
ZEB Master Plan - Conversion of Divisions (Cost)



- Simple Gantry Arrangement
  - ~$50M - $80M per Division
- Sophisticated with Solar and Battery Storage
  - ~$70M - $120M per Division



Thank you