WTA ZEB TRANSITION STUDY – DRAFT REPORT (PART 2)

04/17/2023 WTA PRESENTATION

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WHAT TRANSPORTATION CAN BE.

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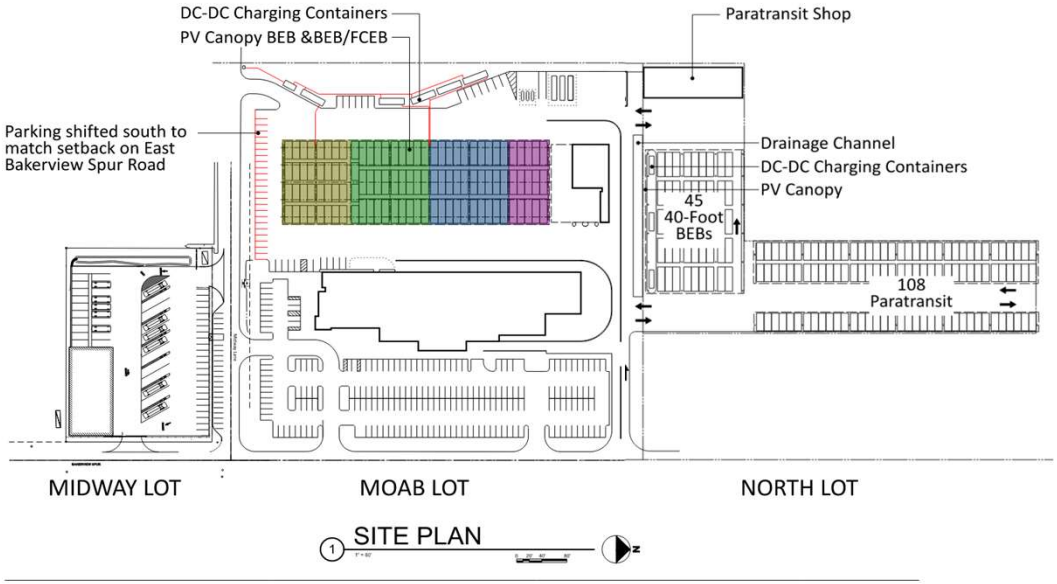
MEETING AGENDA – STUDY OVERVIEW

1. MOAB Facility Needs
2. Transition Options
   (cost and GHG estimates)
3. Future / Near Term Planning

MOAB SITE UPGRADES

MOAB LAYOUT AND UPGRADES – BEB OPTION

- Room for ~84 X 40’ BEBs and chargers
- Deployed in stages
  - By colored groups if pantograph
  - As needed for plug-in
- ~2 MW additional electrical load capacity needed
- Backup Generator(s) (~2-3 MW)
- Increased fire suppression (coordination with fire dept.)
- Maintenance Bay Upgrades
- Staff safety training



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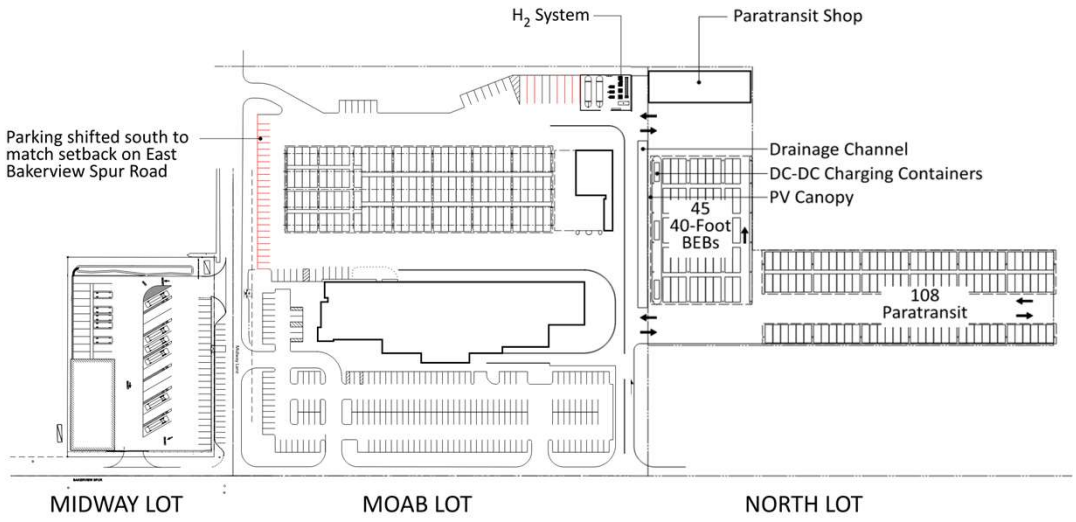
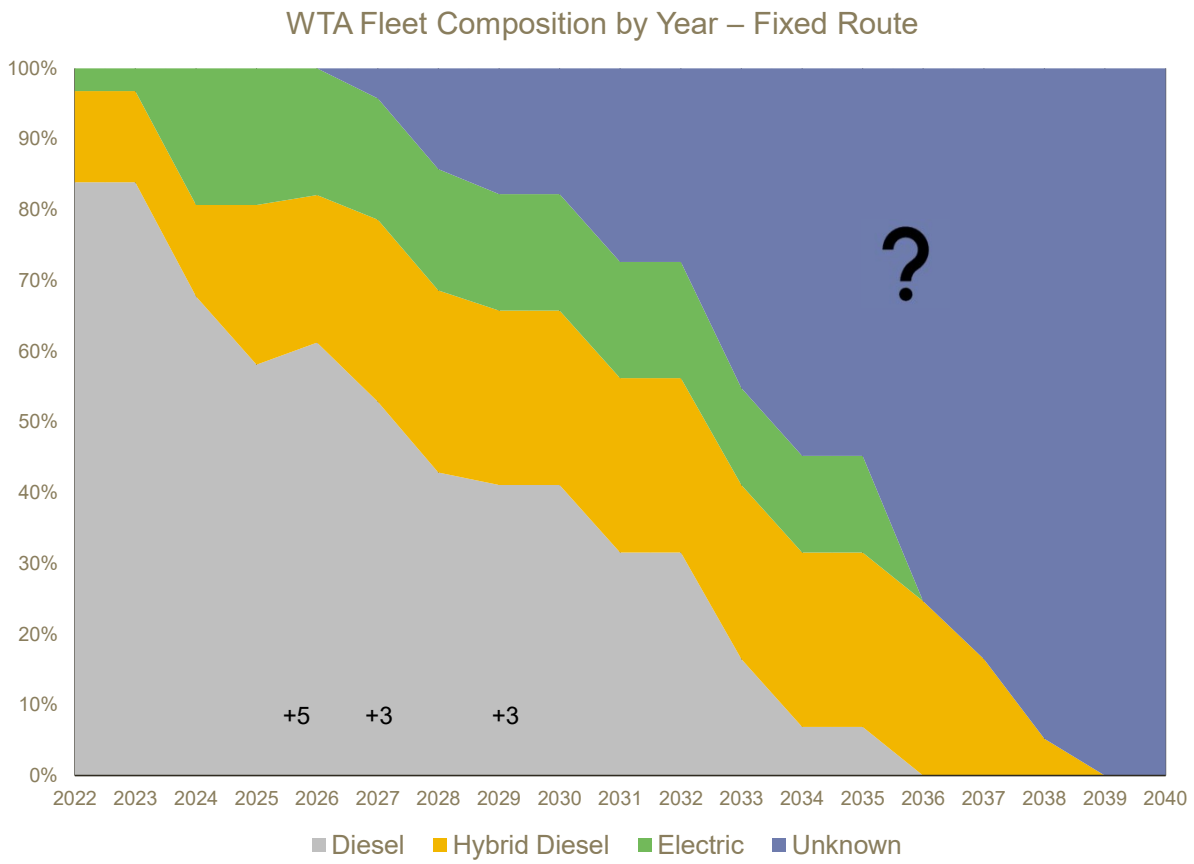
MOAB LAYOUT AND UPGRADES – FCEB OPTION

- H_2 System would be a major one (or two) time investment
  - ~ $4.5 million for station for 50 FCEBs (scaled by size)
- May need additional electrical capacity (H_2 compression)
- H_2 Detector Alarms
- Increased Ventilation
- Increased Fire Suppression
- Maintenance Bay Upgrades
- Staff Safety Training



TRANSITION PLAN OPTIONS

TRANSITION PLAN – WTA OPTIONS



+# indicates planned fleet expansion

- Currently 62 buses in FR fleet
  - 52 diesel, 8 hybrids, 2 BEBs
- 2023 -> 2 BEBs (& dispensers)
- 2024 -> 8 BEBs (& dispensers)
- Short Term Plan – Buy Hybrids to enter service in 2025, 2026, 2027
- Use intervening years to evaluate new BEBs, follow ZEB market, and make site upgrades

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TRANSITION PLAN – WTA OPTIONS

Option 1 – all BEB

- Requires significant infrastructure investment
- BEBs are cheaper to buy (and fuel?) compared to FCEB
- Charging logistics

Option 2 – all FCEB after 2027

- Requires infrastructure investment (less than BEB)
- FCEB more expensive to buy and fuel(?) than BEB
- *Single largest issue with FCEB is lack of available H_2*

Option 3 – BEB and FCEB Blend

- Can align technology with route demands, more flexible operations
- Requires both types of infrastructure upgrades (hydrogen compressor station and BEB chargers, increased staff training and safety)

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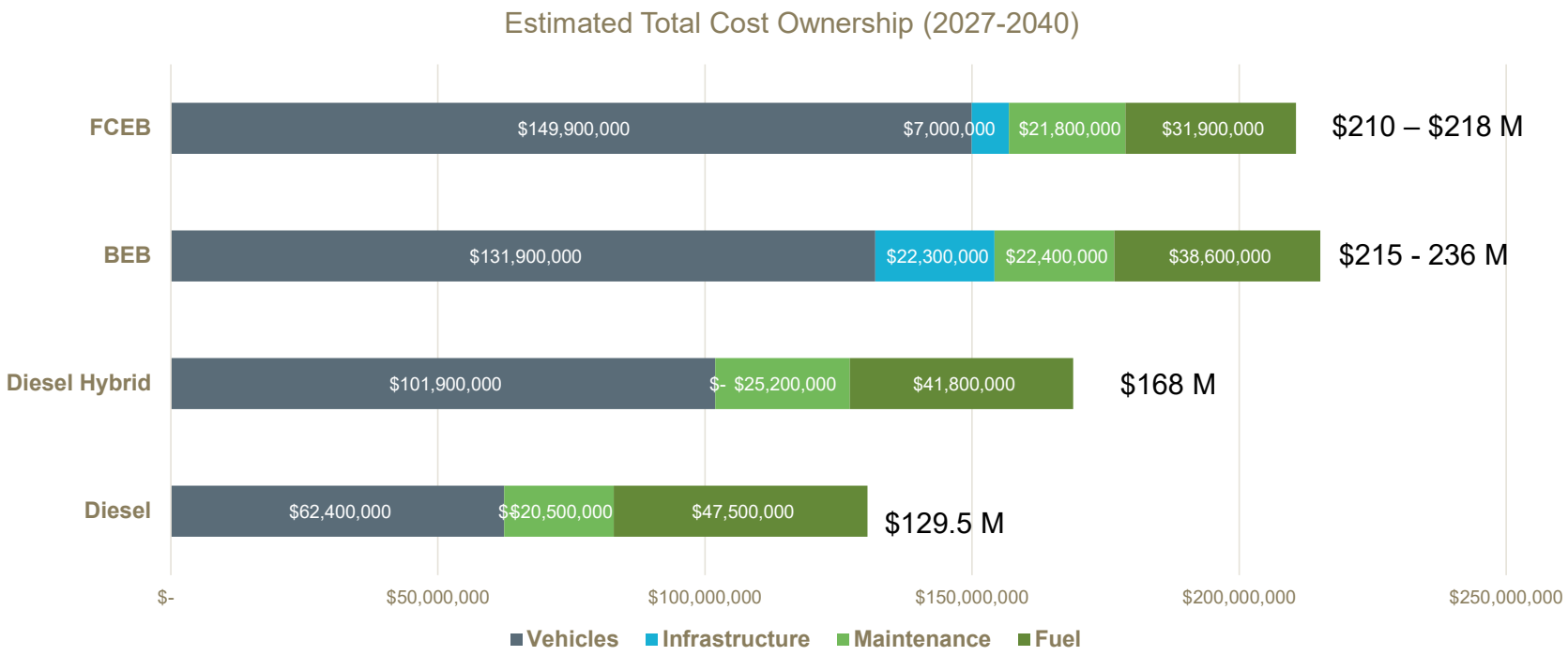
TOTAL COST OF OWNERSHIP



Numbers shown do not account for any grants or funding awards.

GREENHOUSE GAS ESTIMATES

GREENHOUSE GAS ASSUMPTIONS

Diesel

- 1 gallon of diesel produces ~22.46 lbs CO_2e (CO_2 equivalent)
  - carbon emissions for refining and transporting diesel fuel, which would increase the GHG impact of diesel is not included
- WTA fuel consumption is expected to increase proportionally with fleet size

Electricity

- 1 kWh of electricity from Puget Sound Energy (PSE) currently produces 0.8986 lbs CO_2e
- PSE to produce 100 percent carbon free electricity in 2045
  - The analysis assumed a linear relationship between 2022 carbon emissions and 2045 carbon emissions per kWh of electricity generated
    - 2040 estimate for 1 kWh of electricity = 0.19 lbs CO_2e

Hydrogen

- 1 kg of hydrogen currently produces approximately 20.5 lbs CO_2e via the Steam Methane Reforming process (which accounts for 99 percent of hydrogen generated in the US)
  - This emissions rate of hydrogen generation is assumed to be reduced by 50% by 2040, linearly each year.
- Hydrogen is assumed to be trucked to the WTA facility, where it would be stored as a liquid in tanks before undergoing compression and pumping into the FCEB. This compression is assumed to require ~1kWh per kg of hydrogen

	Grey Hydrogen	Blue Hydrogen	Green Hydrogen
Process	Reforming or gasification	Reforming or gasification with carbon capture	Electrolysis
Energy Source	Fossil fuels	Fossil fuels	Renewable electricity
Estimated Emissions from Production Process (lbs of CO2e/kg of hydrogen)	Reforming: 9-11 Gasification: 18-20	0.4-4.5	0

https://www.energypolicy.columbia.edu/research/article/hydrogen-fact-sheet-production-low-carbon-hydrogen

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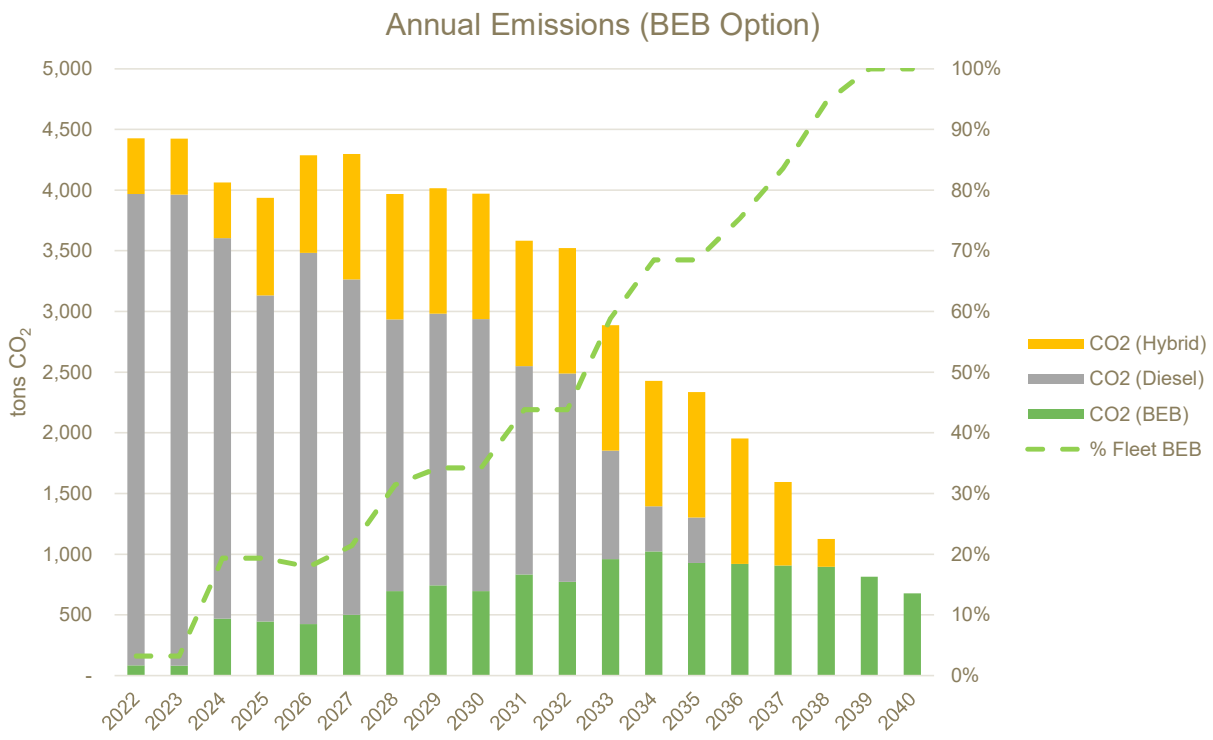
ESTIMATED EMISSIONS - BEB OPTION



- ~85% reduction in annual emissions by 2040
- Assumed GHG-free in 2045 (based on state mandate)

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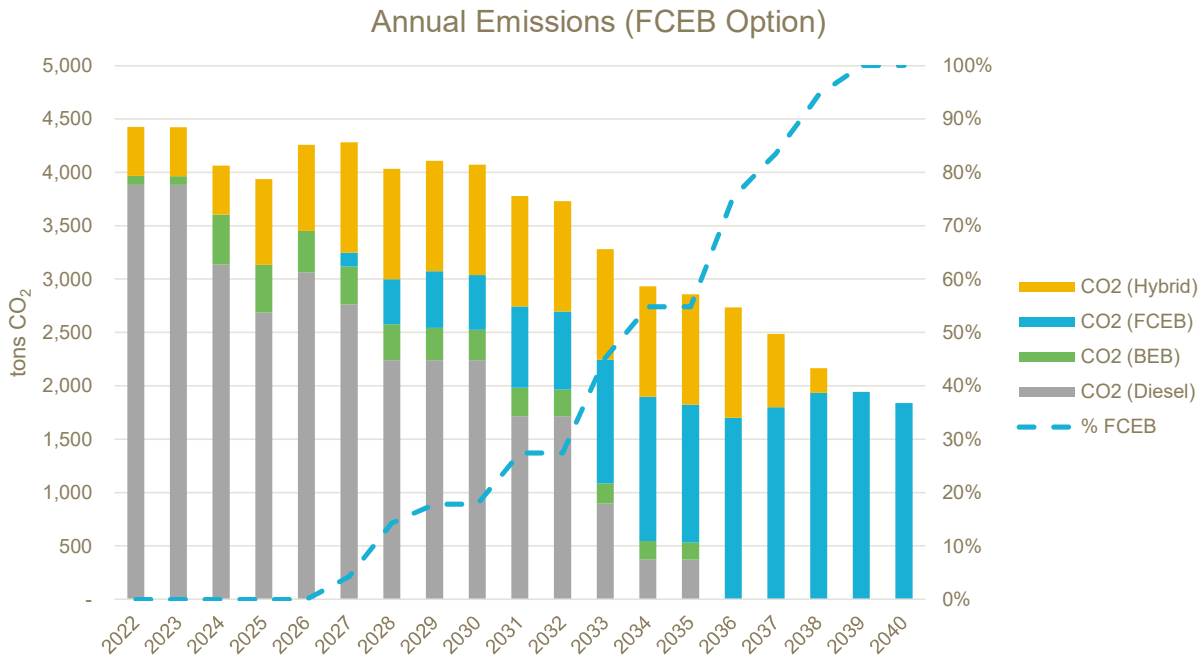
ESTIMATED EMISSIONS - FCEB OPTION



- 60% reduction from 2022 levels
- 12.5% increase over BEB option
- Not assumed to be a net-zero option by 2045

Assumes hydrogen generation is 50% GHG free by 2040

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NEAR AND LONG TERM PLANNING

CURRENT WTA TRANSITION TIMELINE

- 2023 – 2 BEBs (and chargers) arrive
- 2024 – 8 BEBs (and chargers) arrive
- 2025 – Hybrids
- 2026 – Hybrids
- 2027 – order new ZEB technology

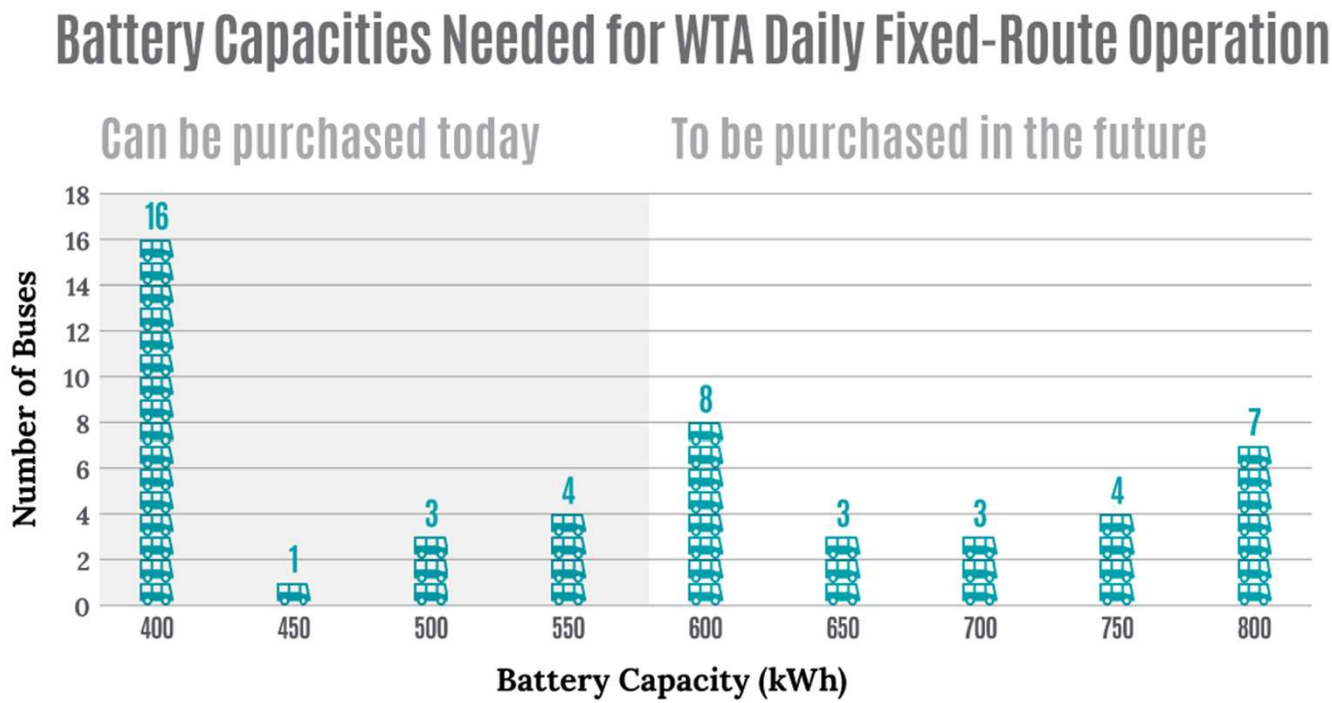
Where is ZEB market going?

What should WTA do after 2027?

WHAT DO WE EXPECT TO HAPPEN WITH ZEB TECH?

Better Batteries

(~5% increase in energy density/year although last 3 years saw > 30% increase, 440->588 kWh)



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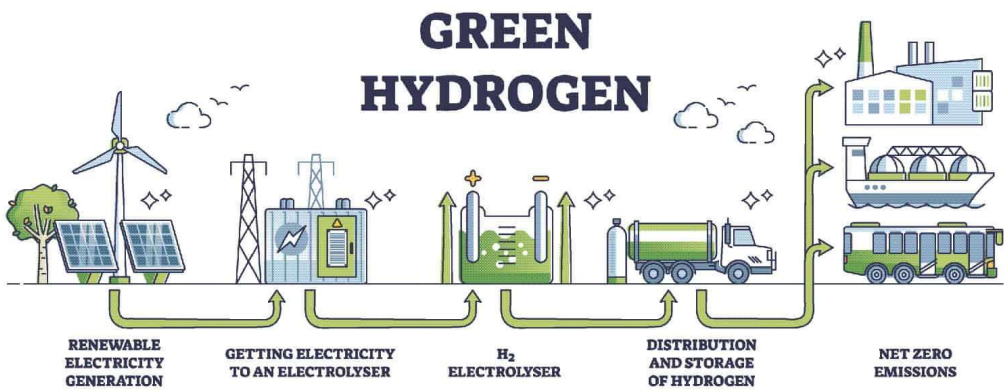
WHAT DO WE EXPECT TO HAPPEN WITH ZEB TECH?

Increased Hydrogen Availability

- SB 5910 – aiming to make WA a hub of hydrogen production
- IIJA included $8 billion for clean hydrogen research and deployment
- US Department of Energy Goal -> $2 / kg of green hydrogen by 2026
- Douglas PUD -> hydroelectric hydrogen production starting in June 2024



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WTA – RECOMMENDED PLAN

2023

1. **Continue planned BEB deployments in 2023 and 2024.**
2. **Explore Charge Management Software Tools.**
3. **Proactively Monitor ZEB Industry.**

June 2024

Decide on ZEB Deployment Technology for 2027-2032.

1. Can WTA procure hydrogen reliably at a reasonable cost to ensure potential FCEBs can be fueled?
2. Can WTA procure up to 20 FCEB vehicles reliably?
3. How well are BEBs operating?
4. Has BEB battery capacity continued to expand?
5. What level of electrical improvements are needed to bring additional power to MOAB to charge future BEBs?

2024

Site Design for Selected Technology (BEB or H_2 Fueling Station)

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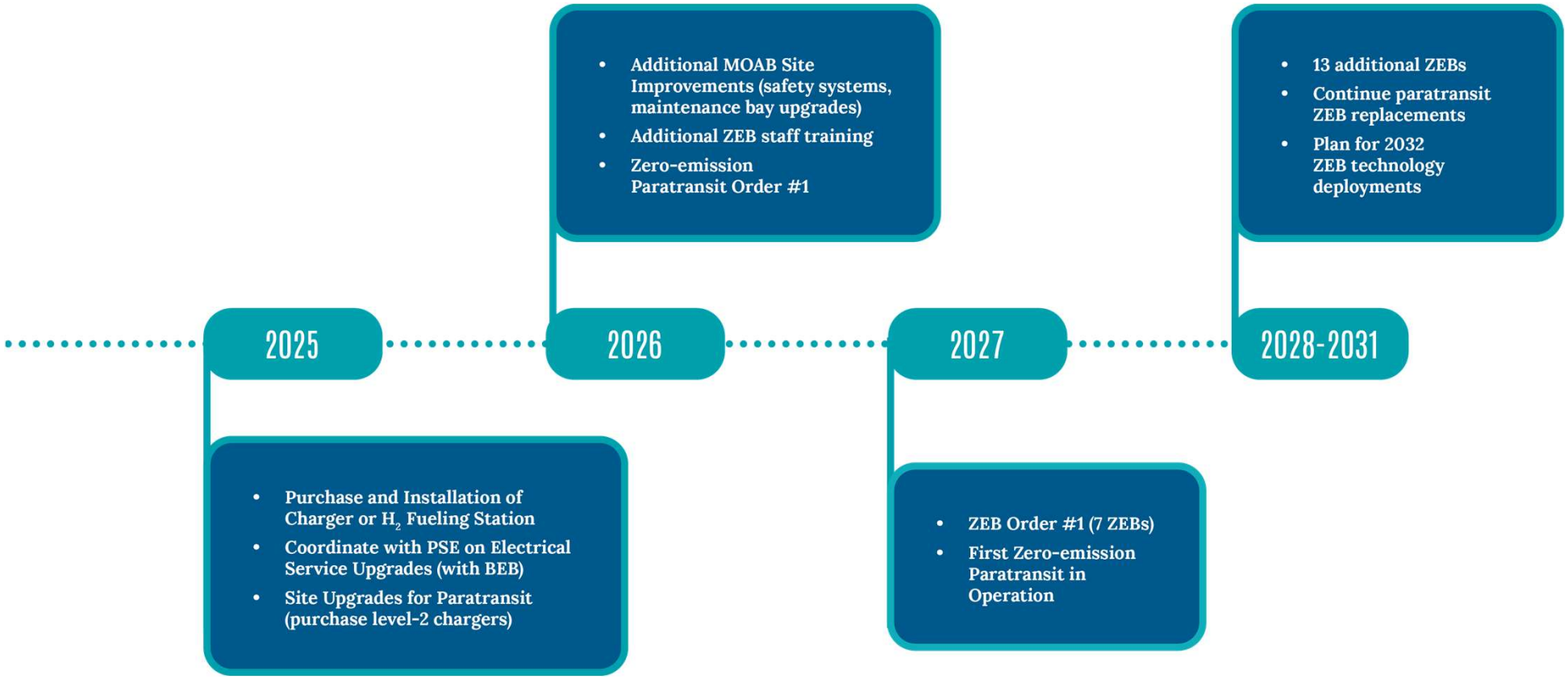
WTA – RECOMMENDED PLAN



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Q&A

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