WHATCOM TRANSIT ZEB TRANSITION PLAN

06/16/2022 WTA BOARD PRESENTATION

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WHAT TRANSPORTATION CAN BE.

MEETING AGENDA

1. Meet the Team
2. Our Experience
3. Project Schedule
4. Summary of Zero Emission Bus Technologies
   - Battery electric
   - Fuel cell
5. Q&A

OUR TEAM

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Chris Titze AICP/PP
Transit SME

Paul Sharman PE
Electrification Lead

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Paul Kaufmann
ZEB Procurement SME

Michael Broe
Fleet and Facilities
Electrification SME

Jason Rogers
Vehicle Engineering

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OUR EXPERIENCE WITH ZEB

Transpo Group

- JTA Electric Bus Feasibility Study (with STV)
- Transit Orange Alternative Fuels Study (with STV)
- Seatac Airport shuttle electrification study

STV

- ZEB Master Plan for LA Metro
- Toronto Transit Commission Master Plan for Bus/Paratransit/Non-Revenue Fleets
- ZEB Infrastructure Planning for NCTD
- ZEB Master Plans for NYPA (including 5 agencies)
- ZEB Transition Plans for HRT and Pace Bus

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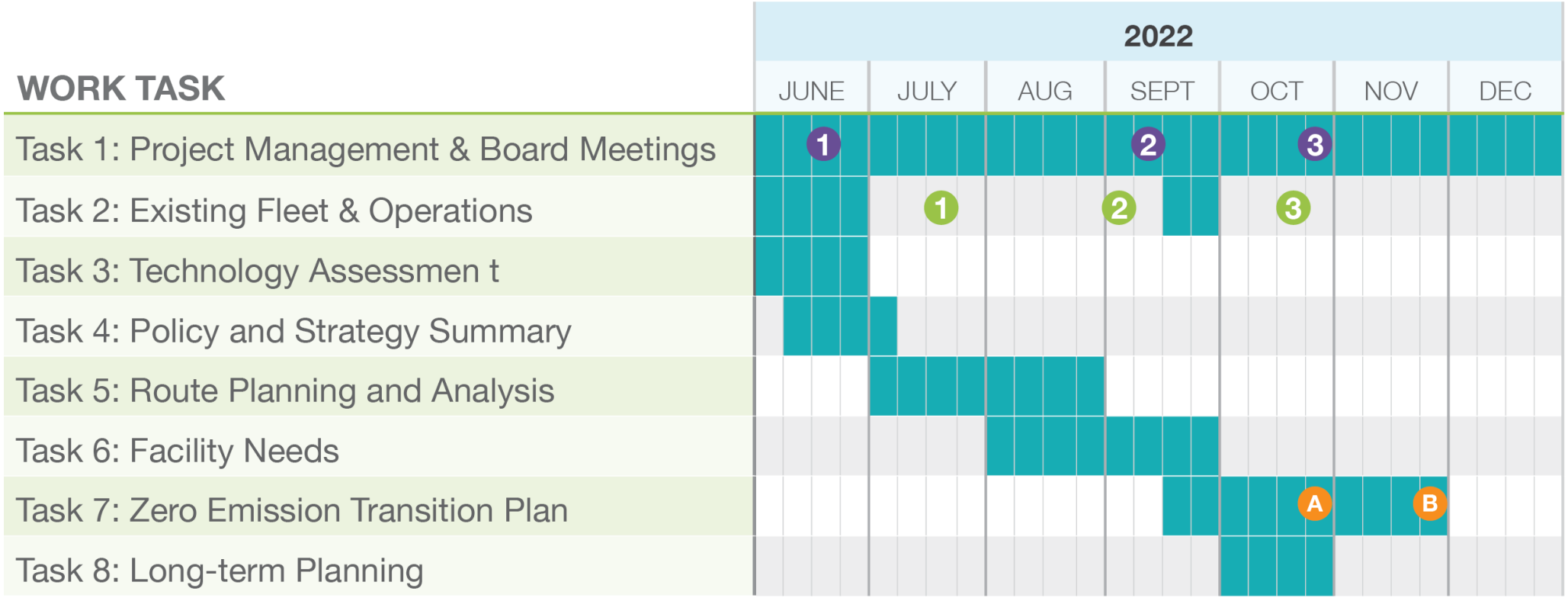
PROJECT SCHEDULE



Executive Staff Meetings

Board Meetings

1. *Project Overview/Technology*
2. *Operations Analysis*
3. *Draft Plan*

Deliverables

A. *Draft Zero Emission Plan*
B. *Final Zero Emission Plan*

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STATE OF BEB OPERATIONS I

A. Charge via plug-in (150-200 kW), pantograph (150-450 kW), or induction (wireless, 150-350 kW)

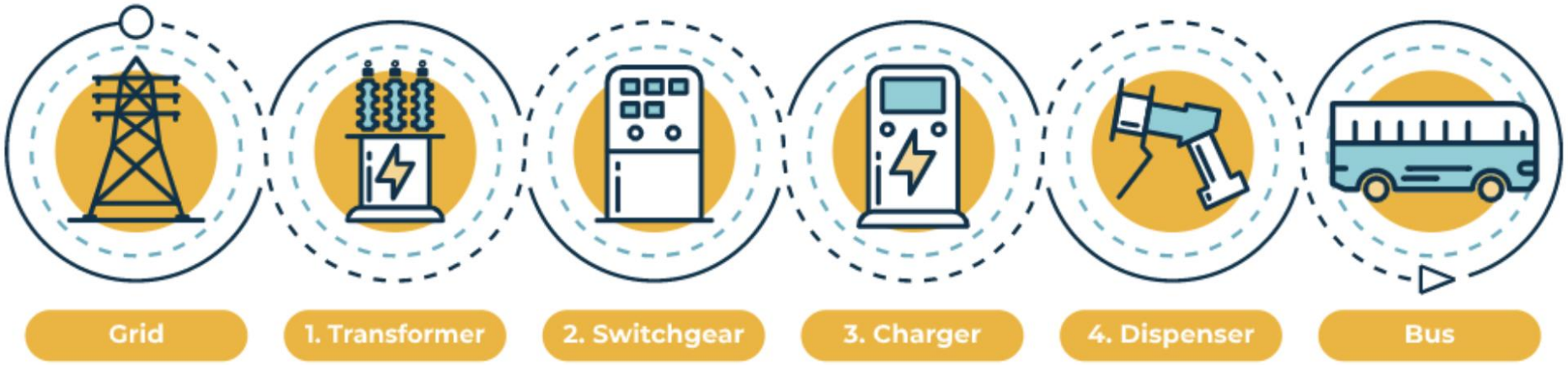
B. 200 kW charger can charge a bus in 3-4 hrs

C. 5 manufacturers currently provide Altoona tested BEBs that are Buy America Compliant (Gillig, New Flyer, Nova Bus, ElDorado, Proterra)

D. Bus Charging performed via depot or on-route charging (or combination)

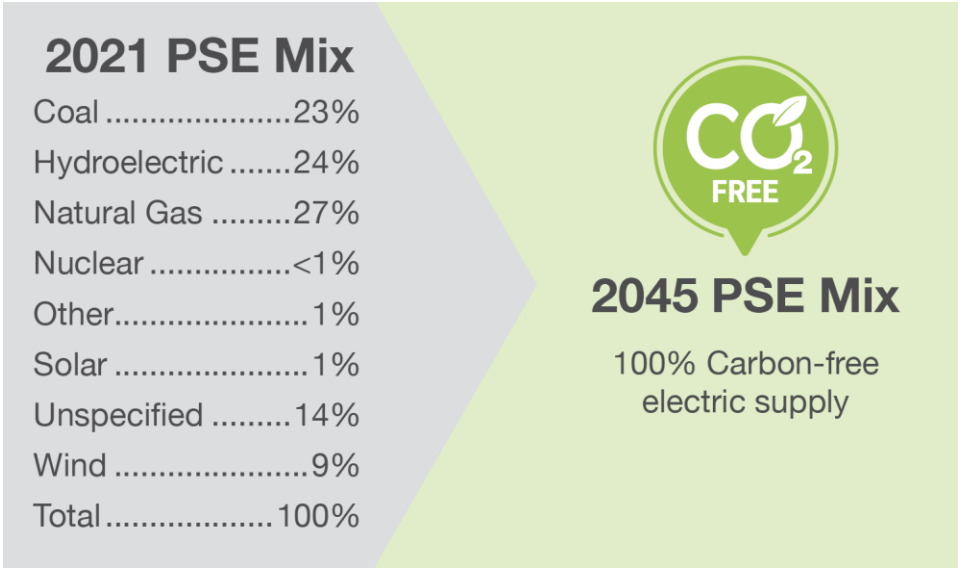
E. Sustainability and Resiliency – explore onsite energy storage options

F. Encourage utility negotiations to provide a transit specific tariff



STATE OF BEB OPERATIONS II

- 25% increase in battery energy density over last 5 years (with similar gains expected going forward)
- Recent TTC Report – comparing bus availability for revenue service between diesel-hybrid and three BEB manufacturers
  - *New Flyer 89%, BYD 52%, Proterra 62%, compared to Diesel/Hybrid at 95%*
- BEB Charging Infrastructure ~$1,000/kW, so 150 kW charger = $150,000 + transformers, conduit, cabling, fire suppression, etc.
- BEBs have higher upfront costs but lower operating/maintenance costs over the life of the bus
- Carbon footprint - how does utility generate electricity?



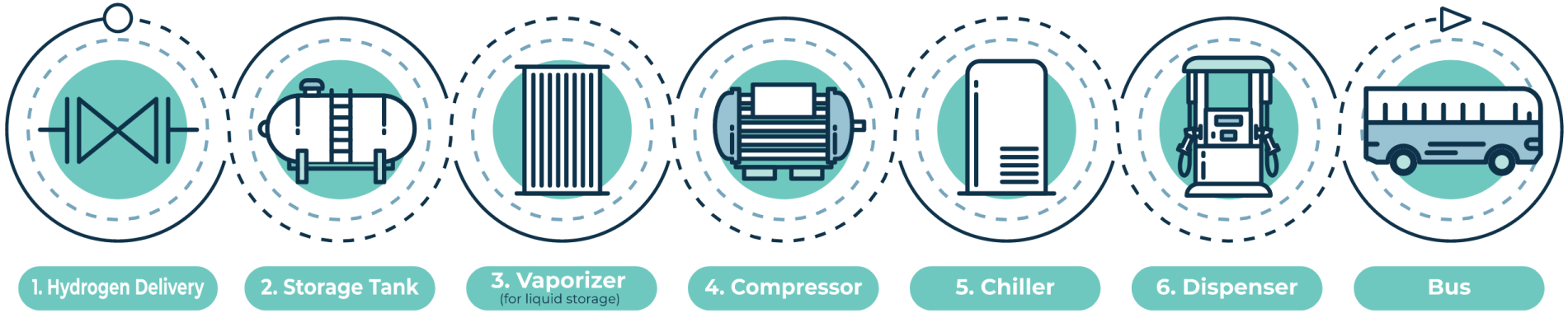
STATE OF FCEB OPERATIONS I

A. Battery-dominant fuel cell bus technology is the use of on-board hydrogen storage, supplied to fuel cell which generates electricity for batteries/electric drivetrain to power bus. FC emissions are heat and water

B. FCEB is currently closer to 1:1 replacement of diesel buses than BEB, due to increased range and similar refueling times as CNG buses but cost more than BEB/CNG/Hybrid/Diesel

C. Hydrogen refueling/facility costs are significantly higher than BEB/CNG/Hybrid/Diesel

D. 2 OEMs currently produce Altoona tested FCEBs



STATE OF FCEB OPERATIONS II

Hydrogen Charging Station

- Lack of available hydrogen
- Hydrogen is expensive
  - Significant difference for cost of hydrogen from on-site generation vs. trucking in hydrogen
- Emissions from hydrogen processing and distribution are currently high
- Only a handful of agencies have deployed this technology across the country

Q&A

AVAILABLE ELECTRIC BUSES (2022)

OEM	Bus Length	Battery Size	Range	Cost
Gillig	35’	588 kWh	~225 mi	$1.10 M
	40’	588 kWh	~200 mi	$1.15 M
New Flyer	40’	525 kWh	~225 mi	$1.25 M
	60’	525 kWh	~200 mi	$1.4 M
Nova Bus	40’	564 kWh	~225 mi	$1.25 M
Proterra	35’	492 kWh	~200 mi	$1.15 M
	40’	492 kWh	~200 mi	$1.25 M

Altoona Tested BEB Available as of 2022

FUEL CELL BUS TECHNOLOGY SUMMARY

OEM	Bus Model	Bus Length	Fuel Cell Power	Battery Capacity	OEM-Advertised Range	Cost
ENC	Axess-FC	*35'*	*100kW*	*Not provided*	*225+ mi*	*$1.15 M*
		40'	100kW	Not provided	260+ mi	$1.25 M
New Flyer	XcelsiorCHARGE H2	40'	160kW	150kWh	350	$1.25 M
		60'	320kW	150kWh	300	$1.55 M

Altoona Tested FCEB Available as of 2022