Berkshire Regional
Transit Authority
BRTA

BRTA HYDROGEN FUEL CELL ELECTRIC BUS PROJECT

Net-Zero Roll out plan.
Zero Emissions Bus
(ZEB)

INTRODUCTION

Massachusetts State Laws require Green House Gas (GHG) reductions from the transportation sector as described in the "Clean Energy and Climate Plan for 2025 and 2030". After discussions with several out of state major transit authorities that have already began their transition, and considering the BRTA environment and routes, the focus of this roll out plan will be the hydrogen fuel cell electric bus (FCEB) solution.

Hydrogen buses are already a competitive alternative to battery buses, with significantly faster fueling time and therefore, less downtime. They are also becoming more of a competitive alternative to diesel buses on a total cost of ownership basis.

The new environment friendly hydrogen buses will reduce the county's carbon footprint and harmful particle emissions with the only by-product from the buses being water from the chemical reaction of hydrogen with oxygen from the air.

BRTA CURRENT EMISSIONS

Fuel Type	No. of Buses	Annual VTM	Total Direct Emissions per Year GHG (MTCO2eq)	Avg. Direct CO2 Emissions per year per Vehicle
Hybrid Diesel	5	432,500	698.48	139.70
Diesel	8	692,645	1,353.43	169.18
Gas (Fixed)	16	416,221	503.21	31.45
Gas (Para)	17	153,976	186.16	10.95
Total	46	1,695,342	2,741.28	59.59

Approximate numbers based on 2024 VTM (304 days)

FTA Estimates Data Set emissions:

Diesel	0.001954 MTCO2eq vehicle miles per year
Hybrid Diesel	0.001615 MTCO2eq vehicle miles per year
Gas	0.001209 MTCO2eq vehicle miles per year
Zero Emissions	0.000000 MTCO2eq vehicle miles per year

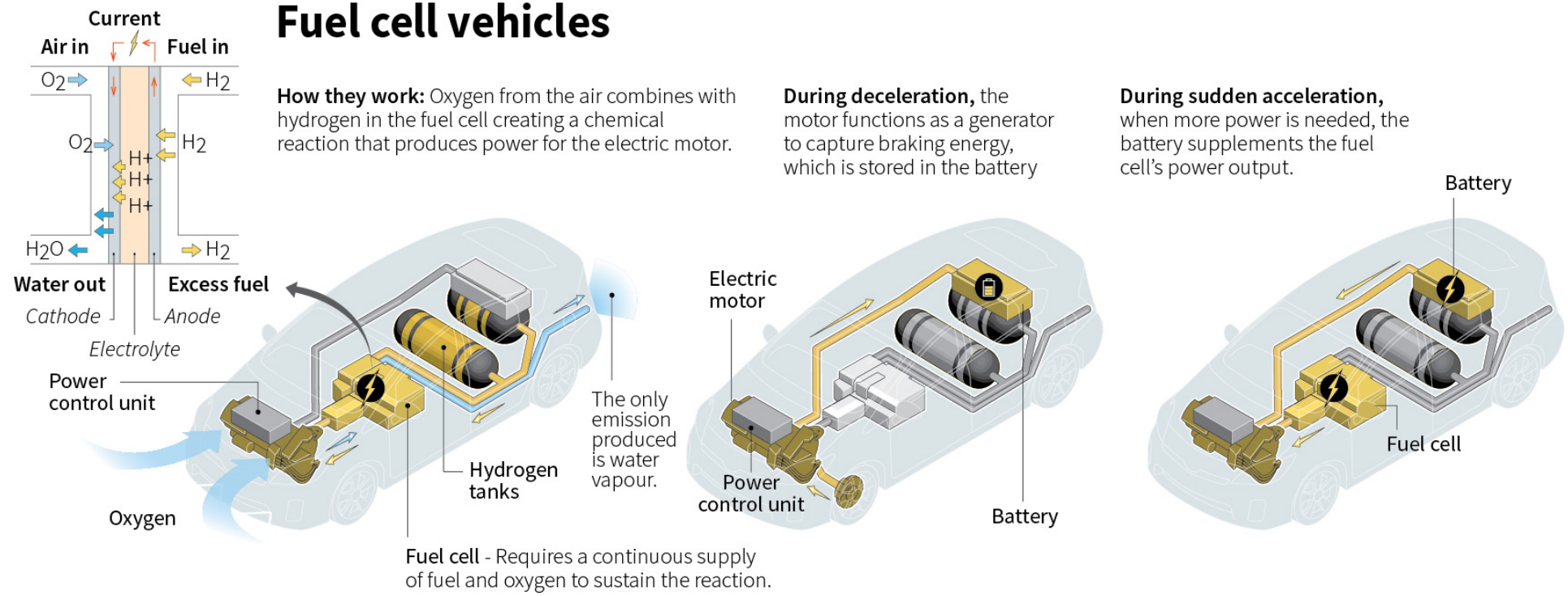
BRTA HYDROGEN FUEL REQUIREMENT

Fuel Type	No. of Buses	Annual VTM	H_2 kg per day (6 mpg)	H_2 kg per year (6 mpg)
Hybrid Diesel	5	432,500	226	71,871
Diesel	8	692,645	364	115,441
Gas (Fixed)	16	416,221	219	69,370
Gas (Para)	17	153,976	81	25,663
Total	46	1,695,342	890	282,345

Approximate numbers based on 2024 VTM (304 days)

HOW IT WORKS

The majority of hydrogen vehicles on the road today store H2 gas in fiber composite wrapped pressure vessels with service pressures of 350 bar (5,000 psi).



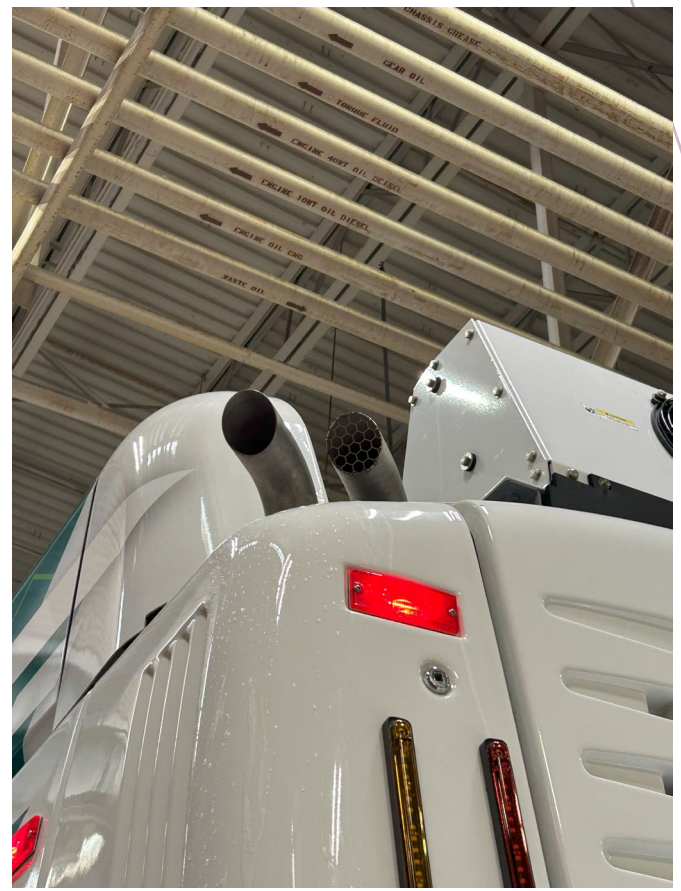
Sources: Reuters; Toyota; U.S. Department of Energy.

C. Inton, G. Cabrera, 13/09/2019

REUTERS

HYDROGEN FCEB

Fuel Cell



Water exhaust

FY2024 LOW OR NO EMISSIONS GRANT

Rochester-Genesee Regional Transportation Authority has received three New Flyer FCEB and one Plug Power HL 1500 Portable Refueler with 1,588 kg liquid hydrogen storage. Four FCEB would require 190 kg per day which means the storage would last 8.35 days before refueling.

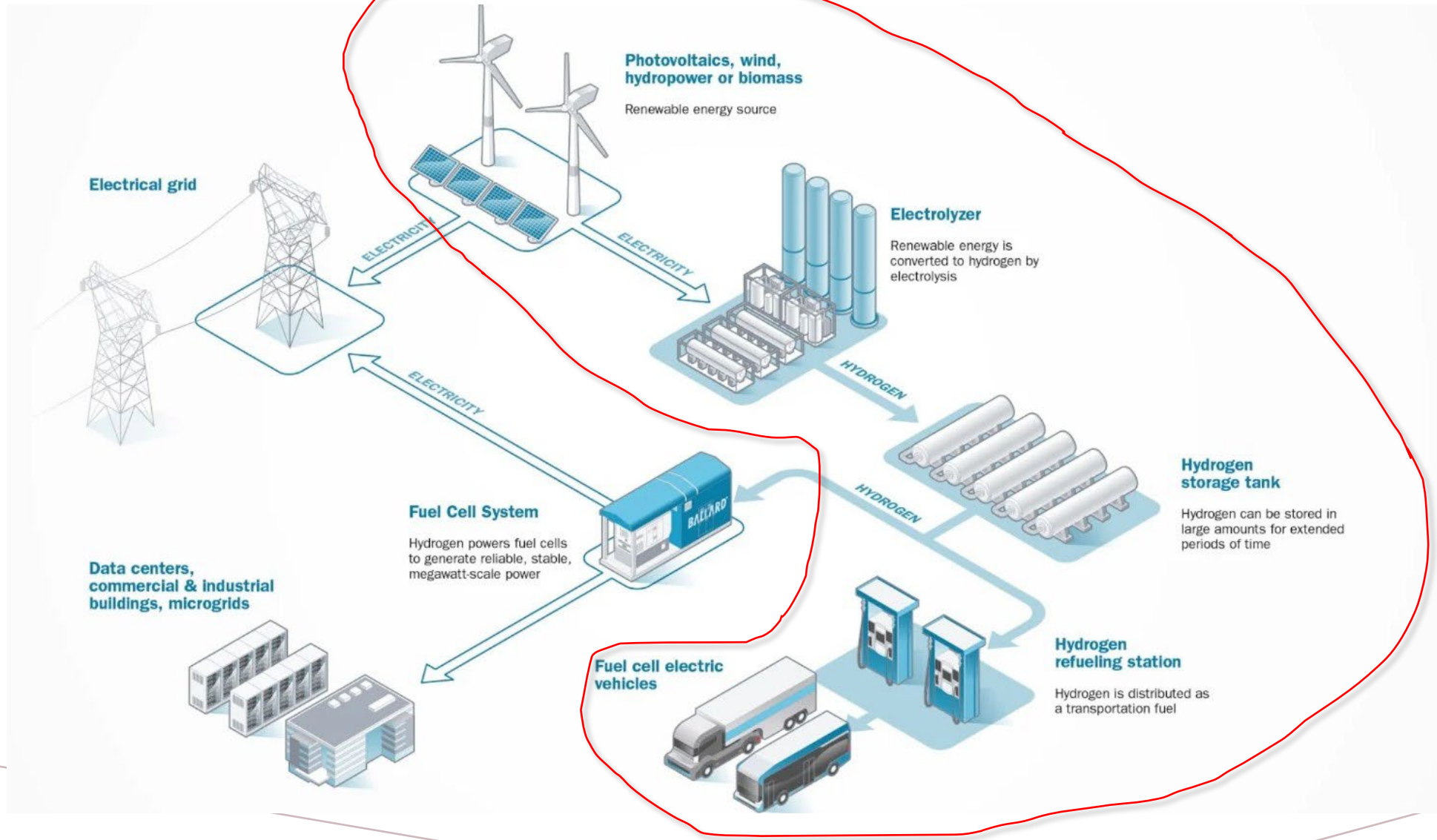
Source: RGRTA

H2wai'i HYDROGEN STATION

Photograph Courtesy of Royer Studios

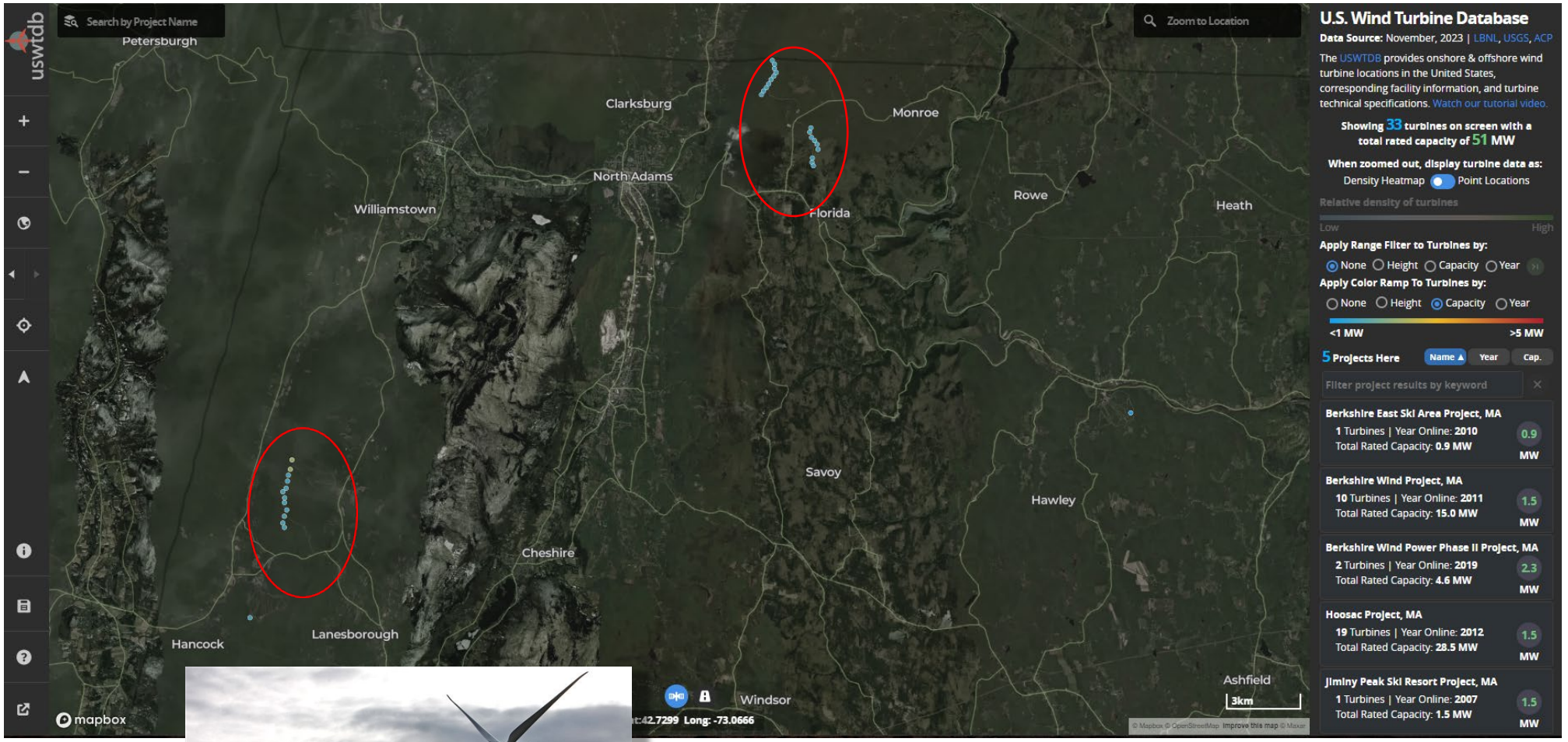
HNEI NELHA HYDROGEN PRODUCTION & FUELING STATION VISITOR BRIEFING

PROJECT LAYOUT



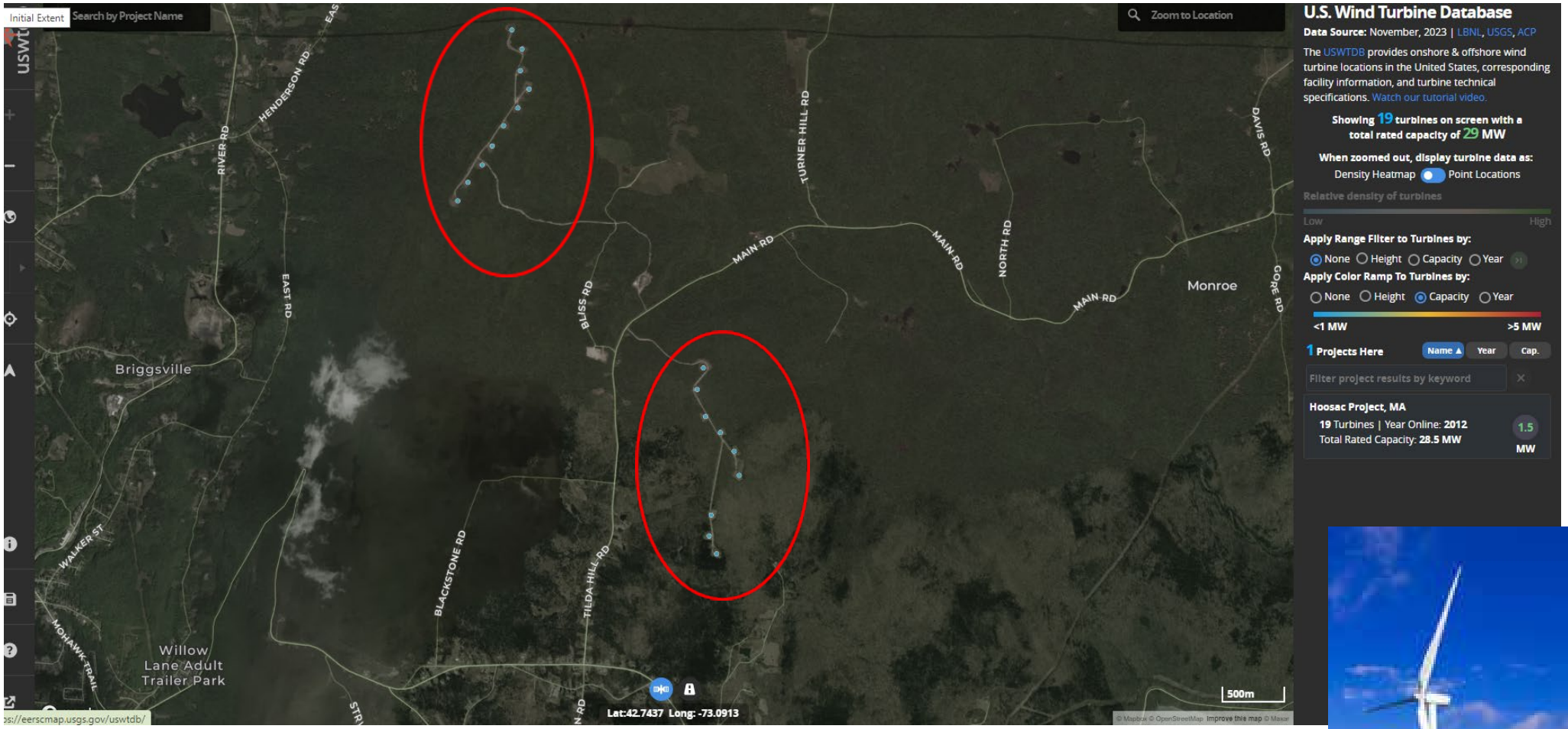
Source: vendor B

GREEN HYDROGEN SOURCE



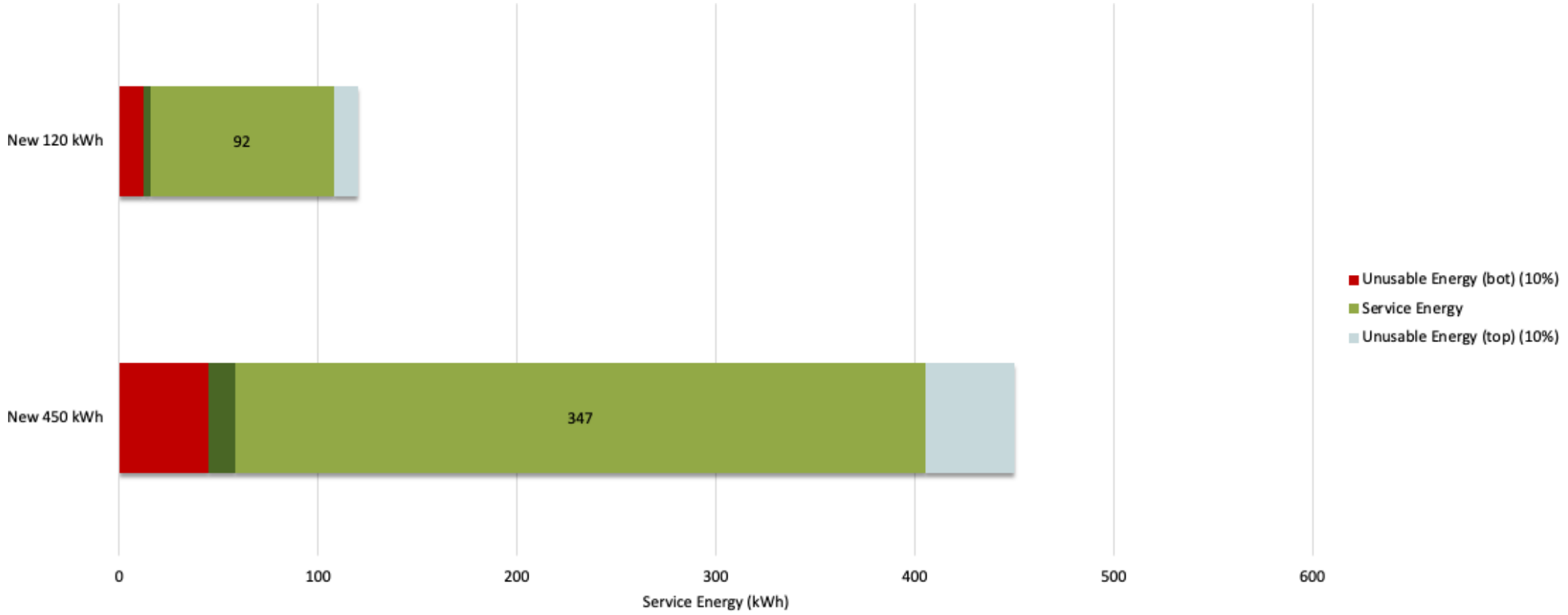
Berkshire Wind Co-Op:
Location – Hancock Offtake Customer – Mass Municipal Wholesale Electric Company (MMWEC)
Rated Capacity – 15 MW (phase 1), 4.6 MW (phase 2)
COD – 2011, 2019
Avg. Annual Availability Factor – 45.39% (8.89 MW)
Capacity Factor – 28.51% (5.58 MW)
Owner – Berkshire Wind Co-op

GREEN HYDROGEN SOURCE



Hoosac Project:
Location - Florida/Clarksburg Offtake Customer – Eversource Utilities
Rated Capacity – 28.5 MW
COD – 2012
Avg. Annual Availability Factor – 45% (12.82 MW)
Capacity Factor – 28.51% (7.98 MW)
Owner – Avangrid Renewables

USEABLE BATTERY CAPACITY PROJECTION (KWH)



- CTE estimates usable energy conservatively at 80% of nameplate, with an additional 3% loss of derated energy, based on validation testing from other deployments. Useable battery capacity and aging performance will vary across OEMs.
- CTE estimates 69% of nameplate for battery degradation, used to estimate feasibility.

VEHICLE PERFORMANCE

Bus Size (ft)	2024 Nameplate Battery Capacity (kWh)	Useable Battery Capacity (kWh)	Strenuous Efficiency (kWh/mi)	References
Cutaway	120	92	1.5	**Battery Capacity:** Market Average 2024 **Fuel Efficiency:** CTEAux Estimate
30	450	347	2.7	
35	450	347	2.9	

- Usable energy estimated at 80% of nameplate.
- CTE estimates 69% of nameplate for battery degradation, used to estimate feasibility.
- Vehicle efficiencies used assume all-electric heater.
- Battery capacity increases 5% every two years based on anticipated technology improvements.

VEHICLE PERFORMANCE

Weekday (MUWTF) **Saturday (A)**

Division	Route ID	Bus Group	Operating Days	Pull Out Time [HH:MM]	Pull In Time [HH:MM]	Block Duration [HH:MM]	In-Service Distance [mi]	Off-Service Distance [mi]	Total Distance [mi]	Total Number of Trips on Block	Number of trips per route	Strenous Energy (kWh)	BEB Useful Capacity (347 kWh)	BEB Useful Capacity (92 kWh)
Downing Garage	1A, 1B	29'	MUWTF	5:00	22:00	17:00	635.5	27	662.5	12	1A:12, 1B:12	1789	No	No
Downing Garage	1A, 1B	32'	A	6:30	19:45	13:15	492	36	528	12	1A:12, 1B:12	1426	No	No
Downing Garage	2A, 2B	32'	MUWTF	5:15	20:40	15:25	383.4	8.2	391.6	11	2A:11, 2B:11	1057	No	No
Downing Garage	2A, 2B	32'	A	7:00	19:20	12:20	351.45	6.6	358.05	11	2A:11, 2B:11	967	No	No
Downing Garage	3A	25'	MUWTF	5:50	20:25	14:35	372	45.4	417.4	14	3A:14	626	No	No
Downing Garage	3A	25'	A	6:50	20:25	13:35	303.6	45.5	349.1	11	3A:11	524	No	No
Downing Garage	4A	25'	MUWTF	5:00	19:35	14:35	177.1	5	182.1	7	4A:7	273	Yes	No
Downing Garage	4A	25'	A	5:55	19:35	13:40	164.2	6.8	171	6	4A:6	257	Yes	No
Downing Garage	5A	25'	MUWTF	5:00	18:50	13:50	110.6	9	119.6	7	5A:6	179	Yes	No
Downing Garage	5A	25'	A	7:00	18:35	11:35	94.8	0	94.8	6	5A:6	142	Yes	No
Downing Garage	11A/15A	25'	MUWTF	5:00	21:50	16:50	173.8	0	173.8	11	11A/15A:11	261	Yes	No
Downing Garage	11A/15A	25'	A	8:30	18:50	10:20	126.4	0	126.4	8	11A/15A:8	190	Yes	No
Downing Garage	12A	35'	MUWTF	5:35	18:30	12:55	149.5	6.6	156.1	11.5	12A:11.5	453	No	No
Downing Garage	12A	35'	A	7:35	16:55	9:20	110.5	6.6	117.1	8.5	12A:8.5	340	Yes	No
Downing Garage	14A	35'	MUWTF	18:30	22:10	3:40	147.2	6	153.2	11.5	14A:11.5	444	No	No
Downing Garage	21B	25'	MUWTF	5:45	19:05	13:20	446	18	464	11	21B:11	696	No	No
Downing Garage	21B	25'	A	7:25	19:05	11:40	407.2	18	425.2	10	21B:10	638	No	No
Downing Garage	921A	25'	MUWTF	5:00	21:55	16:55	127.8	22.5	150.3	3	921A:3	225	Yes	No
Downing Garage	921A	25'	A	17:00	21:45	4:45	42.6	22.5	65.1	1	921A:1	98	Yes	No
Downing Garage	3A/34A	35'	MUWTF	4:50	23:30	18:40	286.2	0	286.2	13	3A:13	830	No	No
Downing Garage	3A/34A	35'	A	6:00	20:45	14:45	171.6	0	171.6	12	3A:12	498	No	No

FAQ RESPONSES

Hydrogen Fuel is dirty?

- Emission of FCEB is water.
- Electricity supply for Massachusetts is In 2023, 49% gas (methane), 20% nuclear, 11% renewables, 8% hydro, 0.16% coal, 0.28% oil, 13% net flow over external ties, Quebec, New Brunswick and New York.

BEB is less expensive than FCEB?

- BEB cost for 35' is $1,028,187.
- FCEB cost for 40' is $1,305,000 (more passenger seating).
- Due to the limited BEB range, we need two BEB for each diesel bus replacement.

Hydrogen infrastructure is expensive?

- Berkshire County distribution grid does not support charging capacity needed.
- Larger bus depot is needed for bus spacing for the charging.
- BEB requires up to 10 hours of charging in the evening.

Hydrogen fuel is expensive?

- The US Department of Energy is focused on Hydrogen Hubs Development with an $8 Billion grants and reduce hydrogen cost to $2 per kg.

THANK YOU