PROTERRA

TS 88.4 Cost of Ownership

The Agency is interested in the long-term cost of ownership, particularly the maintenance requirements that are routine, scheduled and/or reasonably predictable. In addition to the Proposers submittals describing and defining the service and maintenance requirements for the equipment, a "Cost of Ownership" template has been developed and included in the forms to be filled out by the Proposer as an element of the submittal package. This form itemizes tasks in three areas, PMI, scheduled maintenance and major component replacement.

- *Estimated energy consumption (kW/m).*
- *Estimated service and maintenance costs per mile ($/mile).*
- *Miles between road calls.*
- *Miles between major rebuilds.*
- *Hours of training required for mechanics and service/cleaning personnel to become proficient in the proper maintenance, repair and service the proposed buses.*
- *A list of recommended spare parts to service and maintain the buses in the first year with costs.*
- *Preventative Maintenance schedule.*
- *Special tools.*

Proterra's Total Cost of Operation (TCO) tool was built to estimate life-cycle costs associated with the operation of Proterra Battery Electric Buses (BEBs) over a set time period given certain operating conditions. For this analysis, Proterra is using the below assumptions relative to PSTA's desired operation of these BEBs:

- BEBs will operate over a twelve (12) year period or 500,000 miles.
- This includes only the costs of energy, parts, preventive and non-preventive maintenance
- Estimated energy consumption is based on ***2.2 kWh/mile***, Proterra's average customer efficiency
- Estimated service and maintenance costs - ***$0.38/mile***
    - *Please refer to the following page which contains the calculations on service and maintenance costs*
- Estimated total Life Cycle Costs / Total Cost of Ownership
    - *Please refer to the following page (page 3) which contains the fuel (energy) cost calculations using Xcel Energy rate tariffs and incorporating the service and maintenance costs.*
- Miles between road calls – 8,500 miles
- Miles between major rebuilds – 250,000 miles
- Required training hours – 96 hours (standard offering)
- Recommended spare parts – See attached Recommended Spare Parts list
- Preventative Maintenance schedule – See attached Preventative Maintenance Schedule
- Special tools – See attached list of Special Tools

Proterra Service Cost Estimation - PSTA

Assumptions			
40' ZX5+ BUS WITH 2ND GEN PRO-DRIVE SYSTEM			
Labor cost per hour	$110	$/hr	<<- Enter the labor rate for service. This will be a retail ratefrom a contractor, or the fully-burdened rate of a staff technician (estimate wage+35% if unknown)
Miles per year	50,000	miles	<<- Enter the expected number of miles to be driven each year.
Number of buses	1		<<- Enter the number of buses to factor.
Life span of bus	15	years	<<- Enter the number of years of expected use.
Miles per lifetime	750000	Miles	
All numbers are estimated based on field data - Actual results may vary			

Miles	Interval (miles)	# In Life of Bus	Parts Cost	Labor Time	Lifetime Labor Hours	Lifetime Labor Cost	Lifetime Parts Cost	Total Cost
PMI 6000 mile general	6000	125	$ 40	2.5	312.5	$ 34,375	$ 5,000	$ 39,375
PMI 48000 mile general	48000	15	$ 250	4	60	$ 6,600	$ 3,750	$ 10,350
Air dryer desicant cartridge	48000	15	$ 70	0.5	7.5	$ 825	$ 1,050	$ 1,875
Air comp filter	48000	15	$ 160	0.25	3.75	$ 413	$ 2,400	$ 2,813
HVAC filter	48000	15	$ 100	0.25	3.75	$ 413	$ 1,500	$ 1,913
Defroster filter	48000	15	$ 40	0.25	3.75	$ 413	$ 600	$ 1,013
Grease and lube	48000	15	$ 10	1	15	$ 1,650	$ 150	$ 1,800
Wiper blade	48000	15	$ 65	0.25	3.75	$ 413	$ 975	$ 1,388
Brake general	70000	10	$ 225	4	40	$ 4,400	$ 2,250	$ 6,650
HVAC AC Dryer	70000	10	$ 200	1	10	$ 1,100	$ 2,000	$ 3,100
Shocks	70000	10	$ 1,200	6	60	$ 6,600	$ 12,000	$ 18,600
Coolant	150000	5	$ 150	3	15	$ 1,650	$ 750	$ 2,400
Transmission oil	100000	7	$ 80	0.5	3.5	$ 385	$ 560	$ 945
Power steering fluid	150000	5	$ 40	1	5	$ 550	$ 200	$ 750
Air comp oil	60000	12	$ 50	1	12	$ 1,320	$ 600	$ 1,920
Air comp rebuild	60000	12	$ 400	4	48	$ 5,280	$ 4,800	$ 10,080
12v batteries	150000	5	$ 800	0.75	3.75	$ 413	$ 4,000	$ 4,413
Differential oil	150000	5	$ 50	0.75	3.75	$ 413	$ 250	$ 663
Tie rods	150000	5	$ 500	4	20	$ 2,200	$ 2,500	$ 4,700
Suspension bushings	150000	5	$ 500	6	30	$ 3,300	$ 2,500	$ 5,800
HVAC AC Compressor oil	150000	5	$ 100	2	10	$ 1,100	$ 500	$ 1,600
Brake rotors	180000	4	$ 2,000	5	20	$ 2,200	$ 8,000	$ 10,200
Brake pads	180000	4	$ 800	5	20	$ 2,200	$ 3,200	$ 5,400
Axle seals	250000	3	$ 200	5	15	$ 1,650	$ 600	$ 2,250
Wheel bearing	250000	3	$ 800	6	18	$ 1,980	$ 2,400	$ 4,380
Tires (Customer may enter own estimate here)	50000	15	$ 2,958	2	30	$ 3,300	$ 44,370	$ 47,670
Transmission rebuild	350000	2	$ 4,000	8	16	$ 1,760	$ 8,000	$ 9,760
Traction Motor inverter rebuild	250000	3	$ 6,000	4	12	$ 1,320	$ 18,000	$ 19,320
Traction Motor rebuild	250000	3	$ 6,000	8	24	$ 2,640	$ 18,000	$ 20,640
Battery pack replacement	500000	1	$ 45,000	16	16	$ 1,760	$ 45,000	$ 46,760

PMI	$ 192,045
Mid-Life	$ 96,480
Grand Total	$ 288,525
Cost/mile	$ 0.38
Cost/yr	$ 19,235

Proterra ZX5+ Total Cost of Ownership / Life Cycle Costs

Total Cost of Ownership, Fuel & Maintenance

		Proterra
		40' ZX5+
Capital Costs		
Rolling Stock		
	Quantity	17
	Average Purchase Price	$880,726
	Total	$14,972,342
Operating Costs		
Annual Mileage		50000
Fuel Inputs		
	Fuel Economy, Miles/kWh	0.45
	Energy Consumption, kWh/mi	2.2
	Fuel Economy, MPG-DGE	17.1
	Stated Electricity Price, $/kWh	$0.05
	Peak Demand Charges, $/kW	$5.63
	Effective Electricity Price, $/kWh	$0.11
	Fuel Price, $/DGE	
Fuel Costs		
	Annual Electricity Use Per Bus, kWh	110,000
	Annual Electricity Use Fleetwide, kWh	1,870,000
	Monthly Demand, kW	1,700
	Annual Demand, kW	20,400
	Total Annual Cost of Electricity (fleet)	$213,027
	Annual Fuel Use Per Bus, DGE	
	Cost per Mile, $/Mile	$0.25
	Annual Cost Per Bus	$12,531
	Annual Cost Per Fleet	$213,027
	Lifetime Cost Per Bus	$187,965
	Lifetime Cost Per Fleet	$3,195,405
Maintenance Cost		
	Annual Parts & Labor, $/yr	$19,235
Total Maintenance Cost		
	Total Maintenance Cost, $/Mile	$0.38
	Annual Cost Per Bus	$19,235
	Annual Cost Per Fleet	$326,995
	Lifetime Cost Per Bus	$288,525
	Lifetime Cost Per Fleet	$4,904,925
Total Operating Costs		
	Annual Operating Cost Per Bus	$31,766
	Annual Operating Cost Per Fleet	$540,022
	Lifetime Operating Costs Per Bus	$476,490
	Lifetime Operating Costs Per Fleet	$8,100,330