Article 30: Healthy School Buses For Students

Better student transportation for Concord

Finance Committee Meeting Supplemental Public Hearing

Tuesday, August 18th 2020

ARTICLE 30: HEALTHY SCHOOL BUSES FOR STUDENTS

To determine whether the Town will vote to raise and appropriate or transfer from available funds, a sum of money not to exceed two hundred thousand dollars ($200,000), or any other sum, to be expended under the direction of the Town Manager, to supplement the cost of two electric school buses and fueling infrastructure, or take any other action relative thereto.

Article 30: Healthy School Buses for Students

Petitioner: Brian Foulds

- 2011 to now – Assist with the beneficial electronification of the Town of Concord
- 2018 - Climate Action Advisory Board
- 2016 - Energy Future Task Force
- 2015 - Alternative Fuels for School Buses

I have helped Concord reduce GHG emissions with practical solutions, while addressing the challenges inherent in transitioning to new technology.

Presentation Overview

- Electric Bus History
- Health
- GHG Emissions
- What is V2G?
- Financials
- Answer Questions

History of Electric School Buses 2011-2019

- Plans for new high school DID NOT include bus depot
  - Citizens save in-town busing campaign
- Citizen School Transportation Committee (2012)
- New bus depot site acquired W.R. Grace (2013)
- Town Meeting approves the purchase of 10 diesel buses (2015)
  - Asks schools to investigate alternatives to diesel buses
- Alternative Fuel Buses Advisory Committee (2015)
- Participated in the State's Electric School Bus Pilot (2016-2018)
- CPS plan is 80% electric when lifecycle cost is lower than diesel
  - Waiting on VW settlement funds to be available (2015-2019)
- CPS applied for one (not two!) in the first round of VW funding (2019)

2015 - Alternative Fuels for School Buses

During the 2015 town meeting, Concord Public Schools requested $1 million to purchase 10 diesel school buses. Citizens requested the school committee research alternatives to diesel to better align with the town's sustainability principals adopted in 2011. The Alternative Fuels for School Buses sub-committee was formed to:

- Assess the current school bus fleet's impact on the environment and children's health
- Assess alternatives
- Assess infrastructure needs
- Assess the financial impact
- Give rationale to support recommendations

Committee Recommended: **Electric Buses**

Final presentation linked here

1st in the Country

AN ELECTRIC MOMENT: Concord welcomes the latest addition to its fleet of school buses a groundbreaking all-electric vehicle. – *Bill Griffith*

November 30, 2016 Boston Globe

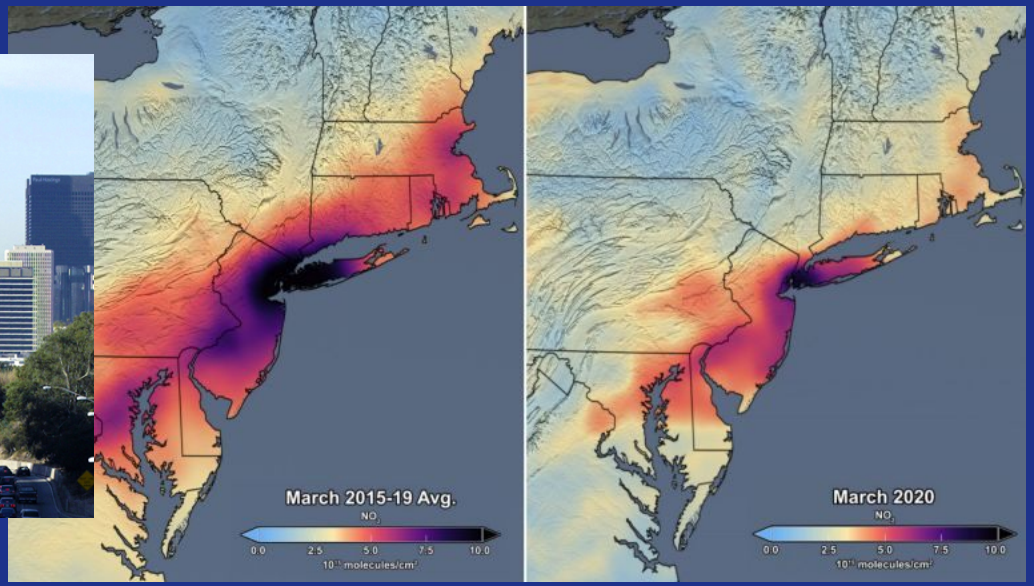
Massachusetts Clean Cities Video of the electric school bus pilot. See interviews with students, parents, school committee members, school superintendents and a utility power supply administrator. (4 minutes)

The Electric School Bus pilot is great!

https://youtu.be/mnvEhN47xJ0

Local Air Pollution

Take internal combustion engine (ICE) vehicles off the road and air quality improves. Images are of pre / post COVID-19 lockdown and satellite readings of NO_2 from NASA



Health - Local Air Pollution

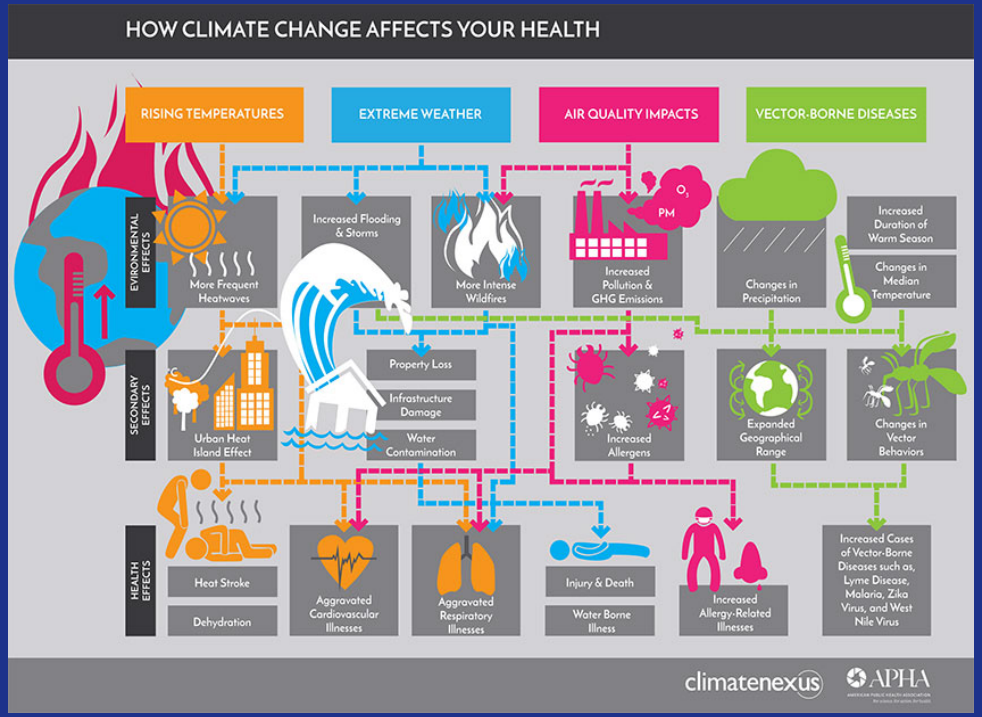
People who live, work or attend school near major roads appear to have an increased incidence and severity of health problems associated with air pollution exposures related to roadway traffic. Children, older adults, people with preexisting cardiopulmonary disease, and people of low socioeconomic status are among those at higher risk for health impacts from air pollution near roadways. (Source EPA)

These risks include:

- Higher rates of asthma onset and aggravation
- Cardiovascular disease
- Impaired lung development in children
- Pre-term and low-birthweight infants
- Childhood leukemia and premature death

How Climate Change Affects Your Health

- Money / Environment / Health
  - Displacement & Migration
  - Vector-Borne Diseases
  - 6th Mass Extinction
  - Extreme Weather
  - Health Care Cost
  - Water Crisis
  - Air Quality
- *"**Climate change can act as a threat multiplier** for instability in some of the most volatile regions of the world, and it presents significant national security challenges for the US."* CNA 2007



Climate Change = Chemistry Problem

IPCC - A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

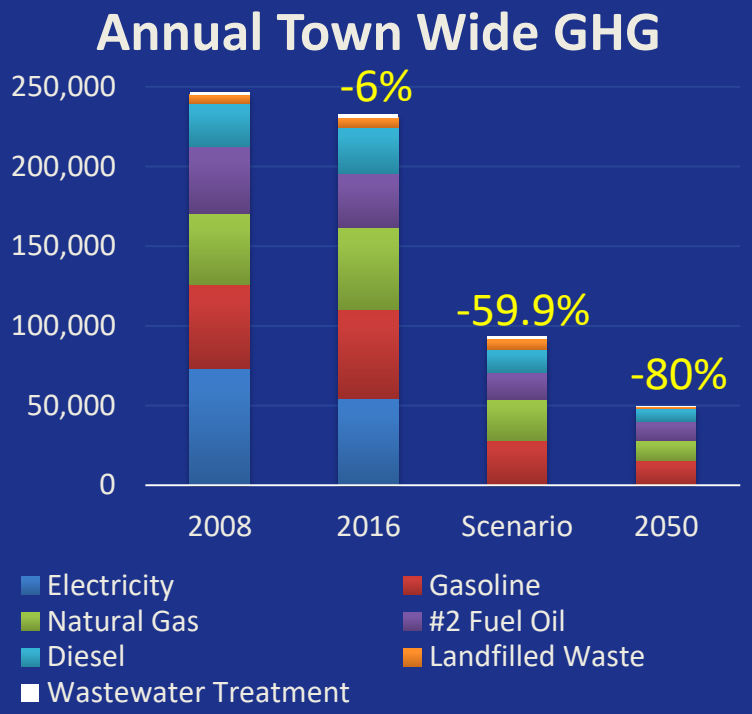
UNFCCC - A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. (Source)

If humanity stops digging up and burning fossil fuels, we will have a stable climate.

Reduction Strategy: Zero Carbon Electricity

"A scenario of also replacing half of the 84,754 $MTCO_2e$ transportation emissions and half of the 85,838 $MTCO_2e$ fossil fuel commercial and residential emissions with carbon free electricity represents an additional 85,296 metric ton reduction for a total of 139,530 $MTCO_2e$, 59.9% of Concord's 2016 emissions. ***No other strategy holds this kind of potential."***

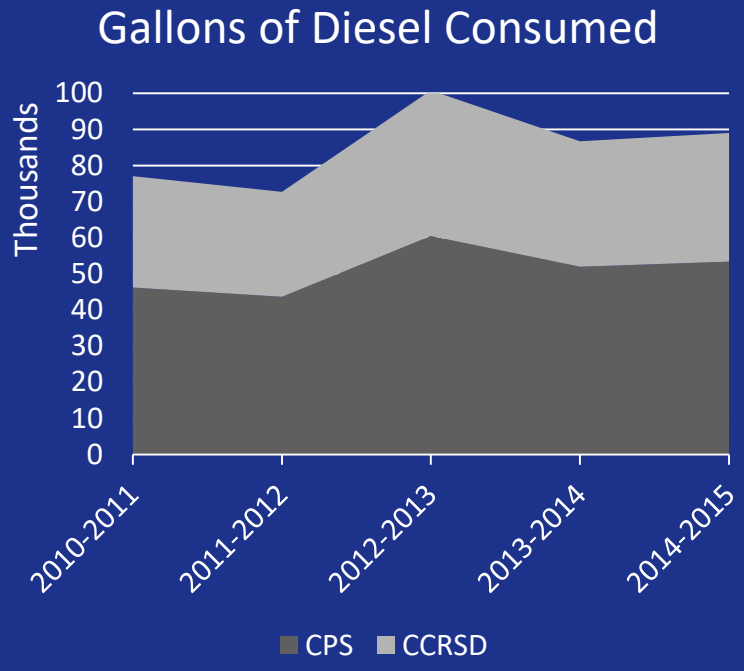
Concord_GHG_Reduction_Strategy_Analysis (page 32)



Article 31: Town Fleet

Concord's Fleet from 2015

- 36 Diesel Buses in 2015 (*old data: now 42*)
- Lifecycle is 12-14 years
- Average of 85,250 gallons per year
- Costing $260,000 at $3.04/gallon
- Average 1,907,895 lbs. of GHG each year (equal in weight to 58 school buses)
- Busing accounts for 8% of all town GHG (buildings, street lights, DPW, everything)



One Diesel molecule needs 20 O_2 from air

$C_{13}H_{28} + 20\ O_2 \rightarrow 13\ CO_2 + 14\ H_2O$

Electric School Buses and Electric Utilities

Electricity is a perishable commodity produced the moment it is needed. Electric school buses are simply large batteries on wheels, a fleet of energy storage.

- The duty cycle of a school bus is the opposite of electricity demand (a good match)
- Idle buses can generate revenue for schools by lowering electric utility expenses (V2G)
- Balance intermittent renewable generation
- Improve power quality (frequency regulation)

Example: Dominion Energy in Virginia

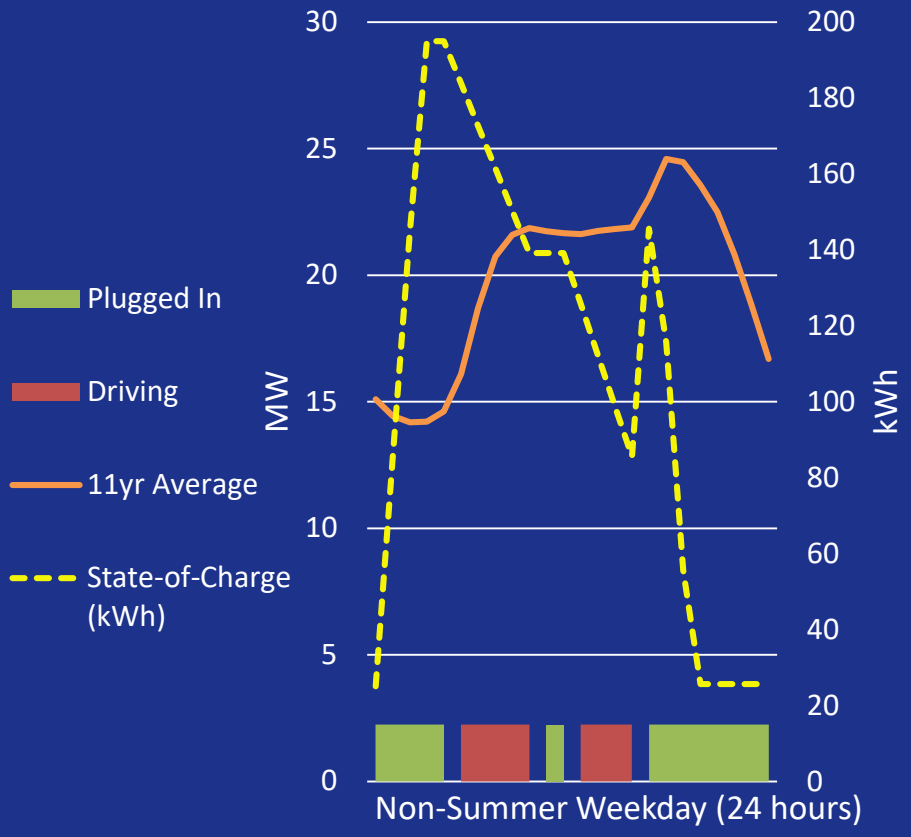
  - 50 electric school buses by the end of 2020
  - 1,000 electric school buses by 2025 + 100% 2030

Concord Light 5.5 MW Solar Array

School Bus Depot (being built 2017)

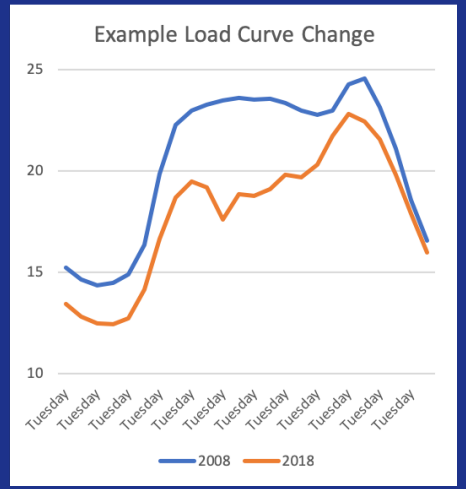
School Day Battery Cycle

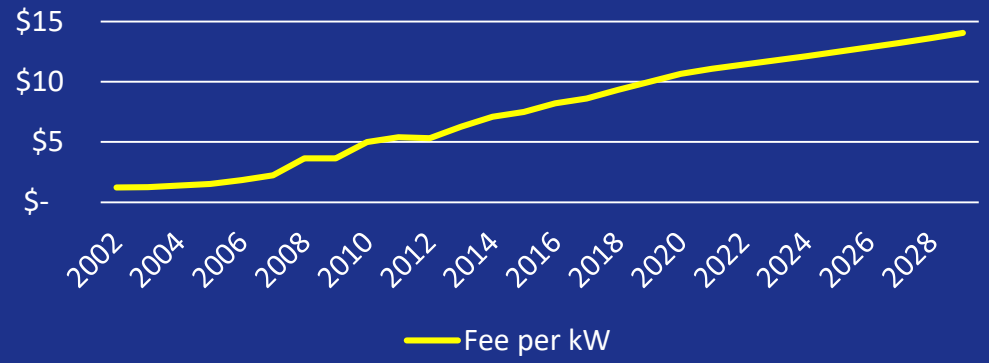
- Around 2am to 3am bus begins charging to 100%
- Bus drives kids to school and home driving 73 miles
- 4pm charges before grid's peak demand for electricity
- 5pm-7pm discharges 60 kW of stored electricity into grid's peak

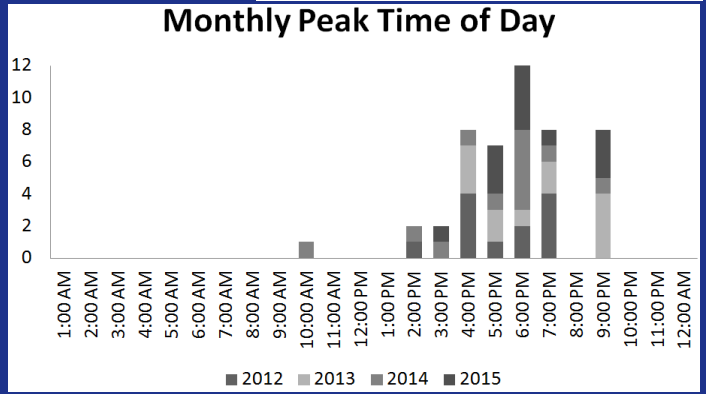


ISO Regional Network Service (RNS)

- Concord Light pays based on this one peak hour each month. (kW of substation load times the RNS rate)
- Article 17 says this will be $3,906,123 in 2020
- The RNS rate continues to climb

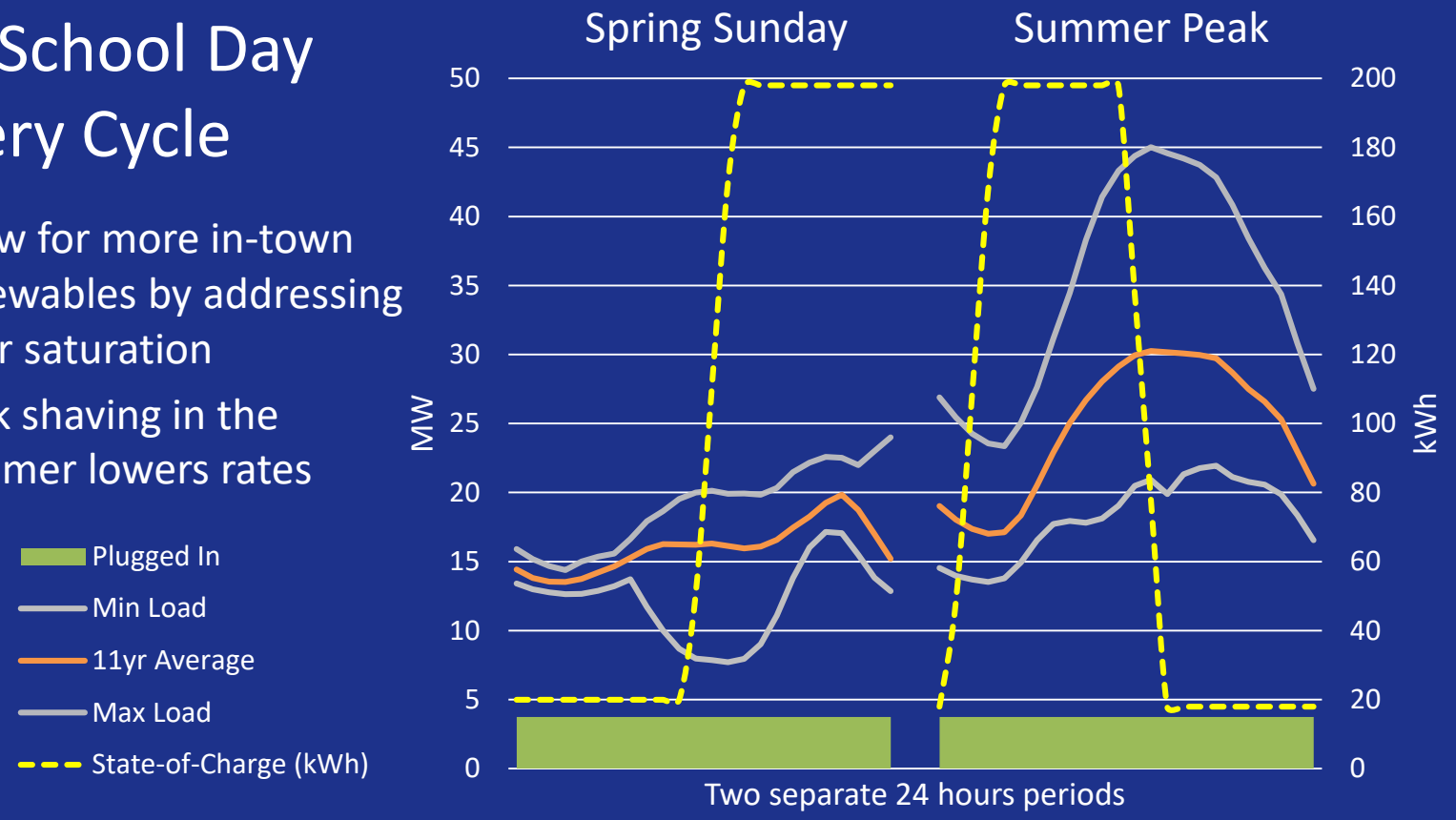






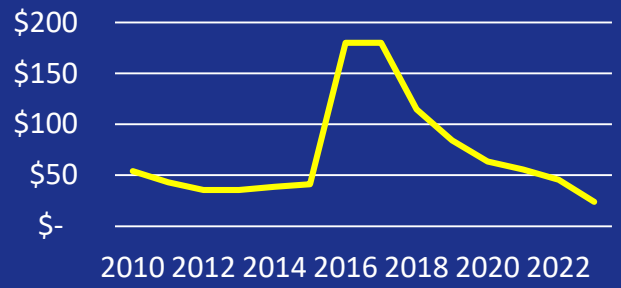
Non-School Day Battery Cycle

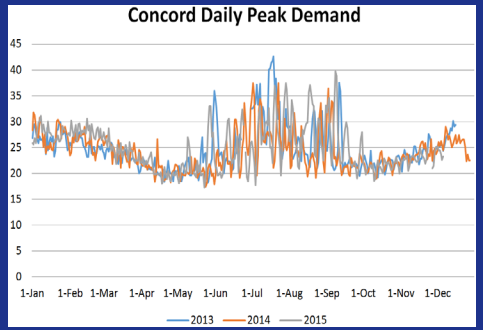
- Allow for more in-town renewables by addressing solar saturation
- Peak shaving in the summer lowers rates



ISO Forward Capacity Market (FCM)

- Concord Light pays based on this one hour each year when all of New England peaks.
- Article 17 says this will be $3,152,952 plus ~$2m in fixed contracts in 2020
- The FCM rate fluctuates based on the market
  - The FCM rate is not known until after load is set
  - High value of $180 per kW in 2016 and 2017





ISO new england

Annual System Peak Day, Hour, and Load

Concord Light MW	Hour Ending	Concord 's % of ISO Peak	Concord 's % of NEMA Peak	
44.851	3:00 PM	0.1600%		
40.957	3:00 PM	0.1589%		
44.628	3:00 PM	0.1737%		
41.497	3:00 PM	0.1680%		
44.169	3:00 PM	0.1654%	0.8125%	
44.579	3:00 PM	0.1632%	0.7888%	
40.854	5:00 PM	0.1599%	0.7619%	
42.601	5:00 PM	0.1583%	0.7648%	Solar Challenge
37.101	3:00 PM	0.1542%	0.7281%	Landfill 3/14
37.445	5:00 PM	0.1557%	0.7604%	
38.317	3:00 PM	0.1526%	0.7277%	
34.188	5:00 PM	0.1454%	0.6833%	WR Grace 12/16
39.618	5:00 PM	0.1552%	0.7472%	

Infrastructure for Vehicle-to-Grid

The bus depot needs

- Detailed construction plans
- New G-3 electrical service connection
- Underground electrical conduit for 13-14 school buses (row near river)
- Concreate pads with bollards

Charging stations and dispensers will be purchased as electric school buses are acquired under grant funding

Total Cost of Ownership

One electric school buses:

- Purchase is 3.5 times a diesel
- Cost less to fuel and maintain
- Diesel fueling infrastructure is already installed and electrical fueling infrastructure has a cost
- Savings from Vehicle-to-Grid is found in avoided cost at Concord Light and does not go to schools
- School buses are 8% of the municipal sector's GHG emissions and each electric bus is a 2/3 reduction in emissions

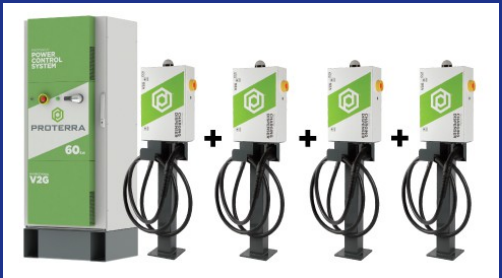
1 Bus	Diesel	Electric w/o VW	Electric with VW	Electric VW & V2G
Purchase	$100,000	$365,000	$365,000	$330,000
VW Funding	$0	$0	($295,000)	($298,000)
Infrastructure	$5,000	$9,000	$9,000	$49,250
Fueling	$82,000	$60,000	$60,000	$60,000
Maintenance	$137,500	$78,000	$78,000	$78,000
Grid Services	$0	$0	$0	($147,000)
Resale 12 Years	($6,000)	($13,500)	($13,500)	($13,500)
TCO per Bus	$318,500	$498,500	$203,500	$58,750
Lifecycle Cost	100%	156%	64%	18%
Pounds CO_2	695,000	229,500	229,500	-/+ 229,500

Disclaimer: Values shown here are based on many technology, schematic design, and financial assumptions so should not be taken as an expectation of financial return. Some, but not all, assumptions are listed here. (18k mile/yr all examples, 6.9 MPG & 1.5 kWh/mile, diesel $2.61gal. & $.19 kWh, maintenance $5.75/mile Diesel & $3/mile BEV 60kw V2G for 3hours, RNS $10kw/mo. & FCM $7kw/mo., 22.2lb. CO2/Gal. & 2018 ISO-NE Emissions Rates 658 lbs/MWh)

Total Cost of Ownership

Two electric school buses:

- VW covers 80% up to $500k
- 2 buses VW covers ~66-69%
- VW funding is limited
- In round one of the VW funding Martha's Vineyard Regional High School District received $500k



2 Bus	Diesel	Electric VW w/o V2G	Electric VW Single V2G	Electric VW Two V2G
Purchase	$200,000	$730,000	$660,000	$660,000
VW Funding	$0	($500,000)	($500,000)	($500,000)
Infrastructure	$10,000	$13,000	$67,650	$98,500
Fueling	$164,000	$120,000	$120,000	$120,000
Maintenance	$275,000	$156,000	$156,000	$156,000
Grid Services	$0	$0	($147,000)	($294,000)
Resale 12 Years	($12,000)	($27,000)	($27,000)	($27,000)
TCO per Bus	$637,500	$246,000	$164,825	$106,750
Lifecycle Cost	100%	78%	52%	33.5%
Pounds CO_2	1,390,000	459,000	-/+ 459,000	-/+ 459,000

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Summary

Concord has experience with electric schools buses. They are a healthier option for the community. Each bus lowers Concord's GHG emission in line with our town goals and they are a financial savings for tax payers and rate payers.

Article 30: Healthy School Buses for Students

To determine whether the Town will vote to raise and appropriate or transfer from available funds, a sum of money not to exceed two hundred thousand dollars ($200,000), or any other sum, to be expended under the direction of the Town Manager, to supplement the cost of two electric school buses and fueling infrastructure, or take any other action relative thereto.

~$50,000 to maximize the VW Settlement funding match without reducing educational program funding for round 2 (2020) of MA DEP VW program.

~$150,000 for electrical fueling infrastructure at the bus depot to realize the maximum financial return on all future electric school bus purchases. (V2G)