REPORT
March 2025

NYSERDA P-12 Schools:
Clean Green Schools Initiative

OGDENSBURG CITY SCHOOL DISTRICT

GRANT AND FUNDING OPPORTUNITIES

SCHOOL BUS FLEET TRANSITION PLAN

Ogdensburg CSD
1100 State Street
Ogdensburg, NY 13669

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Section 1

Introduction

Introduction

Ogdensburg City School District and NYSERDA have obtained Pathfinder now IMEG's services to conduct a study regarding the transition of the district's current gasoline school bus fleet to battery electric buses by 2035. The deliverables of the study include a transition plan providing the district with a guide to transitioning the fleet based on current NYS mandates. Should the current mandates change, this plan will provide the necessary information for the district to adjust the plan accordingly.

Background

In April 2022, New York State's enacted 2022-2023 State Budget included a zero- emission mandate for NYS school buses. The mandate requires, in part, that by July 1, 2027, all new school bus purchases and leases must be zero-emission and that by July 1, 2035, all school districts must only operate and maintain zero-emission school buses. This mandate defines zero-emission school buses as a school bus that "is propelled by an electric motor and associated power electronics and draws electricity from a hydrogen fuel cell or battery; or otherwise operates without direct emission of atmospheric pollutants." Zero- emission school buses are primarily battery electric at this time. Other zero-emission buses such as hydrogen fuel cell are in development but are not readily available commercially.

Ogdensburg City School District elected to prepare for these requirements by developing a transition plan that would provide the district with the planning tools and flexibility necessary to ensure a seamless transition to zero-emission. In September of 2022, Ogdensburg City Schools contracted with Pathfinder now IMEG and NYSERDA through PON 4924 – P12 Schools: Clean Green Schools Initiative – Track 1 in developing a transition plan that provides a path towards a zero-emission bus fleet by 2035. The program goal is to provide districts with a study that evaluates the current school bus fleet and current manufactured electrified buses to replace their existing gasoline fleet. Pathfinder now IMEG also evaluated the current electrical infrastructure in the district and made recommended upgrades that can be used to make informed decisions regarding design and implementation to reduce energy loads and assist in conversion to carbon free fuels. This transition plan can be used as a guide to the district in transitioning and implementing battery electric buses.

Scope of Work

The detailed scope of work can be found in Appendix C and include the following major tasks:

TASK 1 – Project Kickoff and Status Meetings
TASK 2 – Data Collection
TASK 3 – Route Analysis
TASK 3a – Optional Route Analysis
TASK 4 – Conceptual Charging Strategy
TASK 5 – Electric Utility Analysis
TASK 5a – Optional Analysis – Vehicle-to-Grid Charging Analysis
TASK 6 – Concept Development and Phasing Plan
TASK 7 – Phasing Plan Estimates
TASK 7a – O&M Costs

A memo was submitted as a deliverable for each task above detailing the results and findings of the task. These memos are included in the appendices. This report is a summary of the findings of the individual letter reports generated from each task.

Note on Technology

Battery electric bus technology is emerging and rapidly changing. Electric bus battery capacities are increasing as this technology grows while battery sizes and weights continue to decrease due to charge density improvements. Supporting equipment, such as chargers, are also evolving in terms of charger sizes, an increase in features and improving energy efficiencies. As battery capacities increase, the need for larger chargers also increases to enable fully charging a larger battery in the same amount of time.

The recommendations in this report regarding bus battery capacities and charger sizes are based on the route analysis and charger strategies developed in Tasks 3 through 4 utilizing technology that is currently available as well as manufacturers recommendations. As battery electric bus and charger technology evolves, superior bus capacities and charger configurations may become available. This superior equipment may be substituted for the equipment proposed in this report in order to increase efficiency or bus performance. If an increase in charger size is desired, Ogdensburg City School District should confirm compatibility and capacity with the vendor and their utility provider, National Grid, prior to purchasing.

It should also be noted that at the time of this report, fire and building codes have not been updated to include recommendations for preventing or managing battery electric fires. Although the frequency of battery electric bus fires are no greater than their internal combustion counterparts, Lithium- Ion batteries burn much hotter than a diesel/gasoline fire and are extremely difficult to extinguish. Compliance with fire protection requirements for lithium-ion battery storage in New York State involves adhering to a range of regulations that focus on fire suppression, electrical safety, separation distances, emergency ventilation, and ongoing maintenance. Following NFPA standards, including NFPA 855, as well as local and state codes, ensures that lithium-ion battery systems are installed and maintained safely, helping mitigate fire risks associated with these energy storage technologies. As the codes are updated to address battery electric fires the recommendations of this report should be reviewed and updated as necessary and/or required.

Executive Summary

Executive Summary

Strategy, Goals & Constraints

Pathfinder now IMEG developed a transition plan to provide the district with the planning tools and flexibility necessary to ensure a seamless transition to a zero-emission fleet. The goal of the transition plan is to provide a path towards a zero-emission bus fleet by 2035 by providing Ogdensburg City School District with a study that evaluates and recommends infrastructure upgrades that can be used to make informed decisions regarding design and implementation to reduce energy loads and assist in conversion to carbon free fuels. This transition plan can be used as a guide to the district in transitioning to an electrified fleet and implementing battery electric buses.

While Ogdensburg city school district's goal is to transition to zero-emission vehicles (ZEV) by 2035, Pathfinder now IMEG utilized the following guiding principles to develop a transition plan:

- No impact on student experience
- Limit constraints on operations
- Reduce implementation cost and complexity
- Minimize impact on workforce

Pathfinder now IMEG has identified the following constraints when transition to a zero emissions fleet:

- Vehicle range limitations
- Charging duration requirements
- Utility demand requirements
- Demand on facilities and operations
- Maintenance expertise

Analysis Results

Pathfinder now IMEG analyzed current bus route data and determined the anticipated energy requirements per route. The anticipated energy requirements per route determine minimum battery size requirements, charging requirements and charging durations necessary for each route. Pathfinder now IMEG established that of the 13 buses performing daily routes, 3 electric buses could not complete their daily routes. (14 buses in the current fleet, including 1 bus as spare capacity). This is mainly due to the north-country location having longer routes in a harsh weather climate. With the district being high-needs, school does not get canceled due to low temperatures and buses need to perform in sub-zero temperatures. The anticipated energy requirements per route determined the maximum energy usage is 267 kWh. Pathfinder now IMEG recommends that seven (7) IC 210 kWh buses and three (3) IC 315 kWh buses and 3-5 Existing gasoline buses be maintained to complete Ogdensburg's routes. This could change as time goes on and technology improves, route energy requirements will still assume a full electric fleet.

Ogdensburg's city school district had the following total mileage from September 2023 to September 2024 of 25,473.88 for sport trips and 6,167.45 for field trips. Each trip was not individually logged, only a total mileage was accounted for from year to year. The district has noted that sport trips can vary from 40miles round trip to section appearances up to 250miles one way. The current technology of zero-emission vehicles do not allow for this type of range in poor weather conditions. It is Pathfinders now IMEG's recommendation that the school district maintain 3-5 existing buses for sports trips and field trips outside of the normal daily bus routes.

The analysis of the bus routes determined that multiple bus battery sizes could be used to complete 10 of the 13 Ogdensburg City School District daily bus routes. Pathfinder now IMEG chose the IC Bus 210 kWh and 315kWh bus as the basis for the Ogdensburg fleet. This choice is based on the following:

1. Ogdensburg does not have an opinion on a particular bus manufacturer.
2. The 210 kWh battery in the IC Bus is large enough to complete a majority of the routes.
3. There are some longer routes that will require a larger bus battery. On these routes, Pathfinder now IMEG is recommending the IC 315 kWh bus. Three (3) larger battery buses would be required to complete 10 of the 13 current Ogdensburg City School District bus routes.

Pathfinder now IMEG recommends that Ogdensburg City School District utilize six (6) of the Proterra 60 kW chargers and six (6) 20 kW chargers. The Proterra 60 kW chargers were selected as the basis of design for the following reasons:

1. The Proterra 60 kW charger is currently the only Proterra charger that is V2G capable.
2. Other charger manufacturers have chargers comparable to the Proterra 60 kW charger and can be utilized if desired.

The maximum demand from bus charging when all buses are converted to zero-emission vehicles during the least efficient month is 1,319.22 kW.

Phases & Costs

It should be noted that in discussions with IC Bus Engineers, Pathfinder now IMEG was informed that undercoating for winter salt conditions void the motor, battery and drivetrain warranty that is necessary for typical vehicle lifecycle. Extensive conversations should be had with bus manufacturers regarding protection against salt; without adequate protection, the bus lifecycle will be drastically shortened.

Pathfinder now IMEG has estimated the capital cost to purchase battery-electric buses and supporting charging infrastructure to achieve 100% zero-emissions bus operations by 2035. Transition plan phases were determined by the bus implementation/procurement schedule provided by Ogdensburg. The bus implementation schedule below determines when infrastructure is required per phase. All components of phase 1 will be required to charge battery electric buses. If Ogdensburg adjusts their procurement schedule, the timing of phases can be impacted. Based on this transition plan (*Table 1*) and bus implementation schedule, Ogdensburg is fully transitioned to a zero emission battery electric fleet by 2035 (13 operational buses by 2035 and maintain 5 existing buses from original fleet by 2035).

Table 1. Ogdensburg Electric Bus Transition Plan

	Existing	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total
Battery Electric Buses Procured	0	1	1	1	1	1	1	1	1	1	2	3	14
Battery Electric Bus Fleet Size	0	1	2	3	4	5	6	7	8	9	11	14	14

<u>Phase 1</u>

Phase 1 is the new electrical distribution panelboard adjacent to the bus parking lot that will supply the necessary power to each charging station. This phase requires a new 800A panel board, feeder, and associated charges for the new electrified buses.

Costs

- Charging infrastructure for Phase 1: $250,000*
- *Charging stations not included in the cost.

<u>Phase 2</u>

Phase 2 and each subsequent phase for the remainder of the school's districts bus fleet will only require the need for a new feeder from the bus parking lot distribution panelboard to each new charging station. The work anticipated would be a new feeder and distribution breaker to the parking space and charging station.

Costs

- Charger feeder and breaker Phase 2: $30,000*
- *Charging stations not included in the cost.

Utility Requirements & Impacts

Ogdensburg CSD receives power from National Grid. The Ogdensburg Academy CSD site is fed from National Grid and supplied with a 1000kVA 120/208volt 3 phase 4 wire service. The maximum demand for the service was 430.9kVA over the past 12 months of 2024. According to National Grid, and the existing demand on the service there is approximately 460kW of headroom, which indicates capacity available for EV charging on the existing service.

Based on the load profile developed as part of this study, the total connected charger load at Ogdensburg CSD at full battery electric bus implementation would be 200kVA with an anticipated peak demand load of 250kVA.

Pathfinder now IMEG is awaiting the full report from National Grid on demand charges and review of our Route Analysis, but they have conducted their own route analysis and concluded that our calculations are comparable to theirs and a new electrical service would not be required to electrify their current bus fleet. We anticipate providing a new 800A 3 pole branch circuit breaker into the existing Main Distribution panelboard in the Academy main electrical room. We would provide a NEMA 3R distribution panelboard adjacent to the bus parking lot for powering each individual charging station. The main feeder would be underground to a new distribution panelboard and individual breakers would be provided for each charging station.

In the meantime, Pathfinder now IMEG has worked with the internal estimating team to provide an estimated allowance for the proposed work at the Academy. Pathfinder now IMEG estimated the cost of the new power distribution, feeder, initial feeders to charging stations, and site disruption and restoration to be around $250,000.

Environmental Impacts

The transition to battery electric buses from gasoline buses would remove 84 MT CO2e, reduce energy consumption by 1,395 MMBtu's and reduce energy costs by $20,308 per school year.

Table 2. Comparison of Gasoline and Electric Bus Fleet Energy

Gasoline Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Bus Efficiency	8.1	MPG
Total Gallons	21,662.7	Gallons
Energy Used	2,707.8	MMBtu
Gasoline Cost	$ 3.09	Per Gallon
Total Cost	**$ 66,977.14**	

Electric Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Avg. Bus Efficiency	2.2	kWh/Mile
Total kWh	384,615.9	kWh
Energy Used	1,312.4	MMBtu
Average cost per kWh of all 5 temperatures per NG fleet assessment	$ 0.12	
Total annual cost to charge fleet	**$ 46,669.24**	

Section 3

Data Collection

DATA COLLECTION

Data collection plays a vital role in understanding, optimizing, and managing battery electric bus transitions. It enables evidence-based decision-making, facilitates operational efficiency, and supports the successful integration of BEBs into existing school district systems.

Pathfinder now IMEG requested the following information below from Ogdensburg City School District on 10/2/2024. An on site kick off meeting was conducted on 10/8/2024 and the requested data was discussed.

- Bus Fleet Information – Fleet size (current and projected), bus replacement plan/schedule, bus types/size
- Bus Schedules and Route Data – Detailed bus routes, departure and return times, operational hours, mileage, fuel consumption, operational contingency/resiliency plans.
- Bus Parking/Storage Arrangements – Indoor/Outdoor, location
- Fueling – Current operational requirements for fueling
- Utility Data – Name of local utility, existing service size (kVA) and voltage, utility contact
- Existing School Electrical Distribution Information – Existing capacity, condition, expansion capability, as-built electrical site drawings (one-line distribution drawings)
- Existing Site Plan – CAD file of overall site plan
- Fleet maintenance data and historical cost

Bus Fleet Information

Bus fleet information is vital for effective planning, replacement strategies, and financial planning related to the transition of battery electric buses. It forms the foundation for a well-informed and successful zero-emission vehicle transition plan. Ogdensburg provided a bus list containing 14 buses with their associated age, make, model, trim, etc. See *Figure 1* below:

Figure 1. Current Bus Fleet Information

Year	Make	NYS Body Model	Bus #	Purchase Price	Mileage	AC	Wheelchair	NOTES
2022	BLUB	2147-NY-65-00WC-BBB	1	$116, 846.00	29,538	NO	NO	
2022	BLUB	2147-NY-65-00WC-BBB	2	$116, 846.01	32,684	NO	NO	
2022	BLUB	2147-NY-65-00WC-BBB	3	$116, 846.02	33,675	NO	NO	
2022	BLUB	2147-NY-65-00WC-BBB	4	$116, 846.03	25434	NO	NO	
2022	BLBU	2147-NY-65-00WC-BBB	5	$116, 846.04	30,933	NO	NO	
2022	BLUB	2147-NY-65-00WC-BBB	6	$116, 846.05	30,532	NO	NO	Storage underneath
2022	BLUB	2147-NY-65-00WC-BBB	7	$116, 846.06	30,523	NO	NO	
2022	BLUB	2147-NY-65-00WC-BBB	8	$116, 846.07	41,481	NO	NO	Storage underneath
2022	BLUB	2207-NY-59-00WC-BBB	9	$126,197.00	31,084	NO	YES (3)	
2020	MICR	927-NY-21-00WC-MBI	10	$70,650.00	44,347	YES	YES (3)	
2021	MICR	1424-NY-30-00WC-MBI	11	$59,702.00	69,793	NO	NO	
2021	MICR	1424-NY-30-00WC-MBI	12	$59,702.00	62,282	NO	NO	
2023	BLUB	2168-NY-71-00WC-BBB	13	$136,368.00	25,225	YES	NO	Storage underneath
2025	BLUB	2247-NY-71-00WC-BBB	14	$194,588.93	8,234	YES	NO	Storage underneath
2021	Ford	Explorer	C-1	$46,899.00	67,629	YES		6 passenger
2022	Ford	Explorer	C-2	$46,398.00	26,466	YES		6 passenger

Mileage for Sports Trips September 2023 to September 2024 - 25,473.88

Mileage for Field Trips September 2023 to September 2024 - 6167.45

Bus Schedules and Route Data

Vehicle schedules and route data for all buses was provided by Ogdensburg city school district. The data provides specific information on each individual route that is driven by Ogdensburg's fleet of school buses. This data included departure and arrival times, total duration, and mileage for each route. The duration and distance of the routes are essential to determine the energy requirements of each route, and the bus battery size required.

The routes were combined by vehicle name and then broken up into "am" and "pm" routes. Each route group has a cumulative start and finish time, total duration, and total distance. *Figure 2* shows an example of combining the routes:

Figure 2. Ogdensburg Combined Bus Route Schedule

Bus #	A.M. Route	AG Studies A.M.	A.M. BOCES	Midday/BOCES	AG Studeis P.M.	P.M. BOCES	P.M. Route	Notes
1	7:10-10:00			10:35-12:05			1:20-4:00	
2	6:00-8:00	8:00-905 a.m.					2:15-3:45	
3	6:30-7:45		8:15-9:00			1:45-2:20	2:30-3:45	
4	6:30-8:00					1:30-2:05	2:05-4:00	
5	6:30-7:45					2:00-2:20	2:30-3:30	
6	6:45-7:45					1:50-2:20	2:30-3:30	
7	6:00-8:00			10:15-12:00			2:15-3:45	
9	5:45-8:30						12:45-3:15	
10	7:15-7:45						2:30-3:00	
11	7:45-9:30						1:30-3:45	
12	6:45-9:00				1:00-2:20		2:30-3:30	
13	6:30-8:45			10:45-12:00			1:30-3:45	A.M./P.M. Back to Back Runs
14	6:30-8:00		8:15-9:00/8:15-11:15				2:15-3:45	
C-1	5:45-10:45						11:00-4:45	Monday/Friday
C-2							3:50-5:30	

I have combined all the routes that each bus takes per day. They will be grouped together, so you get an accurate picture of what the days look like. The times that are listed above are more accurate than what shows on the route sheet, it does not account for wait times at schools, etc.

Pathfinder now IMEG calculated the percent deadhead miles, total active duration and "resting" duration of each individual bus route to improve the accuracy of the analysis portion of the plan. Calculated drive times were then calculated and documented in *Table 3*.

Table 3. Ogdensburg Individual Bus Route

Individual Bus Route Data					
Bus Route	bus #	total-time (hrs)	drive-time (hrs)	time stopped (hrs)	Miles traveled
Route 1 Am, Potsdam	1	2.83	1.56	1.27	75
Route 1 PM	1	2.67	1.47	1.20	68
Route 2 Am	2	2.00	1.10	0.90	28
Route 2 PM	2	1.50	0.83	0.68	18
Route 3 Am	3	1.25	0.69	0.56	21
Route 3 PM	3	1.25	0.69	0.56	27
Route 4 Am	4	1.50	0.83	0.68	15
Route 4 PM	4	2.00	1.10	0.90	16
Route 5 Am	5	1.25	0.69	0.56	15
Route 5 PM	5	1.00	0.55	0.45	14
Route 6 Am	6	1.00	0.55	0.45	13
Route 6 PM	6	1.00	0.55	0.45	16
Route 7 Am	7	2.00	1.10	0.90	13
Route 7 PM	7	1.50	0.83	0.68	15
Route 9 Am	9	2.75	1.51	1.24	77
Route 9 PM	9	2.50	1.38	1.13	66
Route 10 Am	10	0.50	0.28	0.23	8
Route 10 PM	10	0.50	0.28	0.23	8
Route 11 Am	11	1.75	0.96	0.79	64
Route 11 PM	11	2.25	1.24	1.01	78
Route 12 Am	12	2.25	1.24	1.01	47
Route 12 PM	12	1.00	0.55	0.45	18
Route 13 Am *Includes 2 routes	13	2.25	1.24	1.01	28
Route 13 PM *Includes 2 routes	13	2.25	1.24	1.01	23
Route 14 Am	14	1.50	0.83	0.68	21
Route 14 PM	14	1.50	0.83	0.68	17
AG studies AM	2	1.00	0.55	0.45	44
AG studies PM	12	1.25	0.69	0.56	44
AM Boces, bus 3	3	0.75	0.41	0.34	6
AM Boces, bus 14	14	3.00	1.65	1.35	42
Midday Boces, bus 1	1	1.50	0.83	0.68	8
Midday Boces, bus 7	7	1.75	0.96	0.79	6
Midday Boces, bus 13	13	1.25	0.69	0.56	6
PM Boces, bus 3	3	0.50	0.28	0.23	3
PM Boces, bus 4	4	0.50	0.28	0.23	3
PM Boces, bus 5	5	0.50	0.28	0.23	3
PM Boces, bus 6	6	0.50	0.28	0.23	3

Additional Data

The items from the request for information (listed at the top of this section and below) add key pieces of information needed to perform a high-quality data driven study and can be found in appendix A "Additional Information".

- Bus parking/storage arrangements – Indoor/Outdoor, location
- Fueling- Current operational requirements for fueling
- Utility Data – Name of local utility, existing service size (kVA) and voltage, utility contact
- Existing School Electrical Distribution information – Existing capacity, condition, expansion capability, as-built electrical site drawings (one-line distribution drawings)
- Existing Site Plan – CAD file of overall site plan
- Fleet maintenance data and historical cost

Data from previous studies was utilized to enhance the depth and comprehensiveness of the analysis. By leveraging the valuable insights and findings from these earlier investigations, Pathfinder now IMEG was able to build upon existing knowledge and establish a stronger foundation for the study.

Section 4

Route Analysis

ROUTE ANALYSIS

Pathfinder now IMEG analyzed the available bus route data for each route to determine the time and distance required for a bus to complete the routes. The analysis developed energy requirements per route and determined the minimum battery size requirements, charging requirements, and charging durations necessary per route.

Route Adjustments and Process

Pathfinder, now IMEG, engaged in consultations with IC Bus engineers and sales representatives to acquire actionable data on kWh per mile and kWh per hour battery consumption, including insights into battery degradation across varying temperatures. This data enables precise calculations of battery consumption under different thermal conditions, facilitating accurate route energy estimations throughout the academic year. The information obtained from IC Bus is illustrated in *Figure 3*.

Figure 3. Electric Bus Estimated Battery Mileage at Various Temperatures

Tempature	Estimated miles	Idle time	Estimated Mileage Reduction	Est Mileage w/idle time
40	133	0 hr.	30	103
40	133	2 hr.	37	96
40	133	4 hr.	44	89
Tempature	Estimated miles	Idle time	Estimated Mileage Reduction	Est Mileage w/idle time
20	133	0 hr.	46	87
20	133	2 hr.	57	76
20	133	4 hr.	67	66
Tempature	Estimated miles	Idle time	Estimated Mileage Reduction	Est Mileage w/idle time
0	133	0 hr.	57	76
0	133	2 hr.	70	63
0	133	4 hr.	83	50

Utilizing this dataset, Pathfinder, now IMEG, can extrapolate kWh per mile and kWh per hour consumption figures, applying them to additional temperatures to encompass the full range of bus operational scenarios. By leveraging local meteorological data, five distinct temperatures were selected for calculations to demonstrate temperature-induced battery degradation: -20°F, 0°F, 20°F, 40°F, and 68°F. Pathfinder's calculations of battery consumption at these temperatures are depicted in *Table 4*.

Table 4. Battery Consumption at Various Temperatures

Data From IC Bus				Pathfinder Calcs						
temperature	idle time	mileage reduction	Mileage with idle time	% reduction	battery size (kwh)	kwh/mile	% penalty for idleing	% idle penalty per hour	idle penalty per hour (kwh)	idle penalty per hour (miles)
-20	0	65	68	49%	210	**3.09**	NA	NA	NA	NA
-20	2	79.9	53.1	60%	210	NA	21.9%	11.0%	**23.0**	**14.6**
-20	4	94.8	38.2	71%	210	NA	43.8%	11.0%	**23.0**	**14.6**

Data From IC Bus				Pathfinder Calcs						
temperature	idle time	mileage reduction	Mileage with idle time	% reduction	battery size (kwh)	kwh/mile	% penalty for idleing	% idle penalty per hour	idle penalty per hour (kwh)	idle penalty per hour (miles)
0	0	57	76	43%	210	**2.76**	NA	NA	NA	NA
0	2	70	63	53%	210	NA	17.1%	8.6%	**18.0**	**11.4**
0	4	83	50	62%	210	NA	34.2%	8.6%	**18.0**	**11.4**

Data From IC Bus				Pathfinder Calcs						
temperature	idle time	mileage reduction	Mileage with idle time	% reduction	battery size (kwh)	kwh/mile	% penalty for idleing	% idle penalty per hour	idle penalty per hour (kwh)	idle penalty per hour (miles)
20	0	46	87	35%	210	**2.41**	NA	NA	NA	NA
20	2	57	76	43%	210	NA	12.6%	6.3%	**13.3**	**8.4**
20	4	67	66	50%	210	NA	24.1%	6.0%	**12.7**	**8.0**

Data From IC Bus				Pathfinder Calcs						
temperature	idle time	mileage reduction	Mileage with idle time	% reduction	battery size (kwh)	kwh/mile	% penalty for idleing	% idle penalty per hour	idle penalty per hour (kwh)	idle penalty per hour (miles)
40	0	30	103	23%	210	**2.04**	NA	NA	NA	NA
40	2	37	96	28%	210	NA	6.8%	3.4%	**7.1**	**4.5**
40	4	44	89	33%	210	NA	13.6%	3.4%	**7.1**	**4.5**

Data From IC Bus				Pathfinder Calcs						
temperature	idle time	mileage reduction	Mileage with idle time	% reduction	battery size (kwh)	kwh/mile	% penalty for idleing	% idle penalty per hour	idle penalty per hour (kwh)	idle penalty per hour (miles)
68	0	0	133	0%	210	**1.58**	NA	NA	NA	NA
68	2	2	131	2%	210	NA	1.5%	0.8%	**1.6**	**1.0**
68	4	4	129	3%	210	NA	3.0%	0.8%	**1.6**	**1.0**

In *Table 4*, the cells highlighted in green indicate kWh/mile when the bus is in motion, as well as kWh/hour when an occupied bus is stationary during a route. *Figure 1* shows the negative correlation between battery consumption and ambient temperature based on data procured from IC Bus.

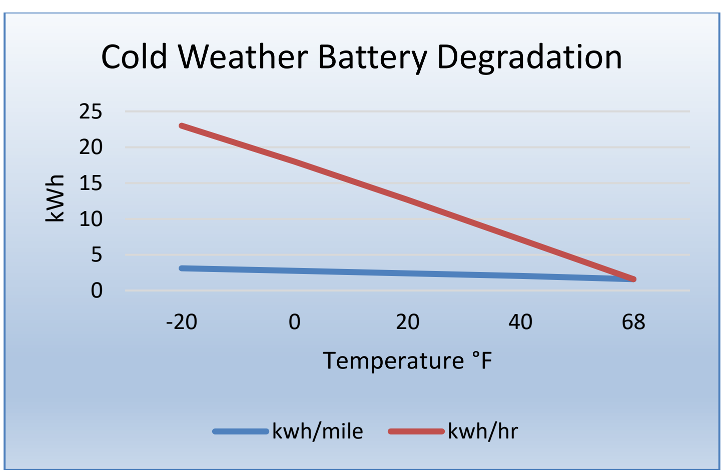

Figure 4. Temperature Based Battery Degradation Study

Figure 4. shows the linear relationship between ambient temperature and battery degradation. kWh/mile battery consumption increases 96% from 1.58 to 3.09 when ambient temperature drops from 68°F to -20°F

Armed with credible kWh/mile and kWh/hour battery consumption data, these metrics can be applied to individual routes across the five temperatures. Route consumption for each temperature is detailed in Appendix A. For expedient reference, the extreme scenarios (-20°F and 68°F) are depicted in *Table 5*.

Table 5. Electric Bus Battery Operation in Extreme Weather Conditions

Worst Case Operations @ -20°F				Ideal Operation at 68°F		
Bus Route	3.09 kwh /mile consumption (kwh)	cold weather idle penalty (23kwh / hr)	Worst Case Route Consumption (kwh)	1.58 kwh /mile consumption (kwh)	cold weather idle penalty (1.6kw/hr)	Average Route Consumption (kwh)
Route 1 Am, Potsdam	231.6	29.3	**260.9**	118.4	2.0	**120.4**
Route 1 PM	210.0	27.6	**237.6**	107.4	1.9	**109.3**
Route 2 Am	86.5	20.7	**107.2**	44.2	1.4	**45.6**
Route 2 PM	55.6	15.5	**71.1**	28.4	1.1	**29.5**
Route 3 Am	64.9	12.9	**77.8**	33.2	0.9	**34.0**
Route 3 PM	83.4	12.9	**96.3**	42.6	0.9	**43.5**
Route 4 Am	46.3	15.5	**61.9**	23.7	1.1	**24.8**
Route 4 PM	49.4	20.7	**70.1**	25.3	1.4	**26.7**
Route 5 Am	46.3	12.9	**59.3**	23.7	0.9	**24.6**
Route 5 PM	43.2	10.4	**53.6**	22.1	0.7	**22.8**
Route 6 Am	40.1	10.4	**50.5**	20.5	0.7	**21.2**
Route 6 PM	49.4	10.4	**59.8**	25.3	0.7	**26.0**
Route 7 Am	40.1	20.7	**60.9**	20.5	1.4	**21.9**
Route 7 PM	46.3	15.5	**61.9**	23.7	1.1	**24.8**
Route 9 Am	237.8	28.5	**266.3**	121.6	2.0	**123.5**
Route 9 PM	203.8	25.9	**229.7**	104.2	1.8	**106.0**
Route 10 Am	24.7	5.2	**29.9**	12.6	0.4	**13.0**
Route 10 PM	24.7	5.2	**29.9**	12.6	0.4	**13.0**
Route 11 Am	197.6	18.1	**215.8**	101.1	1.2	**102.3**
Route 11 PM	240.9	23.3	**264.2**	123.2	1.6	**124.8**
Route 12 Am	145.1	23.3	**168.4**	74.2	1.6	**75.8**
Route 12 PM	55.6	10.4	**65.9**	28.4	0.7	**29.1**
Route 13 Am	86.5	23.3	**109.8**	44.2	1.6	**45.8**
Route 13 PM	71.0	23.3	**94.3**	36.3	1.6	**37.9**
Route 14 Am	64.9	15.5	**80.4**	33.2	1.1	**34.2**
Route 14 PM	52.5	15.5	**68.0**	26.8	1.1	**27.9**
AG studies AM	135.9	10.4	**146.2**	69.5	0.7	**70.2**
AG studies PM	135.9	12.9	**148.8**	69.5	0.9	**70.4**
AM Boces, bus 3	18.5	7.8	**26.3**	9.5	0.5	**10.0**
AM Boces, bus 14:	129.7	31.1	**160.8**	66.3	2.1	**68.4**
Midday Boces, bus 1	24.7	15.5	**40.2**	12.6	1.1	**13.7**
Midday Boces, bus 7	18.5	18.1	**36.6**	9.5	1.2	**10.7**
Midday Boces, bus 13	18.5	12.9	**31.5**	9.5	0.9	**10.4**
PM Boces, bus 3	9.3	5.2	**14.4**	4.7	0.4	**5.1**
PM Boces, bus 4	9.3	5.2	**14.4**	4.7	0.4	**5.1**
PM Boces, bus 5	9.3	5.2	**14.4**	4.7	0.4	**5.1**
PM Boces, bus 6	9.3	5.2	**14.4**	4.7	0.4	**5.1**

An example of individual route analysis is depicted in *Figure 5.* As the temperature drops from ideal temperature conditions, Route #1 battery consumption (kWh) increases.

Route #1 Consumption		
temperature	kWh's	% Increase
-20	260.9	117%
0	230.1	91%
20	197.2	64%
40	162.0	35%
68	120.4	0%

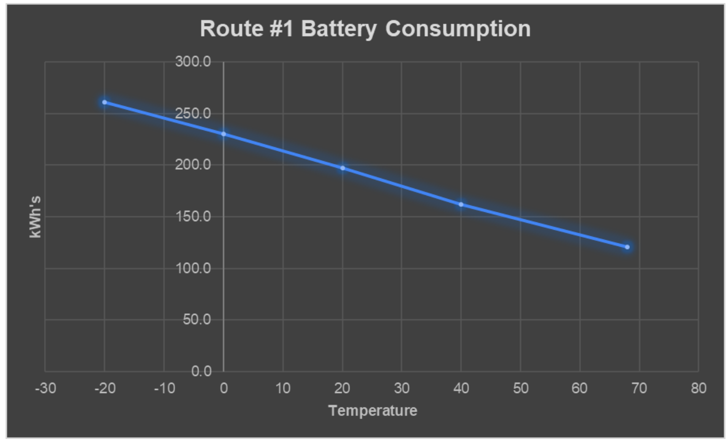

Figure 5. Route #1 Battery Consumption Temperature Variation

Weather Analysis

To secure an accurate annual energy consumption figure (kWh) for charging an all-electric fleet of school buses, it is essential to acquire hourly temperature data to determine the frequency of bus route operations at each of the five temperature points. This necessitated a comprehensive weather analysis based on raw data from the Massena, NY weather station (*Figure 6*).

Bin	Days Per Year	
	Typical	Extreme
T <= -10	0	2
-10 < T <= 10	6	16
10 < T <=30	35	31
30 < T <= 50	74	62
T > 50	65	69
Total:	**180**	**180**

Bin	Percentage	
	Typical	Extreme
T <= -10	0%	1%
-10 < T <= 10	3%	9%
10 < T <=30	19%	17%
30 < T <= 50	41%	34%
T > 50	36%	38%

Figure 6. Massena, NY Weater Analysis

Figure 6 organizes hourly data for a 180-day school year between 6 AM and 4 PM over the past five years, detailing the duration of bus operations across the five temperature ranges. While the majority of activities occur above 30°F, bus services must be sustained in sub-zero temperatures, as districts with significant needs do not suspend school due to low temperatures and wind chills.

Annual Fleet Energy Consumption

The acquired temperature and consumption data enables precise calculation of annual energy consumption (kWh) for an all-electric fleet. *Figure 7* presents a comprehensive analysis of daily fleet battery consumption across temperature ranges, the frequency of temperature occurrences during the academic year, and the resulting annual fleet energy requirements:

Daily kWh Total for Days Between **-30°F and -10°F**	3,599.6
# of Days Between -30°F and -10°F During 180 Day School Year	2.0
Annual School-year Energy Consumption for temperatures between -30°F and -10°F (kWh)	**7,199.2**

Daily kWh Total for Days Between **-10°F and 10°F**	3,154.2
# of Days Between -10°F and 10°F During 180 Day School Year	16
Annual School-year Energy Consumption for temperatures between -10°F and 10°F (kWh)	**50,467.7**

Daily kWh Total for Days Between **10°F and 30°F**	2,679.0
# of Days Between 10°F and 30°F During 180 Day School Year	31
Annual School-year Energy Consumption for temperatures between 10°F and 30°F (kWh)	**83,050.4**

Daily kWh Total for Days Between **30°F and 50°F**	2,172.6
# of Days Between 30°F and 50°F During 180 Day School Year	62
Annual School-year Energy Consumption for temperatures between 30°F and 50°F (kWh)	**134,699.3**

Daily kWh Total for Days Between **above 50°F**	1,582.6
# of Days Above 50°F During 180 Day School Year	69
Annual School-year Energy Consumption for temperatures above 50°F (kWh)	**109,199.3**

Total Annual Energy (kWh) To Charge Bus Fleet. Assumes 180-day School Year, Weather Data from September-July, 6am-4pm.	**384,615.9**

Figure 7. Daily Fleet Battery Consumption Across Temperature Ranges

Daily Bus Schedules & Battery Consumption

The granular route consumption data enables precise simulation of battery utilization for each vehicle throughout a typical operational day across all five temperature points. While comprehensive data for all scenarios is available in appendix B, *Figure 8* illustrates the extreme operational conditions (-20°F and 68°F) for bus #1.

*Daily battery consumption at -20°F

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	260.9	54.1	0.0	54.1	40.2	13.8	60.0	88.8	237.6	**-148.8**	30.9

*Daily battery consumption at 68°F

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	120.4	194.6	0.0	194.6	13.7	180.9	0.0	180.9	109.3	**71.6**	16.2

Figure 8. Bus #1 Operation at Extreme and Optimal Conditions

Figure 8 presents a chronological analysis of route schedules, depicting individual routes as red blocks with corresponding start and end times, duration of travel, and intervening charging windows. The battery capacity timeline correlates with route consumption and available charging intervals. Red-highlighted capacity cells indicate insufficient battery levels (below 20% minimum charge), while green highlights denote adequate capacity above the minimum threshold. This particular vehicle is equipped with a 315 kWh battery capacity. The analysis reveals operational feasibility at 68°F without mid-day charging, while -20°F conditions preclude route completion.

The analytical framework established in Figure 8 illuminates critical operational parameters including minimum battery capacity requirements, essential charging rates, and daily power demand patterns for individual vehicles and the entire fleet. *Table 6* synthesizes these findings across all five temperature points, detailing battery specifications, minimum charging requirements, and operational viability.

Table 6. Individual Bus Operational Viability at Various Temperatures

Bus #	Battery Size (kWh)	Minimum Charger Size (kWh)	Able to complete routes @ -20°F	Able to complete routes @ 0°F	Able to complete routes @ 20°F	Able to complete routes @ 40°F	Able to complete routes @ 68°F
1	315	60	no	no	no	no	yes
2	315	20	no	yes	yes	yes	yes
3	210	60	yes	yes	yes	yes	yes
4	210	15	yes	yes	yes	yes	yes
5	210	15	yes	yes	yes	yes	yes
6	210	15	yes	yes	yes	yes	yes
7	210	15	yes	yes	yes	yes	yes
9	315	60	no	yes	yes	yes	yes
10	210	15	yes	yes	yes	yes	yes
11	315	60	yes	yes	yes	yes	yes
12	315	40	yes	yes	yes	yes	yes
13	210	25	yes	yes	yes	yes	yes
14	315	25	yes	yes	yes	yes	yes

Operational constraints identified indicate that buses 1, 2, and 9 cannot complete their assigned routes under certain conditions, necessitating the retention of Internal combustion vehicles for these specific routes. Additionally, Internal combustion buses remain essential for athletic events and field trips, where destination distances typically exceed battery range and access to remote charging infrastructure is limited.

Electrical Demands

The operational data derived from Figure 8 facilitates the calculation of daily power demand profiles for individual vehicles and the collective fleet. *Figure 9* illustrates demand pattern at the extreme temperature points of -20°F and and *Figure 10* illustrates demand pattern at 68°F. This comparison reveals significant variations in charging requirements depending on temperature. The comprehensive demand profiles across all five temperature points are detailed in appendices A.

24-Hour Fleet Charging rate cycle, Ambient Temp @ -20°F																								
Total Rate or Charge (kWh)	147.3	147.3	147.3	147.3	147.3	113.2	15.7	0.0	134.0	191.0	172.0	192.0	119.0	40.0	20.4	136.0	147.3	147.3	147.3	147.3	147.3	147.3	147.3	147.3
Time of Day	1:00am	2:00am	3:00am	4:00am	5:00am	6:00am	7:00am	8:00am	9:00am	10:00am	11:00am	12:00pm	1:00pm	2:00pm	3:00pm	4:00pm	5:00pm	6:00pm	7:00pm	8:00pm	9:00pm	10:00pm	11:00pm	12:00am

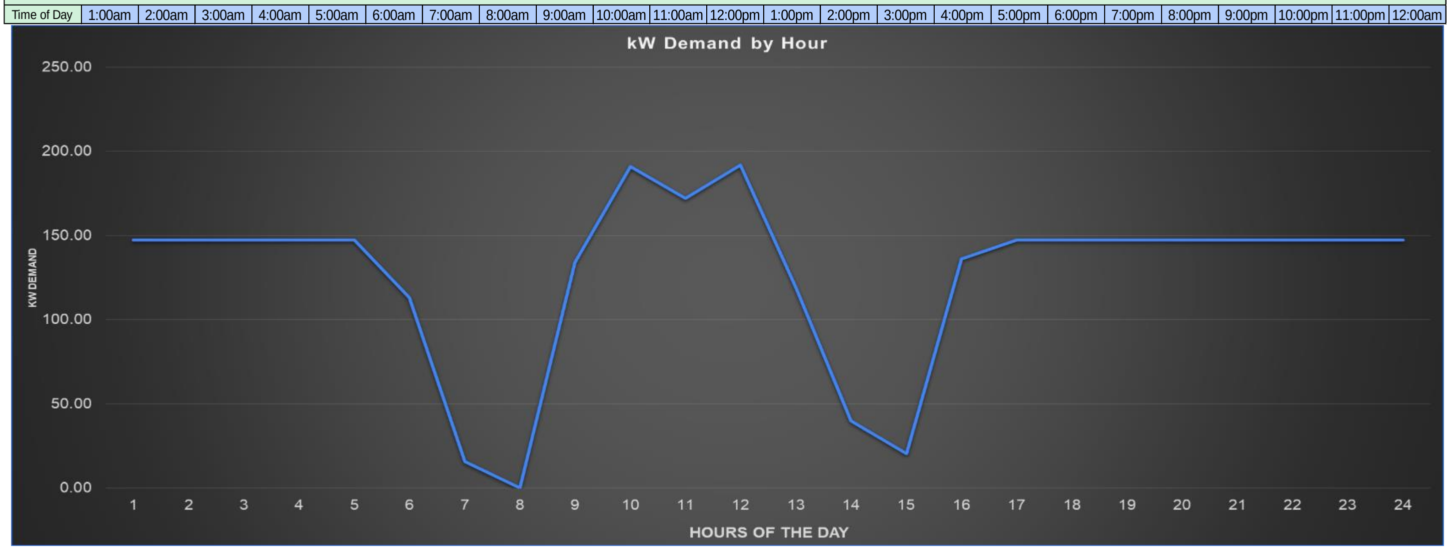

Figure 9. Electric Bus Demand Pattern at -20°

24-Hour Fleet Charging rate cycle, Ambient Temp @ 68°F																								
Total Rate or Charge (kWh)	89.2	89.2	89.2	89.2	89.2	63.5	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	82.8	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2
Time of Day	1:00am	2:00am	3:00am	4:00am	5:00am	6:00am	7:00am	8:00am	9:00am	10:00am	11:00am	12:00pm	1:00pm	2:00pm	3:00pm	4:00pm	5:00pm	6:00pm	7:00pm	8:00pm	9:00pm	10:00pm	11:00pm	12:00am

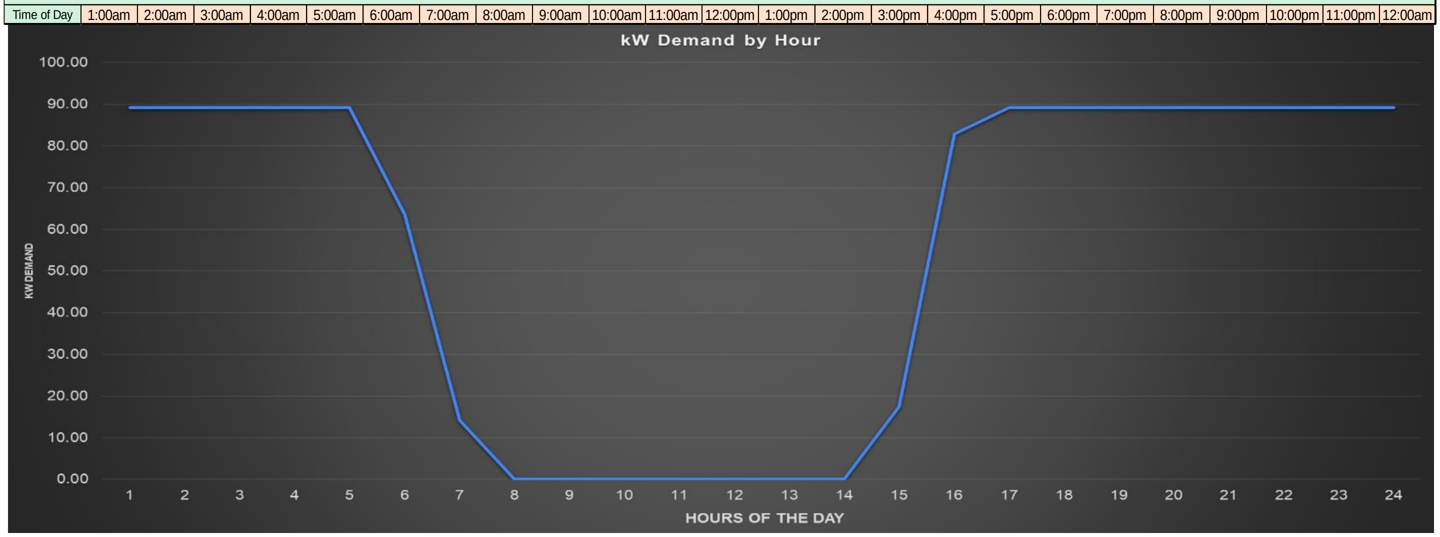

Figure 10. Electric Bus Demand Pattern at 68°F

Working With National Grid for Estimated Utility Rates:

Through collaborative engagement with National Grid, Pathfinder, now IMEG, conducted an extensive analysis incorporating daily fleet electrical demand (*Figures 9&10*) and consumption patterns (*Table 4*) across the temperature spectrum. National Grid's engineering team performed a comprehensive fleet assessment, generating temperature-specific utility rates that account for demand fluctuations associated with fleet charging operations (*Figure 11*). These rates reflect National Grid's innovative EV phase-in-rate program, scheduled for implementation in October 2025, designed to mitigate demand charges associated with electric bus fleet operations.

Worst Case Operations @ -20°F		
$/kWh	$	0.11
Annual Electrical costs associated with fleet between -30°F and -10°F	$	791.91

Operations @ 0°F		
$/kWh	$	0.11
Annual Electrical costs associated with fleet between -10°F and 10°F	$	5,551.45

Operations at 20°F		
$/kWh	$	0.12
Annual Electrical costs associated with fleet between 10°F and 30°F	$	9,966.05

Annual Average Operations @ 40°F		
$/kWh	$	0.12
Annual Electrical costs associated with fleet between 30°F and 50°F	$	16,163.92

Ideal Operation at 68°F		
$/kWh	$	0.13
Annual Electrical costs associated with fleet above 50°F	$	14,195.91

Total annual cost to charge fleet based on rates from National Grid per fleet assesment derived from our daily KW demand.	**$**	**46,669.24**

Figure 11. Daily Fleet Battery Consumption Across Temperature Ranges

Gasoline vs. Electric Cost Comparison:

Figure 12 presents a detailed cost comparison between conventional gasoline-powered operations and the proposed electric fleet. Based on the district's 2023-2024 academic year fuel consumption and cost data, excluding athletic and field trip operations, the analysis reveals:

Gasoline Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Bus Efficiency	8.1	MPG
Total Gallons	21,662.7	Gallons
Energy Used	2,707.8	MMBtu
Gasoline Cost	$ 3.09	Per Gallon
Total Cost	**$ 66,977.14**	

Electric Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Avg. Bus Efficiency	2.2	kWh/Mile
Total kWh	384,615.9	kWh
Energy Used	1,312.4	MMBtu
Average cost per kWh of all 5 temperatures per NG fleet assessment	$ 0.12	
Total annual cost to charge fleet	**$ 46,669.24**	

Figure 12. Comparison of Gasoline and Electric Bus Fleet Energy

Battery Electric Bus Selection

BLUE BIRD

Standard Battery: 155 kWh
Operating Range: 120 miles
Battery Type: Li-NMC-G Charge
Options: AC Level 2&3 Drive
Train: Cummins
Price Range: $250 – $350k

THOMAS BUILT

Standard Battery: 226 kWh
Operating Range: 138 miles
Battery Type: Li-NMC-G Charge
Options: AC Level 2&3 Drive
Train: Proterra
Price Range: $325 – $400k

IC BUS

Standard Battery: 210 kWh
Operating Range: 155 miles
Battery Type: Lithium- ion
Charge Options: AC Level 2&3

Optional 315 kWh Battery
Optional diesel heater
Price Range: $325 – $400k

LION

Standard Battery: 126 kWh
Operating Range: 100
– 155 miles
Battery Type: Li-NMC-G Charge
Options: AC Level 2&3

Optional 168 kWh Battery
Optional 210 kWh Battery Price
Range: $340 – $370k

Different school bus manufacturers offer unique configurations for bus batteries and charging systems. Pathfinder, now known as IMEG, conducted an analysis of four manufacturers and their bus models to assess performance based on current route demands. The evaluation focused on battery electric buses from Blue Bird, Thomas Built, IC Bus, and Lion, examining factors such as battery size, vehicle-to-grid capabilities, and existing partnerships with the district. Currently, Ogdensburg school district is not biased on a certain manufacturer for their fleet. Pathfinder, now IMEG, selected the IC Bus with a 210 kWh battery as the design basis. This choice was due to its larger battery size, which is better suited for longer routes, its potential for vehicle-to-grid integration, and its established relationship with the district. For routes exceeding the 210 kWh capacity, the IC Bus 321 battery electric bus was chosen, as it offers the largest battery capacity and range. Detailed specifications of bus types and quantities will be provided in the charge modeling section of the report.

Electric Bus Incentives

The Ogdensburg City School District, as a priority school district serving a disadvantaged community, is eligible for several funding programs that could make the acquisition of electric school buses nearly cost-free.

- The **NYSERDA New York Bus Incentive Program** covers a substantial portion of the cost of zero-emission school buses, with additional bonuses for priority districts like Ogdensburg. This program offers a critical opportunity to significantly reduce the upfront costs of zero-emission bus purchases, with 60% of the incremental cost covered plus priority district bonuses.
- The **EPA Clean School Bus Program Rebate** is allocating up to $965 million nationwide, with priority given to high-need school districts. The program provides funding to subsidize the purchase of battery-electric, propane, or compressed natural gas (CNG) buses, as well as related infrastructure, workforce training, and other eligible costs. Rebates are issued upfront, allowing selected entities to receive funding before paying vendors.
- The **DOE Renew America's Schools Prize** is a $500 million initiative designed to fund clean energy and energy-efficient infrastructure improvements at K-12 public schools. Since 2022, it has invested $372.5 million aiming to reduce energy use and costs, improve indoor air quality, and create healthier learning environments. This funding could be used towards the acquisition of a zero-emission school bus or used to install electric vehicle charging infrastructure, supporting the district's transition to a zero-emission school bus fleet while enhancing its overall energy efficiency.
- The **Clean Vehicle Tax Credit (IRC 45W)** provides up to $40,000 for qualified commercial vehicles, including electric school buses with a gross vehicle weight rating (GVWR) of 14,000 pounds or more. To qualify, the buses must be battery-electric or fuel cell vehicles with a battery capacity of at least 15 kilowatt-hours. These vehicles must be manufactured primarily for use on public roads and meet additional standards for clean propulsion. This credit helps reduce the upfront cost of electric school buses, making it a valuable incentive for Ogdensburg City School District to transition to a cleaner, more sustainable fleet.

The Ogdensburg City School District can maximize cost savings by stacking these incentives, though the combined funding cannot exceed the total cost of the electric school bus. The price comparison of electric school buses and gasoline school buses are depicted in *Table 7*. Gasoline bus prices for 2025 were estimated based off the current fleet with an additional 4% inflation for each year after purchase.

Table 7. Electric Bus Price Comparison with Available Incentives

Scenario	Electric Bus Price After Incentive	2025 Gasoline Bus Price	Price Difference
No incentive	$362,000	$147,496	$214,504
NYSBIP	$178,250	$147,496	$30,754
EPA	$117,000	$147,496	($30,496)
CVTC	$322,000	$147,496	$174,504
DOE	$332,000	$147,496	$184,504
NYSBIP +EPA	$67,000	$147,496	($80,496)
NYSBIP + DOE	$185,000	$147,496	$37,504
EPA +DOE	$217,000	$147,496	$69,504
NYSBIP+ CVTC	$138,250	$147,496	($9,246)
EPA+ CVTC	$117,000	$147,496	($30,496)
DOE+ CVTC	$217,000	$147,496	$69,504
NYSBIP+EPA+DOE	$37,000	$147,496	($110,496)
NYSBIP +EPA +CVTC	$27,000	$147,496	($120,496)
NYSBIP + DOE+CVTC	$47,000	$147,496	($100,496)
EPA +DOE+CVTC	$47,000	$147,496	($100,496)
NYSBIP+EPA+DOE+CVTC	$0	$147,496	($147,496)

Programs like the NYSERDA New York Bus Incentive Program, the EPA Clean School Bus Rebate, and the Clean Vehicle Tax Credit (IRC 45W) can be stacked to cover different portions of the bus price. However, funding is strictly limited to the purchase of the bus itself, excluding utility or infrastructure costs, and any excess funds beyond the total bus cost will not be awarded. The DOE Renew America's Schools Prize can be put towards the price of the electric school bus as well as any utility or infrastructure costs. This strategic stacking of incentives helps Ogdensburg transition to zero-emission buses affordably, minimizing financial strain while supporting progress toward New York State's climate goals.

Conceptual Charging Study

CONCEPTUAL CHARGING STRATEGY

Pathfinder now IMEG developed a conceptual charging strategy for the fleet based on the bus route data collected and the route analyses developed in previous tasks. The goal of the conceptual charging strategy is to determine the smallest available battery size that meets the district's route needs. The charging strategy identified the following items:

- Number, types, and sizes of chargers required to charge the fleet in the allotted time frames – assuming a low limit of 20% state of charge and upper limit of 80 % state of charge
- Anticipated peak demand during both on-peak and off-peak utility periods
- Optimum charger size and configuration – 1 to 1 chargers to dispensers

Charging Model Development Process:

Data from previous daily bus routes depicted below allow formulation of minimum charging rates for each bus to complete daily routes. While complete data sets for all temperature conditions are available in Appendix B, we focus here on the two boundary cases that demonstrate the system's operational extremes: severe winter conditions (-20°F) and optimal ambient temperature (68°F).

*Daily battery consumption at -20°F

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	260.9	54.1	0.0	54.1	40.2	13.8	60.0	88.8	237.6	**-148.8**	30.9

*Daily battery consumption at 68°F

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	120.4	194.6	0.0	194.6	13.7	180.9	0.0	180.9	109.3	**71.6**	16.2

Electric Bus & Charger Requirements

The charging strategy utilizes data from tables above and Appendix B focuses on charging for long periods of time at low charging speeds. The bottom line of tables show batteries' charging rate based on the duration of time to charge. The maximum single bus charging rate for any hour throughout the winter month was 60 kW. Some chargers can modulate below 10%, but the charging time required would be excessive.

Bus #	Battery Size (kWh)	Minimum Charger Size (kWh)
1	315	60
2	315	20
3	210	60
4	210	15
5	210	15
6	210	15
7	210	15
9	315	60
10	210	15
11	315	60
12	315	40
13	210	25
14	315	25

The breakdown above shows the variety of chargers that could be utilized by Ogdensburg school district to charge their school bus fleet. Pathfinder now IMEG only used two charger sizes to reduce the operational impact on the school district when transitioning to battery electric buses.

The models provide additional insights on the charger infrastructure required when converting to BEB's. Although many buses do not require a DC fast charger, the basis of the model utilized Proterra "fast" chargers which can charge up to 60 kW and are vehicle to grid capable.

The charging model shows that (5) of the routes have charging requirements above 30 kW and would need to utilize 60 kW Proterra chargers. The maximum number of buses charging at any one hour is all 14 buses, meaning Ogdensburg would need the ability to charge all 14 buses simultaneously.

Basis of Design

- 8 – 210 kWh IC Buses & 6 – 315 kWh IC Buses
- 6 – 60kW Proterra Chargers (Cut sheets provided in appendix)
- 6 – 20 kW Proterra Chargers (Cut sheets provided in appendix)

Charge Management

Charge management[1] is an essential part of a successful battery electric bus transition plan. Charge management will manage charging operations and energy management. An ideal charging strategy focuses on charging for long periods of time at low charging speeds while ensuring the buses are sufficiently charged to complete their routes. Lower charging rates help to keep a more consistent demand profile, a lower peak demand and longer battery life. Additional strategies like "on" and "off" peak charging can be added into the charging strategy as well to minimize the cost impact on the district.

A charge management system is a software system that provides real time demand reduction analysis and automatically manages the fleet of chargers based on each of the buses needs. Charge management systems utilize bus telemetric data, route data, and battery data to perform its analysis. Today's systems can limit the overall utility demand to preset limits, based on the power distribution systems designed for charging.

Charge management systems are available through independent third-party suppliers, such as Mobility House, SYNOP, and BP Pulse. Some bus manufacturers such as Proterra also sell charge management systems.

Pathfinder now IMEG strongly recommends implementing a charge management system for managing charging operations and energy management. Pathfinder now IMEG has assumed charge management within the calculations, and it has been incorporated into the charging model.

Utility Analysis

ELECTRIC UTILITY ANALYSIS

Ogdensburg CSD receives power from National Grid. The Ogdensburg Academy CSD site is fed from National Grid and supplied with a 1000kVA 120/208volt 3 phase 4 wire service. The maximum demand for the service was 430.9kVA over the past 12 months of 2024. According to National Grid, and the existing demand on the service there is approximately 460kW of headroom, which indicates capacity available for EV charging on the existing service.

Based on the load profile developed as part of this study, the total connected charger load at Ogdensburg CSD at full battery electric bus implementation would be 200kVA with an anticipated peak demand load of 250kVA.

Pathfinder now IMEG is awaiting the full report from National Grid on demand charges and review of our Route Analysis, but they have conducted their own route analysis and concluded that our calculations are comparable to theirs and a new electrical service would not be required to electrify their current bus fleet. We anticipate providing a new 800A 3 pole branch circuit breaker into the existing Main Distribution panelboard in the Academy main electrical room. We would provide a NEMA 3R distribution panelboard adjacent to the bus parking lot for powering each individual charging station. The main feeder would be underground to a new distribution panelboard and individual breakers would be provided for each charging station.

In the meantime, Pathfinder now IMEG has worked with the internal estimating team to provide an estimated allowance for the proposed work at the Academy. Pathfinder now IMEG estimated the cost of the new power distribution, feeder, initial feeders to charging stations, and site disruption and restoration to be around $250,000.

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[1] Connected load is the total load physically connected to the system and may be different than operating load
[2] Peak Demand is the anticipated maximum energy demand on the system

Electric and Gasoline Utility Analysis

Through collaborative engagement with National Grid, Pathfinder (now IMEG) conducted an extensive analysis incorporating daily fleet electrical demand (Figure 10) and consumption patterns (Figure 4) across the temperature spectrum. National Grid's engineering team performed a comprehensive fleet assessment, generating temperature-specific utility rates that account for demand fluctuations associated with fleet charging operations. These rates reflect National Grid's innovative EV phase-in-rate program, scheduled for implementation in October 2025, designed to mitigate demand charges associated with electric bus fleet operations.

Worst Case Operations @ -20°F		
$/kWh	$	0.11
Annual Electrical costs associated with fleet between -30°F and -10°F	$	791.91

Operations @ 0°F		
$/kWh	$	0.11
Annual Electrical costs associated with fleet between -10°F and 10°F	$	5,551.45

Operations at 20°F		
$/kWh	$	0.12
Annual Electrical costs associated with fleet between 10°F and 30°F	$	9,966.05

Annual Average Operations @ 40°F		
$/kWh	$	0.12
Annual Electrical costs associated with fleet between 30°F and 50°F	$	16,163.92

Ideal Operation at 68°F		
$/kWh	$	0.13
Annual Electrical costs associated with fleet above 50°F	$	14,195.91

Total annual cost to charge fleet based on rates from National Grid per fleet assessment derived from our daily KW demand.	**$**	**46,669.24**

Ogdensburg CSD provided monthly fuel purchases giving Pathfinder now IMEG appropriate data to come up with total gallons of fuel used, average cost of fuel and average fleet MPG. The goal is to get total annual cost of fuel for the fleet, excluding sports and field trips as gasoline buses will need to maintained for that. Total miles traveled divided by total gallons of fuel purchased gives us an average MPG of 8.1.

Overall Fleet Average MPG	
total annual mileage including sports & field trips	207,502.0
total annual gallons of fuel purchased	25,560.4
overall fleet average MPG	8.1

23-24 fiscal year fuel costs			
Month	Payment $	Gallons	$/gallon
Sep-24	$ 8,637.28	2867.37	$ 3.01
Aug-24	$ 1,602.25	505.85	$ 3.17
Jul-24	$ 3,773.08	1187.29	$ 3.18
Jun-24	$ 7,554.87	2427.74	$ 3.11
May-24	$ 8,667.22	2731.81	$ 3.17
Apr-24	$ 6,475.49	2060.13	$ 3.14
Mar-24	$ 6,960.53	2388.78	$ 2.91
Feb-24	$ 5,849.80	2059.16	$ 2.84
Jan-24	$ 6,582.47	2374.84	$ 2.77
Dec-23	$ 6,851.13	2322.73	$ 2.95
Nov-23	$ 6,449.77	2043.01	$ 3.16
Oct-23	$ 8,668.29	2591.71	$ 3.34
average fuel cost per gallon for 23-24:			**$ 3.09**
Total fuel cost for 23-24 fiscal year:			**$ 78,072.18**
Total gallons of fuel:			**25,560.4**

Calculated fleet MPG from above can be applied to total fleet milage excluding sports and field trips to reflect fleet costs associated with daily routes. Tables below show cost and energy differences between gasoline and electric fleet. Annual savings of electric over gasoline is approximately $20k.

Gasoline Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Bus Efficiency	8.1	MPG
Total Gallons	21,662.7	Gallons
Energy Used	2,707.8	MMBtu
Gasoline Cost	$ 3.09	Per Gallon
Total Cost	**$ 66,977.14**	

Electric Bus Fleet Energy Analysis		
Route Data	175,860.0	Miles
Avg. Bus Efficiency	2.2	kWh/Mile
Total kWh	384,615.9	kWh
Energy Used	1,312.4	MMBtu
Average cost per kWh of all 5 temperatures per NG fleet assessment	$ 0.12	
Total annual cost to charge fleet	**$ 46,669.24**	

Utility Incentives

The Ogdensburg City School District has access to several utility rebates and incentives that can significantly support its transition to a fully electric school bus fleet. The Demand Charge Rebate Program provides a 50% rebate on billed demand charges for EV charging customers on demand rates. This program can help reduce recurring energy costs associated with operating EV chargers, ensuring financial sustainability as the district adopts electric buses. While this offering is temporary, it will remain available until a new EV phase-in rate is implemented, providing immediate relief for early adopters.

The MHDV Pilot Infrastructure Support Program offsets up to 90% of utility-side infrastructure costs and 50% of customer-side expenses for DACs, reducing the financial burden of building EV charging infrastructure. With expanded funding through 2025, this program ensures that the district can install charging stations affordably. Additionally, the NY Load Management Technologies Incentive Program supports energy storage systems and load management solutions by covering up to 100% of installation and permitting costs, as well as providing up to five years of software support. This program can optimize charger performance, reduce demand charges, and expand capacity for future fleet growth. Together, these incentives provide a comprehensive financial and operational framework to make the district's transition to electric buses both feasible and cost-effective.

Concept Development & Phasing Plan

CONCEPT DEVELOPMENT & PHASING PLAN

The concept development and phasing plan is the culmination of the previous tasks in the study. The phasing plan incorporates several components and include:

1. Deadlines issued as part of the state mandate including:
    a. By July 1, 2027 all new school buses purchased and or leased must be zero-emission
    b. By July 1, 2035 all school buses on the road must be zero-emission
2. Ogdensburg CSD's preferred battery electric bus procurement schedule
3. On-site electrical distribution/charger equipment procurement and construction lead times
4. Utility service upgrade equipment and construction lead times
5. Availability of capital funding including state aide, school capital programs and grant funds

For the purposes of this report, we are assuming the following:

- The state mandated deadlines pertaining to zero-emission school buses will be upheld by the state.
- Funding will be available when required for capital improvements and bus purchases.

Ogdensburg CSD Bus Procurement Schedule

Ogdensburg CSD currently has 14 gasoline school buses. The projected battery electric school bus (BEB) procurement schedule for Ogdensburg CSD is depicted in the following table:

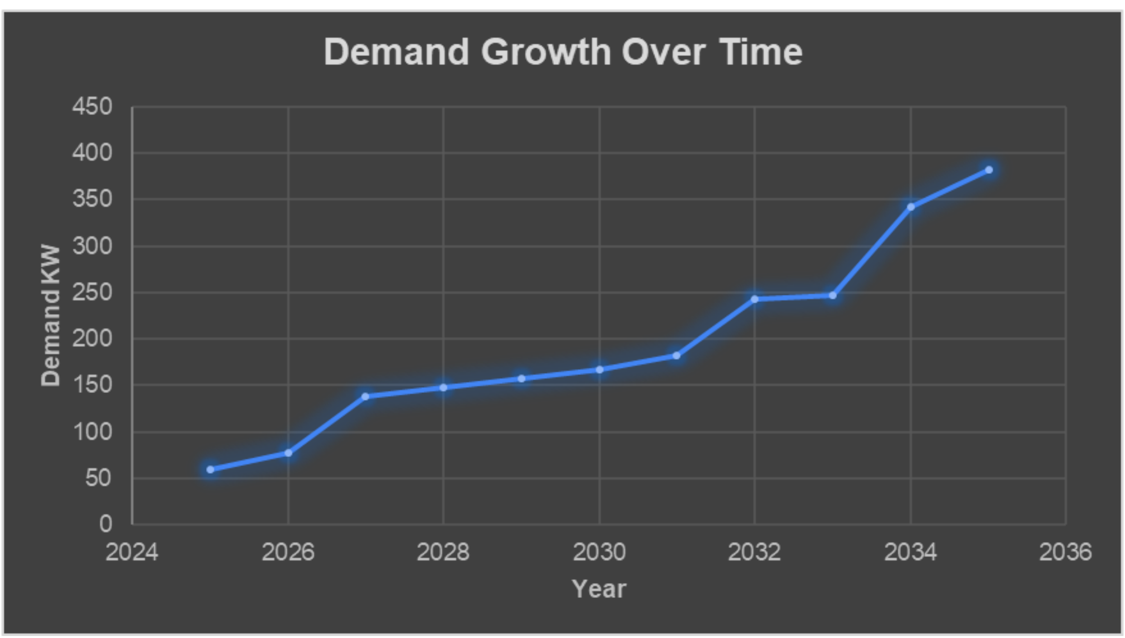
	Existing	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total
Battery Electric Buses Procured	0	1	1	1	1	1	1	1	1	1	2	3	13
Battery Electric Bus Fleet Size	0	1	2	3	4	5	6	7	8	9	11	14	14

This proposed BEB procurement schedule is subject to change based on available funding.

The proposed battery electric bus procurements will include a mix of different battery sizes and charger sizes. The table below summarizes both for the electric fleet:

Bus #	Battery Size (kWh)	Minimum Charger Size (kWh)
1	315	60
2	315	20
3	210	60
4	210	15
5	210	15
6	210	15
7	210	15
9	315	60
10	210	15
11	315	60
12	315	40
13	210	25
14	315	25

Based on the proposed procurement schedule, the route analysis and the charging strategy developed for Ogdensburg CSD, the projected charger load growth over time is as follows:



Phasing Plan

The proposed phasing plan for Ogdensburg CSD consists of two phases, phase one will be the initial phase providing power to the bus parking and staging area. This phase will be based off the current bus fleet, route analysis and charging strategy outlined in the report to reduce the electrical demand on the service, while maintaining the bus fleet and being prepared within a 24 hour time frame.

Phase 1

Phase 1 is the new electrical distribution panelboard adjacent to the bus parking lot that will supply the necessary power to each charging station. This phase requires a new 800A panel board, feeder, and associated charges for the new electrified buses.

Costs

- Charging infrastructure for Phase 1: $250,000*
- *Charging stations not included in the cost.

Phase 2

Phase 2 and each subsequent phase for the remainder of the school's districts bus fleet will only require the need for a new feeder from the bus parking lot distribution panelboard to each new charging station. The work anticipated would be a new feeder and distribution breaker to the parking space and charging station.

Costs

- Charger feeder and breaker Phase 2: $30,000*
- *Charging stations not included in the cost.

Notes regarding Phasing Plan

1. Phasing plan costs assume all equipment included in that phase are purchased and installed at the same time. Ogdensburg CSD may elect to purchase and install all equipment except the chargers/dispensers and install chargers and dispensers as buses are purchased.
2. Other than the common equipment installed in Phase 1, the sequence and quantity of chargers installed can be modified.

Workforce Training Needs

Workforce Training Needs

The transition to battery electric school buses (BESBs) presents both opportunities and challenges for school district operations. This comprehensive analysis examines the workforce development requirements and operational considerations necessary for successful BESB implementation.

The integration of electric buses demands a strategic approach to staff training and operational modifications. While electric vehicles share some commonalities with traditional buses, their unique characteristics necessitate specialized knowledge in four critical domains: safety protocols, maintenance procedures, facility management, and daily operations.

Safety Considerations

Electric vehicle systems introduce high-voltage components that require enhanced safety measures. A comprehensive safety program should encompass:

1. Specialized electrical safety protocols, including voltage management and isolation procedure
2. Advanced battery handling and emergency response protocols
3. Updated incident management procedures
4. Modified first responder training programs

During talks with IC Bus Engineers, maintenance comparisons to Internal combustion buses were a main topic of discussion. Ogdensburg CSD has full engine & drivetrain warranties on current gasoline fleet, so no savings will be realized on engine and drivetrain maintenance with an electric fleet. For an electric fleet, there is no regular maintenance associated with the high-voltage motor, battery, drivetrain, but if any unplanned issues or breakdowns occur a dealer technician needs to take care of it under warranty. This makes the dealer with closest proximity and readily available technicians an important factor. The only maintenance unique to an electric fleet is an annual brake air filter change, power steering fluid change and coolant flush. All can be performed by district maintenance staff. All other maintenance (tires, brakes, etc.) is comparable to a gasoline fleet.

It should be noted that in discussions with IC Bus Engineers, Pathfinder now IMEG was informed that undercoating for winter salt conditions void the motor, battery and drivetrain warranty that is necessary for typical vehicle lifecycle. Extensive conversations should be had with bus manufacturers regarding protection against salt; without adequate protection the bus lifecycle will be drastically shortened.

Converting facilities to support electric bus operations requires substantial infrastructure modifications. This includes:

- Installation of charging systems with appropriate power distribution
- Implementation of energy management systems
- Development of new maintenance protocols

- Creation of specialized diagnostic and repair procedures
- Upgraded lifts to accommodate increased weight of electric school buses

Successful BESB implementation requires modifications to existing operational procedures. Key areas include:

Energy Management: Development of charging strategies that align with route requirements and power availability.

Route Planning: Implementation of range-optimized routing that accounts for factors such as weather conditions, terrain, and payload.

Emergency Procedures: Establishment of protocols for managing low-charge situations and roadside incidents.

Training Framework
A successful transition requires a structured training program that addresses:

- Technical safety certification for maintenance personnel
- Operational training for drivers
- Emergency response procedures for all staff
- Ongoing professional development to maintain expertise

Infrastructure Considerations
The charging infrastructure requires careful planning and maintenance:

- Regular inspection and maintenance of charging equipment
- Implementation of monitoring systems for charging operations
- Development of backup power strategies
- Creation of scalable infrastructure plans for future expansion

This analysis provides a framework for successful BESB implementation while ensuring operational efficiency and safety. The transition requires careful consideration of technical requirements, staff development, and operational modifications to maintain reliable student transportation services.

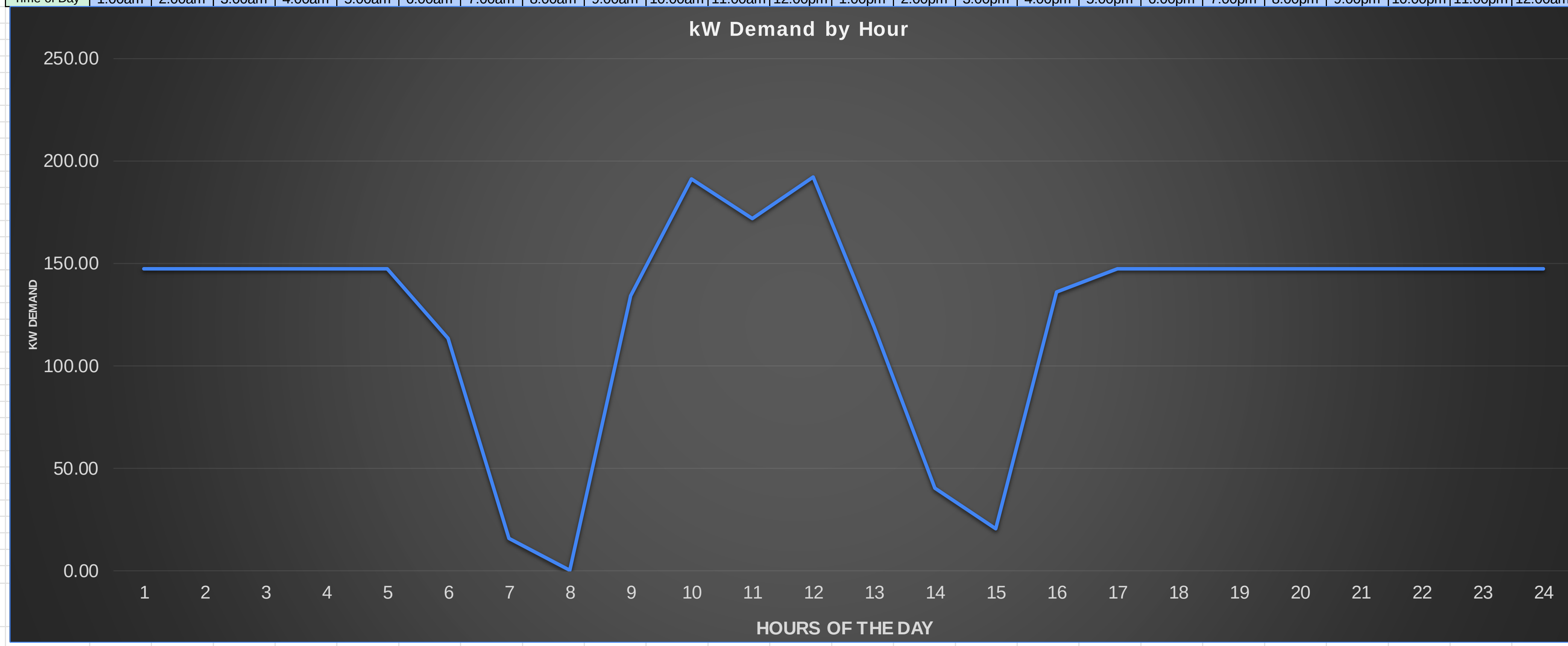
Appendix A

Daily route energy consumption (kWh), total fleet energy consumption (kWh) as well as daily fleet KW demand from charging at -20°F.

Worst Case Operations @ -20°F			
Bus Route	3.09 kwh /mile consumption (kwh)	cold weather idle penalty (23kwh / hr)	Worst Case Route Consumption (kwh)
Route 1 Am, Potsdam	231.6	29.3	**260.9**
Route 1 PM	210.0	27.6	**237.6**
Route 2 Am	86.5	20.7	**107.2**
Route 2 PM	55.6	15.5	**71.1**
Route 3 Am	64.9	12.9	**77.8**
Route 3 PM	83.4	12.9	**96.3**
Route 4 Am	46.3	15.5	**61.9**
Route 4 PM	49.4	20.7	**70.1**
Route 5 Am	46.3	12.9	**59.3**
Route 5 PM	43.2	10.4	**53.6**
Route 6 Am	40.1	10.4	**50.5**
Route 6 PM	49.4	10.4	**59.8**
Route 7 Am	40.1	20.7	**60.9**
Route 7 PM	46.3	15.5	**61.9**
Route 9 Am	237.8	28.5	**266.3**
Route 9 PM	203.8	25.9	**229.7**
Route 10 Am	24.7	5.2	**29.9**
Route 10 PM	24.7	5.2	**29.9**
Route 11 Am	197.6	18.1	**215.8**
Route 11 PM	240.9	23.3	**264.2**
Route 12 Am	145.1	23.3	**168.4**
Route 12 PM	55.6	10.4	**65.9**
Route 13 Am *Includes 2 routes	86.5	23.3	**109.8**
Route 13 PM *Includes 2 routes	71.0	23.3	**94.3**
Route 14 Am	64.9	15.5	**80.4**
Route 14 PM	52.5	15.5	**68.0**
AG studies AM	135.9	10.4	**146.2**
AG studies PM	135.9	12.9	**148.8**
AM Boces, bus 3	18.5	7.8	**26.3**
AM Boces, bus 14:	129.7	31.1	**160.8**
Midday Boces, bus 1	24.7	15.5	**40.2**
Midday Boces, bus 7	18.5	18.1	**36.6**
Midday Boces, bus 13	18.5	12.9	**31.5**
PM Boces, bus 3	9.3	5.2	**14.4**
PM Boces, bus 4	9.3	5.2	**14.4**
PM Boces, bus 5	9.3	5.2	**14.4**
PM Boces, bus 6	9.3	5.2	**14.4**
	daily kWh total for days between -30°F and -10°F		**3,599.6**
	# of days between -30°F and -10°F during 180 day school year		**2.0**
	Annual School-year Energy Consumption for temperatures between -30°F and -10°F (kWh)		**7,199.2**

24-Hour Fleet Charging rate cycle, Ambient Temp @ -20°F

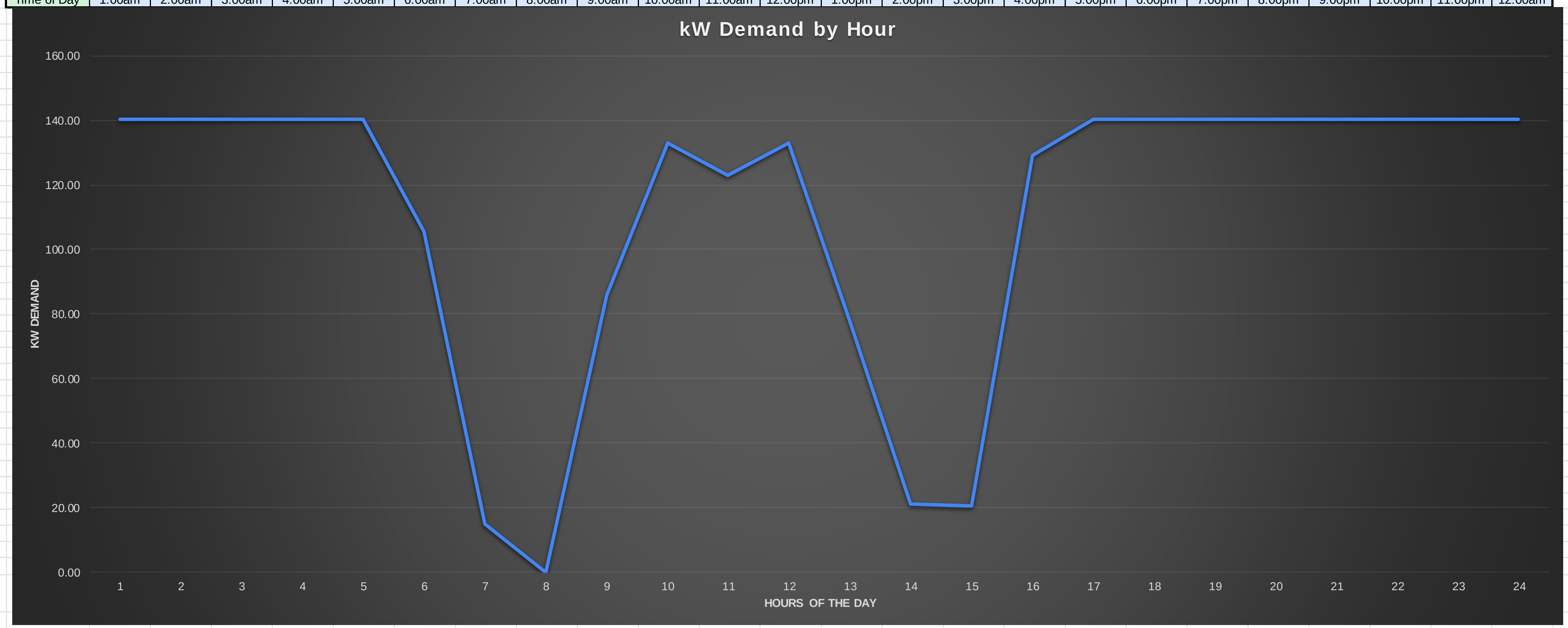
Time of Day	Total Rate or Charge (kWh)
1:00am	147.3
2:00am	147.3
3:00am	147.3
4:00am	147.3
5:00am	147.3
6:00am	113.2
7:00am	15.7
8:00am	0.0
9:00am	134.0
10:00am	191.0
11:00am	172.0
12:00pm	192.0
1:00pm	119.0
2:00pm	40.0
3:00pm	20.4
4:00pm	136.0
5:00pm	147.3
6:00pm	147.3
7:00pm	147.3
8:00pm	147.3
9:00pm	147.3
10:00pm	147.3
11:00pm	147.3
12:00am	147.3



Daily route energy consumption (kWh), total fleet energy consumption (kWh) as well as daily fleet KW demand from charging at 0°F.

Operations @ 0°F			
Bus Route	2.76 kwh /mile consumption (kwh)	cold weather idle penalty (18kwh / hr)	Route Consumption (kwh)
Route 1 Am, Potsdam	207.2	22.9	**230.1**
Route 1 PM	187.9	21.6	**209.5**
Route 2 Am	77.4	16.2	**93.5**
Route 2 PM	49.7	12.1	**61.9**
Route 3 Am	58.0	10.1	**68.1**
Route 3 PM	74.6	10.1	**84.7**
Route 4 Am	41.4	12.1	**53.6**
Route 4 PM	44.2	16.2	**60.4**
Route 5 Am	41.4	10.1	**51.6**
Route 5 PM	38.7	8.1	**46.8**
Route 6 Am	35.9	8.1	**44.0**
Route 6 PM	44.2	8.1	**52.3**
Route 7 Am	35.9	16.2	**52.1**
Route 7 PM	41.4	12.1	**53.6**
Route 9 Am	212.8	22.2	**235.0**
Route 9 PM	182.4	20.2	**202.6**
Route 10 Am	22.1	4.0	**26.1**
Route 10 PM	22.1	4.0	**26.1**
Route 11 Am	176.8	14.1	**191.0**
Route 11 PM	215.5	18.2	**233.7**
Route 12 Am	129.9	18.2	**148.1**
Route 12 PM	49.7	8.1	**57.8**
Route 13 Am *Includes 2 routes	77.4	18.2	**95.6**
Route 13 PM *Includes 2 routes	63.6	18.2	**81.7**
Route 14 Am	58.0	12.1	**70.1**
Route 14 PM	47.0	12.1	**59.1**
AG studies AM	121.6	8.1	**129.7**
AG studies PM	121.6	10.1	**131.7**
AM Boces, bus 3	16.6	6.1	**22.6**
AM Boces, bus 14:	116.1	24.2	**140.3**
Midday Boces, bus 1	22.1	12.1	**34.2**
Midday Boces, bus 7	16.6	14.1	**30.7**
Midday Boces, bus 13	16.6	10.1	**26.7**
PM Boces, bus 3	8.3	4.0	**12.3**
PM Boces, bus 4	8.3	4.0	**12.3**
PM Boces, bus 5	8.3	4.0	**12.3**
PM Boces, bus 6	8.3	4.0	**12.3**
	daily kWh total for days between -10°F and 10°F		**3,154.2**
	# of days between -10°F and 10°F during 180 day school year		**16.0**
	Annual School-year Energy Consumption for temperatures between -10°F and 10°F (kWh)		**50,467.7**

24-Hour Fleet Charging rate cycle, Ambient Temp @ 0°F																								
Total Rate or Charge (kWh)	140.4	140.4	140.4	140.4	140.4	105.6	14.8	0.0	86.0	133.0	123.0	133.0	78.0	21.0	20.6	129.0	140.4	140.4	140.4	140.4	140.4	140.4	140.4	140.4
Time of Day	1:00am	2:00am	3:00am	4:00am	5:00am	6:00am	7:00am	8:00am	9:00am	10:00am	11:00am	12:00pm	1:00pm	2:00pm	3:00pm	4:00pm	5:00pm	6:00pm	7:00pm	8:00pm	9:00pm	10:00pm	11:00pm	12:00am

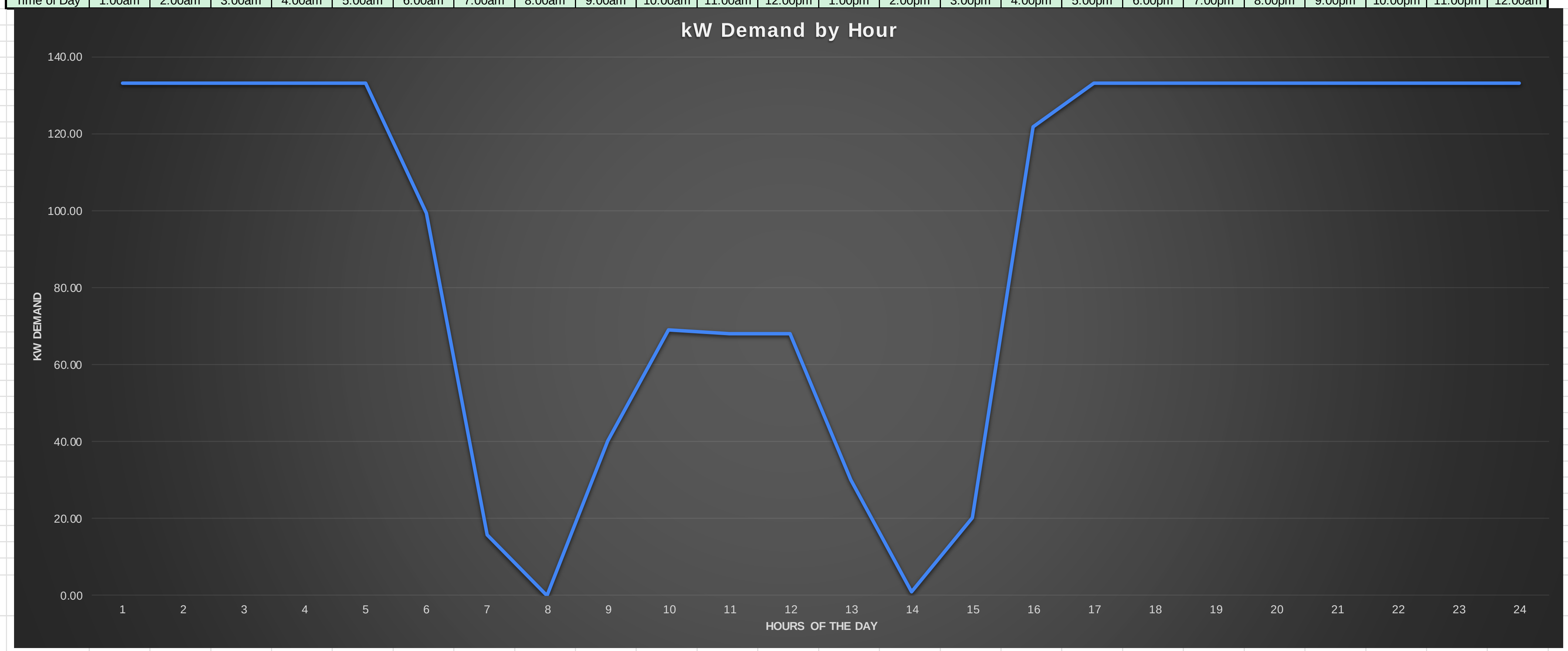


Daily route energy consumption (kWh), total fleet energy consumption (kWh) as well as daily fleet KW demand from charging at 20°F.

Operations at 20°F			
Bus Route	2.41 kwh /mile consumption (kwh)	cold weather idle penalty (12.7kwh / hr)	Route consumption (kwh)
Route 1 Am, Potsdam	181.0	16.1	**197.2**
Route 1 PM	164.1	15.2	**179.4**
Route 2 Am	67.6	11.4	**79.0**
Route 2 PM	43.4	8.6	**52.0**
Route 3 Am	50.7	7.1	**57.8**
Route 3 PM	65.2	7.1	**72.3**
Route 4 Am	36.2	8.6	**44.8**
Route 4 PM	38.6	11.4	**50.0**
Route 5 Am	36.2	7.1	**43.3**
Route 5 PM	33.8	5.7	**39.5**
Route 6 Am	31.4	5.7	**37.1**
Route 6 PM	38.6	5.7	**44.3**
Route 7 Am	31.4	11.4	**42.8**
Route 7 PM	36.2	8.6	**44.8**
Route 9 Am	185.9	15.7	**201.5**
Route 9 PM	159.3	14.3	**173.6**
Route 10 Am	19.3	2.9	**22.2**
Route 10 PM	19.3	2.9	**22.2**
Route 11 Am	154.5	10.0	**164.5**
Route 11 PM	188.3	12.8	**201.1**
Route 12 Am	113.4	12.8	**126.3**
Route 12 PM	43.4	5.7	**49.2**
Route 13 Am *Includes 2 routes	67.6	12.8	**80.4**
Route 13 PM *Includes 2 routes	55.5	12.8	**68.3**
Route 14 Am	50.7	8.6	**59.2**
Route 14 PM	41.0	8.6	**49.6**
AG studies AM	106.2	5.7	**111.9**
AG studies PM	106.2	7.1	**113.3**
AM Boces, bus 3	14.5	4.3	**18.8**
AM Boces, bus 14:	101.4	17.1	**118.5**
Midday Boces, bus 1	19.3	8.6	**27.9**
Midday Boces, bus 7	14.5	10.0	**24.5**
Midday Boces, bus 13	14.5	7.1	**21.6**
PM Boces, bus 3	7.2	2.9	**10.1**
PM Boces, bus 4	7.2	2.9	**10.1**
PM Boces, bus 5	7.2	2.9	**10.1**
PM Boces, bus 6	7.2	2.9	**10.1**
	daily kWh Total for days between 10°F and 30°F		**2,679.0**
	# of days between 10°F and 30°F during 180 day school year		**31.0**
	Annual School-year Energy Consumption for temperatures between 10°F and 30°F (kWh)		**83,050.4**

24-Hour Fleet Charging rate cycle, Ambient Temp @ 20°F

Time of Day	Total Rate or Charge (kWh)
1:00am	133.0
2:00am	133.0
3:00am	133.0
4:00am	133.0
5:00am	133.0
6:00am	99.2
7:00am	15.6
8:00am	0.0
9:00am	40.0
10:00am	69.0
11:00am	68.0
12:00pm	68.0
1:00pm	30.0
2:00pm	1.0
3:00pm	20.2
4:00pm	121.7
5:00pm	133.0
6:00pm	133.0
7:00pm	133.0
8:00pm	133.0
9:00pm	133.0
10:00pm	133.0
11:00pm	133.0
12:00am	133.0

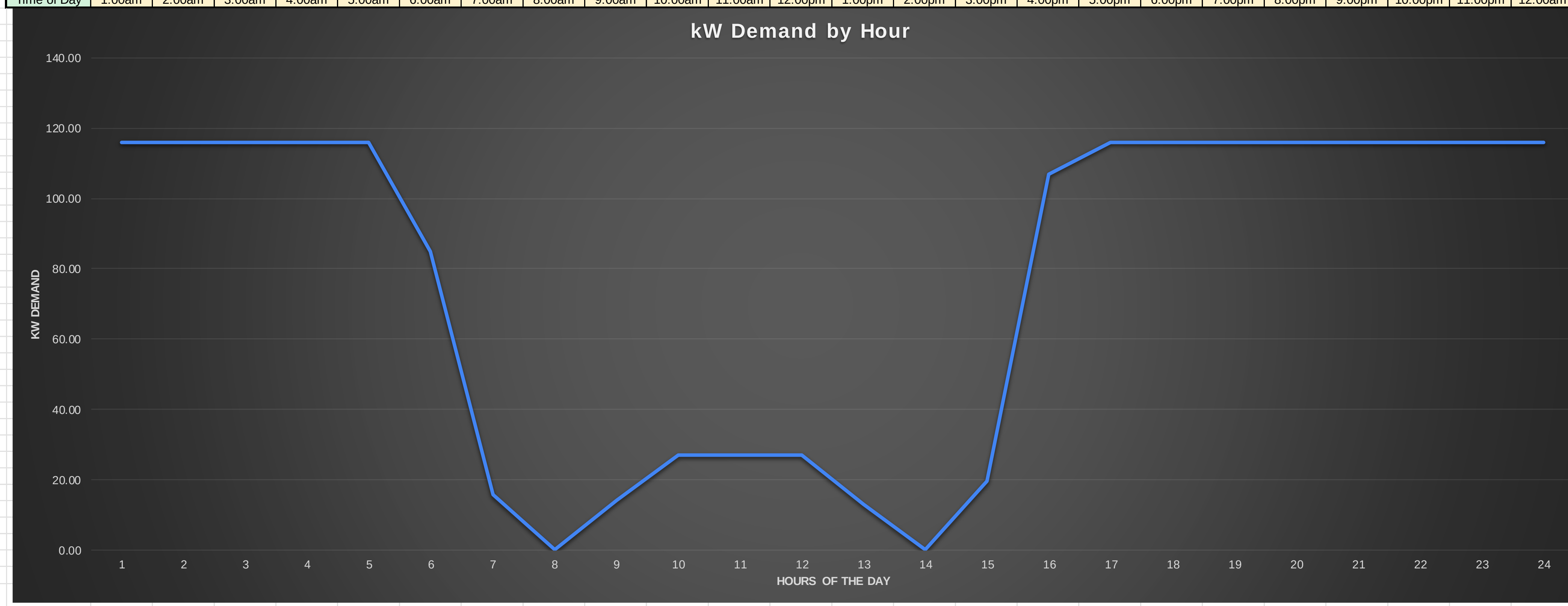


Daily route energy consumption (kWh), total fleet energy consumption (kWh) as well as daily fleet KW demand from charging at 40°F.

Annual Average Operations @ 40°F			
Bus Route	2.04 kwh /mile consumption (kwh)	cold weather idle penalty (7.1kw/hr)	Average Route Consumption (kwh)
Route 1 Am, Potsdam	152.9	9.1	**162.0**
Route 1 PM	138.6	8.6	**147.2**
Route 2 Am	57.1	6.4	**63.5**
Route 2 PM	36.7	4.8	**41.5**
Route 3 Am	42.8	4.0	**46.8**
Route 3 PM	55.0	4.0	**59.1**
Route 4 Am	30.6	4.8	**35.4**
Route 4 PM	32.6	6.4	**39.0**
Route 5 Am	30.6	4.0	**34.6**
Route 5 PM	28.5	3.2	**31.8**
Route 6 Am	26.5	3.2	**29.7**
Route 6 PM	32.6	3.2	**35.8**
Route 7 Am	26.5	6.4	**32.9**
Route 7 PM	30.6	4.8	**35.4**
Route 9 Am	157.0	8.8	**165.8**
Route 9 PM	134.6	8.0	**142.6**
Route 10 Am	16.3	1.6	**17.9**
Route 10 PM	16.3	1.6	**17.9**
Route 11 Am	130.5	5.6	**136.1**
Route 11 PM	159.0	7.2	**166.3**
Route 12 Am	95.8	7.2	**103.1**
Route 12 PM	36.7	3.2	**39.9**
Route 13 Am *Includes 2 routes	57.1	7.2	**64.3**
Route 13 PM *Includes 2 routes	46.9	7.2	**54.1**
Route 14 Am	42.8	4.8	**47.6**
Route 14 PM	34.7	4.8	**39.5**
AG studies AM	89.7	3.2	**92.9**
AG studies PM	89.7	4.0	**93.7**
AM Boces, bus 3	12.2	2.4	**14.6**
AM Boces, bus 14:	85.6	9.6	**95.3**
Midday Boces, bus 1	16.3	4.8	**21.1**
Midday Boces, bus 7	12.2	5.6	**17.9**
Midday Boces, bus 13	12.2	4.0	**16.2**
PM Boces, bus 3	6.1	1.6	**7.7**
PM Boces, bus 4	6.1	1.6	**7.7**
PM Boces, bus 5	6.1	1.6	**7.7**
PM Boces, bus 6	6.1	1.6	**7.7**
	daily kWh total for days between 30°F and 50°F		**2,172.6**
	# of days between 30°F and 50°F during 180 day school year		**62.0**
	Annual School-year Energy Consumption for temperatures between 30°F and 50°F (kWh)		**134,699.3**

24-Hour Fleet Charging rate cycle, Ambient Temp @ 40°F

Time of Day	Total Rate or Charge (kWh)
1:00am	115.9
2:00am	115.9
3:00am	115.9
4:00am	115.9
5:00am	115.9
6:00am	84.9
7:00am	15.6
8:00am	0.0
9:00am	14.0
10:00am	27.0
11:00am	27.0
12:00pm	27.0
1:00pm	13.0
2:00pm	0.0
3:00pm	19.4
4:00pm	106.8
5:00pm	115.9
6:00pm	115.9
7:00pm	115.9
8:00pm	115.9
9:00pm	115.9
10:00pm	115.9
11:00pm	115.9
12:00am	115.9

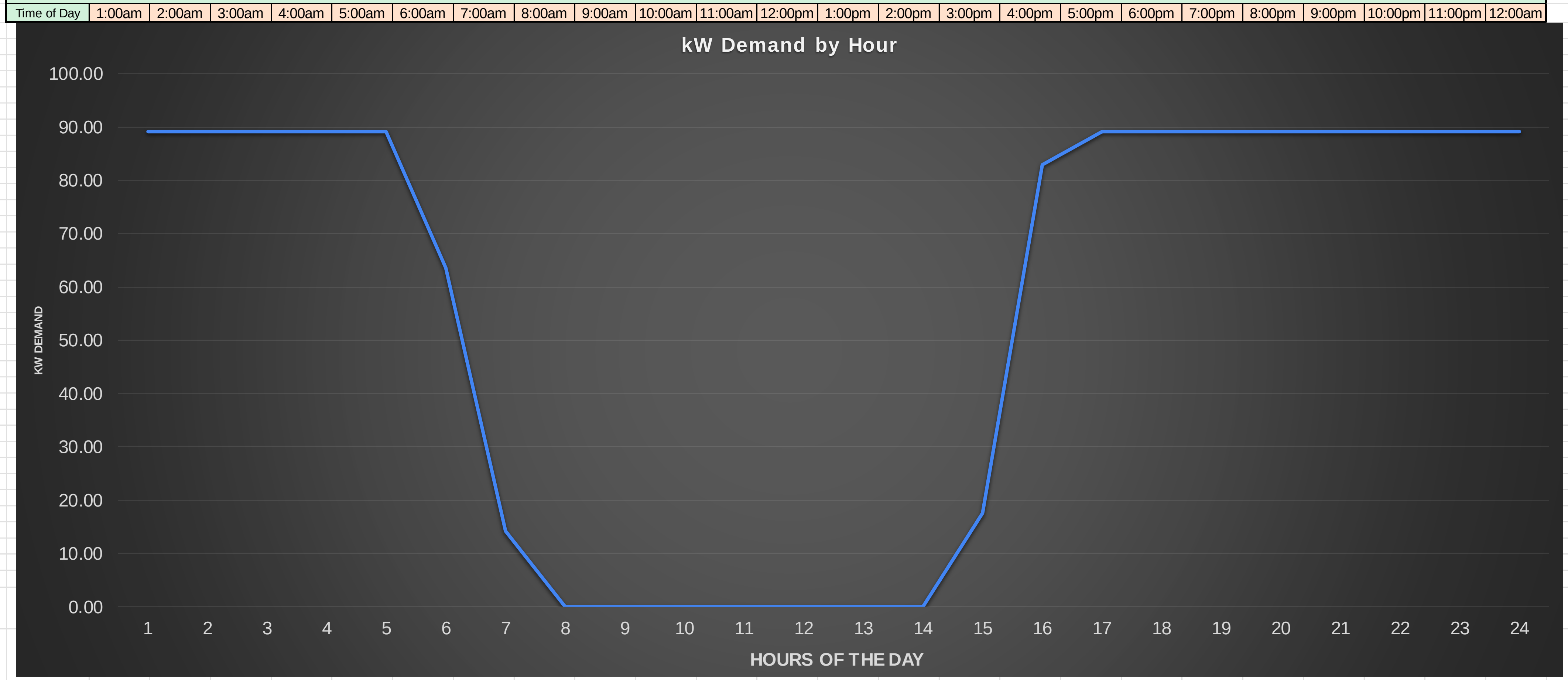


Daily route energy consumption (kWh), total fleet energy consumption (kWh) as well as daily fleet KW demand from charging at 68°F.

Ideal Operation at 68°F			
Bus Route	1.58 kwh /mile consumption (kwh)	cold weather idle penalty (1.6kw/hr)	Average Route Consumption (kwh)
Route 1 Am, Potsdam	118.4	2.0	**120.4**
Route 1 PM	107.4	1.9	**109.3**
Route 2 Am	44.2	1.4	**45.6**
Route 2 PM	28.4	1.1	**29.5**
Route 3 Am	33.2	0.9	**34.0**
Route 3 PM	42.6	0.9	**43.5**
Route 4 Am	23.7	1.1	**24.8**
Route 4 PM	25.3	1.4	**26.7**
Route 5 Am	23.7	0.9	**24.6**
Route 5 PM	22.1	0.7	**22.8**
Route 6 Am	20.5	0.7	**21.2**
Route 6 PM	25.3	0.7	**26.0**
Route 7 Am	20.5	1.4	**21.9**
Route 7 PM	23.7	1.1	**24.8**
Route 9 Am	121.6	2.0	**123.5**
Route 9 PM	104.2	1.8	**106.0**
Route 10 Am	12.6	0.4	**13.0**
Route 10 PM	12.6	0.4	**13.0**
Route 11 Am	101.1	1.2	**102.3**
Route 11 PM	123.2	1.6	**124.8**
Route 12 Am	74.2	1.6	**75.8**
Route 12 PM	28.4	0.7	**29.1**
Route 13 Am *Includes 2 routes	44.2	1.6	**45.8**
Route 13 PM *Includes 2 routes	36.3	1.6	**37.9**
Route 14 Am	33.2	1.1	**34.2**
Route 14 PM	26.8	1.1	**27.9**
AG studies AM	69.5	0.7	**70.2**
AG studies PM	69.5	0.9	**70.4**
AM Boces, bus 3	9.5	0.5	**10.0**
AM Boces, bus 14:	66.3	2.1	**68.4**
Midday Boces, bus 1	12.6	1.1	**13.7**
Midday Boces, bus 7	9.5	1.2	**10.7**
Midday Boces, bus 13	9.5	0.9	**10.4**
PM Boces, bus 3	4.7	0.4	**5.1**
PM Boces, bus 4	4.7	0.4	**5.1**
PM Boces, bus 5	4.7	0.4	**5.1**
PM Boces, bus 6	4.7	0.4	**5.1**
	daily kWh total for days between above 50°F		**1,582.6**
	# of days between above 50°F during 180 day school year		**69.0**
	Annual School-year Energy Consumption for temperatures above 50°F (kWh)		**109,199.3**

24-Hour Fleet Charging rate cycle, Ambient Temp @ 68°F

Time of Day	Total Rate or Charge (kWh)
1:00am	89.2
2:00am	89.2
3:00am	89.2
4:00am	89.2
5:00am	89.2
6:00am	63.5
7:00am	14.2
8:00am	0.0
9:00am	0.0
10:00am	0.0
11:00am	0.0
12:00pm	0.0
1:00pm	0.0
2:00pm	0.0
3:00pm	17.5
4:00pm	82.8
5:00pm	89.2
6:00pm	89.2
7:00pm	89.2
8:00pm	89.2
9:00pm	89.2
10:00pm	89.2
11:00pm	89.2
12:00am	89.2



Appendix B

Daily bus run energy consumption and charging rates at **-20°F**

Bus # 1

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	260.9	54.1	0.0	54.1	40.2	13.8	60.0	88.8	237.6	**-148.8**	30.9

Bus # 2

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00	8:00	2	**0**	8:00	9:00	1	**5.25**	2:15	3:45	1.5	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	107.2	207.8	0.0	207.8	146.2	61.6	12.0	124.6	59.3	**65.3**	17.5

Bus #3

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**0**	8:15	9:00	0.75	**4.75**	1:45	2:20	0.5	**0**	2:30	3:45	1.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	77.8	132.2	0.0	132.2	26.3	105.9	10.0	153.4	14.4	139.0	60.0	139.0	96.3	**42.6**	11.3

Bus #4												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.5	**5.5**	1:30	2:05	0.5	**0**	2:05	4:00	2	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	61.9	148.1	0.0	148.1	14.4	133.7	0.0	133.7	70.1	**63.6**	10.1

Bus #5												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	59.3	150.7	0.0	150.7	14.4	136.3	0.0	136.3	53.6	**82.7**	8.5

Bus #6												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:40	7:45	1	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	50.5	159.5	0.0	159.5	14.4	145.1	0.0	145.1	59.8	**85.3**	7.8

Bus #7

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:00	8:00	2	**2.25**	10:15	12:00	1.75	**2.25**	2:15	3:45	1.50	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	60.9	149.1	**0.0**	149.1	36.6	112.5	**0.0**	112.5	61.9	**50.6**	11.2

Bus #9

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	5:45	8:30	2.75	**4.25**	12:45	3:15	1.50	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	266.3	48.7	60.0	303.7	229.7	**74.0**	16.6

Bus #10

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:15	7:45	0.50	**7.25**	2:30	3:00	0.50	**15.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	29.9	180.1	0.0	180.1	29.9	**150.2**	3.8

Bus #11								
Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:45	9:30	1.75	**4**	1:30	3:45	2.25	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	215.8	99.2	57.0	327.2	264.2	**63.1**	15.7

Bus #12													
Daily Timeline	AM pickup				Miday Run				PM dropoff				
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	AG studies AM start	AG studies AM end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:45	9:00	2.25	**4**	1:00	2:20	1.25	**0**	2:30	3:30	1.00	**15.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	168.4	146.6	**33.0**	278.6	148.8	129.7	**20.0**	129.7	65.9	**63.8**	16.5

Bus #13												
Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:45	2.25	**2**	10:45	12:00	1.25	**1.5**	1:30	3:45	2.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	109.8	100.2	**19.0**	138.2	31.5	106.8	**20.0**	136.8	94.3	**42.4**	11.4

Bus #14													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.50	**0**	8:15	11:15	3.00	**3**	2:15	3:45	1.50	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	80.4	234.6	**0.0**	234.6	160.8	73.9	**20.0**	133.9	68.0	**65.8**	16.9

Daily bus run energy consumption and charging rates at **0°F**

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	230.1	84.9	0.0	84.9	34.2	50.7	60.0	125.7	209.5	**-83.8**	26.6

Bus # 2												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00	8:00	2	**0**	8:00	9:00	1	**5.25**	2:15	3:45	1.5	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	93.5	221.5	0.0	221.5	129.7	91.8	5.0	118.1	51.6	**66.5**	17.4

Bus #3																
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**0**	8:15	9:00	0.75	**4.75**	1:45	2:20	0.5	**0**	2:30	3:45	1.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	68.1	141.9	0.0	141.9	22.6	119.2	5.0	143.0	12.3	130.6	60.0	130.6	84.7	**45.9**	11.1

Bus #4

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.5	**5.5**	1:30	2:05	0.5	**0**	2:05	4:00	2	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	53.6	156.4	0.0	156.4	12.3	144.1	0.0	144.1	60.4	**83.7**	8.7

Bus #5

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	51.6	158.4	0.0	158.4	12.3	146.1	0.0	146.1	46.8	**99.4**	7.4

Bus #6

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:40	7:45	1	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	44.0	166.0	0.0	166.0	12.3	153.7	0.0	153.7	52.3	**101.4**	6.8

Bus #7

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:00	8:00	2	**2.25**	10:15	12:00	1.75	**2.25**	2:15	3:45	1.50	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	52.1	157.9	**0.0**	157.9	30.7	127.2	**0.0**	127.2	53.6	**73.6**	9.6

Bus #9

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	5:45	8:30	2.75	**4.25**	12:45	3:15	1.50	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	235.0	80.0	44.0	267.0	202.6	**64.4**	17.3

Bus #10

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:15	7:45	0.50	**7.25**	2:30	3:00	0.50	**15.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	26.1	183.9	0.0	183.9	26.1	**157.7**	3.3

Bus #11

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:45	9:30	1.75	**4**	1:30	3:45	2.25	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	191.0	124.0	47.0	312.0	233.7	**78.3**	14.8

Bus #12

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	AG studies AM start	AG studies AM end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:45	9:00	2.25	**4**	1:00	2:20	1.25	**0**	2:30	3:30	1.00	**15.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	148.1	166.9	**22.0**	254.9	131.7	123.3	**20.0**	123.3	57.8	**65.4**	16.4

Bus #13

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:45	2.25	**2**	10:45	12:00	1.25	**1.5**	1:30	3:45	2.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	95.6	114.4	**10.0**	134.4	26.7	107.8	**11.0**	124.3	81.7	**42.5**	11.4

Bus #14													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.50	**0**	8:15	11:15	3.00	**3**	2:15	3:45	1.50	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	70.1	244.9	**0.0**	244.9	140.3	104.6	**10.0**	134.6	59.1	**75.5**	16.2

<u>Daily bus run energy consumption and charging rates at **20°F**</u>

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	197.2	117.8	0.0	117.8	27.9	90.0	60.0	165.0	179.4	**-14.4**	22.0

Bus # 2												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00	8:00	2	**0**	8:00	9:00	1	**5.25**	2:15	3:45	1.5	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	79.0	236.0	0.0	236.0	111.9	124.1	0.0	124.1	43.3	**80.8**	16.4

Bus #3																
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**0**	8:15	9:00	0.75	**4.75**	1:45	2:20	0.5	**0**	2:30	3:45	1.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	57.8	152.2	0.0	152.2	18.8	133.4	0.0	133.4	10.1	123.3	60.0	123.3	72.3	**51.0**	10.8

Bus #4

	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
Daily Timeline	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.5	**5.5**	1:30	2:05	0.5	**0**	2:05	4:00	2	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	44.8	165.2	0.0	165.2	10.1	155.1	0.0	155.1	50.0	**105.1**	7.2

Bus #5

	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
Daily Timeline	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	43.3	166.7	0.0	166.7	10.1	156.6	0.0	156.6	39.5	**117.1**	6.2

Bus #6

	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
Daily Timeline	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:40	7:45	1	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	37.1	172.9	0.0	172.9	10.1	162.8	0.0	162.8	44.3	**118.5**	5.7

Bus #7

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:00	8:00	2	**2.25**	10:15	12:00	1.75	**2.25**	2:15	3:45	1.50	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	42.8	167.2	**0.0**	167.2	24.5	142.8	**0.0**	142.8	44.8	**98.0**	7.9

Bus #9

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	5:45	8:30	2.75	**4.25**	12:45	3:15	1.50	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	201.5	113.5	29.0	236.7	173.6	**63.1**	17.4

Bus #10

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:15	7:45	0.50	**7.25**	2:30	3:00	0.50	**15.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	22.2	187.8	0.0	187.8	22.2	**165.7**	2.8

Bus #11

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:45	9:30	1.75	**4**	1:30	3:45	2.25	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	164.5	150.5	29.0	266.5	201.1	**65.4**	15.6

Bus #12

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	AG studies AM start	AG studies AM end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:45	9:00	2.25	**4**	1:00	2:20	1.25	**0**	2:30	3:30	1.00	**15.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	126.3	188.7	**10.0**	228.7	113.3	115.4	**20.0**	115.4	49.2	**66.2**	16.3

Bus #13

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:45	2.25	**2**	10:45	12:00	1.25	**1.5**	1:30	3:45	2.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	80.4	129.6	**1.0**	131.6	21.6	110.0	**1.0**	111.5	68.3	**43.1**	11.3

Bus #14													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.50	**0**	8:15	11:15	3.00	**3**	2:15	3:45	1.50	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	59.2	255.8	**0.0**	255.8	118.5	137.3	**0.0**	137.3	49.6	**87.7**	15.4

Daily bus run energy consumption and charging rates at **40°F**

Bus # 1												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	162.0	153.0	0.0	153.0	21.1	131.9	60.0	206.9	147.2	**59.7**	17.0

Bus # 2												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00:00 AM	8:00	2	**0**	8:00	9:00	1	**5.25**	2:15	3:45	1.5	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	63.5	251.5	0.0	251.5	92.9	158.6	0.0	158.6	41.5	**117.1**	13.9

Bus #3																
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**0**	8:15	9:00	0.75	**4.75**	1:45	2:20	0.5	**0**	2:30	3:45	1.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	46.8	163.2	0.0	163.2	14.6	148.5	0.0	148.5	7.7	140.8	40.0	140.8	59.1	**81.7**	8.7

Bus #4

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM BOCES start	PM BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:00	1.5	**5.5**	1:30	2:05	0.5	**0**	2:05	4:00	2	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	35.4	174.6	0.0	174.6	7.7	166.9	0.0	166.9	39.0	**127.8**	5.7

Bus #5

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM BOCES start	PM BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	7:45	1.25	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	34.6	175.4	0.0	175.4	7.7	167.7	0.0	167.7	31.8	**135.9**	4.9

Bus #6

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM BOCES start	PM BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:40	7:45	1	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	29.7	180.3	0.0	180.3	7.7	172.6	0.0	172.6	35.8	**136.7**	4.6

Bus #7

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:00	8:00	2	**2.25**	10:15	12:00	1.75	**2.25**	2:15	3:45	1.50	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	32.9	177.1	**0.0**	177.1	17.9	159.2	**0.0**	159.2	35.4	**123.8**	6.0

Bus #9

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	5:45	8:30	2.75	**4.25**	12:45	3:15	1.50	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	165.8	149.2	14.0	208.7	142.6	**66.1**	17.2

Bus #10

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:15	7:45	0.50	**7.25**	2:30	3:00	0.50	**15.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	17.9	192.1	0.0	192.1	17.9	**174.2**	2.3

Bus #11

Daily Timeline	AM pickup				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	7:45	9:30	1.75	**4**	1:30	3:45	2.25	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	136.1	178.9	13.0	230.9	166.3	**64.6**	15.6

Bus #12

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	AG studies AM start	AG studies AM end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:45	9:00	2.25	**4**	1:00	2:20	1.25	**0**	2:30	3:30	1.00	**15.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	103.1	211.9	**0.0**	211.9	93.7	118.2	**0.0**	118.2	39.9	**78.3**	15.5

Bus #13

Daily Timeline	AM pickup				Miday Run				PM dropoff			
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	miday BOCES start	miday BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:45	2.25	**2**	10:45	12:00	1.25	**1.5**	1:30	3:45	2.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	64.3	145.7	**0.0**	145.7	16.2	129.4	**0.0**	129.4	54.1	**75.3**	9.1

Bus #14													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.50	**0**	8:15	11:15	3.00	**3**	2:15	3:45	1.50	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	47.6	267.4	**0.0**	267.4	95.3	172.1	**0.0**	172.1	39.5	**132.6**	12.4

Daily bus run energy consumption and charging rates at **68°F**

Bus # 1

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	7:10	10:00	2.83	**0**	10:35	12:05	1.5	**1.25**	1:20	4:00	2.67	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	120.4	194.6	0.0	194.6	13.7	180.9	0.0	180.9	109.3	**71.6**	16.2

Bus # 2

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00	8:00	2	**0**	8:00	9:00	1	**5.25**	2:15	3:45	1.5	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	45.6	269.4	0.0	269.4	70.2	199.2	0.0	199.2	24.6	**174.6**	9.9

Bus #3

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AM BOCES start	AM BOCES end	run time		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**0**	8:15	9:00	0.75	**4.75**	1:45	2:20	0.5	**0**	2:30	3:45	1.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	34.0	176.0	0.0	176.0	10.0	165.9	0.0	165.9	5.1	160.9	60.0	160.9	43.5	**117.3**	6.3

Bus #4													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:00	1.5	**5.5**	1:30	2:05	0.5	**0**	2:05	4:00	2	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	24.8	185.3	0.0	185.3	5.1	180.2	0.0	180.2	26.7	**153.5**	3.9

Bus #5													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	7:45	1.25	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**15**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	24.6	185.4	0.0	185.4	5.1	180.3	0.0	180.3	22.8	**157.5**	3.5

Bus #6													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM BOCES start	PM BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:40	7:45	1	**6.25**	2:00	2:20	0.5	**0**	2:30	3:30	1	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	21.2	188.8	0.0	188.8	5.1	183.7	0.0	183.7	26.0	**157.7**	3.3

Bus #7

Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:00	8:00	2	**2.25**	10:15	12:00	1.75	**2.25**	2:15	3:45	1.50	**14.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	21.9	188.1	**0.0**	188.1	10.7	177.3	**0.0**	177.3	24.8	**152.6**	4.0

Bus #9

Daily Timeline	AM pickup			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM run start	PM run end	PM run time (hrs)	
	5:45	8:30	2.75	**4.25**	12:45	3:15	1.50	**14.5**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	123.5	191.5	0.0	191.5	106.0	**85.5**	15.8

Bus #10

Daily Timeline	AM pickup			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM run start	PM run end	PM run time (hrs)	
	7:15	7:45	0.50	**7.25**	2:30	3:00	0.50	**15.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	13.0	197.0	0.0	197.0	13.0	**184.0**	1.6

Bus #11								
Daily Timeline	AM pickup			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		PM run start	PM run end	PM run time (hrs)	
	7:45	9:30	1.75	**4**	1:30	3:45	2.25	**16**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	102.3	212.7	0.0	212.7	124.8	**87.9**	14.2

Bus #12													
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		AG studies AM start	AG studies AM end	run time		PM run start	PM run end	PM run time (hrs)	
	6:45	9:00	2.25	**4**	1:00	2:20	1.25	**0**	2:30	3:30	1.00	**15.25**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	75.8	239.2	**0.0**	239.2	70.4	168.8	**0.0**	168.8	29.1	**139.7**	11.5

Bus #13												
Daily Timeline	AM pickup			down time before next route (hrs)	Miday Run			down time before next route (hrs)	PM dropoff			down time before next route (hrs)
	AM run start	AM run end	AM run time (hrs)		miday BOCES start	miday BOCES end	run time		PM run start	PM run end	PM run time (hrs)	
	6:30	8:45	2.25	**2**	10:45	12:00	1.25	**1.5**	1:30	3:45	2.25	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**210.0**	45.8	164.2	**0.0**	164.2	10.4	153.8	**0.0**	153.8	37.9	**115.9**	6.4

Bus #14													
Daily Timeline	AM pickup				Miday Run				PM dropoff				
	AM run start	AM run end	AM run time (hrs)	down time before next route (hrs)	AM BOCES start	AM BOCES end	run time	down time before next route (hrs)	PM run start	PM run end	PM run time (hrs)	down time before next route (hrs)
	6:30	8:00	1.50	**0**	8:15	11:15	3.00	**3**	2:15	3:45	1.50	**14.75**
	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)	start	route consumption	end	charge rate (kwh)
Battery Capacity (kwh)	**315.0**	34.2	280.8	**0.0**	280.8	68.4	212.3	**0.0**	212.3	27.9	**184.4**	8.9