Sustainable Transportation

–

Vehicle & Charging Recommendations Approaching 2025

SUSTAINABLE COLUMBIA

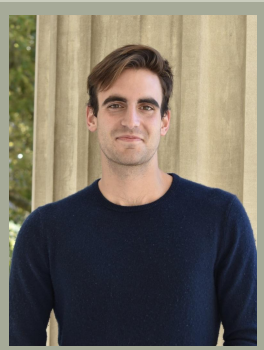
Kate Della Pietra, Jake Duffy, Claire Briglio, Michelle Drandell, Ernest Robertson, Clio Dakolias, Justas Pakašius

Introductions: Our Team

Claire Briglio

Clio Dakolias

Michelle Drandell



Jake Duffy

Justas Pakašius

Kate Della Pietra

Ernie Robertson

Overview of Presentation

Project Overview

Global Initiatives, Plan 2030, Project Methodology

Data Analysis

Emissions Model, Fleet Findings

Fleet Breakdown

Short Description, Vehicle Recommendations

Charging Plan

Campus map with proposed EV charging location

General Recommendations

Areas of improvement, 2025 onwards

Columbia, COP27 and Climate Responsibility

Climate change is global and particles emitted today will persist in the atmosphere for a long time. Emissions here today will affect humans for generations.

Certain communities and societies have a higher responsibility due to higher historic emissions. Columbia has an opportunity to lead not only through its research, but also through action.

Urgent and bold steps are needed to mitigate the worst outcomes of the climate emergency. Columbia's ambitious climate plans require action on behalf of its community

Columbia's Plan 2030's Road to Zero Emissions

-21%

2025

-42%

2030

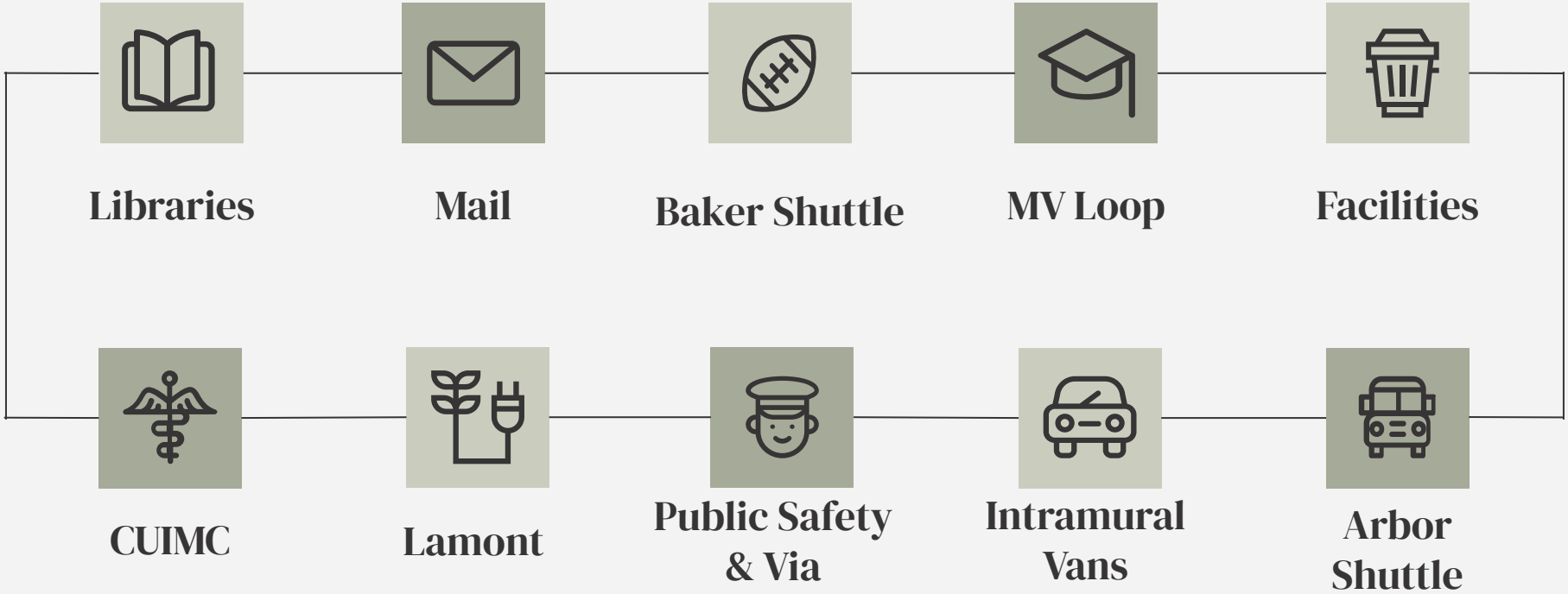
-63%

2035

Project Description

Align Columbia with its vehicle emissions reductions targets for 2025 by proposing a detailed electrification and charging plan.

Fleet Overview



Our Methodology

Background Research	Literature Review of EV space and Sustainable Transportation
10+ Informational Chats	Consultation with fleet managers to understand operations
Data Synthesis	Collection of fleet vehicle usage to create emissions model
Vehicle Analysis	Propose EV replacement for highest emitting vehicles in each fleet
Charging Layout	Consult ConEd, charging companies & Columbia community

Data Overview

Overview of Model

Diesel Calculations:

10,180 grams of CO_2/gallon of diesel = 10.180×10^{-3} metric tons CO_2/gallon of diesel

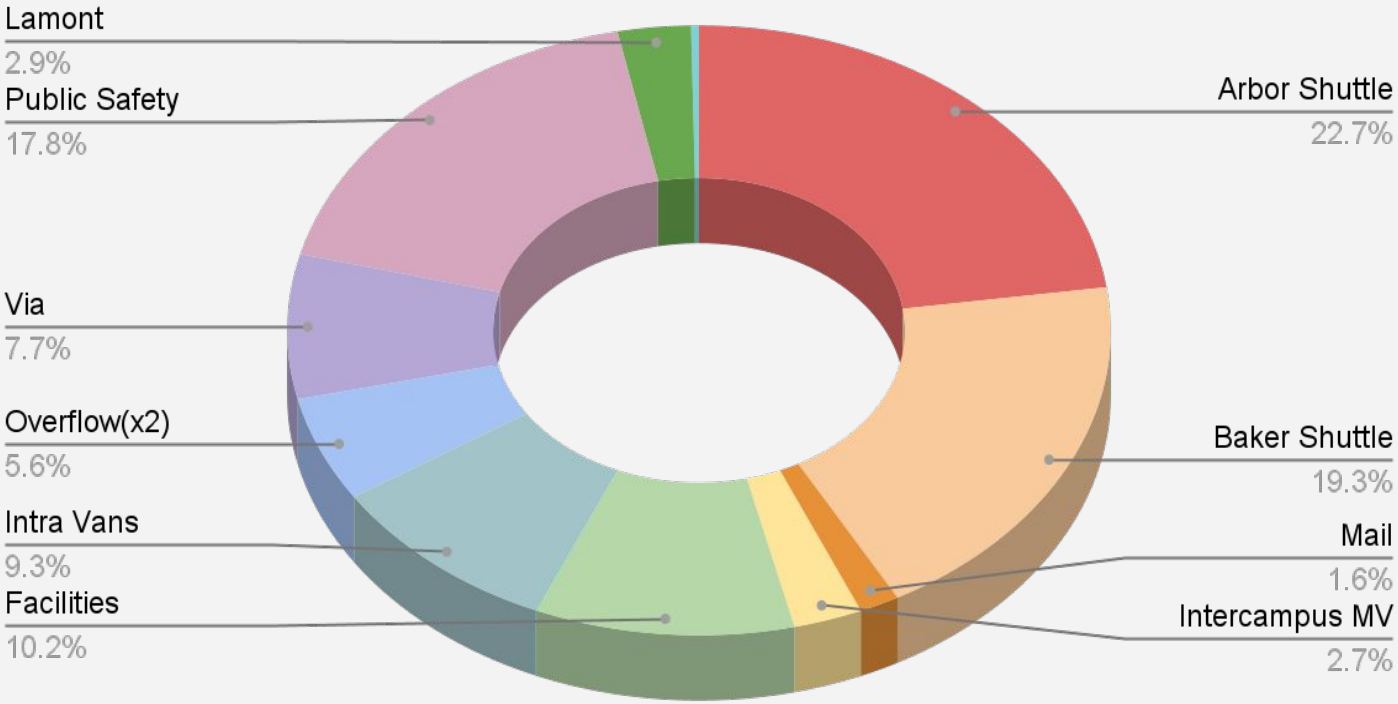
Gasoline Calculations:

8,887 grams of CO_2/gallon of gasoline = 8.887×10^{-3} metric tons CO_2/gallon of gasoline

Department	Emissions(Metric Tonnes of CO2)	Fuel Used(GA)	Diesel Usage	Electric Usage	Gas Usage	% of Total Emissions	% of Diesel Usage	% of Gas Usage
Arbor Shuttle	228.30	25689.64	0.00	0.00	25689.64	22.74%	0.00%	35.05%
Baker Shuttle Emissions (x2)	193.30	18988.12	18988.12	0.00	0.00	19.25%	54.80%	0.00%
Mail	15.88	1716.24	482.84	0.00	1233.40	1.58%	1.39%	1.68%
Intercampus MV Loop	27.12	2664.00	2664.00	0.00	0.00	2.70%	7.69%	0.00%
Facilities	102.33	11267.52	1725.64	5.00	9536.87	10.19%	4.98%	13.01%
CUIMC	0.27	30.00	0.00	0.00	30.00	0.03%	0.00%	0.04%
Intra Vans	93.51	9945.72	3963.72	0.00	5982.00	9.31%	11.44%	8.16%
Overflow(x2)	55.87	5493.20	5493.20	0.00	0.00	5.56%	15.85%	0.00%
Via	76.95	8659.00	0.00	0.00	8659.00	7.66%	0.00%	11.81%
Public Safety	178.65	19908.65	1331.53	0.00	18577.11	17.79%	3.84%	25.35%
Lamont	28.81	3242.26	0.00	0.00	3242.26	2.87%	0.00%	4.42%
Libraries	3.08	346.39	0.00	0.00	346.39	0.31%	0.00%	0.47%
Total	**1004.06**	**107950.73**	**34649.05**	**5.00**	**73296.68**	**100.00%**	**100.00%**	**100.00%**

Source:
https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

2021 Fleet Emissions Breakdown



Fleet Recommendations for 2025

Criteria for Vehicle Recommendations

Provide the same physical capacity

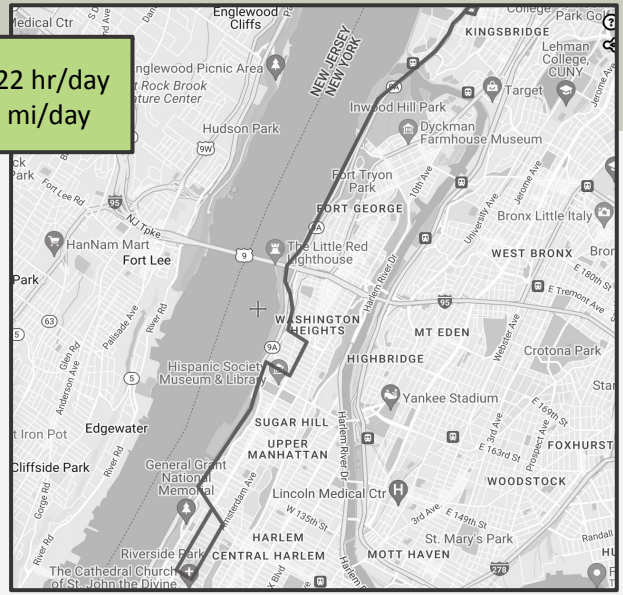
Maintain the department services and operations

Stay around the average market price cost

Ensure the switch is achievable by 2025

Arbor Shuttle

21-22 hr/day
260 mi/day



OVERVIEW
2 VEHICLES

	2021 Total Emissions 22.74%
Ford Goshen	11.46%
Ford Glaval	11.28%

RECOMMENDATIONS:

Plan A

1. Reduce Shuttle Trips
2. Store Vehicles near Columbia or The Arbor
3. Purchase Two EV Shuttles
   a. Ford E-450 Cutaway/Chassis

22% DECREASE IN TOTAL EMISSIONS

Plan B

1. Retrofit Vehicles using XL Fleet or similar company (Flux Hybrid, Make Mine Electric, etc.)

~4.55% DECREASE IN TOTAL EMISSIONS

Baker Shuttle

OVERVIEW

Low Sulfur Diesel Buses

2021 Total Emissions

19.25%

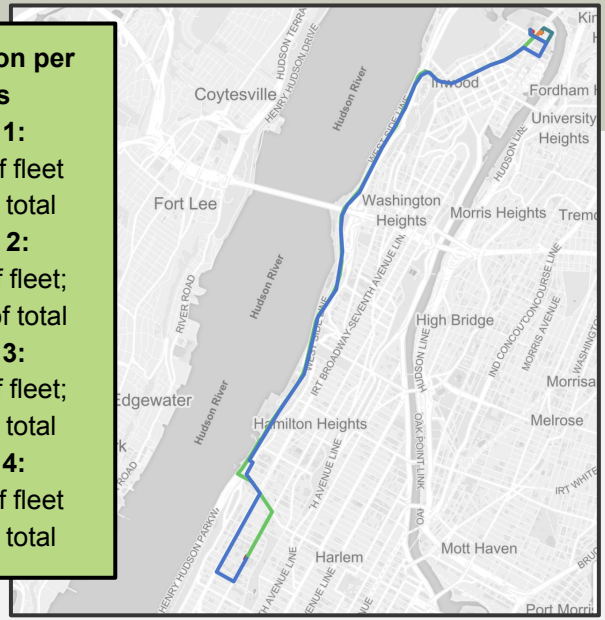
Reduction per Bus

Bus 1:
- 30% of fleet
- 6% of total

Bus 2:
- 27% of fleet;
- 5.4% of total

Bus 3:
- 15% of fleet;
- 3% of total

Bus 4:
- 15% of fleet
- 3% of total



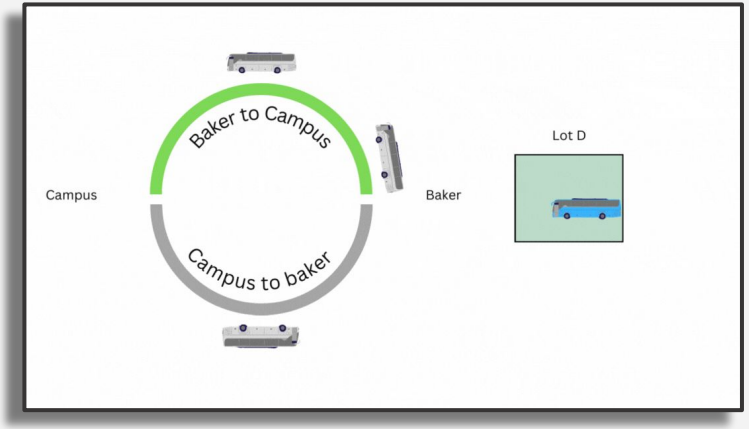
RECOMMENDATION

Diesel Bus Replacement

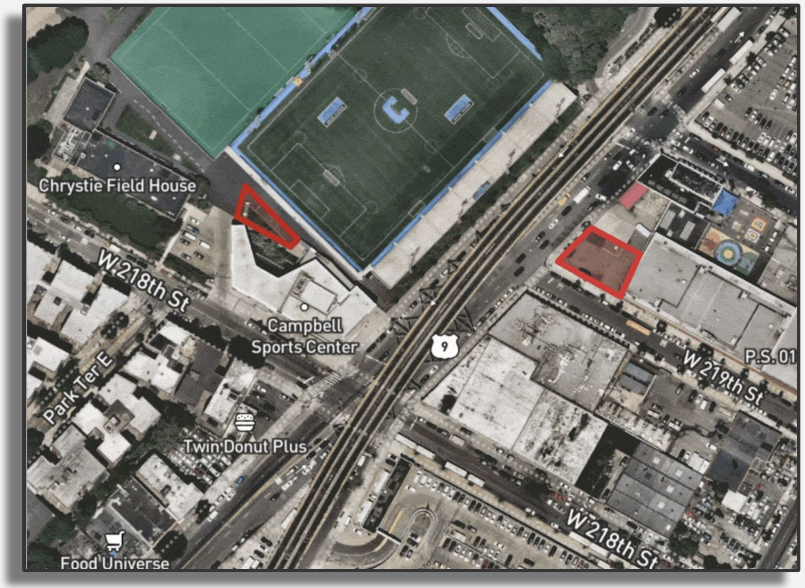
Van Hool CX45E (x4) → 19% Decrease in total Emissions

Proposed Electric Bus Route for the Baker Shuttle

Proposed Baker Loop Using Lot D



*Blue buses are charging



Public Safety

OVERVIEW
27 VEHICLES

2021 Total Emissions
20.73%

RECOMMENDATION

Vehicles to Replace

2015 Nissan Pathfinder
2014 Nissan Pathfinder
2015 Ford Fusion (3x)
2016 Ford Fusion

Replacements

Primary Recommendation:
2022 Hyundai Ioniq 5 SE Standard Range

Secondary Recommendation:
2023 Hyundai Kona Electric SEL

11% DECREASE IN TOTAL EMISSIONS

Facilities

OVERVIEW
15 VEHICLES
(Morningside)

2021 Total Emissions
10.2%

RECOMMENDATION

Vehicles to Replace

2010 Jeep Wrangler
2016 Dodge Grand Caravan
2017 Ram 3500 Promaster
2018 Chevy Colorado

Replacements

Jeep Wrangler 4XE Hybrid
Chevy Bolt EUV
Ford E-Transit Cargo Van
Ford F-150 Pro Lightning

Future replacement of trash trucks:
XLE Electric Curbtender eQuantum

8% DECREASE IN TOTAL EMISSIONS

Intramural Vans

OVERVIEW
12 VEHICLES

Ford E-350
Chevy Express
Mercedes Sprinter Van

2021 Total Emissions
9.3%

RECOMMENDATION

Plan A:
Future Market Availability
12-15 person capacity
300 mile range
Reliable off-site charging infrastructure

Plan B:
Implement a plan to phase out the three oldest vans in the fleet (Vans 00, 01, and 22) for the 2023 Ford E transit Passenger van to be used for day trips only and be charged in the Grove.

NO DECREASE IN TOTAL EMISSIONS

Via

OVERVIEW
16 VEHICLES

2021 Total Emissions
8.93%

All vehicles are uniform Mercedes Metris

RECOMMENDATION

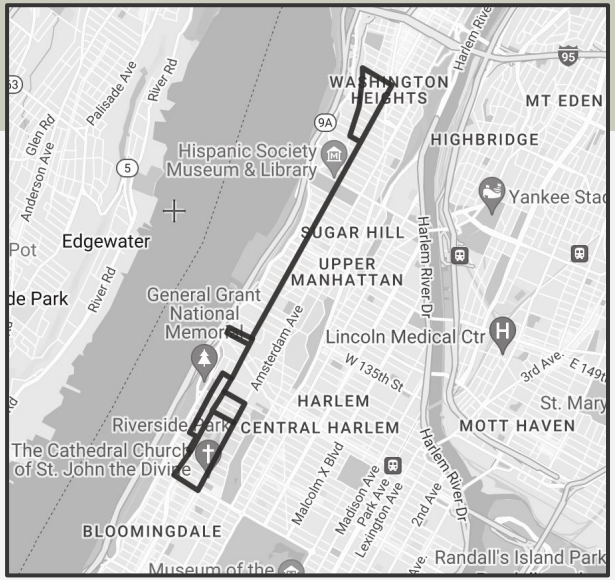
Plan A:
Via has no zero emissions plan unlike Lyft: urge Via to develop one or switch to Lyft.

Wait until 2025 for more affordable and varied 7-passenger vehicles to emerge.

Plan B:
Encourage a switch to Mercedes-Benz EQV or retrofitted Ford minivans, the only existing alternatives.

NO DECREASE IN TOTAL EMISSIONS

Mail



OVERVIEW
8 VEHICLES

2021 Total Emissions
1.58%

Toyota Scion, Tesla, Mercedes 11P Sprinter, Mercedes 15P Sprinter, Chevy Tahoe, Subaru Crosstrek, Chevy Bolt, Ford E350 15P

RECOMMENDATION

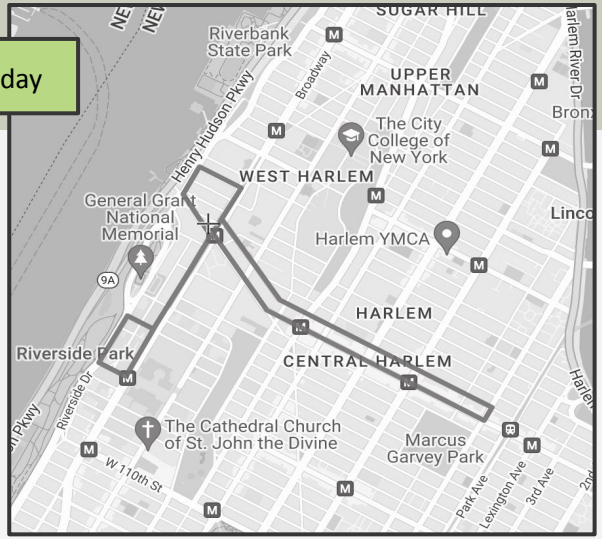
1. Toyota Scion
2. Chevy Tahoe
3. Blue Tech 9P Mercedes Sprinter
4. Mercedes 14P Sprinter

1. Chevy Bolt 5 Door Hatchback
2. Rivian R1S SUV
3. 2023 Ford E-Tourneo Custom
4. Do not replace

1.03% DECREASE IN TOTAL EMISSIONS

MV Loop

15 hr/day



OVERVIEW

1 VEHICLE

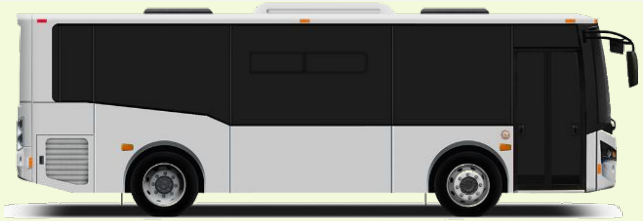
New Flyer Low Floor XE45

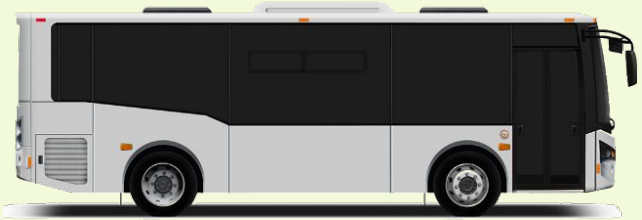
2021 Total Emissions

2.7%

RECOMMENDATION

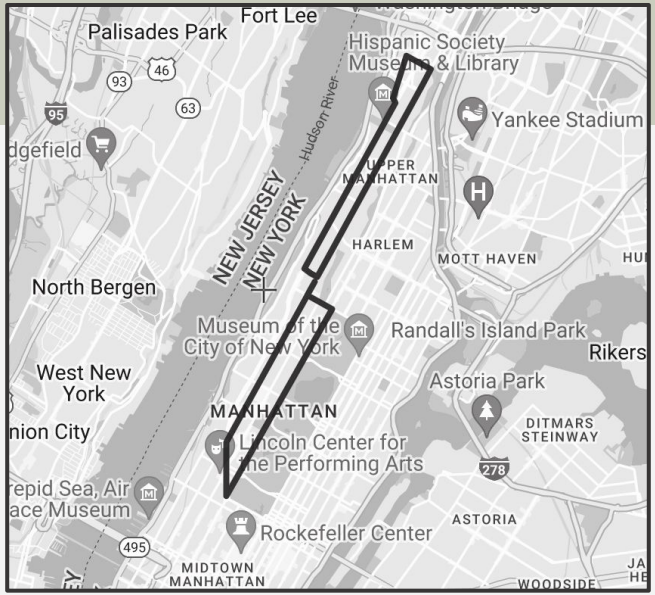
VMC





NO DECREASE IN TOTAL EMISSIONS

Libraries



OVERVIEW

1 VEHICLE

2009 Ford Econoline

2021 Total Emissions

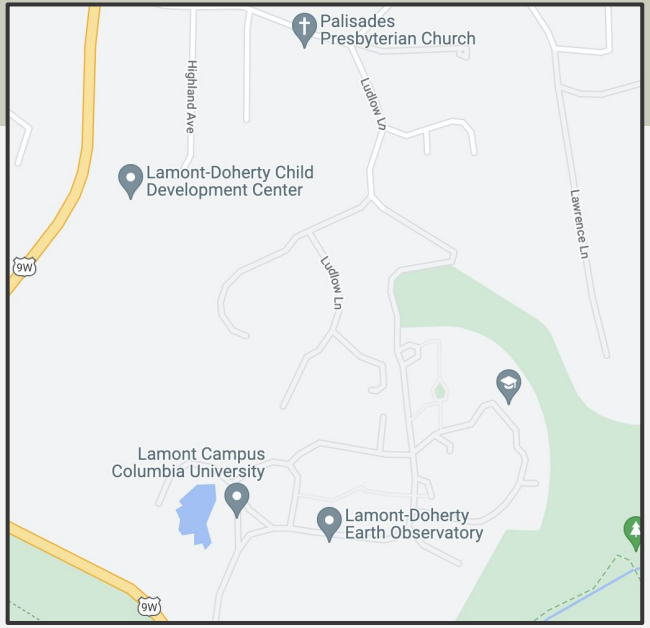
0.36%

RECOMMENDATION

Ford Econoline → Ford E-Transit Low Roof Cargo Van

0.36% DECREASE IN TOTAL EMISSIONS

Lamont Operations



OVERVIEW

11 VEHICLES

Ford F250 Super-Duty
Ford F350 Super-Duty
Chevy Express
Ford Escape

2021 Total Emissions
2.9%

RECOMMENDATION

Await an EV alternative that has the dependability and torque/towing capacity of the current Ford F250 and F350 Super Duty Models to hit the market.

NO DECREASE IN TOTAL EMISSIONS

CUIMC

OVERVIEW
3 VEHICLES

2021 Total Emissions
0.03%

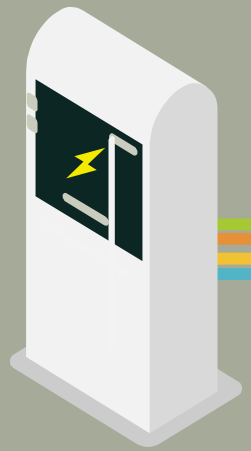
RECOMMENDATION

After 2025, consider the purchase of Ford F-150 Lightning or a similar class of vehicles able to perform the same role.

NO DECREASE IN TOTAL EMISSIONS

Charging

Charging 101



Volt	A unit of electromotive force, the "pressure" that pushes electricity
Amp	The maximum amount of electrical current that can be delivered to the vehicle
kWh	Quantity of electricity delivered to vehicle per hour (V * A / 1000)
kW	Rate of energy flow (V * A) = Charging Rate

Opportunity Charging vs.
Depot Charging

Source: https://marylandev.org/charging/

ChargePoint: Recommended Chargers

CPF50

Level 2

Smart DC Fast Charging Express 250

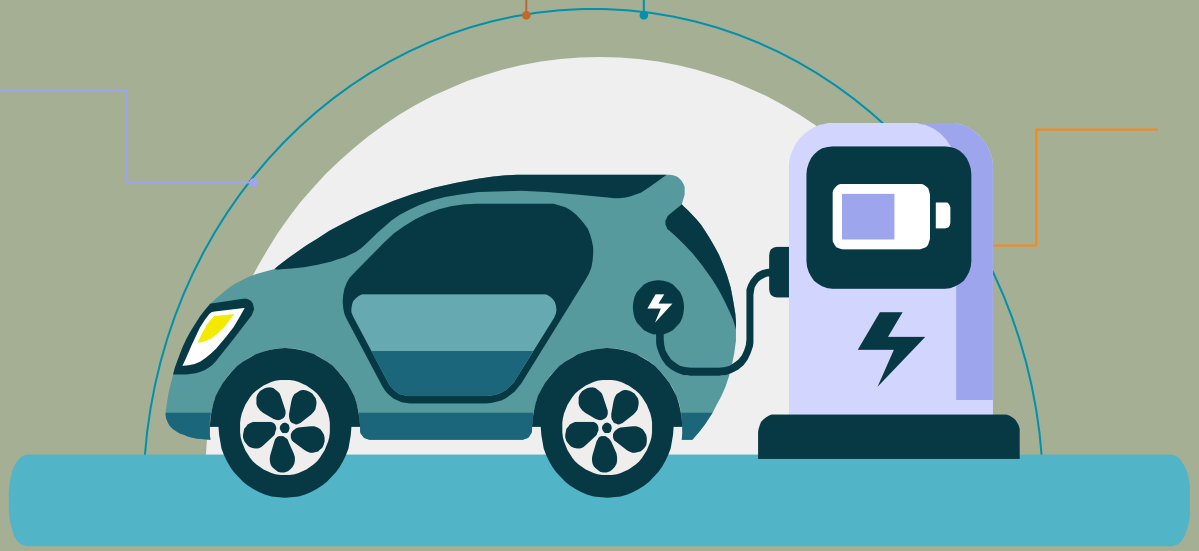
Level 3

CT4000

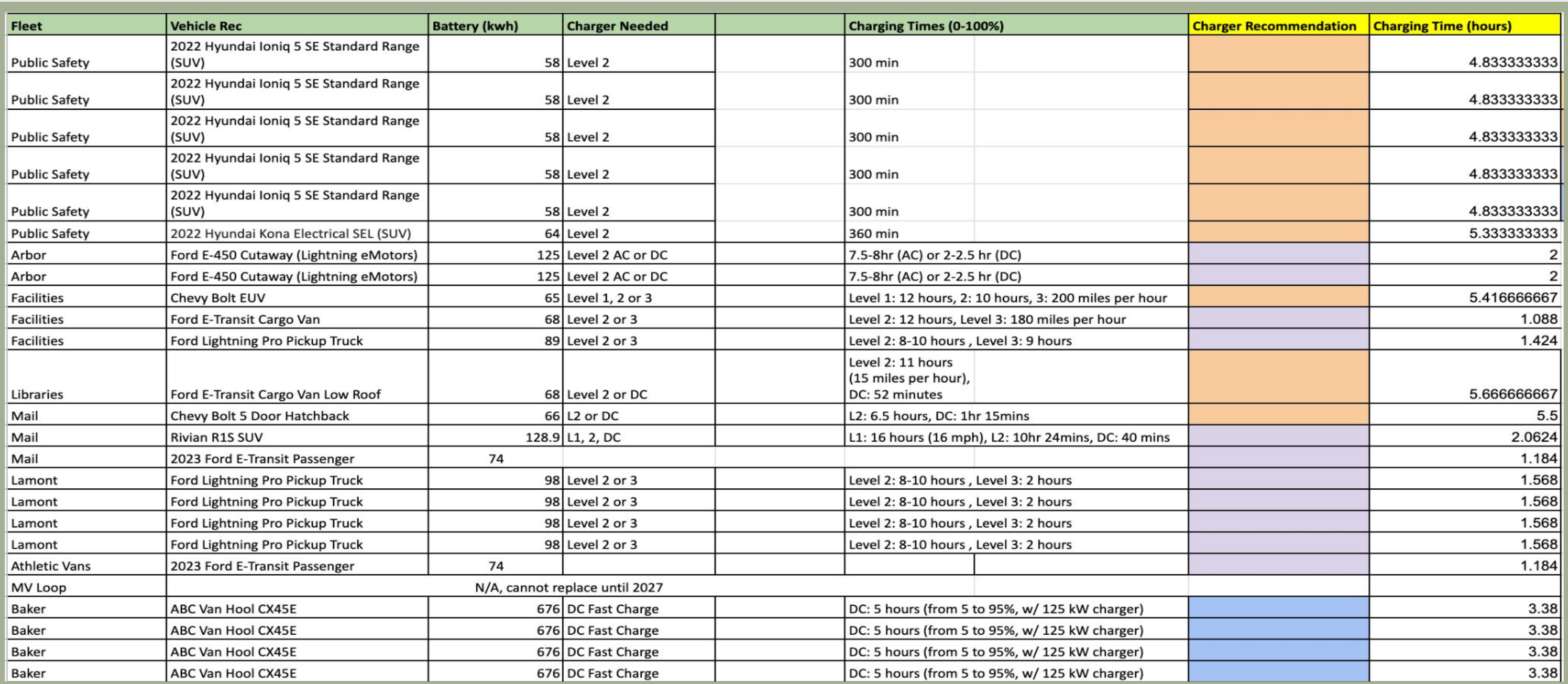
Level 2

Express Plus Power Block

Level 3



Charger Recommendation Per Vehicle



Fleet	Vehicle Rec	Battery (kwh)	Charger Needed		Charging Times (0-100%)	Charger Recommendation	Charging Time (hours)
Public Safety	2022 Hyundai Ioniq 5 SE Standard Range (SUV)	58	Level 2		300 min	🟧	4.833333333
Public Safety	2022 Hyundai Ioniq 5 SE Standard Range (SUV)	58	Level 2		300 min	🟧	4.833333333
Public Safety	2022 Hyundai Ioniq 5 SE Standard Range (SUV)	58	Level 2		300 min	🟧	4.833333333
Public Safety	2022 Hyundai Ioniq 5 SE Standard Range (SUV)	58	Level 2		300 min	🟧	4.833333333
Public Safety	2022 Hyundai Ioniq 5 SE Standard Range (SUV)	58	Level 2		300 min	🟧	4.833333333
Public Safety	2022 Hyundai Kona Electrical SEL (SUV)	64	Level 2		360 min	🟧	5.333333333
Arbor	Ford E-450 Cutaway (Lightning eMotors)	125	Level 2 AC or DC		7.5-8hr (AC) or 2-2.5 hr (DC)	🟪	2
Arbor	Ford E-450 Cutaway (Lightning eMotors)	125	Level 2 AC or DC		7.5-8hr (AC) or 2-2.5 hr (DC)	🟪	2
Facilities	Chevy Bolt EUV	65	Level 1, 2 or 3		Level 1: 12 hours, 2: 10 hours, 3: 200 miles per hour	🟧	5.416666667
Facilities	Ford E-Transit Cargo Van	68	Level 2 or 3		Level 2: 12 hours, Level 3: 180 miles per hour	🟪	1.088
Facilities	Ford Lightning Pro Pickup Truck	89	Level 2 or 3		Level 2: 8-10 hours , Level 3: 9 hours	🟪	1.424
Libraries	Ford E-Transit Cargo Van Low Roof	68	Level 2 or DC		Level 2: 11 hours (15 miles per hour), DC: 52 minutes	🟧	5.666666667
Mail	Chevy Bolt 5 Door Hatchback	66	L2 or DC		L2: 6.5 hours, DC: 1hr 15mins	🟧	5.5
Mail	Rivian R1S SUV	128.9	L1, 2, DC		L1: 16 hours (16 mph), L2: 10hr 24mins, DC: 40 mins	🟪	2.0624
Mail	2023 Ford E-Transit Passenger	74				🟪	1.184
Lamont	Ford Lightning Pro Pickup Truck	98	Level 2 or 3		Level 2: 8-10 hours , Level 3: 2 hours	🟪	1.568
Lamont	Ford Lightning Pro Pickup Truck	98	Level 2 or 3		Level 2: 8-10 hours , Level 3: 2 hours	🟪	1.568
Lamont	Ford Lightning Pro Pickup Truck	98	Level 2 or 3		Level 2: 8-10 hours , Level 3: 2 hours	🟪	1.568
Lamont	Ford Lightning Pro Pickup Truck	98	Level 2 or 3		Level 2: 8-10 hours , Level 3: 2 hours	🟪	1.568
Athletic Vans	2023 Ford E-Transit Passenger	74				🟪	1.184
MV Loop	N/A, cannot replace until 2027						
Baker	ABC Van Hool CX45E	676	DC Fast Charge		DC: 5 hours (from 5 to 95%, w/ 125 kW charger)	🟦	3.38
Baker	ABC Van Hool CX45E	676	DC Fast Charge		DC: 5 hours (from 5 to 95%, w/ 125 kW charger)	🟦	3.38
Baker	ABC Van Hool CX45E	676	DC Fast Charge		DC: 5 hours (from 5 to 95%, w/ 125 kW charger)	🟦	3.38
Baker	ABC Van Hool CX45E	676	DC Fast Charge		DC: 5 hours (from 5 to 95%, w/ 125 kW charger)	🟦	3.38

CT4000

x0

Level 2
Two Ports
$11,000-$16,000
Commercial Use

CPF50

x5

Level 2
Two Ports
$3,500-$8,000
Fleet Manager Use

Smart DC Fast Charging Express 250

x7

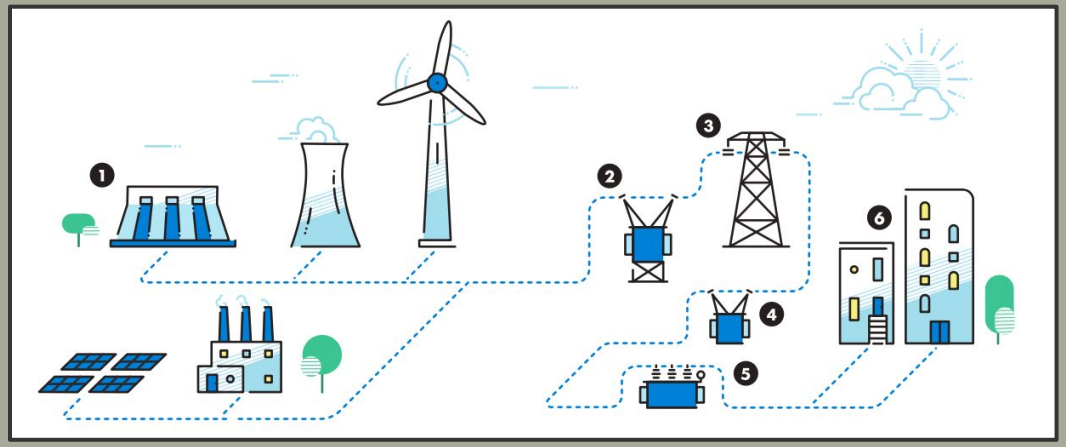
Level 3
One Port
$65,000-$75,000

Express Plus Power Block

x1

Level 3
Two Ports
Intended for Bus Charging

Con Edison



1 SOURCE
We source electricity from all over New York, whether it's from solar, wind, or generating stations.

2 TRANSMISSION SUBSTATION
Then, we step up the voltage for transmission over wires.

3 TRANSMISSION LINES
Nearly 128,000 miles of cables carry your electricity throughout the sourcing process.

4 AREA SUBSTATION
The voltage is stepped down for distribution.

5 TRANSFORMERS
The voltage is stepped again in preparation for its final stop at your home or business.

6 YOUR HOME OR BUSINESS
Finally, the power makes its way to you, all with no delay, despite the journey.

How to get started

- Go to Con Ed's website and select to start a new service
- Input location information
- Set up a consultation with Con Ed to view your location and figure out where to put charging infrastructure
- Utility service and utility transformer come from Con Ed
- Con Ed is committed to provide clean energy and reaching net 0 emissions for customer energy
- https://www.coned.com/en/services-and-outages/service-management-page

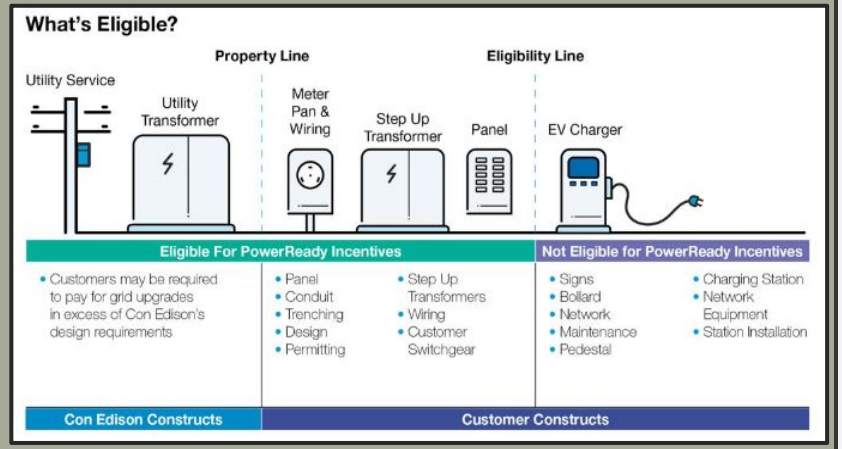
ConEd Incentive Program (Light-Duty Vehicles)

Operational Requirements

All charging stations must be operational for at least 5 years and undergo quarterly reporting

There must be public site accessibility

DC fast charging plugs must be operational 95% of the time annually and DCFC stations for 99% of the time



Cost Incentives

Publicly accessible sites can receive up to 90% of costs covered by program, non-public would be 50%

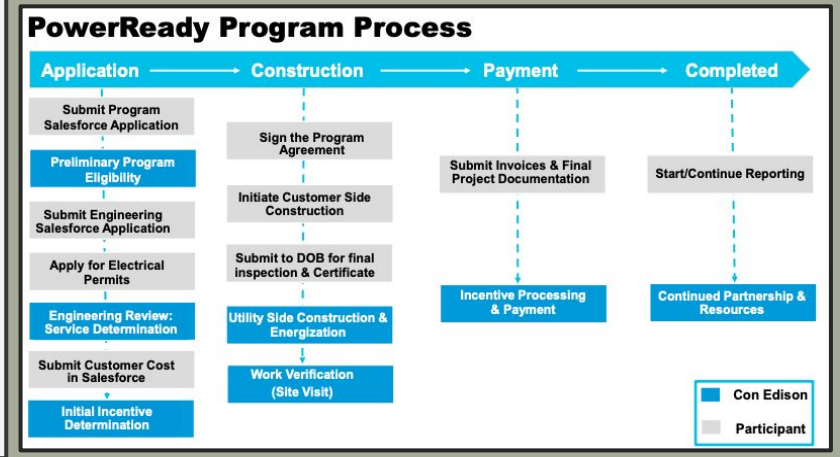
90% covers up to $7,200 per Level 2 charger and $427 per kW for DC fast charge

Eligibility Requirements

Participant Application submission

Hire an approved contractor and network of your choosing or from the list of participating contractors

CU will have to partner with DOT or the city to get permission to build on curbs



ConEd Incentive Program (Medium/Heavy-Duty Vehicles)

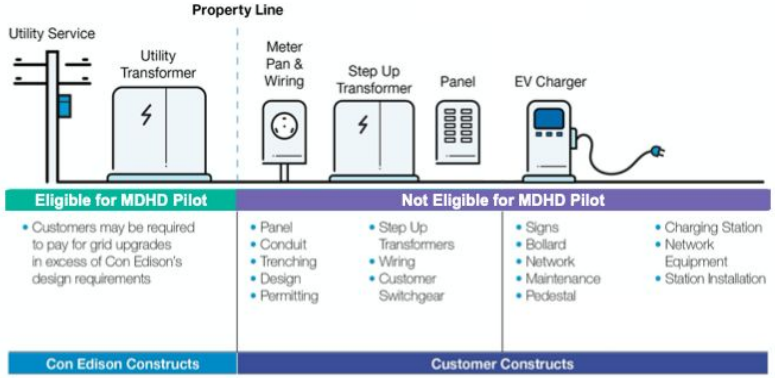
Pilot Incentive Structure

Each participant is eligible for:

Incentive Tier	Participant Cap	Annual Pilot Budget Cap
Up to 85% of utility-side costs	Capped at **$1.2M** per participant (duration of pilot)	Capped at **$3M annually** (first come, first serve)

Incentive is applied towards utility-side EDF costs and is not sent as a check.

What's Eligible?



Pilot Program Basics

Only available for DCFC.

Vehicles must be over 10,000 lbs. gross.

Pilot funds can only be applied to utility-side costs customer is responsible for.

Must receive, plan to receive service from ConEd grid.

Overview of Utility-Side Costs

If a site's service is ruled inadequate, there may be costs associated with upgrading the utility-side infrastructure.

New Business Costs are utility costs that are part of the minimum design costs as part of Con Edison's obligation to serve load. Examples include:

- Upgrading existing service
- Adding meter

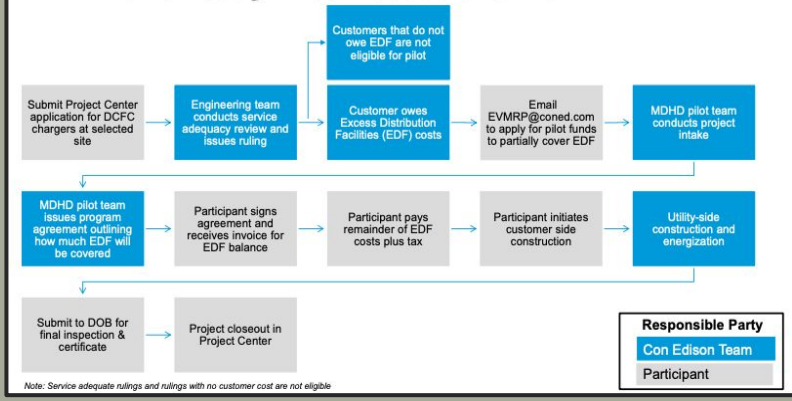
New Business Costs are paid for by the utility and do not factor into your costs

Excess Distribution Facilities (EDF) are utility costs that go above and beyond Con Edison's obligation to serve load. Examples include:

- Adding new service
- Moving Point of Entry

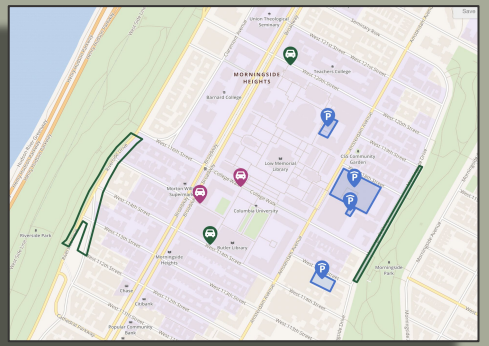
EDF Costs are paid for by the you/the customer and a portion of it can be covered by the MDHD Make Ready pilot pending eligibility and funding availability.

MDHD Make-Ready Pilot Process Overview

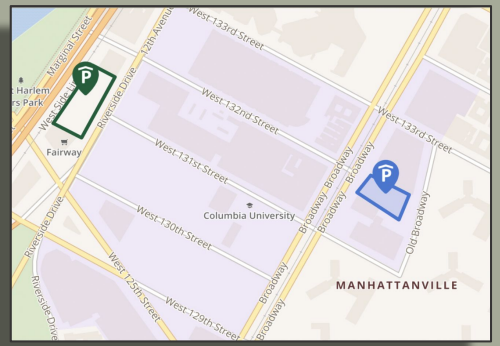


Interactive Map Of Columbia Charging

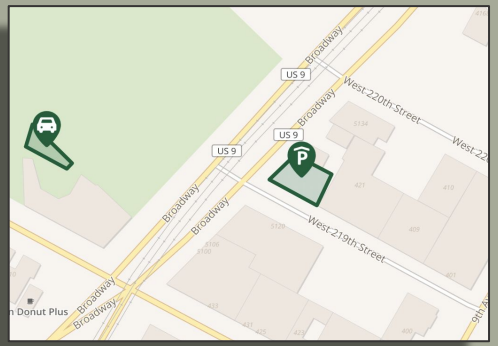
Morningside



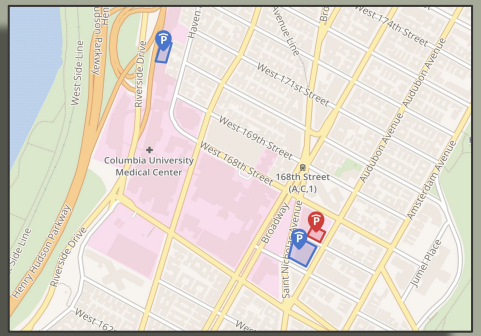
Manhattanville



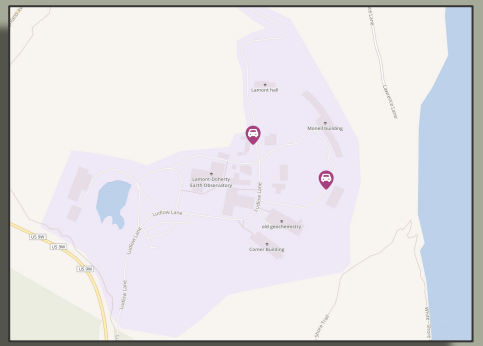
Baker



CUIMC



Lamont



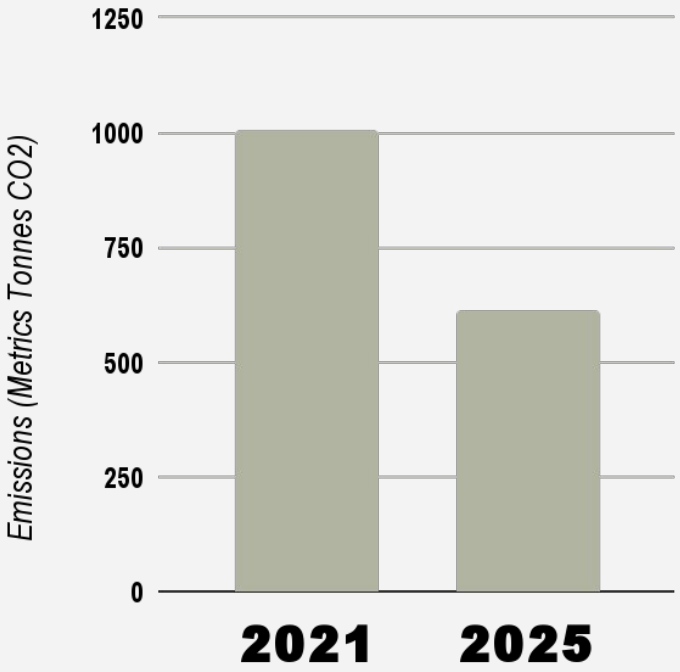
LEGEND

1. Blue Parking icon indicates large parking spaces.
2. Purple Car icon shows single charging stations.
3. Green color denotes proposed charging locations.
4. Red color shows charging which will be removed.

General Recommendations

Looking Forward to Success

1. Collect Ridership Data
2. Strengthen Cross Team Collaboration
3. Create an Organized Database
4. Optimize Fairway Lot
5. Stay in Touch with OES
6. Bold early action



TOTAL EMISSIONS DECREASE: 39.3%

Thank You

Appendix

Additional Methods for Funding

- NYSERDA Drive Clean Rebate for Plug in Electric Cars: Estimate varies
- NYC Clean Trucks Program: $12k-185k
- Con Edison Smartcharge NY: $150 + device to track charging/driving data
- University Transportation Center Program: Application Past Due, but program directly for Universities; perhaps see if there is more funding available
- Climate Smart Communities Grant Program: 50/50 match
  - For the greater community—great way to engage with community & install charging infrastructure
- FTA Buses and Bus Facilities Program: 80% of project cost
- VW Funding for Diesel Replacement and EVSE Projects

Addressing EV Concerns

1. Range anxiety
    a. Benefit of being in NYC—low risk because of minimal mileage & ease of finding charging stations nearby if needed
2. Does winter weather affect the battery?
    a. Yes, the range decreases by around 20%
3. Electrocution?
    a. This is very rare, only a concern if car becomes damaged
4. Lithium-ion battery fires?
    a. Hybrid vehicles fire risk is higher, electric vehicle fire risk is lower
5. What happens if the battery dies?
    a. Just like an engine, batteries eventually need to be replaced, but here are tips for maximizing usage

Costs per Fleet

- Mail
  - Chevy Bolt 5 Door Hatchback **$25,600**
  - Rivian R1S SUV: **$78,000**
  - 2023 Ford E-Tourneo Custom: N/A
- MV Loop
  - VMC: 2 x $550,000 = **$1.1M**
- Libraries
  - Ford E-Transit Cargo Van Low Roof = **$50,185**
- Arbor
  - Lightning eMotors: 2 x Ford E-450 Cutaway = **~$330,000**
- Facilities
  - Chevy Bolt EUV **$33,500**
  - Ford E-transit cargo van **$55,000**
  - Ford Lightning Pro **$51,974**
  - Jeep Wrangler 4XE Hybrid **$54,735**
- Baker
  - 4 x Van Hool CX45E @ ~ $900,000 – $1,000,0000 each
- Public Safety
  - 6 x 2022 Hyundai Ioniq 5 SE Standard Range **$39,950** x 6 = **$239,700**
  - OR
  - 6 x 2023 Hyundai Kona Electric SEL **$37,300** x 6 = **$223,800**
- Lamont
  - 4 x Ford F150 Lightning Pro = **$51,974 each**

Detailed Methodology

1. Background research on charging, other Ivies, Plan 2030, City/State/Federal programs, & general EV technology
2. 10 fleet manager meetings to properly understand the ins and outs of each fleets and its operations
    a. On the ground visits to fleet locations
3. Standardization of fleet inventories and fuel consumption into a spreadsheet
    a. Creation of an emissions model outlining fleet and individual vehicles (if applicable) contributions to total CU transportation emissions by percentage.
4. Survey of current fleet routes and charging infrastructure throughout Columbia's 4 campuses
5. Research of electric/alternatives fuel vehicles for each fleet, if applicable
    a. Identification of high-emitting vehicles with corresponding EV replacement options that could be feasibly replaced by 2025
6. Meetings with ConEd and ChargePoint to create a detailed charging plan for the MS/MV campuses
7. Crowdsourcing from Columbia's executive level leadership to gather more information (e.g., Peter Pilling and Michael Gerrard)

Looking Ahead: 2030 & 2037

- In-Depth Recommendations for all Vehicles in all Fleets (to be distributed to Fleet Managers)
  - Determined based on Fleet Criteria, Fleet Necessities, Range, Cost, Current Vehicle Age
- Work Serves as a Template for Future Projects
- Deliverables as a Resource for Future Emissions Reductions and Infrastructure Options
  - Emissions Model (Input Fleet Information to Understand Emissions Impact)
  - Interactive Charging Maps
  - Proposed Vehicle Lot Storage/Charging Sites

What are other universities doing?

University	Harvard	Yale	Dartmouth	Princeton	Brown	Cornell	Penn
Electrification	Shift to Biodiesel since 2004	X	Plan to eventually introduce electric and hybrid vehicles into the shuttle fleet and will use the study of traffic patterns to inform the evolution of this field	X	Committed to improving its transportation infrastructure and encouraging community to replace gas miles with electric	X	X
Commuter Focus	X	⅓ of employees commute via walk, bike, or shuttle	X	The institution also has a TDM program that since 2008 to shift behavior of former SOV drivers toward alternative modes	Emphasize the usage of the Brown University Shuttle as well as the RIPTA U-PAss Program which allows for all members of the Brown community to ride public transit anywhere in Rhode Island for free.	Focused on the commuter through an emphasis on walking, biking, rideshare, and free shuttle buses	They currently have an initiative to increase the number of staff and faculty choosing sustainable commuting options.
Holistic	Encouraged officers to reduce idling. For their students, they encourage biking and walking	Partnered with the city and other local employers to encourage the use of expanding infrastructure	They have plans to manage traffic, bolster public transportation and parking, as well as improving pedestrian and bike access	Go Electric Plan that focuses mostly on individual riders and commuters	introduced over 100 spin scooters around campus for Brown students.	FLX Carpool which is rideshare for students and also Campus 2 Campus which is a bus service from NYC to Ithaca.	Penn Transportation and Parking look to improve the energy efficiency of parking facilities and works to minimize the environmental impacts of Penn's Transit fleet.

EV Battery (for size/reference)